Fiske Planetarium
Building Improvement Project
CP166185

Specifications
Issue for Bidding and Construction

March 5, 2013

SLATERPAULL
ARCHITECTS

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NOT APPLICABLE

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NOT APPLICABLE

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NOT APPLICABLE

DIVISION 27 - COMMUNICATIONS

NOT APPLICABLE

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

NOT APPLICABLE

DIVISION 31 - EARTHWORK

NOT APPLICABLE

DIVISION 32 - EXTERIOR IMPROVEMENTS

NOT APPLICABLE

DIVISION 33 - UTILITIES

NOT APPLICABLE
DIVISION 34 - TRANSPORTATION
   NOT APPLICABLE

DIVISION 35 - WATERWAY AND MARINE CONSTRUCTION
   NOT APPLICABLE

DIVISION 40 - PROCESS INTEGRATION
   NOT APPLICABLE

DIVISION 41 - MATERIAL PROCESSING AND HANDLING EQUIPMENT
   NOT APPLICABLE

DIVISION 42 - PROCESS HEATING, COOLING, AND DRYING EQUIPMENT
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DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND
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   NOT APPLICABLE

DIVISION 44 - POLLUTION CONTROL EQUIPMENT
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DIVISION 45 - INDUSTRY-SPECIFIC MANUFACTURING EQUIPMENT
   NOT APPLICABLE

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   NOT APPLICABLE

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CUT SHEETS
1.01 CONDITIONS AND REQUIREMENTS

Division 1 - General Requirements shall govern work under all Divisions of the Specifications.

1.02 SPECIFICATION LANGUAGE EXPLANATION

Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words or phrases such as "the Contractor shall," "in conformity therewith," "shall be," "as noted on the Drawings," "a," "the" are intentional. Supply omitted words or phrases by inference in same manner as they are when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used within sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases.

Where reference is made to specifications, societies, institutes, or associations or manufacturer's directions, they are, except as may be inconsistent herewith, made part of specifications, to same extent as if written out in full herein. Use latest edition, at time of bidding, if a date is not given.

1.03 SUBMITTALS

A. Prepare data for use by the University of Colorado, Facilities Management personnel.

B. Format:
   1. Submit electronically in Portable Document Format (PDF) format as one document, OCR (Optical Character Recognition) searchable, bookmarked according to the Construction Specifications Institute (CSI) standards.
   2. Title shall be "SPECIFICATIONS", and shall include:
      a. Name of project and submittal stage and date of submittal (month, day, and year).
      b. University of Colorado Project number (Include on cover and in header or footer of each page)

1.04 CONTENT OF MANUAL

A. An electronically-written table of contents shall be provided for each volume, arranged according to CSI standards. Include the following:
   1. Name of responsible installing principal contractor, address, and telephone number.

1.05 ABBREVIATIONS

References in Contract Documents to trade associations, technical societies, recognized authorities and other institutions include following organizations, which are sometimes referred to only by corresponding abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Aluminum Association</td>
</tr>
<tr>
<td>AAMA</td>
<td>Architectural Aluminum Manufacturer's Association</td>
</tr>
<tr>
<td>ACI</td>
<td>American Concrete Institute</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>AIMA</td>
<td>Acoustical and Insulating Materials Association (successor to AMA and IBI)</td>
</tr>
<tr>
<td>AISC</td>
<td>American Institute of Steel Construction</td>
</tr>
<tr>
<td>AISI</td>
<td>American Iron and Steel Institute</td>
</tr>
<tr>
<td>AITC</td>
<td>American Institute of Timber Construction</td>
</tr>
<tr>
<td>AMA</td>
<td>Acoustical Materials Association</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute (successor to USASI and ASA)</td>
</tr>
<tr>
<td>APA</td>
<td>American Plywood Association</td>
</tr>
<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating and Air Conditioning Engineers</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing Materials</td>
</tr>
<tr>
<td>AWI</td>
<td>Architectural Woodwork Institute</td>
</tr>
<tr>
<td>AWPA</td>
<td>American Wood Preservers Association</td>
</tr>
<tr>
<td>AWS</td>
<td>American Welding Society</td>
</tr>
<tr>
<td>CDA</td>
<td>Copper Development Associations, Inc.</td>
</tr>
<tr>
<td>CM/GC</td>
<td>Construction Manager/General Contractor</td>
</tr>
<tr>
<td>CRA</td>
<td>California Redwood Association</td>
</tr>
<tr>
<td>CRSI</td>
<td>Concrete Reinforcing Steel Institute</td>
</tr>
<tr>
<td>CS</td>
<td>Commercial Standard (U.S. Department of Commerce)</td>
</tr>
<tr>
<td>DFPA</td>
<td>Douglas Fir Plywood Association</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td>FGMA</td>
<td>Flat Glass Marketing Association</td>
</tr>
<tr>
<td>FIA</td>
<td>Factory Insurance Association</td>
</tr>
<tr>
<td>FM</td>
<td>Factory Mutual Engineering Division</td>
</tr>
<tr>
<td>FS</td>
<td>Federal Specification</td>
</tr>
<tr>
<td>MIA</td>
<td>Marble Institute of America</td>
</tr>
<tr>
<td>MIL</td>
<td>Military Specification</td>
</tr>
<tr>
<td>MILMA</td>
<td>Metal Lath Manufacturer's Association</td>
</tr>
<tr>
<td>NAAMM</td>
<td>The National Association of Architectural Metal Manufacturers</td>
</tr>
<tr>
<td>NBFU</td>
<td>National Board of Fire Underwriters</td>
</tr>
<tr>
<td>NBS</td>
<td>National Bureau of Standards</td>
</tr>
<tr>
<td>NCMA</td>
<td>National Concrete Masonry Association</td>
</tr>
<tr>
<td>NEC</td>
<td>National Electric Code (of NBFU)</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers' Association</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute of Occupational Safety and Health</td>
</tr>
<tr>
<td>NMWIA</td>
<td>National Mineral Wool Insulation Association</td>
</tr>
<tr>
<td>NPVLMA</td>
<td>National Paint, Varnish and Lacquer Manufacturers’ Association</td>
</tr>
<tr>
<td>NTMA</td>
<td>The National Terrazzo and Mosaic Association</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration</td>
</tr>
<tr>
<td>PCA</td>
<td>Portland Cement Association</td>
</tr>
<tr>
<td>PCI</td>
<td>Prestressed Concrete Institute</td>
</tr>
<tr>
<td>PEI</td>
<td>Porcelain Enamel Institute</td>
</tr>
<tr>
<td>PS</td>
<td>Product Standard (U.S. Department of Commerce)</td>
</tr>
<tr>
<td>SCPI</td>
<td>Structural Clay Products Institute</td>
</tr>
<tr>
<td>SDI</td>
<td>Steel Deck Institute</td>
</tr>
<tr>
<td>SJI</td>
<td>Steel Joist Institute</td>
</tr>
<tr>
<td>SMACNA</td>
<td>Sheet Metal and Air Conditioning Contractor's National Association</td>
</tr>
<tr>
<td>SPA</td>
<td>Southern Pine Association</td>
</tr>
<tr>
<td>SPI</td>
<td>The Society of Plastic Industry, Inc.</td>
</tr>
<tr>
<td>SPR</td>
<td>Simplified Practice Recommendation (U.S. Department of Commerce)</td>
</tr>
<tr>
<td>SSPC</td>
<td>Steel Structures Painting Council</td>
</tr>
<tr>
<td>SWI</td>
<td>Steel Window Institute</td>
</tr>
</tbody>
</table>
1.04 LAYING OUT WORK

The Contractor will furnish reference bench mark and maintain bench mark and all other grades, lines, and levels and dimensions as indicated in the Contract Documents. Report any errors or inconsistencies in above to Owner before commencing work.

Except as delegated by subcontract or normal trade practice, the Contractor will be responsible for all lines, elevations, and measurements of work indicated.

1.05 EXAMINATION OF SITE

Failure to visit the site will in no way relieve any Contractor from the necessity of furnishing materials or performing work that may be required to complete work in accordance with the Contract Documents without additional cost to Owner.

END OF SECTION
1.01 SCHEDULE OF DRAWINGS, SPECIFICATIONS AND ADDENDA

The following Drawings, Project Manual, and Addenda form the Contract Documents.

A. Drawings & project manuals dated March 5, 2013. Drawing list is as follows:

<table>
<thead>
<tr>
<th>Sheet No.</th>
<th>Titled</th>
</tr>
</thead>
<tbody>
<tr>
<td>G -001</td>
<td>General Information and Sheet Index</td>
</tr>
<tr>
<td>G -101</td>
<td>Code Plans</td>
</tr>
<tr>
<td>AD-111</td>
<td>First Floor Demolition Plan</td>
</tr>
<tr>
<td>AD-112</td>
<td>Mezzanine Floor Demolition Plan</td>
</tr>
<tr>
<td>AD-113</td>
<td>Roof Demolition Plan</td>
</tr>
<tr>
<td>AD-121</td>
<td>First Floor Reflected Ceiling Plan</td>
</tr>
<tr>
<td>A-111</td>
<td>First Floor Plan</td>
</tr>
<tr>
<td>A-112</td>
<td>Mezzanine Floor Reflected Ceiling Plan</td>
</tr>
<tr>
<td>A-113</td>
<td>Roof Plan</td>
</tr>
<tr>
<td>A-121</td>
<td>First Floor Reflected Ceiling Plan</td>
</tr>
<tr>
<td>A-122</td>
<td>Mezzanine Floor Reflected Ceiling Plan</td>
</tr>
<tr>
<td>A-141</td>
<td>Floor Finish Plans and Interior Elevations</td>
</tr>
<tr>
<td>A-310</td>
<td>Wall Sections and Interior Details</td>
</tr>
<tr>
<td>A-510</td>
<td>Partition Types/Door Schedule</td>
</tr>
<tr>
<td>M-001</td>
<td>Mechanical Legends and Notes</td>
</tr>
<tr>
<td>M-002</td>
<td>Mechanical Schedules and Details</td>
</tr>
<tr>
<td>M-003</td>
<td>Controls Diagram</td>
</tr>
<tr>
<td>M-101</td>
<td>First Floor HVAC Plans</td>
</tr>
<tr>
<td>M-102</td>
<td>Second Floor HVAC Plans</td>
</tr>
<tr>
<td>M-103</td>
<td>Roof HVAC Plans</td>
</tr>
<tr>
<td>M-201</td>
<td>Plumbing Plans</td>
</tr>
<tr>
<td>E-001</td>
<td>Electrical Legends Details, Schedules, and Notes</td>
</tr>
<tr>
<td>E-002</td>
<td>Electrical One-Line Diagram and Schedules</td>
</tr>
<tr>
<td>ED-111</td>
<td>First Floor Power Demolition Plan</td>
</tr>
<tr>
<td>ED-112</td>
<td>Second Floor Power Demolition Plan</td>
</tr>
<tr>
<td>ED-121</td>
<td>First Floor Lighting Demolition Plan</td>
</tr>
<tr>
<td>ED-122</td>
<td>Second Floor Lighting Demolition Plan</td>
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<td>E-111</td>
<td>First Floor Power Plan</td>
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<td>E-112</td>
<td>Second Floor Power Plan</td>
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<tr>
<td>E-113</td>
<td>Roof Power Plan</td>
</tr>
<tr>
<td>E-121</td>
<td>First Floor Lighting Plan</td>
</tr>
<tr>
<td>E-122</td>
<td>Second Floor Lighting Plan</td>
</tr>
</tbody>
</table>


C. Addenda: All Addenda issued prior to bidding.

1.02 WORK COVERED BY CONTRACT DOCUMENTS
A. Work covered: Work under this contract includes all materials, equipment and labor necessary to complete the work indicated on the drawings, described in specifications, addenda or reasonably inferred.

1.03 CONTRACTORS

All work will be executed under one prime construction contract between the Owner and the Contractor.

Except as indicated otherwise, all work under this contract will be under the direction of the prime contractor.

1. Sky-Skan has been awarded the work to install the star projectors and related equipment.
2. CU to perform hazardous material abatement.
3. CU to provide workstations and related computer equipment.
4. Projection screen purchased by CU but installed by the general contractors.

1.04 JOB CONDITIONS

A. Areas of the building immediately adjacent to areas under construction will be occupied by the public during the work of this project. Conduct the work of this project in a manner that will minimize disruption of the Owner's occupancy of adjacent areas.
B. Do not interrupt building access and use, except as permitted by the Owner.

Provide **eight (8)** work days notice to the Owner of construction activities which will severely impact the occupancy and use of adjacent areas.

C. Provide temporary barriers and/or partitions as required to protect the occupants of the building and the general public from injury due to the work of this project; and/or to protect adjacent areas of the building from the spread of dust and dirt caused by the work or this project.

Remove temporary barriers and partitions upon completion of the Project.

1. Temporary partitions shall be constructed of 1/2" plywood on the construction face nominal 2" X 4" wood studs and 1/2" gypsum wallboard on the public occupied face.

D. Do not interrupt power, lighting, plumbing, telephone and HVAC services to occupied areas without Owner's approval. Such interruptions must be scheduled at least **eight (8)** work days in advance and have Owner's approval.

1.05 PROTECTION OF WORK AND ADJACENT PROPERTY

A. Buildings and property adjacent to work included in this project may be subject to damage due to construction operations.

Prior to the start of the work included in this Contract engage the services of a photographer to record the existing condition of adjacent structures and property. Contractor shall provide a set on disk to the Owner and retain negatives and one set of prints for their records. Sufficient photos with adequate detail to thoroughly document the conditions surrounding the work shall be provided.

B. At the completion of the project, Contractor shall restore existing buildings, landscaping, parking facilities and property to same condition as prior to the start of the work.

C. In addition to the requirements of the General Conditions of the Contract for Construction, the Contractor shall:

1. Notify, in writing, the Owner of University or private property which interferes with the work and arrange with them for disposition of such property.
2. Provide and maintain proper shoring and bracing to prevent earth from caving or washing into excavation. Provide temporary protection around openings through and at floors, roofs, and other openings.
3. Provide and maintain proper shoring and bracing for existing underground utilities, sewers, etc., encountered during excavation work, to protect them from collapse or other type of damage until such time as they are to be removed, incorporated into the work of this project, or can be properly back-filled upon completion of new work.
4. Weather Protection: Provide protection against rain, snow, wind, ice, storms, or heat so as to maintain work, materials, apparatus, and fixtures free from injury or damage. At the end of each day's work, cover new work likely to be damaged.

5. Provide and maintain adequate protection of the work from damage due to freezing, especially freezing earth and soils. Risk of proceeding with the work on or with freezing or frozen materials will be the sole responsibility of the Contractor.

6. Water Protection: Provide protection from damage at all times from rain water, ground water, backing up of drains or sewers, and other water. Provide pumps and equipment enclosures to provide this protection.

7. The Contractor will maintain free of obstructions and debris, all designated corridors and emergency exits, handicap access ramps and sidewalks to building. Provide temporary directional handicapped signage for routing to the nearest accessible facilities.

1.06 EXISTING FURNITURE AND EQUIPMENT

The Owner will remove or relocate existing movable furniture and equipment from the areas in which the Contractor is working. Notify the Owner not less than three days prior to starting work in areas where furniture and equipment require moving.

1.07 CONTRACTOR'S ACCESS PARKING AND STAGING AREAS

A. Work included in this project will need to be performed within the limitations of available access at the site. The University shall limit the area available for staging and parking due to the additional number of construction projects planned during the execution of this contract. Contractor shall adjust the means and methods of construction to allow for the restrictions surrounding the site.

B. All parking on campus except for some one-hour zones on city streets and a few metered spaces is under control and authority of the Parking and Transportation Services (PTS) of the University. All University parking is by permit only.

C. Types of parking and staging are defined as follows:

General Staging Areas are approved areas adjacent to the site when available or in University designated group staging yards. General Staging Areas may be used for any purpose, including employee parking, on a space available basis, but must be coordinated through the UCB Project Manager and PTS. Vehicles may not park outside of general staging areas except in areas coordinated and approved by PTS.

Restricted Staging Areas are approved areas near the site for the construction dumpster, off-loading of equipment, contractor's work trailer, and materials that are soon to be incorporated into the work. No vehicles shall park in a restricted staging area for more than 20 minutes between the hours of 8:00 a.m. and 5:00 p.m. weekdays.

Contractor Employee Parking are areas for workers needing parking on campus. Coordinate through UCB Project Manager and PTS.

Limited parking is available for this project in University parking lots, as follows:

One (1) space in the service vehicle parking spaces adjacent to the planetarium complex. This space will require a "vendor permit" parking pass. Three (3) spaces in a nearby parking lot on a monthly permit basis. Parking in the FISK loading dock area is only allowed for the time it takes to load or unload project materials. Contact CU Boulder Parking and Transportation Services, Betsy Watts, at 303-735-3691 for information and permits.
Prohibited Parking are areas designated in the Contract Documents as No Parking areas. The contractor shall not allow any parking in areas so designated under any circumstance.

D. The restrictions in this Section are in addition to any other restrictions or rules provided by PTS. Fees shall be assessed for the use of any PTS facility for staging and construction activities.

E. The designated staging area for this project shall be: Loading Dock area, the only space available- unless Sweeney previously directed otherwise.

“General Staging area shall be Service Area Parking spaces on north side of Fiske Planetarium.”

1.08 OCCUPANCY REQUIREMENTS

A. Owner may occupy designated areas for the purpose of storage of furnishings and equipment and installation of equipment.

B. Execute Certificate of Substantial Completion for each designated portion of work prior to Owner occupancy. Contractor shall allow:
   1. Access for Owner personnel.
   2. Use of parking facilities.
   3. Operation of HVAC and electrical systems.

C. On occupancy, Owner will provide, for occupied areas:
   1. Operation of HVAC and electrical systems.
1.09 CONSTRUCTION AND SEQUENCE SCHEDULE:

A. In order to accommodate the uninterrupted operation of the existing building during the various phases of construction, the sequence of construction operations shall be as follows:

1. The sequence concept is to: (1) prepare the existing facility to function during renovation through completion; (2) thence occupy the newly remodeled portion; and (3) upon completion, finally reoccupy the remodeled portions.

2. Utilizing this concept break down the Schedule into broad scope categories augmented by "Owner Action" and "Contractor action" columns that indicate coordination tasks which define the various phases of the work.

3. The intent of the categorization is to generally summarize the nature and extent of work to be performed without in any way limiting specific requirements of the Contract Documents.

4. Some overlapping between the several construction operations will occur, and where possible, permission may be granted to start certain portions of the work before the previous operations were completed in their entirety. Such detail scheduling shall be done as the work progresses, provided that the Owner's operations remains uninterrupted, but in all cases must receive Owner approval.

5. Where it may not be possible to complete certain mechanical and electrical services in connection with making the work complete and ready for occupancy, temporary services as directed and as approved shall be installed to permit occupancy by the Owner at the earliest possible date.

6. The construction sequence schedule and related drawings are intended to aid the Contractor in bidding and in the preparation of a specific construction schedule. Deviations of sequence may be made upon approval of the Owner and the Architect. The preparation of a specific construction schedule remains the responsibility of the Contractor.

1.10 TEMPORARY ELECTRIC SERVICE

A. Connect to existing power service. Power consumption shall not disrupt owners need for continuous service. Owner to pay for power consumed. Provide power outlets for construction operations, branch wiring, distribution boxes, and flexible power cords as required.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to work of this section.

1.02 SURVEYS, LAYOUTS, AND LEVELS

A. General: Working from lines and levels established by the existing building, and as shown in relation to the work, establish and maintain bench marks and other dependable markers to set the lines and levels for the work of construction as needed to properly locate every element of the work of the entire project. Calculate and measure required dimensions as shown (within recognized tolerances if not otherwise indicated); do not scale the drawings to determine dimensions. Continuously advise tradesmen performing the work of the marked lines and levels provided for use in the layout of work.

1.03 PROJECT RECORD DOCUMENTS

A. Maintain at job site, one copy of:
   1. Contract Drawings
   2. Specifications
   3. Addenda
   4. Reviewed Shop Drawings
   5. Change Orders
   6. Other Modifications to Contract
   7. Field Test Records
   8. As-Built Drawings

B. Maintain documents in clean, dry, legible condition and do not use record documents for construction purposes. Make documents available at all times for inspection by the Consultant and Owner.

C. Label each document "Project Record" in 1" or larger printed letters.

D. Record drawing information in colored pencil with different colors for the various systems and defined by color legend.

E. Record drawings and specifications shall include the following:
   1. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure. Location of concealed valves, dampers, controls, balancing devices, junction boxes, clean-outs, and other items requiring access or maintenance.
   2. Field changes of dimension and detail, changes made by Change Order or Field Order and details not on original contract drawings.
   3. Fire protection and alarm systems shop drawings.
F. Submit all record drawings in electronic DWG format to the Consultant at the completion of the project.

1.04 CLEANING

A. Cleaning and Protection Work: At the time each unit of work or element of the construction is completed (substantially) in each area of the Project, clean the unit or element to a condition suitable for occupancy and use (as intended), and restore minor or superficial damage. Replace units and elements which are damaged beyond successful restoration. Clean and restore adjoining surfaces and other work which was soiled or damaged (superficially) during the installation; replace other work damaged beyond successful restoration. Where the performance of subsequent work could possibly result in damage to the complete unit or element, provide protective covering or other provisions to minimize possible damage. Repeat cleaning and protection operations during remainder of construction period, wherever work might otherwise be damaged by sustained soiling or exposure.

B. During Construction: Oversee cleaning and ensure that building, grounds, and public properties are maintained free from accumulation of waste materials and rubbish. At reasonable intervals during daily progress of work, clean up site and access and dispose of waste materials, rubbish, and debris. Vacuum clean interior building areas when ready and continue vacuum cleaning on an as-needed basis until building is ready for acceptance or occupancy.

1.05 PROJECT SIGN

Erect no project sign or job-site sign of any kind, except warning signs as specified in Section 01500, without written authorization of the Owner.

1.06 COORDINATION

A. The Contractor shall coordinate the work so as not to interfere with the building custodian's normal cleanup activities.

B. The Contractor shall be responsible for coordinating all the work of the project. The Contractor shall coordinate the efforts of all subcontractor(s) and the deliveries of suppliers so that the work progresses in an orderly fashion without delay towards timely completion of a complete project in accordance with the drawings and specifications.

C. The Contractor shall note that concurrent with his work, other contractors, suppliers, and the Owner's facilities and maintenance personnel may be working in relatively close proximity. The Contractor will be solely responsible for coordinating his work with that of other contractors and will make no claims for failure to do so.

1.08 METHODS OF CONSTRUCTION

A. The procedure and method of construction is the prerogative and the responsibility of the Contractor. If professional assistance is required to safely implement method of construction, the Contractor shall, on his own, employ professional help.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Schedule of allowances.
   2. Selection of products.
   3. Adjustment of costs.

1.02 ALLOWANCES FOR PRODUCTS

A. The amount of each allowance shall include:
   1. The cost of the Product to the Contractor.
   2. Delivery to the site.
   3. Applicable taxes.
   4. Handling at the site.
   5. Protection.
   7. Contractor's and Subcontractor's overhead and profit.
   8. Other expenses required to complete the installation.

1.03 SELECTION OF PRODUCTS UNDER ALLOWANCES

A. Contractor's Duties:
   1. Assist Owner in determining qualified suppliers or installers.
   2. Obtain proposals from suppliers and installers.
   3. Make appropriate recommendations.

1.04 ADJUSTMENT OF COSTS

A. Should the net cost be more or less than the specified amount of the allowance, the Contract Sum will be adjusted accordingly by Change Order.
   1. The amount of the Change Order will recognize:
      a. Any changes in handling costs at the site.
      b. Labor.
      c. Installation costs.
      d. Overhead and profit.
      e. Other expenses caused by the selection under the allowance.

B. Submit any claims for anticipated additional costs at the site.

C. At contract close-out, reflect all approved changes in contract amounts in the final statement of accounting.

PART 2 - PRODUCTS

Not Used
PART 3 - EXECUTION

3.01 SCHEDULE OF ALLOWANCES

END OF SECTION
PART 1 - GENERAL

1.01 GENERAL

Quantities indicated on the drawing or extra quantities specified shall be included in the Contractor's Base Bid. For Adding or Deducting from Base Bid quantities, the unit prices described in this section will be applied. The Contractor will be notified, in writing, of the quantities applicable for each unit price, and the Contract Price will be adjusted accordingly by Change Order.

All unit prices shall include all labor, materials, equipment, services, delivery to the project, overhead, profit, insurance, and all other incidental expenses to complete the work specified unless indicated otherwise. All work covered by unit prices shall be performed in accordance with requirements of the applicable sections of the Specifications.

1.02 UNIT PRICES

There are not any unit prices. END OF SECTION
PART 1 - GENERAL

1.01 GENERAL ALTERNATE REQUIREMENTS

A. General: The description for each alternate is recognized to be incomplete and abbreviated but implies that each change must be complete for the scope of work affected. Refer to applicable sections and to applicable drawings for the specific requirements of the owner, whether or not references are so noted in the description of each alternate. Modify surrounding work as required to integrate with the work of each alternate.

1.02 SPECIFIC ALTERNATES

A. Add Alternates:

Reference specific drawings or specifications for each alternate; then briefly describe the alternate here.

1. HVAC equipment for production room.
2. Hanging light reflector screens and luminaries in the production room.
3. Ticket office- dual window setup.
4. Power and data connection in the production room for a TV monitor.
5. Acoustic door seals at production room.
6. Production Room- acoustic panels on the ceiling.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. General Contractor is responsible for all of the work of this contract.
   1. Assign and subcontract portions of the work as required to assure that all work is constructed in compliance with these documents.
   2. Coordinate the work of the several subcontractors for the project.
   3. Coordinate work of this contract with work by separate contractors.

B. Each subcontractor shall:
   1. Coordinate work of his own employees and subcontractors.
   2. Expedite his work to assure compliance with schedules.
   3. Coordinate his work with that of other subcontractors and work by separate contractor.
   4. Comply with orders and instructions of owner.

C. Related Requirements
   1. All Division 1 Sections.

1.02 CONSTRUCTION ORGANIZATION AND START-UP

A. Establish on-site lines of authority and communications.
   1. Attend pre-construction meeting with subcontractors upon commencement of the project.
   2. Establish procedures for intra-project communications.
      a. Submittals.
      b. Reports and records.
      c. Recommendations.
      d. Coordination Drawings.
      e. Schedules.
      f. Resolution of conflicts.
      a. Consult with Architect to obtain interpretation.
      b. Assist in resolution of questions or conflicts which may arise.
      c. Transmit written interpretations to subcontractors, and to other concerned parties.
   4. Assist in obtaining permits and approvals.
      a. Obtain building permits and special permits required for work or for temporary facilities.
      b. Verify that subcontractors have obtained inspections for work and for temporary facilities.
   5. Control the use of site.
      a. Supervise field engineering and site layout.
      b. Allocate space for each subcontractor's use for field offices, sheds, work and storage areas.
      c. Establish access, traffic and parking allocations and regulations.
      d. Monitor use of site during construction.
1.03 CONTRACTOR DUTIES

A. Construction Schedules.
   1. Coordinate schedules with several subcontractors.
   2. Monitor schedules as work progresses.
      a. Identify potential variances between schedules and probable completion dates for each phase.
      b. Recommend adjustments in schedule to meet required completion dates.
      c. Adjust schedules of subcontractors as required.
      d. Document changes in schedule.
   3. Observe work of each subcontractor to monitor compliance with schedule.
      a. Verify that labor and equipment are adequate for the work and the schedule.
      b. Verify that product procurement schedules are adequate.
      c. Verify that product deliveries are adequate to maintain schedule.

B. Process Shop Drawings, Product Data and Samples.
   1. Review for compliance with Contract Documents.
      a. Field dimensions and clearance dimensions.
      b. Relation to available space.
      c. Relation to other trades, equipment and systems.
      d. Submit to Architect.

C. Monitor the use of temporary utilities.
   1. Verify that adequate services are provided and maintained.

D. Inspection and Testing.
   1. Inspection work to assure performance in accord with requirements of Contract Documents.
   2. Administer special testing and inspections of suspected work.
   3. Reject work which does not comply with requirements of Contract Documents.
   4. Coordinate testing laboratory services.
      a. Verify that required laboratory personnel are present.
      b. Verify that tests are made in accordance with specified standards.
      c. Review test reports for compliance with specified criteria.
      d. Recommend and administer required retesting.

E. Monitor contractor’s periodic cleaning.
   1. Enforce compliance with specifications.
   2. Resolve any conflicts.

F. Coordinate changes.
   1. Recommend necessary or desirable changes.
   2. Assist owner in negotiating change orders.
   3. Promptly notify all subcontractors of pending changes.

G. Maintain Reports and Records at Job Site available to Architect and Subcontractors.
   1. Log progress of work of each subcontractor.
   2. Records
      a. Contracts.
      b. Purchase orders.
c. Materials and equipment records.
d. Applicable handbooks, codes and standards.

3. Obtain information from subcontractors and maintain file of Project Record Documents.
4. Assemble documentation for handling of claims and disputes.

H. Coordinate work of this Contract and requirements of this section with work by Separate Contract including but not limited to:
   1. Removal of asbestos containing materials by separate contract.

1.04 CONTRACT CLOSEOUT

A. Coordinate equipment start-up.
   1. Provide seven days notification prior to start-up of each item.
   2. Ensure that each piece of equipment or system is ready for operation.
   3. Execute start-up under supervision of responsible persons in accordance with manufacturer's instructions.
   4. Perform required testing and balancing.
   5. Record dates of start of operation of systems and equipment. Submit written report that equipment or system has been properly installed and is functioning correctly.
   6. Provide written notice of beginning of warranty period for equipment put into service.

B. Demonstration and Instructions
   1. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to Substantial Completion.
   2. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, seasonal operation, and shutdown of each item of equipment.

C. At completion of work of each Section, conduct an inspection to assure that
   1. Specified cleaning has been accomplished.
   2. Temporary facilities have been removed from site.

D. At completion
   1. Conduct an inspection to list work to be completed or corrected.
   2. Supervise correction and completion of work as established in Certificate of Completion.

E. When a portion of the Project is occupied prior to final completion, coordinate established responsibilities of each subcontractor.

F. Final completion.
   1. When each Subcontractor determines that work is finally complete, conduct an inspection to verify completion of work.
   2. Assist owner and architect in inspection.

G. Administer contract closeout.
   1. Receive and review Subcontractor's final submittals.
   2. Transmit to architect with recommendation for action.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Carefully coordinate the interface between Division 15 (Mechanical) and Division 16 (Electrical) before submitting any equipment for review or commencing installation.

B. Responsibility: Unless otherwise indicated, all motor and controls for Division 15 equipment shall be furnished, set in place and wired in accordance with the following schedule:

* Items crossed off are not in this contract.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FURNISHED UNDER</th>
<th>SET IN PLACE UNDER</th>
<th>POWER WIRING UNDER</th>
<th>CONTROL WIRING UNDER</th>
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<td>Equipment Motor</td>
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<td>Automatically Controlled</td>
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<td>In Motor Control Centers</td>
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<td>Motor Speed Controllers</td>
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<td>Disconnect (Note 1) Switches</td>
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<td>Contactors</td>
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<td>Thermal Overload (Note 1) Switches</td>
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<td>Switches</td>
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<td>Control Transformers</td>
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<td>Control Circuit Outlets</td>
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<tr>
<td>Thermostats (Note 2)</td>
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## Mechanical and Electrical Coordination

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<td>Thermostats (Note 2) Controls: Integral with Equipment Directly Applied to Ducts, Pipes, etc.</td>
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<td>Valve Motors, Damper Motors, Soleno Valves, etc.</td>
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<td>EP Valves or Switches, P.E. Switches</td>
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<tr>
<td>Control Circuit Outlets</td>
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<td>Fire Alarm Systems</td>
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<td>Fire Sprinkler Alarm</td>
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<td>Equipment Interlocks</td>
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<td>Boiler and Water Heaters</td>
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</tbody>
</table>

### Notes:

1. If furnished as part of factory wired equipment furnished and set in place under Division 15, wiring and connections under Division 16.
2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished under Division 15, but they shall be set in place and connected under Division 16 except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be set in place under Division 15 and connected under Division 16. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired under Division 15.
C. Control Wiring: Consists of wiring in pilot circuits of contact or starters, sensors, controllers, and relays, and wiring for valve and damper operators.
   1. Connections: Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

D. Starters: Provide magnetic starters for all three phase motors and equipment complete with:
   1. Control transformers.
   2. 120V holding coils.
   3. Integral hand-off-auto switch.
   4. Auxiliary contacts required for system operation plus one (1) spare.

E. Remote Switches and Push Button Stations: Provide all remote switches and/or push button stations required for manually operated equipment (if no automatic controls have been provided) complete with pilot lights of an approved type lighted by current from load side of starter.

F. Special Requirements: Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

G. Identification: Provide identification of purpose for each switch and/or push button station furnished. Identification may be either engraved plastic sign or permanent mounting to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate areas.

H. Control Voltage:
   1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.
   2. Provide 20A breakers in emergency panels under Division 16 as required for Building Management System Air Temperature Controls (BMS/ATC). Provide all control transformers, control wiring and connections to circuits under Section 15950 of Division 15.

I. Related Requirements
   1. Section 16480: Electric Motors
      a. Coordinate with efficiency requirements.

J. Contractor must review all concrete embedded items (including conduit) with owner prior to placement.
PART 2 - PRODUCTS

2.01 MOTOR HORSEPOWER

A. In general, all motors 1/2 HP and above shall be three phase, all motors less than 1/2 HP shall be single phase.

B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or General Condition 2.01 A., above.

C. Work under Division 15 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Division 16, before ordering the equipment.
   1. If motor horsepower is changed under the work of Division 15, without a change in duty of the motor’s driven device, coordination of additional electrical work (if any) and additional payment for the work (if any) shall be provided under the section of Division 15 initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Engineer.

PART 3 - EXECUTION

NOT USED.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: This section establishes general requirements in addition to those indicated in the General Conditions of the Contract for Construction pertaining to cutting, fitting, and patching of the work required to:
   1. Make the several parts fit properly.
   2. Uncover work to provide for installation, inspection, or both, of ill-timed work.
   3. Remove and replace work not conforming to requirements of Contract Documents.
   4. Patch new construction into existing construction.

B. Related Work:
   1. In addition to requirements specified, upon the Consultant's request, uncover work to provide for inspection of covered work, and remove samples of installed materials for testing.
   2. Do not cut or alter work performed under separate contract without the Consultant's written permission.

1.02 QUALITY ASSURANCE

A. Perform all cutting and patching in strict accordance with pertinent requirements of the Specifications and, in the event no such requirements are determined, in conformance with the Consultant's written direction.
   1. Use skilled workmen to perform all cutting and patching work.
   2. Use methods least likely to damage existing surfaces and materials to remain, while providing proper surfaces to receive installation of repair, patching, and/or new work.

B. Visual Quality:
   1. Do not cut and patch work exposed to public view, and the exterior and/or interior of the building in a manner that will result in an unacceptable appearance as determined by the Consultant.
   2. Do not cut and patch work in a manner that will result in obvious appearance that cutting and patching work was done.
   3. When cutting existing structural concrete, do not extend saw cuts beyond the corners of the required opening on either side of the opening.

1.03 EXISTING CONSTRUCTION

A. Where cutting and patching of existing construction is required; prior to start of work, inform Owner of existing construction to be disturbed. Owner will determine if elements of existing construction contain asbestos. Do not proceed with work until after Owner has examined areas to be disturbed. Refer to Exhibit A, Project Pre-Inspection for Possible Presence of Asbestos for additional information concerning the possible presence of materials containing asbestos.

1.04 SUBMITTALS

A. Submit proposed cutting and patching procedures in writing for the following categories of work prior to proceeding with this work:
1. Cutting new openings in existing structural concrete walls, parapets, and suspended slabs.
2. Cutting new openings in existing roofs and roofing materials.

B. Submittals shall comply with Section 01300.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Except as otherwise indicated in pertinent sections of these specifications, or as directed by the Consultant, use materials which are identical to existing materials in workmanship, appearance, and performance.

B. If identical materials are not available, match existing as closely as possible, especially existing visual characteristics.

PART 3 - EXECUTION

3.01 INSPECTION

A. Before proceeding, inspect existing conditions, including elements subject to movement or damage during cutting, excavating, backfilling, and patching.

B. After uncovering the work, inspect conditions affecting installation of new work.

C. If uncovered conditions are not as anticipated or if existing construction is not as indicated on the Drawings, immediately notify the Consultant for further instructions.

3.02 PREPARATION

A. Provide shoring, bracing, and support as required to maintain structured integrity of the project.

B. Take all necessary action required to protect adjacent existing surfaces from damage due to the work of this section.

C. Take all precautions necessary to protect existing surfaces and materials, new work, and the work of this section from damage due to adverse weather conditions.

D. Provide temporary support of work to cut and adjacent work to prevent failure or damage due to the work of this section.

E. Properly prepare substrate surfaces exposed during cutting as required to receive the work of this or other sections of these specifications in strict compliance with manufacturer's recommendations and these specifications.
3.03 EXECUTION

A. Perform all required cutting and patching as required or reasonably implied under pertinent sections of these specifications.

B. Perform cutting and demolition by methods which will prevent damage to other portions of the work and will provide proper finished installation complying with the specified tolerances and finishes.

3.04 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work, and will provide proper surfaces to receive installation of repairs and new work. Saw-cut and otherwise isolate areas to be demolished.

B. Repair or otherwise rebuild and/or construct all surfaces affected by cutting and demolition. Execute fitting and adjustment of products to provide totally finished installation to comply with tolerances, finishes, and profiles of adjacent surfaces, whether new or existing.

C. Restore work which has been cut or exposed by demolition; install new construction in compliance with specifications for type of new work to be done or as required to match existing adjacent surfaces. In no case shall any exposed existing surface be left in a raw, marred, or unfinished surface.

D. Refinish entire surfaces as necessary to provide an even finish.
   1. Continuous Surfaces: To nearest intersections.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General Conditions and other Division
      1 - Specification sections, apply to work of this section.

1.02 SUMMARY:
   A. Section Includes:
      1. General administrative requirements and procedures and related applicable codes.

1.03 APPROVAL AND RECOMMENDATION AGENCIES:
   A. The University of Colorado at Boulder has jurisdiction for the interpretation and
      enforcement of code requirements for construction of projects.

1.04 CODES:
   A. All Contractors shall comply with all applicable codes, ordinances and regulations in effect
      at the time of bid openings.

APPROVED STATE BUILDING CODES

The following approved building codes and standards have been adopted by State Buildings Programs
(SBP) as the minimum requirements to be applied to all state-owned buildings and physical facilities
including capital construction and controlled maintenance construction projects.

(as adopted by the Colorado State Buildings Program as follows: Chapters 2-35 and Appendices C and I)

The 2009 International Fire Code (IFC)

The 2009 edition of the International Mechanical Code (IMC)
(as adopted by the Colorado State Buildings Program as follows: Chapters 2-15 and Appendix A)

(as adopted by the Colorado State Buildings Program)

(National Fire Protection Association Standard 70) (as adopted by the Colorado State Electrical Board)

The 2009 edition of the International Plumbing Code (IPC)
(as adopted by the Colorado Examining Board of Plumbers as follows: Chapter 1 Section 101.2,102,
Chapters 2-13 and Appendices B, D, E, F and G)

The National Fire Protection Association Standards (NFPA)
(as adopted by the Department of Public Safety/Division of Fire Safety as follows with editions shown in
Note: Additional codes, standards and appendices may be adopted by the state agencies and institutions in addition to the minimum codes and standards herein adopted by State Buildings Programs.

1. The 2006 edition of the IBC became effective on July 1 of 2007. Consult the state electrical and plumbing boards and the state boiler inspector and conveyance administrator and the Division of Fire Safety for adoption of current editions and amendments to their codes.

2. Projects should be designed and plans and specifications should be reviewed based upon the approved codes at the time of A/E contract execution. If an agency prefers to design to a different code such as a newer edition of a code that State Buildings Programs has not yet adopted, the agency must contact SBP for approval and then amend the A/E contract with a revised Exhibit D, Approved State Building Codes. Please note that the state plumbing and electrical boards enforce the editions of their codes that are in effect at the time of permitting not design.

3. The state’s code review agents, or the State Buildings Programs approved agency building official, shall review all documents for compliance with the codes stipulated herein. Note: The Department of Public Health and Environment, Division of Consumer Protection will review drawings for food service related projects.

4. This policy does not prohibit the application of various life safety codes as established by each agency for specific building types and funding requirements. NFPA 101 and other standards notwithstanding, approved codes will supersede where their minimum requirements are the most restrictive in specific situations. If a conflict arises, contact State Buildings Programs for resolution.

5. It is anticipated that compliance with the federal Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) and Colorado Revised Statutes Section 9-5-101 will be met by compliance with the 2006 International Building Code and ICC/ANSI A117.1. However, each project may have unique aspects that may require individual attention to these legislated mandates.

6. The 2003 edition of the International Building Code (IBC) is to be applied to factory-built nonresidential structures as established by the Division of Housing within the Department of Local Affairs.

A. Appendices

Appendices are provided to supplement the basic provisions of the codes. Approved IBC Appendices are as follows:

1. Mandatory
   IBC Appendix Chapter C - Agricultural Buildings
   IBC Appendix Chapter I - Patio Covers

2. Optional
   Any non-mandatory appendix published in the International Building Code may be utilized at the discretion of the agency. Use of an appendix shall be indicated in the project code approach.

B. Amendments
C. **Referenced Codes**

1. While not adopted in entirety, portions of the following codes are referenced in the International Building Code (IBC), the International Mechanical Code (IMC), the International Energy Conservation Code (IECC) the International Plumbing Code (IPC), and the International Fuel Gas Code (IFGC). These following codes would be applied as reference standards.

   - 2006 International Fire Code (IFC)
   - 2006 International Existing Building Code (IEBC)

D. **Referenced Standards**

The IBC, IMC, IECC, IPC and IFGC standards shall be utilized to provide specific, or prescriptive, requirements on how to achieve the requirements established in the code. These standards may be unique to the code or may be derived from other established industry standards. Recognized standards may also be used to show compliance with the standard of duty established by the code.
1.05 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA):

A. The Contractor shall have sole responsibility for compliance on the job site to all applicable portions of the Occupational Safety and Health Act. The Contractor is responsible for other regulatory requirements as they relate to occupational Health and Safety requirements. For example, NIOSH, ANSI, and MSA.

B. Protection of life, health and public welfare as it relates to the execution of the construction contract is the responsibility of the Contractor. The Owner’s Representative may, at their discretion, observe, inspect, or comment on plans, procedures, or actions employed at the project as they relate to safety of life, health or public welfare. If conditions are imposed by the Owner which interfere with, or imply actions detrimental to safety, written notice shall be returned to the Owner for action prior to affecting any unsafe conditions.

C. Contractors shall use OSHA Lock Out / Tag Out procedures when working with energized equipment.

D. All contractors entering confined spaces owned by CU or while conducting work under contract with CU shall develop a written program and utilize procedures that, at a minimum, comply with all federal, state and local confined space standards and all applicable regulatory requirements. Contractors shall, independent of the University, monitor the space to obtain their own data to ensure a safe entry and exit. Any data generated by a contractor's confined space entry, should be provided to the Facilities Management confined Space Program Manager.

E. When contractors perform work that may involve Facilities Management controlled permit required confined spaces, Facilities Management will:
   1. Inform contractors of permit required confined spaces and that entry is allowed only after compliance with the confined space entry standard;
   2. Require contractors planning to enter a confined space to provide the Facilities Management Confined Space Program Manager in charge of that space, 48-hour advance notice of such planned entry. The contractors entry will be in accordance with the current Occupational Safety and Health Administration confined space entry standard and a signed document stating such, shall be provided to the FM Confined Space Program Manager prior to entry.

F. The FM Confined Space Program Manager, following receipt of notice of contractor planned entry, will:
   1. Apprise contractor of the hazards identified in the confined space and of any prior experience that is documented on the space;
   2. Appraise the contractor of any precautions or procedures that CU has implemented for the protection of workers in or near the confined space;
   3. Coordinate entry operations with the contractor when both Facilities Management and contractor personnel are working in or around the confined space;
   4. Debrief the contractor at the end of the entry operations regarding hazards confronted or created.

1.06 HOT WORK PERMITS

A. All contractors shall be required to obtained a Hot Work Permit, three (3) working days in advance, for work that involves welding, heat treating, grinding, thawing pipe, hot riveting, soldering and brazing, power driven fasteners and similar activities involving spark, flame or heat. Compliance with the requirements of the applicable fire code, the International Building Code, and NFPA Standard 51B are mandatory and all contractors performing hot work activities shall read and understand these code requirements. To obtain a current Hot Work Permit, go to website: http://fm.colorado.edu/firesafety/hotwork.html
B. Contractors shall read and comply with the procedures and requirements for Fire Watch, Fire Alarm Interruption and Fire Suppression Interruption as found on the following websites:

Fire Watch Procedures:
http://fm.colorado.edu/firesafety/firewatch.htm

Fire Alarm and Detection System Interruption/Outage:
http://fm.colorado.edu/firesafety/firealarmdetectsys.htm

Fire Suppression System Interruption/Outage:
http://fm.colorado.edu/firesafety/firesuppressionsystems.html

C. No hot work shall be conducted in any campus facility without a hot work permit. Any person or firm who conducts hot work without a permit shall be fined one thousand dollars ($1,000) for each occurrence and their non-permitted activities shall be stopped immediately until they obtain a hot work permit. Contractor shall be responsible for any damages caused as a result of improper hot work activities or the work stoppage.

D. Individuals or firms who obtain a permit shall fully read, understand and implement the requirements of the permit. Any person or firm who conducts hot work without the full implementation of the permit requirements shall be fined five hundred dollars ($500) the first time and one thousand dollars ($1,000) for subsequent occurrences. When the requirements of the hot work permit are not being implemented, the improper activities shall be stopped immediately until a hot work permit is obtained. Contractor shall be responsible for any damages caused as a result of improper hot work activities or the work stoppage. Any contractor who is found to be in non-compliance a third time, will not be allowed to work on campus until further notice by Facilities Management.

E. The campus inspectors, project managers and fire marshal shall have the authority to stop improper or non-permitted hot work activities.

F. The Contractor shall notify the CU Fire Alarm Supervisor to deactivate all smoke alarms in the vicinity of the work prior to any demolition and construction work activity. Failure of the Contractor to comply with the smoke alarm deactivation requirement and cause a false alarm and arrival of the Boulder Fire Department shall be a $400 fine per occurrence.

1.07 PERMITS

A. The contractor must obtain a no fee building permit prior to starting work from Office Manager, Facilities Management at (303) 492-2904 in the Planning, Design and Construction Office, Research Laboratory No. 2, 1540 30th Street, Boulder, Colorado. Building permits are required on all projects except the following:

1. Fences not over 6 feet high & general landscape work
2. Retaining walls which are not over 4 feet in height, unless supporting a surcharge of impounding Class I, II or III-A liquids
3. Platforms, walks and driveways not more than 30 inches above grade and not over any basement or story below.
4. Painting, papering, and similar finish work that meet the requirements of chapter 8 of UBC. (Uniform Building Code).
5. Temporary motion picture, television and theater stage sets and scenery. Review for fire-safety issues is required.

B. The contractor must post the permit(s) in a prominent location at the jobsite including all inspection reports. The contractor shall have an updated set of contract documents available at the jobsite for all inspections.


1.08 INSPECTIONS

A. The Contractor must schedule all required inspections 48 hours in advance by calling (303) 492-2922. CU or their designated inspectors will complete these inspections within 48 hours with the exception of weekends and state holidays.

B. The contractor is required to arrange for the following inspections:

1. Required inspections: General. Reinforcing steel or structural framework of any part of any building of structure shall not be covered or concealed without first obtaining the approval of the building official.
2. Lath or gypsum board inspection: To be made after lathing and gypsum board, interior and exterior, is in place, but before any plastering is applied or before gypsum board joints and fasteners are taped and finished.
3. Final inspection: To be made after finish grading and the building is completed and ready for occupancy.
4. Special inspection: Special inspection may be required on special projects and special types of construction.
5. Re-inspections: A re-inspection fee may be assessed for each inspection or reinspection when such portion of work for which inspection is called is not complete or when corrections called for are not made.

C. The Contractor will be responsible for all cost related to re-inspections and will be billed at a rate of $50.00 per hour for CU re-inspections and at the testing agency bill-out rate for other re-inspections.

1.09 UNIVERSITY OF COLORADO SEXUAL HARASSMENT POLICY

A. Contractors should be aware of and review the University of Colorado at Boulder’s policies that prohibit discrimination and harassment on the basis of race, color, national origin, sex, age, disability, creed, religion, sexual orientation or veteran status. These policies are located on the web at: http://www.colorado.edu/odh/ Contractor personnel must adhere to these policies and conduct themselves in a manner that does not discriminate or harass as a result of interacting with an around the University of Colorado faculty, staff and students and visitors.

1.10 FIRE ALARM INTERRUPTION

A. Contractor shall contact CU Fire Alarm Systems Supervisor at 303-492-0633 prior to all interruptions or shutdowns of fire alarm systems. Interruptions or shutdowns shall be scheduled three (3) working days in advance with CU Fire Alarm Systems Shop, CU Project Manager and building proctor. Contractor shall provide a fire watch as directed by CU Fire Alarm Systems Shop during interruption or shutdown.

B. The Contractor shall be responsible for preventing nuisance alarm due to activities at their work site. Common sources of nuisance alarms are:

1. Smoke (soldering, welding, cooking, etc.)
2. Grinding
3. Dust (drilling, sweeping, canister vacuums, sand blasting, etc.)
4. Water leaking (plumbing leaks, overflows)
5. Water sprayed on or near detectors (pressure washing or cleaning with water)
6. Popcorn or other food burning in microwaves
7. Static electricity (covering or uncovering detectors)
8. Changing filters on air handling units (dust)
9. Steam (leaks, pressure pop-offs)
10. Broken or frozen sprinkler heads
11. Sprinkler drain valves turned by mistake
12. Vandalism
Precautions to prevent nuisance alarms are:

1. During construction projects, treat all buildings, except totally new construction, as though they were occupied buildings with live systems.
2. Do not assume that all detectors are in plain sight. Contact University personnel for verification.
3. Maintain dust control measures per UCB Standards:
   a. Maintaining barriers
   b. Covering air returns
   c. Asking CU personnel to cap or disable smoke detectors (Note any capping or disabling of fire safety devices is to be done ONLY by CU personnel, not contractors.)
   d. Avoiding recirculation of dust or smoke through the building air handling system.
4. Follow campus hot work procedures. Refer to specification Section 01060, paragraph 1.06.
3. Do not expose fire alarm devices to water or extreme temperatures.
4. Contact Fire Systems Group for any actions that affect fire detection, alarm, and suppression systems.

1.11 STORMWATER MANAGEMENT PLAN (SWMP)

A. Stormwater Management Plan (SWMP): Prior to any construction activity disturbing one acre of land or more, an approved SWMP and a Stormwater Permit for Construction Activity application from the Colorado Department of Public Health and Environment (CDPHE) are required. The SWMP shall be prepared in accordance with the CDPHE requirements for "Contents of the Stormwater Management Plan" and the UDFCD’s Urban Storm Drainage Criteria Manual, Volume 3, "Best Management Practices" (UDFCD Drainage Criteria Manual). Stormwater quality management and erosion control measures are to be constructed and maintained in accordance with the SWMP and the UDFCD Drainage Criteria Manual.

1.12 UTILITY LOCATES

Contractor MUST CALL 811 (or 1-800-922-1987) for utility locates BEFORE DIGGING on any project at the University of Colorado at Boulder. This includes even small projects such as, but not limited to, planting trees or shrubs, sidewalk removal/installation or fence post installation. Digging without calling can disrupt service to the campus or surrounding neighborhoods and potentially result in fines and repair costs.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Work Included:
   1. Specification system format.
   2. Grammar (syntax) description.

1.02 DESCRIPTION

A. These specifications have been derived from automated specification systems, and include minor deviations from format and traditional writing forms. Such deviations must be recognized as a normal result of this production technique, and no other meaning will be implied or permitted.

B. Imperative language of the technical sections is directed to the Contractor. The term "provide" used repeatedly in the text is defined to mean..."furnish and install, complete, in place and ready for operation and use unless specifically indicated otherwise."

C. Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of work or phrases such as "the Contractor shall", "in conformity therewith," "shall be," "as noted on the Drawings", "A", "The", are intentional. Supply omitted words or phrases by inference in same manner as they are when "Note" occurs on Drawings. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

Not used

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Remodel Work scheduling.
   2. Construction sequence scheduling.

B. Related Sections:
   1. Section 01500 - Temporary Facilities and Controls.

1.02 SYSTEM DESCRIPTION

A. An essential condition of this Contract shall be the scheduling and conduct of all phases of
   construction operations in such a manner that the Owner's operations and use of the existing
   buildings and campus shall be uninterrupted at all times, except for such limited interruption
   as is required and approved by the owner.

B. Contractor shall repair at his own expense all damage done to Owner's property, unknown utilities
   and adjoining public property as a result of Contractor's construction activities.

1.03 PROJECT/SITE CONDITIONS

A. Access and use of site:
   1. Contractor shall use the designated site access for construction offices and material
      storage in such a manner that access to existing buildings and campus remain
      accessible at all times for use.
   2. Confine operations to as limited a use of the existing building and campus as possible. A
      route of access to and from the work for employees shall be agreed upon and it shall be
      the Contractor's responsibility to see that the agreed route is maintained in order to
      prevent unwarranted or unnecessary traffic through the existing buildings or site.

B. Owner notice and approval:
   1. All arrangements and scheduling in connection with the work of this Contract shall be
      made with and subject to the approval of the Consultant and the Owner.
   2. All work under this Contract which will require interruption of service of the existing
      building shall be scheduled to suit the need and convenience of the Owner's operation,
      and arrangements shall be made with the Owner and the Architect at least eight (8)
      working days in advance of the start of such work.

PART 2 - PRODUCTS

Not Used
PART 3 - EXECUTION

3.01 REMODELING

A. Construction activities of all areas to be constructed in existing facilities shall be completely separated from the rest of the building by dust-proof enclosures erected by Contractor.

B. All surfaces in existing facilities not indicated to be remodeled, or removal of existing items by any Contractor, shall be repaired by the responsible Contractor to match existing adjoining similar surfaces.

3.02 CLEAN-UP

A. All areas within existing facilities, which are not within enclosed areas to be constructed used for access to work areas shall be completely cleaned of all debris and made "broom-clean" at the end of each day's work.

B. Dust, which permeates areas of existing facilities because of improperly constructed dust-proof barriers, shall be the responsibility of the Contractor. The Contractor shall employ the services of a professional cleaning company to clean any area outside of the designated construction dust barriers that are contaminated by Contractor's operations. Completely clean all such areas to the satisfaction of the Owner at no additional cost.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and other Division 1 - Specification sections, apply to work of this section.

1.02 SUMMARY:
   A. Section Includes:
      1. General administrative requirements and procedures for Hazardous Communication
         Program.
   B. Related Sections:
      1. Summary of Work: Section 01010.

1.03 WORK BY OWNER:
   A. Asbestos:
      1. The Owner has completed an Environmental Site Assessment to identify asbestos
         containing materials and other immediate Health and Safety items. Do not begin work
         until Form Exhibit A (copy following the Supplementary General Conditions) has been
         executed. Where asbestos materials or other hazardous conditions are known to exist in
         locations affected by this project, remediation measures will be taken by the Owner under
         separate contract. The Contractor shall coordinate his sequence and schedule with that
         of the environmental remediation work.
      2. In the event that the Contractor encounters any material on the site which is reasonably
         believed hazardous, which has not been rendered harmless, the Contractor shall:
            a. Stop work immediately in affected areas.
            b. Report the condition in writing to the Department of Facilities Management
               Project Administrator.
            c. Report the condition in writing to the Architect.
            d. Resume work only under the provisions of this section.

1.04 SUBMITTALS:
   A. Material Safety Data Sheets (MSDS):
      1. Copies of all material safety data sheets for all applicable products, including but not
         limited to; paint, adhesives, mastics, solvents, and finishes, etc., shall be retained on site
         by the Contractor for all applicable products used during the construction and/or
         remodeling work. Furnish copies of all MSDS's to the Owner and Architect and include in
         the Project Record Document submittal.

1.05 QUALITY ASSURANCE:
   A. Asbestos containing materials may exist within the general project area where such materials are
      not expected to be disturbed during the work. The Contractor shall review the Environmental
      Health and Safety Environmental Site Assessment Form at the project site and become familiar
      with known asbestos and hazardous containing materials in the work areas.
1.06 PROJECT/SITE CONDITIONS:

A. Hazard Communication Requirements:

1. All Contractors are responsible for compliance with mandatory federal rules and regulations concerning Hazard Communication, including, but not limited to those regulations contained in 29 CFR 1910.1200 Hazard Communication, 1910.146 Confined Space, 1910.147 Lock-out Tag-out, 1910.1101 Asbestos, and 1926.62 Lead. Contractor and all subcontractors working at sites under the control of the Owner shall make available to the Architect, upon request, copies of the Hazard Communication Program used by their firm. In addition to this requirement, all regulations related to Multi-employer workplaces shall be adhered to. These regulations are found in 29 CFR 1910.1200, (e) (2) (i) through (e) (4) specifically:

(e) (2) Multi-employer workplaces. Employers who produce, use, or store hazardous chemicals at workplace in such a way that employees of other employer(s) may be exposed (for example, employees of a construction contractor working on site) shall additionally ensure that the hazard communication programs developed and implemented under paragraph (e) include the following:

(e) (2) (i) The methods the employer will use to provide the other employer(s) with a copy of the material safety data sheet, or to make it available at a central location in the workplace, for each hazardous chemical the other employer(s)' employees may be exposed to while working;

(e) (2) (ii) The methods the employer will use to inform the other employer(s) of any precautionary measures that need to be taken to protect employees during the workplace’s normal operating conditions and in foreseeable emergencies; and,

(e) (2) (iii) The methods the employer will use to inform the other employer(s) of the labeling system used in the workplace

(e) (3) The employer may rely on an existing hazard communication program to comply with these requirements, provided that it meets the criteria established in this paragraph (e).

(e) (4) The employer shall make the written hazard communication program available, upon request, to employees, their designated representatives, the Assistant Secretary and the Director, in accordance with requirements of 29 CFR 1910.20 (e).

2. The referenced regulations were excerpted from 29 CFR 1910.1200. This excerpt shall not be relied upon for compliance with mandatory federal, state and local regulations. The Contractor shall comply with all such regulations and shall be solely liable for insuring that all requirements under applicable regulations are met.

PART 2 - PRODUCTS  (Not applicable)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Asbestos and Hazardous Materials Discovery:

1. The Contractor is cautioned to be alert to the possibility that his work may uncover asbestos-containing or hazardous materials. If suspected materials are found, the Contractor shall notify the Owner and stop all work in the area immediately. If the suspected materials prove to contain asbestos or hazardous materials, the Owner will arrange to have the materials abated in a timely manner.
3.02 HAZARDOUS MATERIALS/EQUIPMENT REMOVAL:

A. Definition:
   1. Removal of hazardous materials/equipment is extremely dangerous. Hazardous materials/equipment is defined to include, but not limited to the following:
      a. Fume hoods
      b. Hood exhaust duct work
      c. Exhaust fans
      d. Laboratory casework and equipment
      e. PCB ballast’s
      f. Mercury and Sodium Vapor Lights
      g. Adjacent material that could come in contact with workers or public.

B. Protection:
   1. Hazardous materials/equipment removal shall include the protection of personnel, material, environment and safe legal disposal of the equipment; and further includes the following:
      a. Notification of Project Administrator and appropriate Environmental Health and Safety Unit
      b. Proper protective clothing for personnel involved in the removal.
      c. Appropriate emergency and first aid facilities.
      d. Removal procedures shall be accomplished during minimal occupancy of the remainder of the building on the weekends or at night.

C. Disposal:
   1. All equipment related to the use, storage or processing of hazardous materials/equipment shall be removed and properly disposed of under the direct, full-time supervision of a qualified Laboratory Specialist fully conversant with the chemistry and properties of the material/equipment involved. Certification is required. Contractors are responsible for the removal of all hazardous materials/equipment and chemicals from the work site as well as proper disposal of all hazardous waste generated by their project.

   2. Hazardous waste disposal must include prior notification to the Department of Environmental Health and Safety in order to verify that the appropriate procedures and documentation are used. Copies of all paper work for shipping and disposing of these materials (hazardous waste manifests, land disposal restrictions, etc.) will be provided by the Contractor to the Department of Environmental Health & Safety (303) 492-6025. Where appropriate, the Main Campus EPF ID COD007431505 will be used for these shipments.

   3. Hazardous chemicals, waste, and other pollutants may not be discharged to the sanitary or storm sewer systems at anytime. Releases to the environment must be reported to CUPD/EH&S immediately.

3.03 ENVIRONMENTAL RESPONSIBILITIES

A. Environmental and Safety Issues and Practices.

Contractors working on the UCB campus are required to comply with all applicable University, City, State and Federal environmental regulations and safety standards. Hazardous and regulated materials must be managed and disposed of properly. Work sites must control dust, debris and run-off, and pay special attention to preventing any pollutants from entering the storm sewer or surface water collection systems. These systems ultimately drain into our creeks and waterways.
B. Contractor will be required to sign an Environmental Responsibilities form. The contractor is responsible for notifying all subcontractors of the responsibilities identified on the form. A copy of this form must be posted, throughout the duration of the project, in a visible area for all workers to see.

END OF SECTION
PART 1 - GENERAL

1.01 REQUIREMENTS

A. The types and minimum requirements for project meetings are included but are not necessarily limited to the following categories:

Pre-construction meeting
Progress and Coordination meetings
Specially called meetings

B. The pre-construction meeting will be scheduled within fifteen days after date of Notice to Proceed, at a central site location designated by the Owner and convenient for all parties.

1. Attendance:
   a. Owner's Representative
   b. Consultant and his sub-consultants, as applicable
   c. Contractor's Superintendent
   d. Major Subcontractor(s)
   e. Others as appropriate

2. Suggested Agenda:
   a. Distribution and discussion of:
      List of major subcontractors and suppliers
      Projected construction schedules
      Critical work sequencing
      Major equipment deliveries and priorities
      Project Coordination
      Designation of responsible personnel
   b. Procedures and processing of:
      Field decisions
      Proposal requests
      Submittals
      Change Orders
      Applications for Payment
   c. Adequacy of Distribution of Contract Documents
   d. Procedure for Maintaining Record Documents
   e. Inspections
   f. Stormwater Management Plan (SWMP)

C. The Architect/Engineer will: Record the minutes; including significant proceedings and decisions.

D. The Contractor shall schedule and administer subcontractor and vendor pre-construction meetings throughout progress of the work. He will:
   1. Prepare agenda for meetings.
   2. Distribute written notice of each meeting four days in advance of meeting date.
   3. Make physical arrangements for meetings.
   4. Preside at meeting.
   5. Record the minutes; including significant proceedings and decisions.
   6. Representatives of Contractors, Subcontractors, and Suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
7. Use of Premises:
   Office, work, staging and storage areas
   Owner’s requirements
8. Temporary construction Facilities, Utilities, Controls and Construction Aids
9. Safety, First-aid, Security and Housekeeping Procedures
10. Administrative Procedures and Documents as Required by Owner

1.02 PROGRESS AND COORDINATION MEETING

The Contractor will schedule and administer job progress and coordination meeting at the site.

A. Attendance:
   1. Owner as needed
   2. Consultant and his sub-consultants as needed
   3. Subcontractor as appropriate to the agenda
   4. Suppliers as appropriate to the agenda
   5. Others

B. Suggested Agenda:
   1. Review of work progress since previous meeting.
   2. Field observations, problems and conflicts.
   3. Problems which impede Construction Schedule.
   4. Review of off-site fabrication and delivery schedules.
   5. Corrective measures and procedures to regain projected schedule.
   6. Revisions to Construction Schedule.
   7. Coordination of schedules.
   8. Progress and schedule during succeeding work period.
   9. Review submittal schedules and expedite as required.
  11. Pending changes and substitutions.
  12. Review proposed changes for:
      a. Effect on Construction Schedule and on completion date.
      b. Effect on other contracts of the Project.

C. The Architect/Engineer shall record and distribute the minutes of all progress meetings throughout the construction period and shall visit the site a minimum of once every two weeks. The Architect/Engineer shall average one visit per week during construction.

The structural engineer shall visit the site immediately prior to every major structural concrete slab pour; every major foundation wall pour; at least twice for each major segment of work [i.e., caissons, columns, steel roof joists, etc].

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Submit shop drawings, product data and samples as required by various sections of the specifications.

1.02 QUALITY ASSURANCE

A. Shop Drawings:
   1. Drawings shall be presented in a clear and thorough manner.
   2. Details shall be identified by reference to sheet, detail, schedule, or room numbers shown on drawings.

B. Product Data:
   1. Preparation:
      a. Clearly mark each copy to identify pertinent products or models.
      b. Show performance characteristics and capabilities.
      c. Show dimensions and clearances required.
      d. Show wiring or piping diagrams and controls.
   2. Manufacturer’s standard schematic drawings and diagrams.
      a. Modify drawings and diagrams to delete information that is not applicable to the work.
      b. Supplement Standard information to provide information specifically applicable to the work.

C. Samples:
   1. Office samples shall be of sufficient size and quantity to clearly illustrate:
      a. Functional characteristics of the product with integrally related parts and attachment devices.
      b. Full range of color, texture and pattern

D. Mock-ups:
   1. Provide complete mock-up of exterior materials to be incorporated into the work.
      a. Mock-up shall include a sample of all materials used in exterior construction, whether specified elsewhere or not in these documents, including but not limited to, masonry, stone, window systems, precast concrete, roof systems, flashing, sealants, masonry paving, paint and other readily visible materials.
      b. Secure Owner approval of mock-ups prior to ordering and placement of materials. Modify mock-ups as directed by the Architect or Owner until acceptable.
      c. Confirm exact mock-up(s) required by Owner prior to fabrication of mock-up(s).
   2. Remove mock-up at the conclusion of the project or when directed by the Architect.
      a. Restore or finish site to finish condition indicated on the Drawings.

E. Responsibilities of the Contractor:
   1. Review shop drawings, product data, samples and project record drawings for specification performance prior to submission.
2. **Determine and Verify:**
   a. Field measurements
   b. Field construction criteria
   c. Catalog numbers and similar data
   d. Conformance with specifications

3. **Coordinate each submittal with requirements of the work and of the Contract Documents.**

4. **Notify the Consultant in writing, at the time of submission, of any deviations in the submittals for requirements of the Contract Documents.**

5. **Begin no fabrication or work that requires submittals until return of submittals with Consultant's acceptance.**

6. **Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by Consultant’s review of submittals.**

7. **Contractor shall stamp, sign or initial, and date each submittal to show compliance with the Contract Documents prior to submittal to the Consultant.**

1.03 **SUBMITTALS**

A. **Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the work.**

B. **Number of Submittals Required:**
   1. **Shop Drawings:** Submit one reproducible transparency and four opaque reproductions. Three copies will be retained by the Consultant.
   2. **Product Data:** Submit seven copies, three of which will be retained by the Consultant.
   3. **Samples:** Submit the number stated in each specification section.

C. **Submittals shall contain:**
   1. Date of the submission and dates of any previous submissions.
   2. Project title and number.
   4. Names of:
      a. Contractor and Subcontractor(s), if applicable.
      b. Supplier
      c. Manufacturer
   5. Identification of product with the specification section number.
   6. Field dimensions, clearly identified as such.
   7. Relation to adjacent or critical features of the work or materials.
   8. Applicable standards, such as ASTM or Federal specification numbers.
   10. Identification of revisions on resubmittals.
   11. An 8"x3" blank space in lower right-hand corner for review stamps.

D. **Resubmission Requirements:**
   1. Make any corrections or changes in the submittals required by the Consultant and resubmit until accepted.
   2. **Shop drawings and product data:**
      a. Revise initial drawings or data and resubmit as specified for initial submittal.
      b. Indicate any changes that have been made, other than those requested by the Consultant.
3. **Samples:** Submit new samples as required for initial submittal.

**E. Distribution:**
1. Distribute reproductions of approved shop drawings and copies of product data to affected subcontractors and retain one copy for use at the job-site.
2. Distribute approved samples as directed.

**F. Consultant's Duties:**
1. Review submittals with reasonable promptness and in accordance with schedule.
2. Review of separate item does not constitute review of an assembly in which item functions.
3. Affix stamp and initials or signature, and indicate requirements for resubmittal or acceptance of submittal.
4. Return submittals to the Contractor for distribution or for resubmission.

**G. Schedule of Values and pay applications:**
1. Submit typed schedule on State Form SC7.2; Contractor's standard form or media-driven printout will be considered on request.
2. Format: Table of Contents of this Project Manual.
3. Include in each line item a directly proportional amount of Contractor's overhead and profit.

**H. Schedule of Submittals:** The Contractor shall submit the submittals required by the specifications. The Contractor shall develop a submittal schedule that confirms the submittals and the time frame for review by the consultants.

**I. Construction Schedule:**
1. The Contractor shall submit a critical-path method (CPM) construction schedule prior to start of construction activities. The CPM schedule shall include notice to proceed, submittal activities, construction activities, change order work (when applicable), close-out, testing, demonstration, and acceptance. The CPM shall correlate specifically to the schedule of values line items and be cost loaded.

   Float, slack time, or contingency within the schedule (i.e., the difference in time between the project's early completion date and the required contract completion date), and total float within the overall schedule, is not for the exclusive use of either the principal representative or the Contractor, but is jointly owned by both and is a resource available to and shared by both parties as needed to meet contract milestones and the contract completion date.

   The Contractor will be required to submit an as-built progress CPM schedule with each progress billing. This CPM schedule will be the basis for making progress payments. The level of detail and quantity of work activities in the CPM schedule should be negotiated with the principal representative prior to starting construction.

**J. Progress Photos**
1. The Contractor shall submit up to 12 - 3x4 inch progress photos with each progress payment. The photos should demonstrate the work in place and be dated with a short description of the photographed item.
K. Coordination Drawings:
1. The Contractor shall submit coordination drawings with all mechanical, electrical, fire protection, and building monitoring systems prior to the Consultant review of any shop drawings or submittals for work in those trades. Approval of required shops and submittals must be obtained prior to starting work, and must be obtained prior to approval of pay applications of the work. The drawings shall be created to include all trades on a particular level of the building on one drawing. Identify conflicts between the systems or between the systems and architectural elements such as ceiling heights, ceiling types, or walls. Conduit routing for electrical, mechanical, energy management system, and security trades shall be included. Identify potential solutions to the conflicts for the Consultant and Owner to review during the submittal process. Revise the coordination drawings to show any comments made during the submittal review process, and reissue for use by all affected trades, Owner and Consultant.
2. The Coordination drawings shall include sectional coordination documents. Identify elevations of systems A.F.F. (above finish floor) and component dimensions. Show elevations whenever component changes height.

L. Daily Reports
1. The contractor shall submit daily reports, due by 5 p.m. the following day. The report should include weather, equipment, manpower count, subcontractors on site, short description of work for that day, inspections, visitors, items that may affect progress or quality of project.

M. Request for Information (RFI):
1. The Contractor will be responsible for submitting RFIs on AIA form G716 or similar. The RFIs should identify in writing any unclear, inconsistent, or conflicting item in the documents that could not be answered by thorough review by the Contractor or subcontractors. The RFI should include a description of the item and a proposed solution. The RFI should indicate schedule or cost impact, if any. Contractor shall be required to submit cost or schedule impact within seven days of receipt of the RFI response. Each RFI shall be numbered in sequence.

N. Weekly Logs:
1. The Contractor shall provide an updated RFI, change request, and submittal logs at weekly construction meetings. Contractor shall provide a 2-week detailed construction schedule at the weekly construction meeting.

PART 2 - MATERIALS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION
PART 1 - GENERAL

1.01 SUPPLEMENTAL TESTING

If required, the following testing shall be performed at the expense of the contractor installing the material being tested:

A. Material Substitution: Any tests of basic material or fabrication equipment offered as a substitute for specified item on which a test may be required in order to prove its compliance with the specifications.

B. Mechanical/Electrical: Tests on mechanical and electrical systems required to insure their proper installation and operation.

C. Any test that fails shall be paid for by the installing contractor subject to the following conditions:
   1. Quantity and nature of tests will be determined by the Consultant.
   2. All test shall be done in the presence of the Owner or his representative.
   3. Proof of noncompliance will make the installing contractor liable for any corrective action which the Owner feels is prudent including complete removal and replacement of defective material.

Nothing contained herein is intended to imply that the installing contractor does not have the right to have tests performed on any material at any time for his own information and job control so long as the Consultant or Owner does not assume responsibility for costs or for giving them consideration when appraising quality of materials.

D. The Consultant shall determine the type and number of tests to be performed on the project.

1.02 TEST REPORTS

Reports of all tests made by testing laboratories shall distributed by the testing laboratory as follows:

1 copy - Contractor
1 copy - Applicable supplier or subcontractor
1 copy - Owner
1 copy - Consultant
Other copies - as directed

1.03 QUALITY CONTROL SYSTEM

A. General: The contractor shall establish a quality control system to perform sufficient inspection and tests of all items of work, including that of all subcontractors, to ensure conformance to the Contract Documents for materials, workmanship, construction, finish, functional performance and identification. This control shall be established for all construction except where the Contract Documents provide for specific compliance tests by testing laboratories or Consultants employed by the Owner.

The quality control system is the means by which the Contractor assures that construction complies with the requirements of the Contract Documents. Controls shall be adequate to cover all construction operations and should be keyed to the proposed construction schedule.
B. The Contractor shall designate a quality control representative on staff to review the work to insure compliance with the contract documents by weekly jobsite visits for observation. The designated employee shall not be involved in the performance of the work. The quality control representative shall review the work and make necessary corrections to bring the work into compliance prior to scheduling the Architect for the final punchlist review.

C. Records: The Contractor shall maintain correct records on an appropriate form for all inspections and tests performed, instruction received from the Owner and actions taken as a result of those instructions. These records shall include evidence that the required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.) proposed or directed remedial action, and corrective action taken. The Contractor shall document inspections and tests as required by each Section of the Specifications.

1.04 INDEPENDENT TESTING AGENCY SERVICES

A. The Owner will employ and pay for the services of an independent Testing Agency to perform the Inspections, special inspections, tests and other services when required by sections of the specification. Services shall be performed in accordance with requirements of governing authorities and with specified standards.

1. Contractor shall cooperate with Testing Agency personnel and shall furnish tools, sample of materials, design mixes, equipment and assistance as requested.

2. Contractor shall provide and maintain, for the sole use of the Testing Agency, adequate facilities for the safe storage and proper curing of concrete testing cylinders on the project site for the first 24 hours after casting as required by ASTM C 31, Method of Making and Curing Concrete Test Specimens in the field.

3. Contractor shall notify Testing Agency sufficiently in advance of operations to allow for completion of initial tests and proper assignment of inspection personnel.

4. Contractor shall notify the testing agency sufficiently in advance of cancellation of required testing operations. The Contractor shall assume responsibility for costs incurred due to the failure to provide such notice.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF REQUIREMENTS
A. This section of the General Requirements outlines the basic requirements for temporary services, utilities, and facilities which will indirectly enable adequate construction progress and processes, and will accommodate other necessary activities at the project site except as otherwise indicated, the costs of providing and using temporary services are included in the Contract Sum.

1.03 QUALITY ASSURANCE
A. Comply with governing regulations and utility company regulations and recommendations for the construction of temporary facilities, including but not necessarily limited to, code compliance, permits, inspections, testing, and health and safety compliance.

1.04 SITE CONDITIONS
A. Provide Temporary facilities and services at the time first needed at the site and maintain, expand, and modify the facilities as needed throughout the construction period and do not remove until no longer needed.

PART 2 - EXECUTION

2.01 GENERAL
A. Use qualified tradesmen for the installation of temporary facilities. Locate facilities where they will serve the total project construction work adequately and result in minimum interference with performance of the work. Relocate, modify, and extend facilities as required during the course of the work to properly accommodate the entire work of the project.

2.02 TEMPORARY FACILITIES
A. Temporary Water: Connect to existing water source as designated by the Owner for construction operations.

B. Temporary Telephone: Provide, maintain and pay for telephone service to field office at time of project mobilization. If a mobile phone is designated as the field office phone then it shall be a local number.

C. Sanitary Facilities: Comply with governing regulations, including safety and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install sanitary facilities in available locations which will best serve the needs of personnel at the project site. Toilet rooms in existing buildings or in new construction may not be used without written approval of the Owner.
D. Temporary Heat and Ventilation: Provide such OSHA approved heat and fuel, heating units, equipment as necessary to provide the required environmental conditions and to protect the work from damage due to cold. Maintain equipment in a clean, safe condition.

E. Fire Extinguisher:
1. Except as otherwise indicated or required, comply with the applicable recommendations of NFPA No. 10 "Portable Fire Extinguisher" for each area of each construction activity whenever combustible materials, flammable liquids, and similar exposures to possible fires are present.
2. Locate extinguisher where most convenient and effective for the intended purposes. Store combustible materials in recognized fire-safe locations and containers.

F. Protection
1. Barricades, Warning Signs, and lights: Comply with recognized standards and code requirements for the erection of substantial and structurally adequate barricades wherever needed to prevent accidents and losses. Paint with appropriate colors, graphics and warning signs to inform personnel at the site and the general public where exposure exists of the hazard being protected. Provide lighting where appropriate and needed for the recognition of the facility, including flashing red lights where appropriate.

G. Temporary Enclosure: Wherever required, provide temporary enclosure of materials, equipment, work in progress, and completed portions of work, so as to afford protection for both the work and employees.

H. Miscellaneous Facilities:
1. Provide ladders, ramps, and temporary stairs for access to all levels of the construction for general access by all trades. Individual contractors and subcontractors shall furnish their own stepladders, scaffolds, staging, work platforms, and other facilities for use of their workmen and as necessary for safety of all personnel.

I. Field Office:
1. The Contractor shall provide and maintain a suitable temporary field office for his own use. Offices and all other temporary structures shall be removed from the site upon completion of the work.
2. Temporary structures or storage used for storage and offices for contractors shall be located on the site in an orderly manner as determined by the Owner.

2.03 OPERATIONS AND TERMINATIONS

A. Supervision: Enforce strict discipline in the use of temporary facilities at the project site. Limit availability of facilities to essential and intended uses, so as to minimize waste and possibility of abuses and the resulting unsanitary and hazardous or dangerous conditions.
B. Maintenance: Operate and maintain temporary facilities in good operating condition through the time of use and until removal is authorized. Protect from damage by freezing temperatures and similar elements at the site.

C. Termination and removal: At the time the need has ended for each temporary facility, or when it has been replaced by authorized use of a permanent facility, or at the time of Substantial completion, promptly remove the facility unless requested by the Consultant to be retained for a longer period of time. Complete or restore permanent work which may have been delayed or otherwise affected by the temporary facility. Replace work which cannot be satisfactorily restored. Except as otherwise indicated, the materials and equipment of temporary facilities remain the property of the contractors.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Products.
   2. Transportation and Handling.
   4. Manufacturer's Instructions.
   5. Product Options.
   6. Products List.
   7. Substitutions.

B. Related Sections:
   1. Section 01400 - Quality Control.
   2. Section 01730 - Operation and Maintenance Data.

1.02 QUALITY ASSURANCE

A. Conform to applicable specifications and standards.

B. Comply with size, make, type and quality specified, or as specifically approved in writing by the Consultant.

C. Manufactured and Fabricated Products:
   1. Two or more items of the same kind shall be identical, by the same manufacturer.
   2. Equipment capacities, sizes and dimensions shown or specified shall be adhered to unless variations are specifically approved in writing.

1.03 TRANSPORTATION AND HANDLING

A. Arrange deliveries of products in accord with construction schedules, coordinate to avoid conflict with work and conditions at the site.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

1.04 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instruction, with seals and labels intact and legible.

B. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged, and are maintained under required conditions.

1.05 MANUFACTURER'S INSTRUCTIONS

A. When Contract Documents require that installation of work shall comply with manufacturer's printed instructions, obtain and distribute copies of such instructions to parties involved in the installation, including one copy to the Consultant and one copy to the Contractor.
B. Perform work in accord with manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

1.06 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards.

B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not specifically named.

C. Consultant will review requests for substitutions with reasonable promptness, and notify, by Addendum, of the decision to accept or reject the requested substitution.

1.07 PRODUCT LIST

A. Within 15 days after signing of agreement, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

1.08 SUBSTITUTIONS

A. Will only be considered prior to bid or in the event that Equipment is not available.

1.09 SYSTEMS DEMONSTRATION

A. Prior to final inspection, demonstrate operation of each system to Consultant and Owner.

B. Instruct Owner's personnel in operation, adjustment, and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION
PART 1 - GENERAL

1.01 SUBSTANTIAL COMPLETION AND FINAL INSPECTION

A. The Contractor shall comply with procedures stated in the General Conditions of the Contract for Notice of Completion, Final Inspection, Notice of Substantial Completion and Notice of Acceptance.

B. Should the Architect/Engineer or the Principle Representative determine that the work is not substantially complete, or the punch list items exceed 25, he will immediately notify the Contractor, in writing, stating reasons. After Contractor completes work, he shall resubmit certification and request for final inspection. The Contractor will be responsible for all costs beyond two Architect/Engineer walk-throughs.

C. Owner may occupy designated portions of the Project under provisions stated in the General Conditions of the Contract.

1.02 CLOSE-OUT FORMS

The Architect/Engineer will complete the Notice of Approval of Beneficial Occupancy, Closing-out Checklist and Contract Close-out forms and forward them to the Contractor. Comply with procedures stated in General Conditions of the Contract.

1.03 FINAL SETTLEMENT AND PAYMENT

A. Contractor shall comply with procedures stated in the General Conditions of the Contract before final settlement and payment are made.

B. The Contractor shall also submit the following prior to the final application for payment:
   1. Contractor’s Affidavit of Payment of Debit and Claims: AIA G706.
   2. Contractor’s Affidavit of Release of Liens (claims): AIA G706A, with:
      a. Consent of Surety to final payment: AIA G707
      b. Contractor’s release of waivers of claims.
      c. Separate release of waivers of claims for subcontractors, suppliers and others with claim rights, against property of owner, together with list of those parties.

1.04 GUARANTEE INSPECTION

A. The Contractor shall comply with procedures stated in the General Conditions of the Contract for Guarantee Inspections after completion of the work.

1.05 WARRANTIES AND SPECIAL GUARANTEES

The Contractor shall comply with procedures and criteria outlined in the General Conditions of the Contract for all warranties and special guarantees of the work.

1.06 OPERATING AND MAINTENANCE DATA

A. Refer to Section 01730 - Operating and Maintenance.

B. Mechanical - By Mechanical Contractor: See Division 15.
C. Electrical - By Electrical Contractor: See Division 16.

1.07 DEMONSTRATIONS

A. Refer to Section 01730 - Operating and Maintenance

B. Mechanical - By Mechanical Contractor: See Division 15

C. Electrical - By Electrical Contractor: See Division 16.

1.08 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, and maintenance materials in quantities specified in each Section, in addition to that used for construction of work. Coordinate with Owner, deliver to Project site and obtain receipt prior to final payment.

B. At the completion of the project, all loose keys for hose bibs; adjustment keys and wrenches for door closers and panic hardware; and keys for electric switches, electrical panels, etc., shall be accounted for by the Contractor and turned over to the Owner.

END OF SECTION
PART 1 - GENERAL

1.01 CLEANING

A. Clean-up During Construction: Each contractor shall keep the building and premises free from all surplus material, waste material, dirt and rubbish caused by his employees or work, and at the completion of his work he shall remove all such surplus material, waste material, dirt and rubbish, as well as his tools, equipment and scaffolding, and shall leave his work clean and spotless, unless more exact requirements are specified. In case of dispute, the owner may remove all such items and charge the cost of such removal to the contractor.

Each sub-contractor shall perform his clean-up daily and shall transport his rubbish to an on-site location designated by the Contractor who will arrange for its removal.

B. Cleaners: With the exception of clean-up of the site and cleaning specifically assigned to Contractors under various sections of the specifications, all final clean-up of exterior and interior of the building shall be done by professional cleaners.

C. Final Clean-up:
   1. Exterior: In addition to items specified below, any new surfaces on exterior, concrete, metal, etc., shall be carefully and thoroughly cleaned.
   2. Glass: Both sides of all glass in work areas shall be carefully and thoroughly cleaned by professional window cleaners and left absolutely clean and free from paint, grease, dirt, etc.
   3. Hardware: Clean and polish all hardware and leave clean and free from paint, grease, dirt, etc.
   4. Plumbing: Clean and polish all plumbing fixtures, fittings, and exposed plated piping. Leave clean and free from paint, grease, dirt, etc. Remove all labels.
   5. Electrical: Clean and polish all electric fixtures, including glassware, switch plates, etc. and leave clean and free from paint, grease, dirt, etc.
   6. Equipment: Carefully and thoroughly clean all items of equipment, mechanical, electrical, cabinets, ductwork, etc.
   7. Floors: Thoroughly clean all floors. Vacuum and clean carpeting. Shampooing of pre-existing carpet is required once project is complete. Contractor is responsible for this.
      a. Contractors are responsible for cleaning (stripping floors if necessary) then applying the required two coats of sealer and three coats of finish before releasing the building for occupancy. Facilities Management will provide a contact person for help concerning campus standards free of charge. Or Custodial floor care services may be sub-contracted out through Facilities Management's work order system.
      b. Facilities Management Approved Sealers and Finishes for Vinyl Tile Flooring:

CU requires floor care products to be from the same product line. (Different brands may interact disastrously).

All of these products may be ordered through Construction Stores, but these products not stocked at Stores, please place orders at least two weeks in advance.
JohnsWax: Freedom
Butchers: Airkeim: Time Buster
Air Strip
Full Impact

Strippers: Freedom
Butchers: Time Buster
Airkeim: Air Strip

Sealers:
Over & Under: Iron Stone
Laser, Gemini: Technique

Finishes:
Show Place: MainStay
Laser, Gemini: Above

Campus safety standards require at least TWO (2) coats of Sealer be applied to a cleaned floor, and at least THREE (3) coats of Finish must be applied on top of the sealer.

c. Floor Cleaning Procedures:
1. Sweep floor clean of debris
2. Cord off area if necessary
3. Put up Caution signs
4. Mix Stripper or Cleaning solution according to label
5. Apply solution to floor
6. Start setting up equipment
7. Place RED abrasive pad on buffer (buffer less than 300 rpms)
8. Begin stripping or cleaning floor working with buffer moving it side to side across the floor.
9. Use HEPA filtered water vacuum to begin to suck up slurry*
   *use of HEPA filtered water vacuum is required on existing floor tile which contains asbestos.
10. Apply additional coats of water and re-vacuum up floor
11. Mop floor with clean water, change rinse water often
12. Mop floor a second time
13. Mop floor to dry completely
14. Clean up equipment
15. Wash red pad with clean water.

d. Sealing Procedures:
1. Using a new mop head or clean wax mop and clean bucket, apply first coat of approved sealer to floor
2. Allow floor to dry completely (at least 20 minutes)
3. Apply second coat of sealer
4. Allow floor to dry

e. Finishing (Waxing) Procedures:
1. Using a clean wax mop and bucket apply first coat of approved finish (wax)
2. Allow floor to dry completely (at least 20 minutes)
3. Apply second coat of finish (wax)
4. Allow floor to dry completely (at least 20 minutes)
5. Apply third coat of finish (wax)
6. Allow floor to dry completely (at least 30 minutes)
7. Wash mop and bucket with clean water
8. If floor is dry - remove caution signs and open area up
f. Burnishing Procedures:
The next working day
1. Sweep floor clean of debris
2. Spot mop floor to remove spots and dirt
3. Set up High Speed Burnisher to make for a safe environment
4. Start Burnishing. Walk forward in a straight line
5. At end of row, turn around and start forward again
6. Repeat steps 5 & 6 until finished
7. Clean up equipment and pad.

E. Completion: The entire work inside and out, and the entire premises shall be in first-class, clean condition upon completion before being accepted by the Owner.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the definitions, recording and maintenance requirements and the submittal requirements for record documents.

1.02 DEFINITIONS

A. The Project Record Documents are intended to indicate all changes and deviations from the original contract documents and permanently record the “as-built” condition of material, equipment and structure. The project record documents shall include the contract drawings, project manual, addenda, change orders, modifications and clarifications, field directives, approved shop drawings, approved product data, manufacturer’s certificates and project test results.

1.03 SUBMITTALS

A. Submit the project record documents in conformance with Section 01700 and prior to the final applications for payment. Submit in drawings in DWG format, and all other documents in PDF format. The final application for payment will not be approved prior to the submittal of record documents.

1.04 QUALITY ASSURANCE

A. The project record documents shall be updated at a minimum on a weekly basis and shall be readily available for inspection by the owner and consultants. Maintain a separate set of complete documents for exclusive use of record documents and protect the documents from damage in a clean, dry location. Note: Progress applications for payment will not be approved if record documents are not current.

B. The record documents shall contain a clear, legible record of all detail and dimensional changes and locate all concealed work including, but not limited to:
   1. Interior and Exterior Utilities
   2. Valves
   3. Dampers
   4. Controls
   5. Junction Boxes
   6. Clean-outs
   7. Access Doors

C. The project manual (specifications) shall indicate all manufacturers’ products complete with catalogue number and trade name of products installed. All changes and corrections to the project manual shall be clearly indicated.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Compile product data and related information appropriate for the University of Colorado's maintenance and operation of products furnished.

B. Prepare operating and maintenance data as specified in this section and as referenced in other pertinent sections of specifications.

C. Instruct the University of Colorado, Facilities Management personnel in the maintenance of PRODUCTS and in the operation of equipment and systems.

1.02 QUALITY ASSURANCE

A. Preparation of data shall be done by personnel:
   1. Trained and experienced in maintenance and operation of the described products.
   2. Completely familiar with requirements of this section.
   3. Skilled as a technical writer to the extent required to communicate essential data.
   4. Skilled as a draftsman competent to prepare required drawings.

1.03 SUBMITTALS

A. Prepare data in the form of an instructional manual for use by the University of Colorado, Facilities Management personnel. Quantities are listed in Part 1.07.

B. Format:
   1. Submit electronically in Portable Document Format (PDF) format as one document, OCR (Optical Character Recognition) searchable, bookmarked according to the Construction Specifications Institute (CSI) standards.
   2. Title shall be "OPERATING AND MAINTENANCE INSTRUCTIONS", and shall include:
      a. Name of project and date of completion (month and year).
      b. Project number.
      c. Identify of general subject matter covered in the manual (e.g., Architectural, Mechanical, Electrical and/or Civil).

1.04 CONTENT OF MANUAL

A. An electronically-written table of contents shall be provided for each volume, arranged according to CSI standards.
   Include the following:
   1. Name of responsible installing principal contractor, address, and telephone number.
   2. A list of each product being included, indexed to the content of the volume.
   3. List with each product, the name, address, and telephone number of:
      a. Maintenance contractor, as appropriate.
      b. Identity of the area of responsibility of each.
   4. Identify each product by product name and other identifying symbols.
B. Product Data:
   1. Local source of supply for parts and replacement.
   2. Include only those sheets that are pertinent to the specific product, with the following information.
      a. Clearly identify the specific product or part installed.
      b. Clearly identify the data applicable to the installation.
      c. Delete references to inapplicable information.

C. Drawings:
   1. Supplement product data with drawings as necessary to clearly illustrate:
      a. Relations of component parts of equipment and systems.
      b. Control and flow diagrams.
   2. Coordinate drawings with information in project record drawings to ensure correct illustration of completed installation.
   3. Do not use project record drawings as maintenance drawings.

D. Provide written text, as required, to supplement product data for the particular installation:
   1. Organize in a consistent format under separate headings for different procedures.
   2. Provide a logical sequence of instructions for each procedure.

E. Provide a copy of each warranty, bond, and service contract issued. Provide information sheets for the University of Colorado, Facilities Management's personnel and give:
   1. Proper procedures in the event of failure.
   2. Instances that might affect the validity of warranties or bonds.

1.05 MANUALS FOR ARCHITECTURAL MATERIAL AND FINISHES

A. Submit copies (per schedule shown in paragraph 1.07) of complete manual in final form.

B. Content for architectural products include applied materials and finishes.
   1. Manufacturer's data, giving full information on products.
      a. Catalog number, size, and composition.
      b. Color and texture designations.
      c. Information required for reordering special manufactured products.
   2. Instructions for care and maintenance:
      a. Manufacturer's recommendation for types of cleaning agents and methods.
      b. Cautions against cleaning agents and methods that are detrimental to the product.
      c. Recommended schedule for cleaning and maintenance.

C. Content for moisture-protection and weather-exposed products:
   1. Provide manufacturer's data, giving fully information on products.
      a. Applicable standards
      b. Chemical composition
      c. Details of installation
   2. Provide instructions for inspection, maintenance, and repair.
1.06 MANUAL FOR NON-ARCHITECTURAL EQUIPMENT AND SYSTEMS

A. Submit copies (per schedule) of complete manual in final form.

B. Content for each unit of equipment and system, as appropriate shall contain:
   1. Description of unit and component parts (Consultant-approved submittals).
      a. Function, normal operating characteristics, and limiting conditions.
      b. Performance curves, engineering data, and tests.
      c. Complete nomenclature and Commercial number of all replaceable parts.
   2. Operating Procedures:
      a. Start-up, break-in, routine, and normal operating instructions.
      b. Regulation, control, stopping, shutdown, and emergency instructions.
      c. Summer and winter operating instructions.
      d. Special operating instructions.
   3. Maintenance Procedures:
      a. Routine operations.
      c. Disassembly, repair, and reassembly.
      d. Alignment, adjustment, and checking.
   4. Servicing and Lubrication Schedule, including a list of lubricants required.
   5. Manufacturer's operating and maintenance instructions.
   6. Description of sequence of operation by control manufacturer.
   7. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance and replacement.
      a. Predicted life of parts subject to wear.
      b. Items recommended to be stocked as spare parts.
   8. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

C. Content for each electric and electronic system, as appropriate, shall contain:
   1. Description of system and component parts:
      a. Function, normal operating characteristics, and limiting conditions.
      b. Performance curves, engineering data, and tests.
      c. Complete nomenclature and Commercial number of replaceable parts.
   2. Operating Procedures:
      a. Routing and normal operating instructions.
      b. Sequences required.
      c. Special operating instructions.
   3. Maintenance Procedures:
      a. Routing operations.
      c. Disassembly, repair, and reassembly.
      d. Adjustment and checking.
      e. Manufacturer's printed operating and maintenance instructions.
      f. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

D. Prepare and include additional data when the need for such data becomes apparent during instruction of the University of Colorado, Facilities Management's personnel.
1.07 OPERATION & MAINTENANCE MANUAL

A. Operations and Maintenance Manuals – all disciplines – submit electronically in Portable Document Format (PDF) format as one document, OCR (Optical Character Recognition) searchable, bookmarked according to the Construction Specifications Institute (CSI) standards.

1.08 SUBMITTAL SCHEDULE

A. Submit one electronic copy to the Consultants and one to the University of draft of proposed formats and outlines of contents upon completion of the submittal process. The Consultants and the University staff will review the draft and will submit comments through the consultants.

B. Submit electronic copies of complete manual(s) in final form 15 days prior to final inspection or acceptance. Comments will be submitted after final inspection.

C. Submit specified number of CDs or DVDs of approved data in final form prior to acceptance.

1.09 INSTRUCTION OF UNIVERSITY OF COLORADO, FACILITIES MANAGEMENT PERSONNEL

A. Fully instruct the University of Colorado, Facilities Management personnel’s designated operating and maintenance personnel in the operation, adjustment, and maintenance of all products, equipment, and systems as required elsewhere in the specification.

B. Operating and Maintenance manual may be required as the basis of instruction.

PART 2 - MATERIAL

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Prepare commissioning process based on the Commissioning Checklists found in the UCB Standards website:

   [http://fm.colorado.edu/construction/standards/](http://fm.colorado.edu/construction/standards/)

B. Coordinate the requirements of Project Closeout and Operating and maintenance sections that are part of Division 1.

C. Schedule the required commissioning activities with the University of Colorado Facilities Department and their consultants at least 72 hours prior to conducting Commissioning activities.

PART 2 - MATERIALS

Not Used.

PART 3 - EXECUTION

NOT USED

END OF SECTION
PART 1 – GENERAL

1.01 SUMMARY

A. Section includes:
   1. Construction Storm Water Requirements
   2. Post-Construction Storm Water Requirements

B. Related Sections
   1. Section 02200 - Earthwork
   2. Section 02221 – Trenching, Backfilling, Compaction

1.02 QUALITY ASSURANCE

A. All construction sites
   1. All construction sites that disturb any land must take appropriate erosion control and
      stormwater detention measures to contain water run-off from site.

B. Construction sites – one acre and larger
   1. All construction sites that are one acre and larger must prepare and submit a Storm
      Water Management Plan (SWMP) for approval before any work begins. The SWMP
      must conform to all the requirements contained herein.

1.03 SUBMITTALS

A. Storm Water Management Plan (SWMP)

   Storm Water Management Plan (SWMP): Prior to any construction activity disturbing one acre of
   land or more, an approved SWMP and a Stormwater Permit for Construction Activity application
   from the Colorado Department of Public Health and Environment (CDPHE) are required. The
   SWMP shall be prepared in accordance with the CDPHE requirements for “Contents of the
   Stormwater Management Plan” and the UDFCD’s Urban Storm Drainage Criteria Manual, Volume
   management and erosion control measures are to be constructed and maintained in accordance
   with the SWMP and the UDFCD Drainage Criteria Manual.

PART 2 – MATERIALS

2.01 Storm Water Management Plan

A. Preparation Standards: Design of the SWMP and the Storm Water Quality and Erosion Control
   Plan shall include the following elements:
   1. Protection for adjacent properties (including public right-of-way) from erosion and/or
      sediment deposition.
   2. Protection for public streets from the deposit of sediment from run-off or vehicles tracking
      mud at construction access routes.
   3. Stabilization for all disturbed areas as defined in the UDFCD Drainage Criteria Manual.
4. Protection for all storm sewer inlets from the entry of sediment-laden water.
5. Long-term stability of cut and fill slopes and the successful establishment of permanent vegetative cover on exposed soil.
6. The following standard notes:
   a. “All temporary erosion control facilities shall be installed before any construction activities take place”.
   b. “Solid waste, industrial waste, yard waste and any other pollutants or waste on any construction site shall be controlled through the use of BMP’s. Waste and/or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waster that may blow, wash or otherwise be released from the site is prohibited. Sanitary waste facilities shall be provided and maintained by the owner or contractor”.
   c. “Ready-mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying it, shall be contained on construction sites for proper disposal. Release of these materials is prohibited”.
   d. “Cover shall be applied within 14 days to inactive soil stockpiles, and shall be maintained for stockpiles that are proposed to remain in place longer than 30 calendar days”.
   e. “BMP’s shall be implemented to prevent the release of sediment from construction sites. Vehicle tracking of mud shall not be allowed to enter the MS4 or waters of the State. Sediment tracked onto public streets shall be removed immediately”.
   f. “Techniques shall be used to prevent dust, sediment or debris blowing from the site”.
   g. “Stormwater discharges from construction activities shall not cause or threaten to cause pollution, contamination or degradation of waters of the State”.
   h. “All earth disturbances shall be designed, constructed and completed to limit the exposed area of any disturbed land to the shortest possible period of time”.
   i. “Bulk storage structures for petroleum products and other chemicals shall have adequate protection so as to contain all spills and prevent any spilled material from entering the MS4 or waters of the State”.
   j. Any disturbance to temporary and permanent BMP’s resulting from construction activity shall be repaired or replaced within 48 hours.

PART 3 – EXECUTION

3.1 PERMITTING

A. Contractor shall develop the SWMP in accordance with all of the requirements herein and utilizing the most recent SWMP guidance document prepared by the CDPHE and good engineering hydrologic and pollution control practices and submit to the University for approval.

B. Contractor shall apply for and obtain a CDPHE storm water general permit for construction activities. Provide copies of the permit to the University prior to the start of construction operations.
3.2 CONSTRUCTION

A. The Contractor will be required to have the SWMP on site at all times and shall be prepared to respond to maintenance of specific BMP's.

B. The Contractor shall inspect all BMP's at least every 14 days and within 24 hours after any precipitation or snow melt event that causes surface run-off. Inspections of BMP's shall be conducted by an individual who has successfully completed formal training in erosion and sediment control by an organization acceptable to the University. A certification of successful completion of such training shall be provided upon request.

C. The Contractor shall amend the SWMP whenever there is a change in design, construction, operation, or maintenance, which has an effect on the potential for discharge of pollutants to the MS4 or receiving waters, or if the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with construction activities.

D. Records of inspection are to be maintained on site with the SWMP. Inspection records are to be available at the project site at all times and shall be made available to the University upon request.

E. Prior to commencement of work, all general contractors, subcontractors and utility agencies shall obtain and comply with the approved, current SWMP for the project.

3.3 POST CONSTRUCTION

At the conclusion of all construction activities and as a part of construction close-out, contractor shall remove all temporary BMP's and inactivate the stormwater permit.

END OF SECTION
SECTION 024119 - 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.

B. Related Requirements:
   1. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
   2. Section 017300 "Execution" for cutting and patching procedures.

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 ready for reuse.

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.

1.5 INFORMATIONAL SUBMITTALS

A. 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 building manager'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. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

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. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

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

E. 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.

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.

PART 3 - EXECUTION

SELECTIVE DEMOLITION
3.1 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

   1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. 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. Building manager will arrange to shut off indicated services/systems when requested by Contractor.
   2. 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.
   3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

      a. Equipment to Be Removed: Disconnect and cap services and remove equipment.
      b. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
      c. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
      d. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

3.2 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 portable fire-suppression devices during flame-cutting operations.

5. Maintain adequate ventilation when using cutting torches.

6. Dispose of demolished items and materials promptly.

3.3 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

3.4 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 in an EPA-approved landfill.

B. Burning: Do not burn demolished materials.

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

3.5 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.

END OF SECTION 024119
SECTION 072100 - THERMAL INSULATION

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. Closed-cell spray foam
   2. Glass-fiber board insulation.
   4. Spray-applied cellulosic insulation.

B. Related Sections:
   1. Section 092116 "Gypsum Board Assemblies."

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BOARD INSULATION
A. Manufacturers: Subject to compliance with requirements, provide products by the following:

2. Owens Corning.

B. Unfaced, Flexible Glass-Fiber Board Insulation: ASTM C 423, Sound Absorption with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

1. "Sound Black Acoustic Board"; 2" thick.

2. Mechanical Fasteners:
   a. Gemco, Type IH-A.
   b. Eckoustic-Klip.
   c. Inc Stick-Pin

2.2 GLASS-FIBER BLANKET INSULATION

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

1. CertainTeed Corporation.
2. Guardian Building Products, Inc.
5. Owens Corning.

B. Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class C (faced surface not rated for flame propagation); Category 1 (membrane is a vapor barrier).

2.3 SPRAY-APPLIED CELLULOSIC INSULATION

A. Self-Supported, Spray-Applied Cellulosic Insulation: ASTM C 1149, Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications), chemically treated for flame-resistance, processing, and handling characteristics.

B. Manufacturers:

1. Ure-K Cellulose.

2.4 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E
84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   
a. BASF Corporation.
   b. BaySystems NorthAmerica, LLC.
   c. Dow Chemical Company (The).
   d. ERSystems, Inc.
   e. Gaco Western Inc.
   f. Henry Company.
   g. NCFI; Division of Barnhardt Mfg. Co.
   h. SWD Urethane Company.
   i. Volatile Free, Inc.

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

PART 3 - EXECUTION

3.1 PREPARATION
   
A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL
   
A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION
   
A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to
substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100
SECTION 081113 - 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 087111 "Door Hardware (Descriptive Specification)" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions, 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.

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- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Ceco Door Products; an Assa Abloy Group company.
   2. Commercial Door & Hardware Inc.
   3. Curries Company; an Assa Abloy Group company.
   4. Rocky Mountain Metals, Inc.
   5. Steelcraft; an Ingersoll-Rand company.

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

2.2 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. Standard-Duty Doors and Frames: SDI A250.8, Level 1. At location indicated in the Door and Frame Schedule.
1. Doors:
   a. Type: As indicated in the Door and Frame Schedule.
   c. Face: cold-rolled steel sheet, minimum thickness of 0.032 inch.
   d. Edge Construction: Model 1, Full Flush.
   e. Core: Polystyrene or Polyurethane with steel stiffeners.

2. Frames:
   a. Materials: cold-rolled steel sheet, minimum thickness of 0.042 inch.
   b. Construction: Knocked down.


2.3 FRAME ANCHORS

   A. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, 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 height adjustment. Terminate bottom of frames at finish floor surface.

2.4 MATERIALS

   A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
   B. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

2.5 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, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no
more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.

2. 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.

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. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2. Door 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.

3. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

      1) Three anchors per jamb from 60 to 90 inches high.

   b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

      1) Four anchors per jamb from 60 to 90 inches high.

4. 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.

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.

2.6 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.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.
   1. Color and Gloss: Dark grey, matte finish.

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. 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.

4. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
5. 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.
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, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, 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 plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. At Bottom of Door: Max, 3/8 inch
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/16 inch.

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 and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION 081113
SECTION 083473 - SOUND CONTROL DOOR ASSEMBLIES

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. Sound-control seals.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include sound ratings, construction details, material descriptions, core descriptions, and finishes.

B. Shop Drawings: Include the following:

1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
2. Details of accessories.
3. Details of moldings, removable stops, and glazing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver door seals wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

4. Provide additional protection to prevent damage to finish of frame seals

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.6 COORDINATION

A. Coordinate installation of anchorages for sound-control door assemblies. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves.
inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 SOUND-CONTROL HARDWARE

A. Description: Provide manufacturer's standard sound-control system, including head and jamb seals, door bottoms, cam-lift hinges, and thresholds, as required by testing to achieve STC and fire rating indicated.

1. Compression Seals: One-piece units; consisting of closed-cell sponge neoprene seal held in place by metal retainer; with retainer cover of same material as door frame; attached to door frame with concealed screws.

2. Automatic Door Bottoms: Neoprene or silicone gasket, held in place by metal housing, that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.

   a. Mounting: Surface mounted on face of door and frame as required by testing to achieve STC rating indicated.

3. Door Bottoms: Neoprene or silicone gasket held in place by metal housing; mortised into bottom edge of door.

4. Thresholds: Flat, smooth, unfluted type as recommended by manufacturer; fabricated from aluminum.

   a. Finish: Clear anodic finish.
   b. Color: Black.

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 sound-control door assemblies.

3.2 INSTALLATION

A. General: Install sound-control door assemblies plumb, rigid, properly aligned, and securely fastened in place; comply with manufacturer's written instructions.

B. Frames: Install sound-control door frames in sizes and profiles indicated.
3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Acoustical testing and inspecting agency shall select [one] <Insert number> sound-control door(s) at random from sound-control door assemblies that are completely installed and perform testing for verification that assembly complies with STC rating requirements.

1. Field tests shall be conducted according to ASTM E 336, with results calculated according to ASTM E 413. Acceptable field STC values shall be within 5 dB of laboratory STC values.

2. Inspection Report: Acoustical testing agency shall submit report in writing to Architect and Contractor within 24 hours after testing.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and adjust seals, door bottoms, and other sound-control hardware items right before final inspection. Leave work in complete and proper operating condition.

B. Remove and replace defective work, including defective or damaged sound seals and doors and frames that are warped, bowed, or otherwise unacceptable.

1. Adjust gaskets, gasket retainers, and retainer covers to provide contact required to achieve STC rating.
SECTION 087111 - DOOR HARDWARE (DESCRIPTIVE SPECIFICATION)

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. Mechanical door hardware for the following:
   a. Swinging doors.

B. Related Sections:

1. Section 081113 "Hollow Metal Doors and Frames" for astragals provided as part of labeled fire-rated assemblies and for door silencers provided as part of hollow-metal frames.
2. Section 083473 "Sound Control Door Assemblies" for hinges and gasketing provided as part of sound-rated door assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.7 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for the door as scheduled on Drawings to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

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. Baldwin Hardware Corporation.
b. Hager Companies.
c. McKinney Products Company; an ASSA ABLOY Group company.

B. Plain-Bearing Hinges: Grade 3 (standard weight).

2. Base and Pin Metal: Steel with steel pin.
3. Pins: Non-rising loose unless otherwise indicated.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: Keyed bolt lock.
B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Deadbolts: Minimum 1-inch bolt throw.
C. Lock Backset: 2-3/4 inches, unless otherwise indicated.
D. Lock Trim:
   1. Levers: Cast.
E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
   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. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
      b. Schlage Commercial Lock Division; an Ingersoll-Rand company.
      c. Yale Security Inc.; an ASSA ABLOY Group company.

2.4 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.
   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. McKinney
      b. Rockwood Manufacturing Company.
      c. Trimco.
B. Wall Bumpers: Grade 1; with rubber bumper; 2-1/2-inch diameter, minimum 3/4-inch
projection from wall; with backplate for concealed fastener installation; with convex bumper configuration.

2.5 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

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. Hager Companies.
   b. McKinney.
   c. Pemko Manufacturing Co.; an ASSA ABLOY Group company.

2.6 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

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. McKinney.
   b. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
   c. Reese Enterprises, Inc.
   d. Zero International.

B. Compressing-Top Thresholds: Metal member with compressible vinyl seal on top of threshold that seals against bottom of door; and base metal of aluminum.

2.7 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

   1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

2.8 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

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

C. 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 the 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

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

3.2 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated on Drawings unless otherwise indicated or required to comply with governing regulations.

B. Install each door hardware item to comply 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 with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

3.3 FIELD QUALITY CONTROL

A. The hardware supplier shall perform inspections and to prepare inspection reports.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

END OF SECTION 087111
SECTION 09 2116 - GYPSUM BOARD ASSEMBLIES

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 the following:

   (1) Nonload-bearing steel framing members for gypsum board assemblies.

   (2) Gypsum board assemblies attached to steel framing.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA-505 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 ASSEMBLY PERFORMANCE REQUIREMENTS

A. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those of assemblies whose STC ratings were determined according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

B. Fire Resistance: Provide gypsum board assemblies with fire-resistance ratings indicated.

   (1) Fire-Rated Gypsum Board Assemblies: Comply with UL Design Numbers indicated on the Drawings for fire-rated partitions and floor/ceiling and roof/ceiling assemblies.

1.5 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.
C. Product certificates signed by manufacturers of gypsum board assembly components certifying that their products comply with specified requirements.

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, unless otherwise indicated.

B. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

C. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

D. Fire-Test-Response Characteristics: Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements:

(1) Fire-Resistance Ratings: As indicated by GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

(2) Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

(3) Deflection and Firestop Track: Top runner provided in fire-resistance-rated assemblies indicated is labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack gypsum panels flat to prevent sagging.
1.8 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for applying and finishing gypsum board to comply with ASTM C 840 requirements or gypsum board manufacturer's recommendations, whichever are more stringent.

B. Room Temperatures: For nonadhesive attachment of gypsum board to framing, maintain not less than 40 deg F. Do not exceed 95 deg F when using temporary heat sources.

C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   (1) Armstrong World Industries, Inc.

   (2) Chicago Metallic Corp.

   (3) USG Interiors, Inc.

2.2 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS

A. General: Provide components complying with ASTM C 754 for conditions indicated.

B. Powder-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 hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190 conducted by a qualified independent testing agency.

C. Wire Ties: ASTM A 641, Class 1 zinc coating, soft temper, 0.062 inch thick.

D. Wire Hangers: ASTM A 641, Class 1 zinc coating, soft temper, 0.162-inch diameter.

E. Channels: Cold-rolled steel, 0.0598-inch minimum thickness of base (uncoated) metal and 7/16-inch-wide flanges, and as follows:

   (1) Carrying Channels: 1-1/2 inches deep, 475 lb/1000 feet, unless otherwise indicated.
F. Steel Studs for Furring Channels: ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 0.0329 inch, unless otherwise indicated.
2. Depth: As indicated.

G. Steel Rigid Furring Channels: ASTM C 645, hat shaped, depth of 7/8 inch, and minimum thickness of base (uncoated) metal as follows:

1. Thickness: 0.0179 inch, unless otherwise indicated.
2. Protective Coating: Manufacturer's standard corrosion-resistant coating.

2.3 STEEL FRAMING FOR WALLS AND PARTITIONS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Framing: Comply with Steel Stud Manufactures Association (SSMA) bridging requirements, unless otherwise indicated.
2. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.

B. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 0.0179 inch, (25 ga.), unless otherwise indicated.
(2) Thickness: 0.0329 inch, (20 ga.), as follows:

(a) For head runner, sill runner, jamb, and cripple studs at door and other openings.

(b) In locations indicated to receive cementitious backer units.

(c) Where indicated.

(3) Depth: 3-5/8 inches, unless otherwise indicated on drawings.

C. Deflection Track: Manufacturer's top runner complying with the requirements of ASTM C 645 and with 2-inch-deep flanges.

(1) Provide deflection track with longer flanges of heavier gages where indicated or otherwise required to accommodate structural deflection.

D. Steel Rigid Furring Channels: ASTM C 645, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

(1) Thickness: 0.0179 inch, unless otherwise indicated.

(2) Depth: 7/8 inch.

E. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

F. Steel Flat Strap and Backing Plate: Steel sheet for blocking and bracing complying with ASTM A 653 or ASTM A 568, length and width as indicated, and with a minimum base metal (uncoated) thickness as follows:

(1) Thickness: 0.0329 inch where indicated.

G. Fasteners for Metal Framing: Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

H. Slip-Type Head Joints: At all interior non-load bearing partitions, provide one of the following:
(1) Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.

(2) Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.

(3) 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.

(4) Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to:

(a) Steel Network Inc. VertiClip SLD or VertiTrack VTD Series.

(b) Superior Metal Trim; Superior Flex Track System (SFT).

2.4 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application.

(1) Widths: Provide gypsum board in widths of 48 inches.

B. Gypsum Wallboard: ASTM C 36 and as follows:

(1) Type: Type X for all locations.

(2) Edges: Tapered.

(a) Manufacturer's standard or square edge is acceptable for base layer in multilayer applications.

(3) Thickness: 5/8 inch unless otherwise indicated.

2.5 TRIM ACCESSORIES

A. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:
(1) Material: Formed metal or plastic, with metal complying with the following requirement:

(a) Steel sheet zinc coated by hot-dip or electrolytic process, or steel sheet coated with aluminum or rolled zinc.

(2) Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047:

(a) Corner bead on outside corners, unless otherwise indicated.

(b) LC-bead with both face and back flanges; face flange formed to receive joint compound. Use LC-beads for edge trim, unless otherwise indicated.

(c) One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

B. Accessory for Curved Edges: Corner bead formed of metal, plastic, or metal combined with plastic, with either notched or flexible flanges that are bendable to curvature radius.

2.6 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.

(1) Use pressure-sensitive or staple-attached, open-weave, glass-fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.

C. Joint Tape for Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.

D. Setting-Type Joint Compounds for Gypsum Board: Factory-packaged, job-mixed, chemical-hardening powder products formulated for uses indicated.

(1) Where setting-type joint compounds are indicated as a taping compound only or for taping and filling only, use formulation that is compatible with other joint compounds applied over it.

(2) For prefilling gypsum board joints, use formulation recommended by gypsum board manufacturer.
(3) For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by gypsum board manufacturer.

(4) For topping compound, use sandable formulation.

E. Drying-Type Joint Compounds for Gypsum Board: Factory-packaged vinyl-based products complying with the following requirements for formulation and intended use.


(a) Taping compound formulated for embedding tape and for first coat over fasteners and face flanges of trim accessories.

(b) Topping compound formulated for fill (second) and finish (third) coats.

(c) All-purpose compound formulated for both taping and topping compounds.

F. Joint Compound for Cementitious Backer Units: Material recommended by cementitious backer unit manufacturer.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: 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 according to ASTM E 90.

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 for Exposed and Concealed Joints:

(a) PL Acoustical Sealant; ChemRex, Inc.; Contech Brands.

(b) AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
(c) SHEETROCK Acoustical Sealant; United States Gypsum Co.

(2) Acoustical Sealant for Concealed Joints:

(a) BA-98; Pecora Corp.

(b) Tremco Acoustical Sealant; Tremco, Inc.

2.8 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

B. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum panels.

C. Spot Grout: ASTM C 475, setting-type joint compound recommended for spot-grouting hollow metal door frames.

D. Steel drill screws complying with ASTM C 1002 for the following applications:

(1) Fastening gypsum board to steel members less than 0.033 inch thick.

(2) Fastening gypsum board to gypsum board.

E. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.033 to 0.112 inch thick.

F. Corrosion-resistant-coated steel drill screws of size and type recommended by unit manufacturer for fastening cementitious backer units.

G. Sound-Attenuation Blankets: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

(1) Mineral-Fiber Type: Fibers manufactured from glass, slag wool, or rock wool.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting
performance of assemblies specified in this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with United States Gypsum Co.'s "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.

   (1) Where building structure abuts ceiling perimeter or penetrates ceiling.

   (2) Where partition framing and wall furring abut structure, except at floor.

      (a) Install deflection track top runner to attain lateral support and avoid axial loading.

      (b) Install firestop brackets and gypsum wallboard panels at top of fire-rated partitions as indicated.

D. Do not bridge building control and expansion joints with steel framing or furring members. Independently frame both sides of joints with framing or furring members as indicated.

3.4 INSTALLING STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where gypsum board stud assemblies abut other construction.
(1) Where studs are installed directly against exterior walls, install asphalt felt strips or foam gaskets between studs and wall.

B. Installation Tolerances: Install each steel framing and furring member so that fastening surfaces do not vary more than 1/8 inch from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

(1) Cut studs ½ inch short of full height to provide perimeter relief.

(2) For STC-rated and fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid structural surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed, to support gypsum board closures needed to make partitions continuous from floor to underside of solid structure.

D. Terminate partition framing at suspended ceilings where indicated.

E. Install steel studs and furring in sizes and at spacings indicated.

(1) Single-Layer Construction: Space studs 16 inches o.c., unless otherwise indicated.

(2) Multilayer Construction: Space studs 16 inches o.c., unless otherwise indicated.

(3) Cementitious Backer Unit Construction: Space studs 16 inches o.c., unless otherwise indicated.

F. Install steel studs so flanges point in the same direction and leading edge or end of each gypsum board panel can be attached to open (unsupported) edges of stud flanges first.

G. For curved partitions, install steel framing as follows:

(1) Cut top and bottom runners through leg and web at 2-inch intervals for arc length. In cutting lengths of runners, allow for uncut straight lengths of not less than 12 inches at ends of arcs.

(2) Bend runners to uniform curve of radius indicated and locate straight lengths so they are tangent to arcs.
3. Support outside (cut) leg of runners by clinching a 1-inch- high-by-0.0209-inch-thick steel sheet strip to inside of cut legs using metal lock fasteners.

4. Attach runners to structural elements at floor and ceiling with fasteners located 2 inches from ends and spaced 24 inches o.c.

5. Attach runners to suspended ceilings with toggle bolts or hollow wall anchors located 2 inches from ends and spaced 16 inches o.c. in between where attached to suspended ceilings.

6. Position studs vertically with open sides facing in same direction and engaging floor and ceiling runners. Begin and end each arc with a stud and space intermediate studs equally along arcs at stud spacing recommended by gypsum board manufacturer for radii indicated. Attach studs to runners with 3/8-inch-long pan head framing screws. On straight lengths at ends of arcs, place studs 6 inches o.c. with last stud left free standing.

H. Frame door openings to comply with GA-219, and with applicable published recommendations of gypsum board manufacturer, unless otherwise indicated. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Provide double studs, of thickness indicated, at each door opening jamb.

I. Frame openings other than door openings to comply with details indicated or, if none indicated, as required for door openings. Install framing below sills of openings to match framing required above door heads.

3.5 APPLYING AND FINISHING GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standards: Install and finish gypsum panels to comply with ASTM C 840 and GA-216.

B. Install sound-attenuation blankets, where indicated, prior to installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
E. Locate both edge or 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. Avoid joints other than control joints at corners of framed openings where possible.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Spot grout hollow metal door frames for solid-core wood doors, hollow metal doors, and doors over 32 inches wide. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frames.

I. Form control and expansion joints at locations indicated and as detailed, with space between edges of adjoining gypsum panels, as well as supporting framing behind gypsum panels.

J. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.

(1) Except where 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. 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-wide joints to install sealant.

K. Isolate perimeter of nonload-bearing gypsum board partitions at structural abutments, except floors, as detailed. Provide 1/4- to ½-inch-wide spaces at these locations and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

L. Where STC-rated gypsum board assemblies are indicated, seal construction at perimeters, behind control and expansion joints, openings, and penetrations with a continuous bead of acoustical sealant including a bead at both faces of the partitions. Comply with ASTM C 919 and manufacturer's recommendations for location of edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.
M. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations.

   (1) Space screws a maximum of 12 inches o.c. for vertical applications.

N. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.6 GYPSUM BOARD APPLICATION METHODS

A. Single-Layer Application: Install gypsum wallboard panels as follows:

   (1) On ceilings, apply gypsum panels prior to wall/partition board application to the 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, and provide panel lengths that will minimize end joints.

   (3) On partitions/walls, 8'-0" or less in height, apply gypsum panels horizontally (perpendicular to framing), unless parallel application is required for fire-resistance-rated assemblies. Use maximum-length panels to minimize end joints.

      (a) Stagger abutting end joints not less than one framing member in alternate courses of board.

      (b) At highwalls, install panels horizontally.

B. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and gypsum wallboard 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. Stagger joints on opposite sides of partitions.

C. Single-Layer Fastening Methods: Apply gypsum panels to supports as follows:

   (1) Fasten with screws.

D. Multilayer Fastening Methods: Apply base layers of gypsum panels and face layer to base layers as follows:

   (1) Fasten both base layers and face layers separately to supports with screws.
3.7 INSTALLING TRIM ACCESSORIES

A. General: For trim accessories with back flanges, fasten to framing with the same fasteners used to fasten gypsum board. Otherwise, fasten trim accessories according to accessory manufacturer's directions for type, length, and spacing of fasteners.

B. Install cornerbead at external corners.
   (1) Fasten cornerbead with screws spaced 12 inches o.c. along each flange in addition to crimping. Stagger screws along each flange.

C. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.
   (1) Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.

D. Install control joints at locations indicated, and where not indicated, according to ASTM C 840 and manufacturer's recommendations and in specific locations approved by Architect for visual effect.

3.8 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, flanges of cornerbead, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration.

B. Prefill open joints, rounded or beveled edges, and damaged areas using setting-type joint compound.

C. Apply joint tape over gypsum board joints, except those with trim accessories having flanges not requiring tape.

D. Levels of Gypsum Board Finish: Provide the following levels of gypsum board finish per GA-214.
   (1) Level 1 for ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
   (2) Level 2 where panels form substrates for tile and where indicated.
   (3) Level 4 for gypsum board surfaces, unless otherwise indicated.
E. Use one of the following joint compound combinations as applicable to the finish levels specified:


(a) Use proprietary setting-type joint compound on joints in fiber-reinforced, abuse-resistant gypsum board.

(2) Embedding and First Coat: Ready-mixed, drying-type, all-purpose or taping compound. Fill (Second) Coat: Ready-mixed, drying-type, all-purpose or topping compound. Finish (Third) Coat: Ready-mixed, drying-type, topping compound.

F. For Level 4 gypsum board finish, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration.

G. Where Level 2 gypsum board finish is indicated, embed tape in joint compound and apply first coat of joint compound.

H. Where Level 1 gypsum board finish is indicated, embed tape in joint compound.

I. Finish water-resistant gypsum backing board forming base for ceramic tile to comply with ASTM C 840 and gypsum board manufacturer's directions for treatment of joints behind tile.

J. Finish cementitious backer units to comply with unit manufacturer's directions.

3.9 CLEANING AND PROTECTION

A. Promptly remove any residual joint compound from adjacent surfaces.

B. Provide final protection and maintain conditions, in a manner acceptable to Installer, that ensure gypsum board assemblies are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 09 2116
SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels for ceilings.
   B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, 12 inches in size.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
   B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
   C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:
   1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.

B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.3 ACOUSTICAL PANELS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Classic Acoustical Company, Lakewood, WA
2. E. J. Cody Company, Kansas City, MO.

C. Classification: Provide panels for type, form, and pattern as follows:

1. 12" x 12" x 1/2" white, bevel butt joint acoustical tile, random drilled, fiber tile.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113
SECTION 096513 - RESILIENT BASE AND ACCESSORIES

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. Resilient base.

1.3 ACTION SUBMITTALS

   A. Product Data: For each type of product indicated.
   
   B. Samples for Initial Selection: For each type of product indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

   A. Store resilient products 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 or more than 90 deg F.

1.5 PROJECT CONDITIONS

   A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

      1. 48 hours before installation.
      2. During installation.
      3. 48 hours after installation.

   B. Install resilient products after other finishing operations, including painting, have been completed.
PART 2 - PRODUCTS

2.1 RESILIENT BASE

A. Resilient Base:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

   a. Armstrong World Industries, Inc.
   b. Johnsonite.
   c. Roppe Corporation, USA.


C. Minimum Thickness: 1/8 inch.

D. Height: 4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Finish: To match existing base in Control Room.

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 manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions 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.

B. 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 products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

3.3 RESILIENT BASE INSTALLATION
A. Comply with manufacturer's written instructions for installing resilient base.
B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
E. Do not stretch resilient base during installation.
F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

3.4 CLEANING AND PROTECTION
A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.
B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Damp-mop surfaces to remove marks and soil.
C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

END OF SECTION 096513
SECTION 096816 - SHEET CARPETING

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. Tufted carpet.
   2. Carpet cushion.

1.3 ACTION SUBMITTALS

A. Product Data: For the following, including installation recommendations for each type of substrate:
   1. Carpet: For each type indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Carpet Cushion: For each type indicated. Include manufacturer's written data on physical characteristics and durability.

B. Shop Drawings: Show the following:
   1. Carpet type, color, and dye lot.
   2. Type, color, and location of edge, transition, and other accessory strips.
   3. Type of carpet cushion.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
   1. Carpet: 36-inch- square Sample.
   2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.
   3. Carpet Cushion: 6-inch- square Sample.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet to include in maintenance manuals. Include the
following:

1. Methods for maintaining carpet, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet[ and carpet cushion].

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced Installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.7 WARRANTY

A. Special Warranty for Carpet: Manufacturer agrees to repair or replace components of carpet installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

B. Special Warranty for Carpet Cushion: Manufacturer agrees to repair or replace components of carpet cushion installation that fail in materials or workmanship within specified warranty period.

1. Warranty includes consequent removal and replacement of carpet and accessories.
2. Warranty does not include deterioration or failure of carpet cushion due to unusual traffic, failure of substrate, vandalism, or abuse.
3. Failure includes, but is not limited to, permanent indentation or compression.
4. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TUFTED CARPET <Insert designation>

A. Products: Subject to compliance with requirements, to be selected by the Owner based on an allowance.
1. Architect to recommend color and pattern from the following manufacturers:
   a. Bigelow.
   c. Tandus.
   d. Masland Contract

B. Fiber Content: 100 percent nylon 6, 6.

C. Fiber Type: Antron Legacy Nylon, TDX nulon, and Dupont.


E. Density: 35 oz./cu. yd.

F. Performance Characteristics: As follows:
   1. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.

2.2 CARPET CUSHION

A. Traffic Classification: CCC Class I, moderate traffic.

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet and is recommended or provided by carpet and carpet cushion manufacturers.
   1. Use adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Tackless Carpet Stripping: Water-resistant plywood, in strips as required to match cushion thickness and that comply with CRI 104, Section 12.2.

D. Seam Adhesive: Hot-melt adhesive tape or similar product recommended by carpet manufacturer for sealing and taping seams and butting cut edges at backing to form secure seams and to prevent pile loss at seams.

E. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet performance. Examine carpet for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet[cushion] manufacturer.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 7.3, "Site Conditions; Floor Preparation," and with carpet manufacturer's written installation instructions for preparing substrates.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet.

3.3 INSTALLATION

A. Comply with CRI 104 and carpet and carpet cushion manufacturers' written installation instructions for the following:
   1. Direct-Glue-Down Installation: Comply with CRI 104, Section 9, "Direct Glue-Down Installation."
   2. Double-Glue-Down Installation: Comply with CRI 104, Section 10, "Double-Glue-Down Installation."
   3. Carpet with Attached-Cushion Installation: Comply with CRI 104, Section 11, "Attached-Cushion Installations."
4. Stretch-in Installation: Comply with CRI 104, Section 12, "Stretch-in Installations."

B. Comply with carpet manufacturer's written recommendations and Shop Drawings for seam locations and direction of carpet; maintain uniformity of carpet direction and lay of pile. At doorways, center seams under the door in closed position.

C. Do not bridge building expansion joints with carpet.

D. Cut and fit carpet to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet manufacturer.

E. Extend carpet into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders to comply with CRI 104, Section 15, "Patterned Carpet Installations" and with carpet manufacturer's written recommendations.

H. Comply with carpet cushion manufacturer's written recommendations. Install carpet cushion seams at 90-degree angle with carpet seams.

3.4 CLEANING AND PROTECTING

A. Perform the following operations immediately after installing carpet:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet manufacturer.
2. Remove yarns that protrude from carpet surface.

B. Protect installed carpet to comply with CRI 104, Section 16, "Protecting Indoor Installations."

C. Protect carpet against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet cushion manufacturer.

END OF SECTION 096816
SECTION 099123 - 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.

1.2 SUMMARY
A. Section includes surface preparation and the application of paint systems on:
   1. Concrete.
   2. Steel.
   3. Wood.
   5. Plaster.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product. Include preparation requirements and application instructions.
B. Samples for Initial Selection: For each type of topcoat product.
C. 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 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.
D. 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. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
   a. Vertical and Horizontal Surfaces: Provide samples of at least 20 sq. ft..

2. Final approval of color selections will be based on mockups.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

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.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Benjamin Moore & Co.
2. ICI Paints.
5. Sherwin-Williams Company (The).
2.2 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.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Pretreatment Wash Primers: 420 g/L.

C. Colors: As selected by Architect from manufacturer's full range.

2.3 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: [MPI #50.]

B. Primer, Alkali Resistant, Water Based: [MPI #3.]

C. Primer Sealer, Interior, Institutional Low Odor/VOC: [MPI #149.]

D. Primer, Latex, for Interior Wood: [MPI #39.]

E. Primer Sealer, Alkyd, Interior: [MPI #45.]

2.4 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based: [MPI #107.]

B. Primer, Alkyd, Quick Dry, for Metal: [MPI #76.]

2.5 WATER-BASED PAINTS

A. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1): [MPI #143.]
   1. Per UCB Paint Standards, all wall paint should be 15 to 32 at 60 degrees, unless otherwise approved.
B. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 2):[ MPI #144.]
   1. Per UCB Paint Standards, all wall paint should be 15 to 32 at 60 degrees, unless otherwise approved.

C. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3):[ MPI #145.]
   1. Per UCB Paint Standards, all wall paint should be 15 to 32 at 60 degrees, unless otherwise approved.

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. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. 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. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. 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.

C. 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 reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
D. 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.

E. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

F. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

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 to topcoat manufacturers.

B. 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.

C. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:
   a. Equipment, including panelboards and switch gear.
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. 

2. Paint the following work where exposed in occupied spaces:
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

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.

3.6 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Institutional Low-Odor/VOC Latex System:

   a. Prime Coat: Primer sealer, interior, institutional low odor/VOC[, MPI #149].
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2)[, MPI #144].

B. Steel Substrates:
1. Institutional Low-Odor/VOC Latex System:
   a. Prime Coat: Primer, rust-inhibitive, water based[ MPI #107].
   c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2)[, MPI #144].

C. Wood Substrates: Including wood trim architectural woodwork doors wood-based panel products glued-laminated construction.
1. Institutional Low-Odor/VOC Latex System:
   a. Prime Coat: Primer, latex, for interior wood[ MPI #39].
   c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2)[, MPI #144].

D. Gypsum Board Substrates:
1. Institutional Low-Odor/VOC Latex System:
   a. Prime Coat: Primer sealer, interior, institutional low odor/VOC[, MPI #149].
   c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2)[, MPI #144].

END OF SECTION 099123
SECTION 101100 - VISUAL DISPLAY UNITS

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. Markerboards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for visual display surfaces.

1. Include rated capacities, operating characteristics, electrical characteristics and individual panel weights for sliding visual display units.
2. Include computer system requirements for electronic markerboards.

B. Shop Drawings: For visual display surfaces. Include plans, elevations, sections, details, and attachments to other work.

1. Show locations of panel joints.
2. Include sections of typical trim members.

C. Samples for Initial Selection: For each type of visual display surface indicated, for units with factory-applied color finishes, and as follows:

1. Actual sections of porcelain-enamel face sheet or melamine visual display surface .

D. Samples for Verification: For each type of visual display surface indicated.

1. Visual Display Surface: Not less than 8-1/2 by 11 inches, mounted on substrate indicated for final Work. Include one panel for each type, color, and texture required.
2. Trim: 6-inch- long sections of each trim profile.
3. Accessories: Full-size Sample of each type of accessory.
1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display surfaces completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display surfaces vertically with packing materials between each unit.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Porcelain-Enamel Face Sheet: ASTM A 424, enameling-grade steel, uncoated thickness indicated; with exposed face and edges coated with primer, 1.7-to-2.5-mil-thick ground coat, and color cover coat; and with concealed face coated with primer and 1.7-to-2.5-mil-thick ground coat.

1. Matte-Finish Cover Coat: Low reflective; chalk wipes clean with dry cloth or standard eraser. Minimum 2.0-to-2.5-mil-thick cover coat. Cover and ground coats shall be fused to steel at manufacturer's standard firing temperatures but not less than 1250 deg F.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) APCO
      2) Claridge Products
      3) Ghent
      4) Greensteel
      5) Lemco

B. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F.

1. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
   a. Products: Subject to compliance with requirements, provide one of the following:
1) Egan
2) Ghent
3) Polyvision.

C. Hardboard: ANSI A135.4, tempered.
D. Particleboard: ANSI A208.1, Grade M-1, made with binder containing no urea formaldehyde.
E. Fiberboard: ASTM C 208.
F. Extruded Aluminum: ASTM B 221, Alloy 6063.

2.2 MARKERBOARD ASSEMBLIES
A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch-thick, porcelain-enamel face sheet with low-gloss finish.

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. ADP Lemco, Inc.
   b. Claridge Products and Equipment, Inc.
   c. Egan Visual Inc.
   d. Ghent Manufacturing, Inc.
   e. PolyVision Corporation; a Steelcase company.

2. Hardboard Core: 1/4 inch thick; with 0.013-inch-thick, galvanized-steel sheet backing.
3. Particleboard Core: 1/2 inch thick; galvanized-steel sheet backing.
4. Fiberboard Core: 3/8 inch thick; with galvanized-steel sheet backing.
5. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.

B. Melamine Markerboards: Fabricated from 1/4-inch-thick, sealed and primed hardboard panels permanently bonded with melamine or another high-pressure-laminate writing surface.

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:
2.3 GENERAL FINISH REQUIREMENTS

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.

2.4 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.5 VISUAL DISPLAY SURFACE SCHEDULE

A. Visual Display Board: Field assembled.

1. Markerboard: Porcelain-enamel markerboard assembly.


2. Corners: Square.

3. Width: As indicated on Drawings.

4. Height: As indicated on Drawings.

5. Mounting: Wall.

6. Mounting Height: As indicated on Drawings.


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motor-operated, sliding visual display units.

C. Examine walls and partitions for proper preparation and backing for visual display surfaces.

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

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair the performance of and affect the smooth, finished surfaces of visual display boards, including dirt, mold, and mildew.

C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display surfaces and wall surfaces.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

3.4 INSTALLATION OF FIELD-FABRICATED VISUAL DISPLAY BOARDS AND ASSEMBLIES

A. Field-Assembled Visual Display Units: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
2. Provide manufacturer's standard vertical-joint spline system between abutting sections of markerboards.

3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.

3.5 INSTALLATION OF VISUAL DISPLAY RAILS

A. Display Rails: Install rails in locations and at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches o.c.

1. Mounting Height: 48 inches above finished floor to top of rail.

3.6 INSTALLATION OF VISUAL DISPLAY WALL PANELS

A. Marker Wall Sheets: Attach wall sheets to wall surface with thin layer of adhesive over entire wall surface. Butt join adjacent panels and cover joint with matching joint strip installed with double-stick tape.

1. Join adjacent wall panels with concealed steel splines for smooth alignment.

3.7 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

END OF SECTION 101100
SECTION 15010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 15 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.

B. Related Sections: Refer to all sections in Division 15. Refer to Division 16 specification sections and Division 16 drawings.

C. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

D. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 15. It expands and supplements the requirements specified in Division 1.

1.3 MECHANICAL INSTALLATIONS:

A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.
F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.

G. Verify all dimensions by field measurements.

H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.

I. 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.

J. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

K. Install mechanical equipment to facilitate 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.

L. Make allowance for expansion and contraction for all building components and piping systems that are subject to such.

M. The ceiling space shall not be “layered”. It is the contractor’s responsibility to offset and system as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.

N. In general, all “static” piping systems shall be routed as high as possible, i.e. fire protection systems. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.

O. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, opening/closing of all valves, draining/refilling all mechanical systems and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

P. All work shall operate in accordance with the Vibration, Seismic and Sound Control specification under all conditions of load.

Q. Sound or vibration conditions not in accordance with the Vibration, Seismic and Sound Section and considered objectionable by the University shall be corrected in a manner approved by the project Architect under the work of Division 22/23.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contact sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.
B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Coordination shall include, but not be limited to the following:

1. Fire Protection and Fire Alarm Contractor shall provide shop drawings to all other Contractors.

2. Automatic Temperature Controls, Building Management and Testing, Adjusting and Balancing Contractors shall be provided with equipment product data and shop drawings from other Contractors and shall furnish the same information involving control devices to the appropriate Contractor.

C. Coordination Drawings:

1. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.

2. CADD Drawings: Electronic mechanical AutoCAD drawings are available for purchase by the Contractor from the Engineer. Contact Engineer for further information in acquiring CADD drawings. The Engineers Construction documents cannot be used directly for coordination drawings. They are for information and initial coordination only.

D. Existing Conditions:

1. Carefully survey existing conditions prior to bidding work.

2. Provide proper coordination of mechanical work with existing conditions.

3. Report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform with the progress of the work of other trades.

2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill timed work, when such corrections are required for proper installation of other work.

3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.

B. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Refer to Division 1 and section 15050.

C. Modifications required as result of failure to resolve interferences, provide correct coordinations drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.

D. Coordination with Electrical Work: Refer to Division 1 and 16.
1.6 DESIGN WORK REQUIRED BY CONTRACTOR:

A. The construction of this project requires the Contractor to include the detailing and design of several systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.

B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:
   1. Final coordinated distribution of duct, hydronic, plumbing and other systems within the ceiling cavity.
   2. Any system not fully detailed
   3. Fire protection systems
   4. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
   5. Temperature controls systems
   6. Refrigeration systems

D. Design Limitations:
   1. The Contractor shall not modify the Engineers design intent in any way.
   2. The Contractor shall not change any duct size, pipe size or equipment size without prior written approval from the Engineer.
   3. The Contractor shall conform to the SMACNA Duct Construction Standards when modifying the ductwork layout to avoid collisions.
   4. Back to back 90° fittings on duct system shall not be installed under any circumstance.
   5. Bull nosed tees on piping systems shall not be installed under any circumstance.

1.7 PROJECT CONDITIONS:

A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Field verify all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all mechanical and electrical work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and start-ups, flushing and filling both new and existing systems.
G. Provide temporary ductwork and piping services, where required, to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, one week in advance.

I. Minimize disruptions to operation of mechanical systems in occupied areas.

J. When equipment, wiring, piping, etc. is disconnected or "abandoned", it must be physically removed and disposed of as part of the project.

1.8 SAFETY:
A. Refer to Division 1.

1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:
A. Refer to Division 1 and conform with the Owners requirements.

1.10 REQUIREMENTS OF REGULATORY AGENCIES:
A. Refer to Division 1.

B. Execute and inspect all work in accordance with all Underwriters, local and state codes, rules and regulations applicable to the trade affected as a minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

D. The handling, removal and disposal of regulated refrigerants shall be in accordance with U.S. EPA, state and local regulations.

E. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

F. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.11 PERMITS AND FEES:
A. Refer to Division 1.

1.12 TEMPORARY FACILITIES:
A. Light, Heat, Power, Etc.: Responsibility for providing temporary electricity, heat and other facilities shall be as specified in Division 1.

B. Use of Permanent Building Equipment for Temporary Heating or Cooling: Permanent building equipment shall not be used without written permission from the Owner. If this equipment is used for temporary heating or cooling, it shall be adequately maintained per manufacturer's instructions and protected with filters, strainers, controls, reliefs, etc. Steam and hydronic systems shall be flushed and chemically treated. (ductwork and air moving equipment shall be cleaned to an “AS New” condition). All filters required for the construction period shall be equivalent to the filters required for the final
installation. All filters shall be replaced at the time of substantial completion. The guarantee period of all equipment used shall not start until the equipment is turned over to the Owner for his use. A written record of maintenance, operation and servicing shall be turned over to the owner prior to final acceptance.

1.13 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and Division 1.

B. Materials and equipment of equivalent quality may be submitted for substituted prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date a letter in triplicate requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.

2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.14 MECHANICAL SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.

2. The submittals shall be submitted as one package identified by the specification section. Submittals that are not complete with the required information will be sent back to be corrected.

3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.

4. The submittal package shall be provided in electronic format. The cover shall be identified with the job name, Owner's project number, date, Prime Contractor's name, etc.

5. An index shall be provided which includes:
   a. Product
   b. Plan Code (if applicable)
   c. Specification Section
   d. Manufacturer and Model Number

6. All mechanical divisions shall be submitted at one time. Long lead items may be submitted prior to full submittal if necessary with prior approval.

7. Fire protection and coordination drawings do not apply to the above. These drawings may be submitted in a separate submittal.

B. The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

C. All equipment shall conform to the State and/or local Energy Conservation Standards.
D. Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General Contractor. Data submitted from Subcontractors and material suppliers directly to the Engineer will not be processed unless prior written approval is obtained by the General Contractor.

E. Before starting work, prepare and submit to the Architect/Engineer six (6) sets of all shop drawings and descriptive equipment data required for the project. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer will summarize comments in letter format and return the entire set. Continue to submit six (6) sets of any individual shop drawings, product data or samples which were returned without a "make corrections noted" or "no exceptions taken" action, until they are so marked. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the operation and maintenance manual. Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process.

F. The Design Professional’s review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:

1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
2. Construction means or methods
3. Coordination of the work with other trades
4. Construction safety precautions

G. The Design Professional’s review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional’s judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.

H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.

I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.

1.15 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.

2. Delete or mark-out portions of pre-printed data which are not applicable.

3. Where operating ranges are shown, mark data to show portion of range required for project application.

4. For each product, include the following:
   a. Sizes.
b. Weights.
c. Speeds.
d. Capacities.
c. Piping and electrical connection sizes and locations.
f. Statements of compliance with the required standards and regulations.
g. Performance data.
h. Manufacturer's specifications

B. Shop Drawings:

1. Shop Drawings are defined as mechanical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.

2. Prepare Mechanical Shop Drawings, except diagrams, to accurate scale, min 1/8" - 1'-0", unless otherwise noted.
   a. Show clearance dimensions at critical locations.
   b. Show dimensions of spaces required for operation and maintenance.
   c. Show interfaces with other work, including structural support.

C. Test Reports:

1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.

2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.

3. Submit test reports as required for O & M manuals.

D. Product Listing:

1. Prepare listing of major mechanical equipment and materials for the project, within (2) two weeks of signing the contract Documents and transmit to the Architect. A sample schedule is included at the end of this section to complete this requirement.
   a. Provide all information requested.
   b. Submit this listing as a part of the submittal requirement specified in Division 1, "PRODUCTS AND SUBSTITUTION”

2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.

3. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.
   a. Provide products which are compatible within systems and other connected items.

E. Schedule of Values

1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder. Provide according to the following descriptions:
Fiske Planetarium
University of Colorado – Department of Astrophysical & Planetary Science

BASIC MECHANICAL REQUIREMENTS

a. Site Utilities
b. Plumbing
c. Fire Protection
d. HVAC
   1) Equipment
   2) Sheet Metal
   3) Piping
   4) Insulation
   5) Test and Balancing
   6) Specialty Systems
   7) Temperature Controls
e. Miscellaneous

2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

F. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

G. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.

1.16 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Division 1.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage or contamination during shipment, storage, and handling.

C. Check delivered equipment against contract documents and submittals.

D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage, dirt, dust, freezing, heat and moisture.

E. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

F. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

G. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

H. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.

I. Protect sheet metal ductwork and fittings. Elevate and store above grade and cover ends with waterproof wrapping.
1.17 DEMOLITION:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, piping or ductwork and related items either as shown on the demolition drawings as being removed, or as required for the work. These items shall be tagged, protected from damage and stored as directed by the Architect. A list of all items stored shall be turned over to the Architect. At the completion of the remodeling work or when directed by the Architect, all stored items not reused or wanted by the Owner shall be removed from the premises. Disposition of items not reused is by the direction of the Architect/Engineer.

C. The location of existing equipment, pipes, ductwork, etc., shown on the drawings has been taken from existing drawings and is, therefore, only as accurate as that information. All existing conditions shall be verified from field measurements with necessary adjustment being made to the drawing information.

D. If asbestos material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Architect/Owner immediately. The Architect/Owner will determine the action to be taken for the asbestos removal, which is not a part of the work to be done under this Division.

1.18 CUTTING AND PATCHING:

A. This Article specifies the cutting and patching of mechanical equipment, components and materials to include removal and legal disposal of selected materials, components and equipment.

B. Refer to Division 1.

C. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.

F. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work;
2. Remove and replace defective work;
3. Remove and replace work not conforming to requirements of the Contract Documents;
4. Remove samples of installed work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect/Engineer observation of concealed work.

G. Construction and pre-occupancy indoor air quality (AQ) management:

1. During construction, meet or exceed the recommended design approaches of the SMACNA 1 AQ guideline for occupied buildings under construction, 1995, Chapter 3.

1.19 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 shop drawings and manufacturer's requirements for actual provided equipment for rough-in requirements.

C. Work through all coordination before rough-in begins.

1.20 ACCESSIBILITY:

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

B. Extend all grease fittings to an accessible location.

C. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, dampers, equipment controls, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and Division 15 for duct access door requirements.

D. The minimum size of any access door shall not be less than the size of the equipment to be removed or 20 inches x 20 inches if used for service only.

E. Furnish doors to trades performing work in which they are to be built, in ample time for building-in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

F. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.

G. Access doors in fire-rated walls and ceilings shall have equivalent U.L. label and fire rating.

1.21 BELTS, SHEAVES, IMPELLERS:

A. The Mechanical Contractor shall coordinate with the Test and Balance Contractor and supply correctly-sized drive belts, sheaves, and trimmed impellers.

1.22 NAMEPLATE DATA:

A. Provide permanent operational data nameplate, on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Coordinate with Owner for specific requirements.

1.23 LUBRICATION OF EQUIPMENT:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. Contractor shall properly lubricate all mechanical pieces of equipment which he provided before turning the building over to the Owner. He shall attach a linen tag or heavy duty shipping tag on the piece of equipment showing the date of lubrication and the type and brand of lubricant used.
C. Furnish the Engineer with a typewritten list included in the O and M manuals of each item lubricated and type of lubricant used, no later than two (2) weeks before completion of the project, or at time of acceptance by the Owner of a portion of the building and the mechanical systems involved.

1.24 CLEANING:

A. Refer to Division 1.

B. Refer to Division 15, "TESTING, ADJUSTING AND BALANCING" for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

1.25 RECORD DOCUMENTS:

A. Refer to Division 1. The following paragraphs supplement the requirements of Division 1.

B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.

C. Mark Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; 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.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1 foot-0 inches from where shown on the drawings.

D. At the completion of the project, obtain from the Architect a complete set of the Mechanical Construction Documents in the electronic format used by the design team. This set will include all revisions officially issued through the Architect. The Contractor shall transfer all revisions noted on the record document prints to the electronic drawings. The Contractor shall transmit the final record documents in the electronic format used on the project to the Architect. This contract will not be considered completed until these record drawings have been received and reviewed by the Architect/Engineer.

1.26 OPERATION AND MAINTENANCE DATA:

A. Refer to Division 1.

B. The testing and balancing report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation time frame requirements. Include in the O & M Manual after review with "No Exceptions Taken" has been accomplished.

C. In addition to the information required by Division 1 for Maintenance Data, include the following information:

1. Description of mechanical equipment, function, installation instructions, drawing specification, complete wiring and temperature controls diagrams, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.

5. Manufacturer's service manuals for all mechanical equipment provide under this contract.

6. Include the valve tag list.

7. Alphabetical list of all system components including the name, address and 24 hour phone number of the company responsible for servicing each item during the 1st year's operation.

8. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.

9. Complete parts list. Provide to Owner, recommended spare parts list.

10. Mechanical warranties.

11. Appropriate start-up information by factory representative.

D. This contract will not be considered completed nor will final payment be made until all specified material, including testing and balancing report and final schedule of values with all mechanical change order costs included and identified, is received in this operating and maintenance report and the manual is reviewed by the Architect.

1.27 PROJECT CLOSEOUT:

A. In addition to the requirements specified in Division 1, complete the requirements listed below.

B. The Contractor shall be responsible for the following Mechanical Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements.

C. Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the “Operation and Maintenance Manual” as a guide.

1.28 WARRANTIES:

A. Refer to the Division 1 for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 21, 22 & 23, into the operating and maintenance manuals.

C. Provide complete warranty information for each item to include product or equipment to include date or beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.
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1. For Soft Starters and Variable Frequency Drives
2. Requires Review & Approval from T & B Contractor
3. Warranty Report/Warranty
4. Kitchen Exhaust Hood
5. See Specific Specification Section for Test & Certification Requirements

END OF SECTION 15010
MECHANICAL/ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section specifies the basic requirements for electrical components which are either separate components or are an integral part of all mechanical equipment. These components include, but are not limited to factory installed motors, starters, variable frequency drives and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Wiring of field-mounted switches and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.

C. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Electrical Drawings. In case of conflict, Electrical Drawings shall take precedence. Do not purchase motors or electrical equipment until power characteristics available at building site location have been confirmed by Contractor.

D. Refer to Table in the Electrical Division for Mechanical/Electrical coordination.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of motors, motor starters and drives of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Single Manufacturer: Provide all motors and starters for the project by a single manufacturer except when part of factory packaged equipment. All variable frequency drives and soft start starters for the project shall be by a single manufacturer, including packaged equipment except chillers.

C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing motors, motor starters, capacitors and drives similar to that required for this project.

D. NEC Compliance: Comply with NEC as applicable to wiring methods, construction and installation of motors, motor starters, capacitors and drives.

E. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces".

F. UL Compliance: Comply with applicable requirements of UL 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors", and UL 508, "Electrical Industrial Control Equipment" pertaining to installation of motor starters.

G. UL Compliance: Provide equipment and components which are UL-listed and labeled.

H. ETL Compliance: Provide equipment and components which are ETL-listed and labeled.


K. Standards:
   1. NEMA Standards MG 1: Motors and Generators.
   2. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
   5. Comply with National Electrical Code (NFPA 70).

L. Coordination with Electrical Work: Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 16 sections. Comply with applicable requirements of Division 16 sections for electrical work of this section which are not otherwise specified.

1.3 SUBMITTALS:

A. Product Data: Submit in accordance with Section 15010.

B. Shop Drawings: Submit dimensional drawings of VFD’s showing accurately scaled equipment layouts. Drawings shall include, as a minimum: physical dimensions of each unit; general arrangements with incoming and outgoing conduit locations, schematic; connection diagram sufficient to install system, and enclosure details.

C. Wiring Diagrams: Submit schematic power and control wiring diagrams, prepared for this project, of complete VFD assemblies. General wiring diagrams with various non-applicable options shown are not acceptable. Clearly differentiate between factory and field wiring.

D. Listing, Motors of Mechanical Work: Concurrently, with submittal of mechanical products listing, submit separate listing showing rating, power characteristics, efficiencies, power factors, application and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.

1. Include in listing of motors, notations of whether motor starter is furnished or installed integrally with motor or equipment containing motor.

E. Electrical coordination listing. Provide the following information for each field wired electrical power connection. Information shall use nameplate data and nomenclature of actual installed nameplates. Information should list as a minimum:

1. Field connection details such as maximum/minimum wire size lugs can accommodate. Include number of lugs per phase.
2. Number and location of field connections.
3. Field interconnection wiring.
4. Operating voltage and phase.
5. Maximum fuse size or maximum overcurrent protection size (as applies).
7. Full load amperes.
8. Locked rotor current and duration for high inertia equipment.
9. Manufacturers recommended overload setting (if applicable).

The contractor shall fully coordinate these items with all subcontractors prior to submittal.
1.4 PRODUCT STORAGE:

A. All variable frequency drives shall be protected from dirt, debris, and moisture at all times. Variable frequency drives shall be wrapped air and water tight with dust-tight and moisture proof material until factory start-up of variable frequency drives is initiated.

Exception: Drives may be opened only during wiring terminations by temperature control contractor and/or electrical contractors.

B. All motors not designed for exposure to water or moisture shall be protected at all times.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following manufacturers for each type of product:

1. Motors
   a. AD Smith
   b. Baldor
   c. Reliance
   d. Westinghouse
   e. Toshiba
   f. Gould
   g. General Electric
   h. Louis Allis
   i. Lincoln
   j. ABB

2. Starters:
   a. Cutler Hammer
   b. Allen-Bradley
   c. Sprecher & Schuh
   d. Square D
   e. General Electric
   f. Westinghouse
   g. Siemens

2.2 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 with a time limit acceptable to the motor manufacturer. Motors shall be capable of starting the driven equipment while operating at 90 percent rated terminal voltage.

2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
3. Temperature Rating: Rated for 40 degrees C environment with maximum 80 degrees C temperature rise for continuous duty at full load (Class B Insulation). Provide Class F insulation for variable frequency drive motors.

4. Starting capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.

5. Service Factor: 1.15 for poly-phase motors, 1.35 for single phase motors, and 1.0 for inverter duty motors.

6. Altitude Deration: Motors must be selected to operate within nameplate horsepower at 5400 ft. elevation.

7. All motors rated greater than 1000W shall have a power factor of not less than 85% under rated load condition.

8. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque. Design "E" shall not be used.
   a. Frames: NEMA Standard No. 48 or 54; Use driven equipment manufacturer's standards to suit specific application.
   b. Bearings:
      1) Ball bearings with inner and outer shaft seals.
      2) Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
      3) Bearings shall be rated for minimum L-10 life of 40,000 hours.
      4) Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
      5) For fractional horsepower, light duty motors, sleeve type bearings are permitted.
   c. Enclosure Type:
      1) Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
      2) Guarded drip-proof motors where exposed to contact by employees or building occupants.
      3) Weather protected Type I for housed outdoor use, TEPC II where not housed.
      4) [All cooling tower fan motors shall be TEFC type.] [2-speed] [and reversible with reversible starter at low speed.]
   d. Overload protection: Built-in thermal overload protection for all single phase motors and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
   e. Noise rating: "Quiet". Motors shall not exceed 80DB rating when running their full speed and power range.
   f. Motors 1hp and higher are to be premium efficient, complying with Xcel Energy requirements.
g. All belt-drive motors over 5hp shall have dual push-pull adjustment screws for the motor mounts. For retrofits, the motor mounts must be replaced if not of this type.

h. Nameplate: indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

9. Phases and Current Characteristics: Unless indicated otherwise, provide squirrel-cage induction polyphase motors for 3/4 hp and larger, and provide capacitor-start single-phase motors for 1/2 hp and smaller, except 1/6 hp and smaller may, at equipment manufacturer's option, be split-phase type. Tri-voltage motors are not acceptable. Coordinate current characteristics with power specified in Division 16 sections. Do not purchase motors until power characteristics available at building site have been confirmed by contractor.

10. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate any motors which differ from the scheduled horsepower sizes or correct any motor which does not meet the listed efficiency as called for in mechanical or electrical plans and specifications.

11. Motors shall be of the same manufacturer, except those that are an integral part of a factory assembled packaged unit. These motors shall likewise meet the conditions of the specification in this section except motors which are part of a motor/compressor assembly are exempted from this requirement.

12. All motors 75 HP and larger shall be factory test certified for power factor, efficiency, and shall

2.3 STARTERS, ELECTRICAL DEVICES AND WIRING:

A. Motor Starter Characteristics:

1. Coordinate with the Electrical Contractor for motor control center starters provided by Division 16.
2. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.
3. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
4. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA style, sized and rated, 75 degrees C.

B. Manual switches shall have:

1. Maintained contacted push buttons with pilot lights for single-speed or multi-speed operation.
2. Overload protection: melting alloy type thermal overload relays.

C. Magnetic Starters:

1. Unless otherwise indicated, provide NEMA style, sized and rated magnetic starters including contacts and coils for motors 1/2 hp and larger and for smaller motors where interlock or automatic operation is indicated or required:

   a. Maintained contact H-O-A push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   b. Solid state adjustable motor overload. Select range so that upper limit is no more than 150 percent of the connected motor full load amps.
c. Interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division-15 Controls sections. In addition to the interlock & switches specified above each starter shall be provided with (4) four additional spare sets of auxiliary contacts, (2) two normally open & (2) two normally closed.

d. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.

e. Under-voltage release or protection. Re-start of equipment shall be automatic.

f. All 3-phase motors 2 hp and larger shall be protected against loss of phase (single phasing protection) wired into the starter. Externally operated manual reset.

g. Where reduced voltage starting is required, the starting method shall be part winding or closed transition auto-transformer/solid state electronic starting. Motors shall be constructed accordingly. Other methods of reduced voltage starting shall not be used unless reviewed by the Engineer prior to bid.

h. All starters used for life safety systems shall have an additional control relay to by-pass all external safeties and internal safeties except for overload protection. Coordinate with 15975.

D. Motor connections:

1. Flexible conduit, except where plug-in electrical cords are specifically indicated.

2.4 DISCONNECT SWITCHES:

A. See Division 16 for requirements.

2.5 DRIVES:

A. V-Belt Drives:

1. Capacity of V-Belt Drives at rated RPM shall be not less than 150 percent of motor nameplate horsepower rating.

2. V-Belt Drive combinations shall be limited to A, B, C and fractional horsepower belts. 3V, 5V and 8V belts and sheaves shall not be used.

3. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

4. All fixed pitch sheaves, including single groove fan sheaves, shall be of the bushed type. Fixed bore sheaves will not be acceptable for adjustable pitch sheaves.

5. Belts: Oil-resistant, nonsparking, and nonstatic.

6. Unit manufacturer shall provide OSHA approved belt guard with tachometer holes.

7. For equipment serving hazardous or critical systems (i.e., fume hoods, bio-hazards, life safety, etc.), all fans shall be provided with 1.5 times the number of belts normally required to meet above requirements, with a minimum of 2 belts.

2.6 EQUIPMENT FABRICATION:

A. General: Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives, arranged for lubrication and similar running-maintenance without removal of guards.
PART 3 - EXECUTION

3.1 TEST AND TEST DATA:

A. A factory load test shall be performed on each motor of 1000 watt input or greater to assure compliance with the energy-efficiency section of this specification.

B. Typical test data on every motor to be used on this project shall be made available upon request.

3.2 INSTALLATION:

A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.

C. Install power and control connections for motors to comply with NEC and applicable provisions of Division 16 sections. Install grounding except where non-grounded isolation of motor is indicated.

3.3 INSTALLATION COORDINATION:

A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

B. Verify windings of multi-speed or reduced voltage starters are compatible with the connected motor prior to installation.

C. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.

D. It is the intent of this specification that one "General" Contractor enters an agreement with the Owner. The use and coordination of subcontractors is at the option of the General Contractor. All mechanical equipment, motors and controls shall be furnished, set in place, and wired. The schedule contained in the Electrical Division is provided as a guide only. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of the schedule is to have the Division 15 and 16 Contractors responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Comply with the applicable requirements of Division 16 for all electrical work which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Contractor shall refer to the Division 16 and Division 15 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

END OF SECTION 15040
SECTION 15055 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:

A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.

C. Welding Certifications: Submit reports as required for piping work.

D. Brazing Certifications: Submit reports as required for piping work.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

C. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as follows: B31.1 - Pressure Piping Code / B31.2 - Fuel Gas Piping Code / B31.5 - Refrigeration Piping / B31.9 - Building Service Piping Code.

D. Before any welding is performed, the contractor shall submit to the Architect/Engineer, or his authorized, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by ASME Boiler and Pressure Vessel Code.

E. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.

F. Soldering and Brazing procedures shall conform to ANSI Standard Safety Code for Mechanical Refrigeration.

G. The University requires all plumbing work be performed under the direct supervision of State licensed plumbers (4-year), with a ratio of not more than two apprentices per journeyman. The requirement also applies to licensed pipe fitters. A Denver Journeyman Steam Fitters certification is required to supervise steam or hydronic piping. All refrigeration work shall be supervised by a Denver licensed refrigeration journeyman.

PART 2 PRODUCTS

2.1 GENERAL:

A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is
2.2 STEEL PIPES AND PIPE FITTINGS:

A. Black Steel Pipe: ASTM A 53, Grade B, type E, electric resistance welded.
   1. Interior Exposed or Accessible Natural Gas Piping:
      a. Size: ½” thru 1-1/2”
         Pipe: Schedule 40, ASTM A120
         Fittings: Threaded malleable iron
         Joint Seal: Rector seal or Teflon paste
         Unions: Black malleable iron ground joint, bronze to iron seat, 150lb. class, ANSI B2.1
         and ASTM A197.
      b. Size: 2” and Larger
         Pipe: Schedule 40, ASTM A53, Type S Grade B
         Fitting: Butt weld ASTM A234
         Unions: 150lb. forged steel weld neck flange, ANSI/B16.5 and ASTM A150

B. Galvanized Steel Pipe: ASTM A 53, Grade B.

C. Seamless Steel Pipe: ASTM A 53, Grade B, type S or A106 high temperature.

D. Stainless Steel Pipe: ASTM A 312; Grade TP 304 (high temperature and corrosive service, 1/8 inch
   thru 30 inches).

E. Stainless Steel Sanitary Tubing: ASTM A 270; Finish No. 80, (dairy and food industry, 1 inch thru 4
   inches).

F. Steel Water Pipe: AWWA C200 for pipe 6 inches and larger.

G. Coal Tar Protective Coatings and Linings for Steel Water Pipe: AWWA C203 for enamel and tape, hot
   applied.

H. Chlorinated Rubber-Alkyd Paint System for Steel Water Pipe: AWWA C204 (exterior above-ground
   steel water pipe).


J. Cast-Iron Flanged Fittings: ANSI/ASME B16.1, including bolting (Class 125 and 250).


L. Malleable-Iron Threaded Fittings: ANSI/ASME B16.3; plain or galvanized as indicated (Class 125 and
   300).
M. Malleable-Iron Threaded Unions: ANSI B16.39, Class 150, 250 or 300; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated (Class 150, 250 and 300).


O. Steel Flanges/Fittings: ANSI/ASME B16.5, ASTM A234 (Fire Protection) including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.

   Material Group: Group 1.1.
   End Connections: Buttwelding.
   Facings: Raised-face.

P. Steel Pipe Flanges for Waterworks Service: AWWA C207 (water service piping only).

Q. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing (threaded where pressure is not critical).

R. Forged-Steel Socket-Welding and Threaded Fittings: ANSI B16.11, except MSS SP-79 for threaded reducer inserts; rated to match schedule of connected pipe (up to 4 inch pipe size).

S. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

T. Stainless-Steel Buttwelding Fittings: MSS SP-43.


V. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

W. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 inches, and where pipe size is less than 1-1/2 inches, and do not thread nipples full length (no close-nipples).

2.3 COPPER TUBE AND FITTINGS:

A. Copper Tube: ASTM B 88; Type K or L as indicated for each service; hard-drawn temper, except as otherwise indicated.

B. ACR Copper Tube: ASTM B 280.


D. Wrought-Copper Solder-Joint Fittings: ANSI B16.22.

E. Cast-Copper Solder-Joint Drainage Fittings: ANSI B16.23 (drainage and vent with DWV or tube).

F. Wrought-Copper Solder-Joint Drainage Fittings: ANSI B16.29.


H. Bronze Pipe Flanges/Fittings: ANSI B16.24 (Class 150 and 300).
I. Copper-Tube Unions: Provide standard products recommended by manufacturer for use in service indicated.

2.4 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.


B. Soldering Materials: All soldering materials shall be lead free and antimony-free.

1. Melting Range 450-470 degrees F. All-state “Aquasafe” or equal.
3. Flux: All flux shall be lead free, water soluble, and compatible with the solder and the materials being joined. ASTM B813-93.

C. Brazing Materials: Except as otherwise indicated, provide brazing materials to comply with installation requirements.

1. Comply with AWSA 5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.
   a. Copper phosphorus -Bcup-5, 15 percent solver content, melting range 1190 to 1480 degrees F.
   b. Silver - BAg-36, 45 percent silver, cadmium-free. Melting range 1195 to 1265 degrees F.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

E. Piping Connectors for Dissimilar Non-Pressure Pipe: Elastomeric annular ring insert, or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends and subject to approval by plumbing code.

1. Manufacturer: Subject to compliance with requirements, provide piping connectors of the following:
   a. Husky Technologies (Husky SD 4000):

F. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.

1. Manufacturer: Subject to compliance with requirements, provide piping thread sealant material of the following:
   a. The Rectorseal Corporation
PART 3 EXECUTION

3.1 EXAMINATION:
   A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, and original design, and the referenced standards.
   B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
   C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:
   A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.
      1. Comply with ANSI B31 Code for Pressure Piping.
      2. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.
      3. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
      4. Use fittings for all changes in direction and all branch connections.
      5. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
      6. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
      7. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
      8. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
      9. Install drains in pressure pipe systems at all low points in mains, risers, and branch lines consisting of a tee fitting, hose end ball valve and cap with chain.
     10. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
11. Fire and Smoke Wall Penetrations: Where pipes pass through fire and smoke rated walls, partitions, ceilings, and floors, maintain the fire and smoke rated integrity. Refer to Division 15, Section 15120 and 15050 for materials.

12. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals (See Section 15120). Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.

13. Floor Penetrations:
   a. Install sleeves 2” A.F.F. for all penetrations in rooms with floor drains and for all penetrations in walls surrounding the rooms, kitchens, mechanical, baths, lavs and breakrooms.
   b. All existing floors that are core drilled shall comply with section A.
   c. Provide protective sleeve for insulated piping that penetrates finish flooring.

14. Anchor piping to ensure proper direction of expansion and contraction.

15. Coordinate foundation and all other structural penetrations with structural engineer.

16. All underground piping shall be surrounded by 6” of squeegee.

17. Provide brass couplings or valves at all connections between dissimilar metals in water systems to control corrosion potential caused by galvanic or electrolytic action. Dielectric unions are not acceptable.

B. Sanitary Waste and Vent Piping:

1. Install plumbing drainage piping with 1/4 inch per foot (2 percent) downward slope in direction of drain for piping 3 inches and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install cast iron pipe in accordance with the Cast Iron Soil Pipe Institute Handbook.

2. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. SANITARY CROSSES OR SHORT QUARTER BENDS SHALL NOT BE USED IN DRAIN PIPING.

3. Provide thrust restraints (bracing to structure or rodded joints) at branches and changes in direction for cast iron pipe 5inches and larger suspended within the building.

4. Where cast iron piping is suspended in excess of 18 inches on single rod hangers, sway bracing shall be provided to prevent shear at the joints.

5. Place bell ends or groove ends of piping facing upstream.

C. Refrigerant Piping:


2. Install piping in as short and direct arrangement as possible to minimize pressure drop.

3. Install piping for minimum number of joints using as few elbows and other fittings as possible.
4. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

5. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

6. Insulate suction lines. Liquid line are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
   a. Do not install insulation until system testing has been completed and all leaks have been eliminated.

7. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

8. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

9. Slope refrigerant piping as follows:
   a. Install horizontal hot gas discharge piping with 1/2 inch per 10 feet downward slope away from the compressor.
   b. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
   c. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
   d. Liquid lines may be installed level.

10. System Testing:
   a. Pressure Test – System shall hold 150 psi nitrogen charge for a 24-hour period and be inspected by HVAC representative.
   b. Evacuation – System shall be evacuated to 250 microns, and inspected by HVAC representative.

D. Condensate Drain Piping:

1. Condensate drain piping from air conditioning unit coil condensate drain pan shall be of the sizes shown on the drawings. Pitch 1/8”/ft in direction of flow.

3.3 PIPING SYSTEM JOINTS:

A. General: Provide joints of type indicated in each piping system.

B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
C. Copper ≥ 2": Braze copper tube-and-fitting joints in accordance with ASME B31.

D. Copper ≤ 2": Solder copper tube-and-fitting joints with silver solder or 95-5 tin-antimony/free solder. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.

E. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.

F. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0 degrees F (-18 degrees C) where possible.
   2. Bevel pipe ends at a 37.5 degrees angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inch to 20 inch.
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
   5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

G. Weld pipe joints of steel water pipe in accordance with AWWA C206.

H. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

I. Hubless Cast-Iron Joints: Comply with coupling manufacturer's installation instructions. Use pre-set torque wrench set to 80 in-lbs on heavy duty couplings.

3.4 PIPING APPLICATION:

A. Domestic Hot and Cold Water - Inside Building:
   1. Above Grade Inside Building:
      a. 6 inches and Smaller: Type K, hard drawn copper tube with wrought copper or bronze fittings, 95-5 tin-antimony / silver tin alloy soldered joints.
      b. Provide plastic isolators at all clamps.

B. Sanitary Drainage and Vents - Inside Building:
   1. Above Grade: Service weight cast iron, no-hub type with neoprene gaskets; service weight cast iron, hub and spigot type with neoprene gaskets; or DWV copper with wrought copper of cast brass fittings.
C. Equipment Drains and Overflows:
   1. Type "L" or copper.

D. Refrigerant Piping:
   1. Type "L" ACR copper, cleaned, dehydrated and capped at the factory. Wrought copper fittings with brazed joints.

3.5 PIPING TESTS:

A. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.

B. Test all piping systems as specified. Correct leaks by remaking joints. Remove equipment not able to withstand test procedure during test.

C. Work to be installed shall remain uncovered until the required tests have been completed.

D. Piping which is to be concealed shall be tested before being permanently enclosed.

E. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.

F. Give a minimum of twenty-four hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of owner, agency having jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

G. Contractor shall obtain certificates of approval, acceptance and compliance with regulations of agencies having jurisdiction. Work shall not be considered complete until such certificates have been delivered by the Engineer to the Owner.

H. All costs involved in these tests shall be borne by Contractor.

I. System Tests
   1. Hydrostatic Test: The test shall be accomplished by hand pumping the system to the specified water pressure, and maintaining that pressure until the entire system has been inspected for leaks, but in no case for a time period of less than four hours.
      a. Domestic water systems: 100 psig or 150 percent of system pressure, whichever is greater.

   2. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, the piping system shall be subjected to the gas pressure indicated for that specific system. The piping capped or plugged and water-pumped with oil free air, or a nitrogen bottle shall be introduced into the entire system to the pressure specified. The system shall maintain that pressure for the duration of a soapy water test of each joint.
3. Waste, Drain and Vent Piping: All waste and vent piping, including building drain, roof drain and building sewer, shall be subjected to a water test. All openings in the piping system shall be tightly closed, except the highest opening, and the system filled with water to the point of overflow. The water shall be kept in the system, or in the portion under test, for at least 15 minutes before inspection starts; the system shall then be tight to all points. No section shall be tested with less than a ten foot head of water. Roof drain shall be closed at the lowest point and filled with water to the point of overflow.

4. Test all refrigerant piping systems with nitrogen at 300 psig pressure on high side of system, and at 150 psig pressure on low side of system. Maintain pressure without loss for a time period of not less than 4 hours. After test has been completed, the piping shall be evacuated by means of a vacuum pump for a period of not less than 24 hours or until system has been completely evacuated.

5. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

6. Drain test water from piping systems after testing and repair work has been completed.

3.6 ADJUSTING AND CLEANING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

B. Disinfect all potable water mains and water service piping in accordance with local and health department requirements. Submit test results report. Submit MOP before starting caps.

C. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers. Submit MOP before starting caps.

D. Chemical Treatment: Provide hydronic systems with a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

END OF SECTION 15055
PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
   2. NFPA Compliance: Hangers and supports shall comply with NFPA standard No. 13 when used as a component of a fire protection system.
   3. UL and FM Compliance: Hangers, supports, and components shall be listed and labeled by UL and FM where used for fire protection piping systems.
   4. Duct Hangers: SMACNA Duct Manuals
   5. MSS Standard Compliance:
      a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-69.

1.2 SUBMITTALS:

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

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 15.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   1. Pipe Hangers and Supports:
      a. B-Line Systems Inc.
      b. Grinnell
      c. PHD Manufacturing, Inc.
d. Michigan  
e. Tolco  

2. Saddles, Shield and Thermal Shield Inserts:  
   a. ANVIL International  
   b. Pipe Shields, Inc.  
   c. B-Line  
   d. Insulated Saddle Shield Insert Product Inc.  

3. Roof Equipment Supports:  
   a. Custom Curb, Inc.  
   b. Pate Co.  
   c. Thycurb Div.; Thybar Corp.  
   d. Vent Products, Inc.  

4. Concrete Inserts and Anchors:  
   a. Unistrut Metal Framing Systems  
   b. Power-Strut  
   c. ITW Ramset/Red Head  
   d. Hilti  
   e. B-Line  

2.2 PIPE HANGERS & SUPPORTS:  

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-69.  
   1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.  
   2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.  

B. Adjustable Clevis Hanger: MSS Type.  
   1. Steel Pipe, size 3/8" thru 30", Type 1.  
   2. Non-insulated Copper Pipe, size 1/2" thru 4", Type 1. (PVC Coated)  

C. Adjustable Swivel Ring for Non-insulated Pipe: MSS Type.  
   1. Steel Pipe, size 1/2" thru 8", Type 7.  
   2. Copper Pipe, size 1/2" thru 4", Type 7 (PVC Coated)  

D. Pipe Clamps: MSS Type.  
   2. Copper Pipe, size 1/2" thru 4", Type 8 (PVC Coated).  

E. U Bolts: MSS Type.  
   1. Steel Pipe, size 1/2" thru 30" Type 24
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2. Copper Pipe, size 1/2" thru 8", Type 24 (PVC Coated).

F. Straps: MSS Type 26.

G. Pipe Stanchion Saddle: MSS Type 37.

H. Yoke & Roller Hanger: MSS Type 43

I. Hanger Rods: Continuous threaded steel, sizes as specified.

J. Hangers:
   1. Cold Pipes:
      a. 1/2" through 1-1/2": Adjustable wrought steel ring.
      b. 2" and Over: Adjustable wrought steel clevis.
   2. Multiple or Trapeze: Structural steel channel (with web vertical and engineered for the specific applications), with welded spacers and hanger rods. Provide cast iron roll and base plate for hot pipe sizes six inches and over. Provide hanger rods one size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.

K. Wall Supports for Horizontal Steel Pipe:
   1. ½ inch through 4inches: Offset or straight j-hook.
   2. 4 inches and Over: Welded steel bracket Type 31, 32 or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll Type 44 for hot pipe 200° F and over and for sizes six inches and over.

L. Supports for Vertical Pipe: Steel riser clamp. Type 8.

M. Upper Attachments:
   1. For attaching hanger rods to structural steel I-beams:
      a. Provide adjustable beam clamp, MSS-Type 21. Attach to bottom flange of beam.
   2. For attaching hanger rods to bar joists:
      a. When bottom chord is constructed of structural steel angles, provide square washer. Place hanger rod between backs of the two angles and support with the washer and dual locking nuts on top of the angles. Spot weld washer to angles.
      b. When bottom chord is constructed of round bars, provide Elcen No. 137 bar joint washer or equal.

2.3 CONCRETE INSERTS AND ANCHORS:

A. Inserts: Case shall be of galvanized carbon steel with square threaded concrete insert nut for hanger rod connection; top lugs for reinforcing rods, nail holes for attaching to forms. This type of upper attachment is to be used for all areas having poured in place concrete construction.
   1. Size inserts to suit threaded hanger rods.
B. Provide fasteners attached to concrete ceilings that are vibration and shock resistant. Provide hangers for piping attached to concrete construction with one of the following types.

1. Concrete insert per MSS SP 69, Type 18.
2. Powder driven fasteners subject to approval of Architect and Structural Engineer. Each fastener shall be capable of holding a test load of 1000 pounds whereas the actual load shall not exceed 50 pounds.
3. Self-drilling expansion shields. The load applied shall not exceed one-fourth the proof test load required.
4. Machine bolt expansion anchor. The load applied shall not exceed one-fourth the proof test load required.

C. Anchors: Carbon steel, zinc plated and coated with a clear chromate finish. Installation shall be in holes drilled with carbide-tipped drill bits or by use of self-drilling anchors.

1. Provide anchors suitable for the location of installation and designed to withstand all forces and movements acting in the anchor. Manufacture pipe anchors in accordance with MSS SP 69. Provide a safety factor of four for the anchor installation.

2.4 SADDLES AND THERMAL SHIELD INSERTS:

A. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.

B. Protection Shields: MSS Type 40; 180 degrees arc, galvanized steel, minimum 12 inches long, to prevent crushing of insulation.

C. Thermal Shield Inserts: Provide 100-psi minimum compressive strength, waterproof, asbestos free calcium silicate, encased with a sheet metal enclosure. Insert and shield shall cover the entire circumference or the bottom half circumference of the pipe as required by Part 3 of this Specification, and shall be of length recommended by the manufacturer for pipe size and thickness of insulation. For cold piping, calcium silicate shall extend beyond the sheet metal shield to allow overlap of the vapor barrier. Where piping 4 inches and larger is supported on trapeze or pipe rollers, provide double thickness shields. For piping 12 inches and over, provide 600 psi calcium silicate structural insert.

2.5 MISCELLANEOUS MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

C. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

D. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.
2.6 ROOF EQUIPMENT SUPPORTS:

A. See details on drawings

PART 3 EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 PREPARATION:

A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments. Review Structural Drawings to obtain structural support limitations.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments within concrete or on structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

B. New Construction:

1. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

2. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inches or ducts over 60 inches wide.

3. Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

4. Where inserts are omitted drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab if construction above permits.

C. Existing Construction:

1. In existing concrete construction, drill into concrete slab and insert and tighten expansion anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete construction not to sever reinforcement rods or tension wires.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

C. Support fire-water piping independently from other piping systems.

D. Prevent electrolysis and abrasion in support of copper tubing by use of hangers and supports which are plastic coated, or with EPDM isolation strips. Duct tape or copper coated hangers are not acceptable.

E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

F. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31.9 Building Services Piping Code is not exceeded.

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

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

2. Saddles: Install Protection saddles where supported by pipe rollers. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Shields: Install galvanized steel protection shields, on all insulated piping ¾" and less, except where required to be clamped. Where necessary to prevent dislocation, strap shield to pipe with wire ties or "Zip Strips".

4. Thermal Inserts: Provide thermal shield inserts at all supports for all insulated piping 1 inch and larger and for all piping required to be clamped. Provide 180 percent inserts at clevis and roller hangers. Provide 360 percent inserts for all trapeze and clamped supports.

I. Install horizontal hydronic with the following minimum rod sizes and maximum spacing:

<table>
<thead>
<tr>
<th>SIZE (NPS)</th>
<th>MAX. SPAN IN FEET</th>
<th>MIN. ROD SIZE-INCHES</th>
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<tbody>
<tr>
<td></td>
<td>Steel</td>
<td>Copper</td>
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<tr>
<td>1</td>
<td>7</td>
<td>6</td>
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<td>1-1/2</td>
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<tr>
<td>5</td>
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<td>10</td>
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J. Place a hanger within one foot of each horizontal elbow.

K. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.
L. Support vertical steel and copper piping at every story height but at not more than 15 foot intervals for steel and 10 feet for copper.

M. Where several pipes can be installed in parallel and at same elevation, provide trapeze hangers.

N. Where practical, support riser piping independently of connected horizontal piping.

O. Each pipe drop to equipment shall be adequately supported. All supporting lugs or guides shall be securely anchored to the building structure.

P. Securely anchor and support plumbing domestic water piping in chases or walls. Use factory manufactured clamps and brackets connected to fixture s, waste/vent piping or brackets connected to studs. Wires or straps will not be permitted.

1. When copper supplies are connected to flush valves, support the tubing by the studs or by a fixture, not by clamping to waste/vent piping.

2. Prevent copper tubes from making contact with steel brackets using fire retardant polyethylene inserts or other dielectric insulating material. Duct tape shall not be used.

Q. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than 6 inches) in undisturbed concrete. Where it is considered that many fasteners are improperly installed, the Contractor shall test load any 50 successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.

3. Hangers for piping and ducts shall be attached to cellular steel floor decks with steel plates and bolted rod conforming to the steel deck manufacturer's requirements. Where the individual hanger load exceeds the capacity of a single floor deck attachment, steel angles, beams or channels shall be provided to span the number of floor deck attachments required.

4. Welding may be used for securing hangers to steel structural members. Welded attachments shall be designed so that the fiber stress at any point of the weld or attachment will not exceed the fiber stress in the hanger rod.

R. Place a hanger within 6” of both sides of a control valve.

S. Within walls, support vertical pipe every 6 feet where pipe supplies a fixture.

3.5 INSTALLATION OF ANCHORS:

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31.9, and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure. Comply with ANSI 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. Provide shop drawing for review by Engineer.

3.6 SHEET METAL DUCT HANGERS AND SUPPORTS:

A. Provide in accordance with SMACNA HVAC duct construction standards.

B. Additional Hanger Requirements:
   1. 2" to 24" from flexible connections of fans.
   2. 2" to 24" from the outlets or flexible connections of VAV control units or mixing boxes.
   3. 12" to 36" from the main duct to the first hanger of long branch ducts.
   4. 2" to 12" from the ends of all branch ducts and linear diffuser plenums.
   5. 2" to 24" from fire damper break-away joints.
   6. Hangers at throat and heal of round or square elbows 48" or greater in width.

3.7 EQUIPMENT SUPPORTS:

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

B. Grouting: Place grout under supports for piping and equipment.

C. Concrete bases for the mechanical equipment indoors or outdoors will be provided by the General Contractor only if shown on the architectural or structural drawings. Otherwise, all bases shall be provided by this Contractor.

D. Housekeeping bases shall be 4 inches thick minimum, extended 4 inches beyond machinery bedplates.

E. This Contractor shall be responsible for the proper size and location of all bases and shall furnish all required anchor bolts and sleeves. If bases are provided by the General Contractor, furnish him with templates showing the bolt locations.

F. Equipment shall be secured to the bases with anchor bolts of ample size. Bolts shall have bottom plates and pipe sleeves and shall be securely imbedded in the concrete. All machinery shall be grouted under the entire bearing surface. After grout has set, all wedges, shims and jack bolts shall be removed and the space filled with non-shrinking grout. This Contractor shall provide lead washers at all equipment anchor bolts.

G. Construct equipment supports above floor of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

H. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment. See also Section 15241.

3.8 PREFABRICATED ROOFTOP EQUIPMENT SUPPORTS:

A. Equipment Bases:
1. Equipment base shall be solid top equipment base with and stepped cant to match roof insulation. Base shall pitch to match roof pitch and provide level unit installation.

2. Base shall be constructed of reinforced 18 gauge galvanized steel with all welded components, full mitered corners, factory installed 1-1/2 inches thick rigid fiberglass insulation, wood nailer, and galvanized steel counter-flashing. Base shall be shipped as one piece.

B. Equipment Rails:

1. Equipment rail shall be constructed of 18 gauge galvanized steel shell, base plate, and counterflashing with factory installed wood nailer, fully mitered end sections, stepped cant to match roof insulation. Rails shall pitch to match roof pitch and provide level installation.

C. All supports shall be installed in accordance with manufacturer’s recommendations.

3.9 METAL FABRICATION:

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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. Finish welds at exposed connections so no roughness shows after finishing and contours at welded surfaces match adjacent contours.

3.10 ADJUSTING:

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
SECTION 15190 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

B. Mechanical Identification:
   2. Brimar Industries, Inc.
   3. Industrial Safety Supply Co., Inc.
   4. Seton Name Plate Corp.
   5. PVC Specialties

2.2 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-15 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PLASTIC PIPE MARKERS:

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

B. Insulation: Furnish 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F. (52 degrees C.) or greater. Cut length to extend 2 inches beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6 inches (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inch.

D. Large Pipes: For external diameters of 6 inches and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Steel spring or non-metallic fasteners.
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inches wide; full circle at both ends of pipe marker, tape lapped 3 inches.
3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled, shown, or to match existing building lettering nomenclature system and abbreviate only as necessary for each application length.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.4 PLASTIC DUCT MARKERS:

A. General: Provide manufacturer's standard laminated plastic, duct markers.

B. For hazardous exhausts, use colors and designs recommended by ANSI A13.1.

C. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust, etc.)

2.5 PLASTIC TAPE:

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2 inches wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6 inches, 2-1/2 inches wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.6 ENGRAVED PLASTIC-LAMINATE SIGNS:

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch, except as otherwise indicated.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
2.7 PLASTICIZED TAGS:

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inch x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.8 LETTERING AND GRAPHICS:

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified, scheduled and approved by the Owner/Engineer. Provide numbers, lettering and wording as indicated and approved by the Owner/Engineer for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as designated on the drawings or schedule as well as service.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

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

3.2 DUCTWORK IDENTIFICATION:

A. General: Identify air supply, return, exhaust, intake and relief ductwork and duct access doors with duct markers; or provide stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color). Existing building identification shall match the existing method which exists in the building.

B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50 foot spacing along exposed runs.

C. Access Doors: Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment), other maintenance and operating instructions, and appropriate safety and procedural information.

D. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification in lieu of specified signs, at Installer's option.

3.3 PIPING SYSTEM IDENTIFICATION:

A. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow. Existing building identification shall match the existing method which exists in the building.

B. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
C. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

D. Near each valve and control device.

E. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

F. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.

G. At access doors, manholes and similar access points which permit view of concealed piping.

H. Near major equipment items and other points of origination and termination.

I. Spaced intermediately at maximum spacing of 25 feet along each piping run, except reduce spacing to 15' in congested areas of piping and equipment.

J. On piping above removable acoustical ceilings.

3.4 MECHANICAL EQUIPMENT IDENTIFICATION:

A. General: Install minimum 2 inch x 4 inch engraved plastic laminate equipment marker on each individual items of mechanical equipment.

B. Lettering Size: Minimum 1/4 inch high lettering for name of unit.

C. Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.5 ADJUSTING AND CLEANING:

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 15190
SECTION 15241 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of vibration control work required by this section is indicated on drawings and schedules, and/or specified in other Division-15 sections.

B. Types of vibration control products specified in this section include the following:
   1. Roof-Curb Isolators.

C. Vibration control products furnished as integral part of factory-fabricated equipment, are specified as part of equipment assembly in other Division 15 sections.

D. Refer to other Division 15 sections for equipment foundations; hangers; sealants; gaskets; requirements of electrical connections to equipment isolated on vibration control products; requirements of duct connections to air handling equipment isolated on vibration control products.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products, of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.
   1. Except as otherwise indicated, obtain vibration control products from single manufacturer.
   2. Engage manufacturer to provide technical supervision of installation of support isolation units produced, and of associated inertia bases (if any).

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.
   1. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
   2. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics, ratio of horizontal to vertical stiffness and bases of spring-rated selection for range of loading weights.
   3. Include performance certifications from manufacturers.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weights, required clearances, and method of assembly of components. Detail bases, and show location of equipment anchoring points, coordinated with equipment manufacturer's shop drawings.
   1. Shop drawings showing structural design and details of inertia bases, steel beam bases and other custom-fabricated work not covered by manufacturer's submitted data.
      a. Furnish templates, anchor bolts and sleeve for equipment bases, foundations and other support systems for coordination of vibration isolation units with other work.
2. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.
   
a. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

C. Maintenance Data: Submit maintenance data for each type of vibration control product. Include this data, product data and shop drawings in maintenance manual; in accordance with requirements of Divisions 15.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:
   
A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   
1. Vibration Control Products:
   
a. Amber/Booth
b. Mason Industries, Inc.
c. Korfund
d. Metraflex
e. Vibration Mountings and Control Co.
f. Vibrex

2.2 VIBRATION CONTROL MATERIALS AND SUPPORT UNITS:
   
A. Roof-Curb Isolators: Fabricated frame units sized to match roof curbs, formed with isolation springs Type C between extruded aluminum upper and lower sections, which are shaped and positioned to prevent metal-to-metal contact. Provide continuous airtight and waterproof seal between upper and lower extrusions. Include provisions for anchorage of frame unit to roof curb, and for anchorage of equipment to unit.
   
1. Mason Industries Type CMAB or as indicated on the plans.

PART 3 - EXECUTION

3.1 INSPECTION:
   
A. Examine areas and conditions under which vibration control units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Owner or his representative.

3.2 PERFORMANCE OF ISOLATORS:
   
A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units to achieve minimum static deflection and displacement requirements.
3.3 APPLICATIONS:


3.4 INSTALLATION:

A. General: Except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short- circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Install units between substrate and equipment as required for secure operation and to prevent displacement by normal forces.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where substrate is not level.

D. For air handling equipment, install thrust restraints as indicated, and also wherever thrust exceeds 10 percent of equipment weight.

3.5 EXAMINATION OF RELATED WORK:

A. Installer of vibration isolation work shall observe installation of other work related to vibration isolation work, including work connected to vibration isolation work; and, after completion of other related work (but before equipment startup), shall furnish written report to Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:

1. Equipment installations (performed as work of other sections) on vibration isolators.
2. Piping connections including flexible connections.
3. Ductwork connections including provisions for flexible connections.
4. Passage of piping and ductwork which is to be isolated through walls and floors.

B. Do not start-up equipment until inadequacies have been corrected in manner acceptable to vibration isolation installer.

3.6 ADJUSTING AND CLEANING:

A. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short- circuit unit isolation.

3.7 DEFLECTION MEASUREMENTS:

A. Upon completion of vibration isolation work, prepare report showing measured equipment deflections theoretical floor deflection and isolation efficiency for each major item of equipment.

END OF SECTION 15241
SECTION 15250 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of mechanical insulation specified in this section include the following:

1. Ductwork System Insulation:

   Fiberglass.
   25/50 Rated Flexible Closed Cell Flexible Elastomeric.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products and systems, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this project.

C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove that fire hazard ratings for materials proposed for use do not exceed those specified.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, density, and furnished accessories for each mechanical system requiring insulation. Submit detail product information and installation information for all jacketing systems specified in this section.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide product by one of the following:

1. Mechanical Insulation:
a. Armacell  
b. Certain-Ted  
c. Johns Manville Corp.  
d. Knauf  
e. Nomaco  
f. Owens-Corning.  
g. Snappitz Mechanical Pipe Shields

2. Jacketing & Covering Products:

a. Childers  
b. Ceel-Co  
c. Zeston  
d. Alpha Associates, Inc.

2.2 PIPING INSULATION MATERIALS:

A. Jackets for Piping Insulation: ASTM C 921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. Fitting Covers: UV resistant PVC, pre-molded fitting covers, flame spread 25, smoke developed 50. PVC tape for cold systems, serrated tacks or PVC tape for hot systems.

2. Aluminum Jacketing: Manufactured from T3003 (or T/5005) H14 to H19 aluminum alloy with 3/16" corrugations and shall have a factory attached 1 mil thick polyethylene moisture barrier continuously laminated across the full width of the jacketing. Jacketing shall be .016" thick minimum. Provide matching factory fabricated covers for 90 degrees and 45 degrees elbows, tee fittings, flange fittings valve bodies, blind ends, reducers and other fittings necessary to make the covering system complete, waterproof and weatherproof.

B. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

C. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated and additional finishes as specified.

2.3 DUCTWORK INSULATION MATERIALS:

A. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class 1, 450 degrees F temperature limit, density of 3 pcf. "K" value shall be maximum 0.23 at 75 degrees F. mean temperature, facing of 7 mil, foil reinforced with glass mesh and laminated to 40 lb kraft.

B. Round Surface Semi-Rigid Fiberglass Blanket Insulation: ATSM C 612, Class 1, 450 degrees F temperature limit, 2.5 PCF density “K” value of .25 max at 75 degrees F mean temp, foil-skrim-kraft facing. Orientation of fibers shall be perpendicular to facing to facilitate application on round surfaces.

C. Flexible Fiberglass Ductwork Insulation: ASTM C 553, Type I, 3/4 lbs per cu. ft. density. "K" value shall be maximum 0.25 at 75 degrees F. mean temperature, 250 degree F temperature limit, vapor transmission rating shall not exceed 0.02 perms, facing of .7 mil foil reinforced with glass mesh and laminated to 40 lb kraft.

D. Flexible closed cell elastomeric insulation: ASTM C534, Type I, "K" value shall be a maximum 0.27 at 75 degrees F mean temp, 220 degrees F Temperature limit, water vapor permeability rating of 0.10 perm inches or less.
E. Jackets for Ductwork Insulation: ASTM C 921, Type I for ductwork with temperatures below ambient; Type II for ductwork with temperatures above ambient.

1. Aluminum Jacketing: The jacketing shall be manufactured from T3003 (or T/5005) H14 to H19 aluminum alloy with 3/16 inch corrugations and shall have a factory attached 1 mil thick polyethylene moisture barrier continuously laminated across the full width of the jacketing. Jacketing shall be .016 inches thick minimum. Where available, provide matching factory fabricated covers for 90 degrees and 45 degrees elbows, tee fittings, branch fittings, reducers and other fittings necessary to make the covering system complete, waterproof and weatherproof.

F. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

G. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.4 ADHESIVES, SEALANTS, AND VAPOR BARRIER COATINGS:

A. Materials must be paintable where painting is required.

1. LEED EQc4.1: Low-Emitting Materials:

   a. All interior adhesives and sealants must meet or exceed VOC limit requirements of South Coast Air Quality Management District Rule #1168 and sealants used as fillers must meet requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

2. LEED EQ.4.2: Low-Emitting Materials All interior paints and coatings must meet or exceed VOC limit requirements of Green Seal GS-11 and GS-03:

   a. Vapor Barrier Coatings—used in conjunction with reinforcing mesh to coat insulation on below ambient services temperatures. Permeance shall be no greater than 0.08 perms at 45 mils dry as tested by ASTM E96/ASTM F1249. Foster 30-65; Childers CP-34; Vimasco 749.

   b. Reinforcing Mesh—used in conjunction with coatings/mastics to reinforce. 10x10 polyester or fiberglass mesh. Foster Mast A Fab; Childers Chil Glas #10; Vimasco Elastafab 894.

   c. Lagging Adhesives—used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 Sealfas; Childers CP-50AMV1 Chil Seal; Vimasco 714.

   d. Weather Barrier Mastic—used outdoors to protect above ambient insulation from weather. Foster 46-50 Weatherite; Childers CP-10 Vi Cryl; Vimasco 714.

   e. Fiberglass Adhesive—used bond low density fibrous insulation to metal surfaces. Shall meet ASTM C 916 Type II. Foster 85-60; Childers CP-127; Vimasco 795.

   f. Elastomeric Insulation Adhesive—used to bond elastomeric insulation. Foster 85-75; Childers CP-82; K Flex 373.

   g. Elastomeric Insulation Coating—water based coating used to protect outside of elastomeric insulation. Foster 30-64; K Flex 374; Armacell WB finish.

   h. Metal Jacketing Sealant—used as a sealant on metal jacketing seams to prevent water entry. Foster 95-44; Childers CP-76; Pittsburgh Corning PC 727.
PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

B. Workmanship shall be first class and of the highest quality, poor installation or bad appearance as determined by the engineer shall be due cause to reject the entire project in whole and retainage will be withheld until corrective action is completed to the engineer's satisfaction.

3.2 HVAC PIPING SYSTEM INSULATION:

A. Insulation Omitted: Omit insulation on steam condensate piping between steam trap and union; and on hot piping unions, flexible connections, and expansion joints. Insulation may be omitted inside of cabinet unit heaters, convectors and fan coils for hot piping. Cold piping insulation inside fan coil unit cabinet may be omitted provided piping is located over drain pan. Hot and cold piping routed inside air handler units shall be insulated. Omit insulation on strainers in heating water strainers operating below 200 degrees F.

B. Sub-Freezing Piping (0 to 39 deg. F (-18 to 4 degrees C)):

1. Application Requirements: Insulate the following sub-freezing HVAC piping systems:

   a. Refrigerant suction lines between evaporators and compressors.

2. Insulate each piping system specified above with the following types and thicknesses of insulation:

   a. Pre-Insulated Soft Copper Refrigerant Line Sets - Flexible Elastomeric: 1 inch thickness for pipe sizes up to and including 2 inches.

C. Cold Piping (40 degrees F (4.4 degrees C) to ambient):

1. Application Requirements: Insulate the following cold HVAC piping systems:

3.3 STEM INSULATION:

A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork.

B. Application Requirements: Insulate the following ductwork:

1. Outdoor air intake ductwork and plenums between air entrance and fan inlet or HVAC unit inlet.

2. Mixed air ductwork and plenums between air entrance and fan inlet or HVAC unit inlet.

3. HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet unless ductwork is specified to be lined.

4. HVAC return ductwork in unconditioned spaces or exterior; except omit insulation when ductwork is specified to be lined.

5. HVAC plenums and unit housings not pre-insulated at factory or lined.

6. Rigid oval or round supply air ductwork.
C. Insulate each ductwork system specified above with the following types and thicknesses of insulation:

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>RIGID/ FIBERGLASS</th>
<th>FLEXIBLE FIBERGLASS</th>
<th>FLEXIBLE ELASTOMERIC**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior; concealed; cold, hot or dual temperature duct</td>
<td>1” min. up to 2” as required to cover joints &amp; reinforcements</td>
<td>1-1/2”</td>
<td>1”</td>
</tr>
<tr>
<td>Interior; exposed within conditioned finished spaces; cold, hot, or dual temperature duct</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Exterior; hot or dual temperature duct, all return duct</td>
<td>Not Allowed</td>
<td>Not Allowed</td>
<td>2” with metal jacket</td>
</tr>
</tbody>
</table>

3.4 INSTALLATION OF PIPING INSULATION:

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on cold pipe insulation, and protect to prevent puncture or other damage.

1. Do not use staples or tacks on vapor barrier jackets.

2. Seal vapor barrier penetrations with vapor barrier finish recommended by the manufacturer.

3. Seal fitting covers with PVC tape.

4. Cover all unions, check valves, and other in-line devices. Mark outer covering with indelible marker to identify item covered.

F. Neatly bevel and seal insulation at all exposed edges.

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. See equipment insulation for removable insulation on accessible piping components.
J. See Section 15140 for insulation inserts and shields. Butt pipe insulation against pipe hanger insulation inserts. For all piping apply wet coat of vapor barrier lap cement on butt joints and seal all joints and seams with 3 inch wide vapor barrier tape or band.

K. Flexible Elastomeric Piping Insulation:
   1. Install unslit, by slipping over piping prior to joining, or install pre-insulated soft copper tubing.
   2. Seal butt ends with adhesive.

L. Exposed to Weather: Protect outdoor insulation from weather by aluminum jacketing.
   1. Jacketing shall be secured by 1/2 inch wide stainless steel bands located on 24 inch centers. All joints and seams shall be caulked with clear silicone. Locate all longitudinal seams at the bottom of piping to minimize joint exposure to weather. Contractor may propose pre-fabricated sealing and fastening systems, submit samples and product data for approval.

3.5 INSTALLATION OF DUCTWORK INSULATION:

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
   1. Avoid the use of staples on vapor barrier jackets.
   2. Seal vapor barrier penetrations with vapor barrier tape recommended by the manufacturer.

E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

F. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

G. Flexible Fiberglass Insulation: Cut back insulation to provide a 2 inch facing overlap at all seams. Seams shall be stapled approximately 6 inches on center with outward clinching staples, then sealed with pressure-sensitive tape matching the facing and designed for use with duct insulation. The underside of ductwork 24 inches or greater shall be secured with mechanical fasteners and speed clips spaced approximately 18 inches on center. The protruding ends of the fasteners should be cut off flush after the speed clips are installed, and then sealed with the same tape as specified above.

H. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on all external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

I. Adhere flexible elastomeric sheets to clean oil-free metal surface by compression fit method and full coverage of adhesive. Seal butt joints with same adhesive. For exterior ductwork, notch insulation at reinforcements and joint flanges to provide a smooth surface, unless the reinforcements or joints would penetrate the insulation. Provide a minimum ½ inch cap over any penetrating item. Stagger all joints and seams on multi-layer insulation.
3.6 EXISTING INSULATION REPAIR:

A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation, install new jacket lapping and sealed over existing.

3.7 PROTECTION AND REPLACEMENT:

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.
SECTION 15300 - FIRE PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This Section specifies automatic sprinkler systems for buildings and structures. Materials and equipment specified in this Section include:

   Pipe, fittings, valves and specialties.

   Sprinklers and accessories.

B. Products furnished but not installed include sprinkler head cabinet with spare sprinkler heads. Furnish to the Owner’s maintenance personnel.

C. The work of this section includes engineering by the Contractor. The Contractor shall act as Engineer of record for all fire protection work.

1.2 DEFINITIONS:

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Other definitions for fire protection systems are listed in NFPA Standards 13, 13R, 14, 20 and 24.

C. Working plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 and 14 for obtaining approval of the authority having jurisdiction.

1.3 SYSTEM DESCRIPTION:

A. Fire protection system is a "wet-pipe" system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by fire.

1.4 SUBMITTALS:

A. Product data for each type sprinkler head, valve, piping and piping specialty, fire protection specialty, fire department connection and any equipment installed in accordance with the Contract Documents. Index per specification chapter and item number. Partial submittals shall not be acceptable.

B. Shop drawings prepared in accordance with NFPA 13 identified as "working plans," including detailed riser schematics indicating pipe sizes and lengths; and hydraulic calculations where applicable, which have been approved by the authority having jurisdiction. Do not proceed with the installation of the work until the Architect/Engineer and AHJ review of shop drawings is received.

C. Contractor shall stamp shop drawings indicating compliance with applicable codes and contract drawings. Contractor shall stamp drawing "Approved for Construction."

D. When a fire protection system employs electronic file detection devices to activate a system, e.g., in preaction and deluge systems, detailed fire detection and alarm shop drawings, shall accompany the fire protection shop drawing submittal under appropriate division, Division-15 or 16, as determined by the Engineer.
E. The drawings shall show the location and ratings of all fire rated floors and walls. Each pipe penetration of these rated assemblies shall be detailed on the drawings showing pipe sleeve and a fire rated penetration seal.

F. Completed State of Colorado Plan Registration Form shall accompany the shop drawing submittal.

G. If more than two submittals (either for shop drawings or for record drawings) are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.

H. Maintenance data for each type sprinkler head, valve, piping specialty, fire protection specialty, fire department connection and hose valve specified, for inclusion in operating and maintenance manual specified in Division 1 and Division-15 Section "Basic Mechanical Requirements."

I. Welder's qualification certificate.


K. Hydraulic calculations and drawings submitted to the Engineer shall be prepared under the direct supervision of and bear the signed stamp of a professional engineer registered in the State of Colorado and familiar with this type of installation and with previous similar experience (practicing in the Fire Protection field) certifying that the fire sprinkler system has been designed and hydraulically calculated in compliance with NFPA and governing codes. No design related work shall be subcontracted or performed by persons other than bona fide employees working solely for the contractor.

L. Fire sprinkler piping design drawings shall show all ductwork, air devices, lighting and electrical panels.

M. Shop drawings and hydraulic calculations shall be stamped and signed by the local fire prevention authority prior to submitting shop drawings to the Architect/Engineer.

N. Submit anchoring details and calculations.

O. Final as-built drawings shall be provided and created in a CAD format consistent with UCB CAD standards.

1.5 HYDRAULIC DESIGN:

A. The Fire Sprinkler System shall be hydraulically calculated by the Contractor. Pipe schedule method is acceptable only as allowed in NFPA 13 5-2.2.

B. The wet pipe fire sprinkler system for the building shall be hydraulically calculated to comply with NFPA-13 and the following criteria:

1. Light hazard occupancy for areas unless noted otherwise.


C. The final fire protection system demand shall be a minimum of 10 PSI below the water supply curve.

D. Velocities in pipes shall be shown on hydraulic calculations. Velocities in overhead piping shall not exceed 20 feet per second. Velocities in underground piping shall not exceed 16 feet per second.
E. Allow 10 feet of loss for electric water flow switches and note on hydraulic calculations.

F. The Fire Protection Contractor shall provide as many sets of hydraulic calculations as necessary, performed and submitted to prove that the most remote and demanding areas are calculated.

G. Design information shall be permanently affixed to the main riser as described in NFPA Pamphlet 13.

H. The Fire Protection Contractor shall be responsible for water flow data from the appropriate water department. A copy of the water flow test data from the water department shall accompany the hydraulic calculations before hydraulically calculating equipment fire sprinkler system.

I. The pipe and valve sizes indicated on the drawings and details are minimum sizes to be used regardless of sizes allowed by hydraulic calculations.

1. If a condition arises that is not clearly identified in the Contract Documents, design direction shall be provided in writing by the Engineer. This includes, but is not limited to, walls relocated or not shown on the plans, potential freezing points, ducts and other obstructions, or interferences as they relate to system coverage or hydraulic performance parameters.

2. The Contractor shall be ultimately responsible to guarantee the system against freezing for reasons other than that of the building Owner’s negligence.

1.6 SYSTEM DESCRIPTION:

A. General Design Requirements:

1. The fire sprinkler system shall be equipped with an exterior local alarm (bell and strobe) initiated by the flow detection device. Coordinate with Division 26.

2. The 100% design drawings prepared by the Engineer indicate principal pipe layouts, including risers and cross mains. They do not show every required offset, dimension, fitting or similar details. Contract document drawings shall not be used as shop drawings.

1.7 QUALITY ASSURANCE:

A. Shall be pre-qualified by the University to work on any major projects. Major projects shall be identified by Facilities Management project manager and AHJ on a case by case basis. As a rule of thumb, projects involving more than 50,000 square feet of sprinkler protection should be considered major.

B. The entire fire protection system project including design, calculations, installation and testing, excluding prefabrication, shall be bid by a single firm which has the capabilities to perform all of the work required under this standard. No installation work shall be sub-contracted without prior permission in writing from the AHJ.

C. Fire Protection Contractor, individually shall be able to provide bonding capacity equal to the total amount of the fire protection portion of the contract, for the specific project. Refer to Section 1 – Bonding Requirements.

D. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 years experience in the design and installation of similar products of comparable size and value, familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. The contractor shall be licensed for the design and installation for the specific type of system in the
jurisdiction where the work is to be performed and the State of Colorado. Upon request, submit evidence of such qualifications to the Engineer. Refer to Division-1 Section: "Definitions and Standards" for definitions for "Installers."

E. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, Specifications of Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3."

F. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 13 - Standard for the installation of Sprinkler System, including applicable seismic requirements.
2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
3. NFPA 24 - Installation of Private Fire Service Mains and their applications.
5. NFPA 1963 - Screw Threads and Gaskets for Fire Hose Connections.
6. UL and FM Compliance: All fire protection system materials and components shall be Underwriter's Laboratories and Factory Mutual listed as well as labeled for the application anticipated.
8. International Building Codes, including applicable seismic requirements.
9. Requirements of the local Building Department and Fire Department.
11. UL (Underwriters Laboratories) Fire Resistance Directory
12. UL Fire Protection Equipment Directory
13. Colorado Primary Drinking Water Regulations
15. NFPA-20
16. NFPA-25
17. NFPA-72
18. NFPA-214
19. NFPA-231
20. NFPA-231C
21. Other NFPA Standards as applicable
22. ANSI A-17.1, Safety Code for Elevators and Escalators
23. Colorado Dept. of Public Safety, Division of Fire Safety 8CCR 1507-11
24. Colorado Revised Statutes Section 24-33.5-1202 through 1208 (Senate Bill 90-4)

G. Reference and standards listed are minimum requirements. Where more stringent requirements are specified or noted on the drawings, this shall be applicable.

1.8 SEQUENCING AND SCHEDULING:

A. Schedule rough-in installations with installations of other building components.

B. Minimum time frame for notice of inspections, tests and meetings is five (5) days and list the persons to be notified.

1.9 EXTRA STOCK:

A. Heads: For each style and temperature range (and length for dry heads) required, furnish additional sprinkler heads per NFPA-13.

1. Obtain receipt from Owner that extra stock has been received.
PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS:

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection systems.

B. All equipment used on this project shall be new and UL listed unless noted or specified otherwise.

2.2 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide fire protection system products from one of the following:

1. Gate Valves:
   a. Nibco
   b. Kennedy Valve, Div. of ITT Grinnell Valve Co., Inc.
   c. Mueller
   d. Stockham
   e. Milwaukee

2. Swing Check Valves:
   a. Central
   b. Mueller
   c. Kennedy Valve, Div. of ITT Grinnell Valve Co., Inc.
   d. Viking
   e. Victaulic
   f. Globe

3. Butterfly and Ball Valves:
   a. Nibco
   b. Victaulic
   c. Milwaukee
   d. Kennedy

4. Grooved Mechanical Couplings shall be greaseless type:
   a. Grinnell
   b. Victaulic Company of America
   c. Central Sprink, Inc.

5. Double Check Valve Assembly:
   a. Febco Model 850
   b. Watts Model 709
   c. Conbraco 40-100
d. Ames Model 2000 (epoxy)

6. Fire Protection Specialty Valves (Dry and Preaction):
   a. Viking Corporation
   b. Central
   c. Globe

7. Fire Department Connection:
   a. Croker
   b. Potter-Roemer
   c. Elkhart

8. Sprinkler Heads:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Viking Corp.
   c. Globe
   d. Other manufacturers, if approved by the University as equal.

NOTE: Sprinklers that contain a synthetic, non-metallic o-ring are not acceptable.

9. Fire Protection Specialties:
   b. Potter Roemer, Inc.
   c. Guardian Fire Equipment, Inc.

10. Inspector's Test and Drain Module
    a. Victaulic
    b. A.G.F.
    c. Grinnell/Gem

11. Alarm, Flow and Tamper Switches:
    a. Potter Electric Signal Corp.
    b. System Sensor
    c. Victaulic

2.3 BASIC IDENTIFICATION:

   A. General: Provide identification complying with Division-15 "Mechanical Identification", in accordance with the following listing:

   3. Fire Protection Signs: Provide the following signs:
      a. At each sprinkler valve, sign indicating what portion of system valve controls.
      b. At each outside alarm device, sign indicating what authority to call if device is activated.
c. At door to each sprinkler control valves or at ceiling access points, sign reading "FIRE CONTROL".

d. At each drain or test, sign indicating its purpose.

B. Attach to the riser a metal sign indicating the name, address and telephone number of the fire protection contractor. Also indicate the date of installation.

2.4 BASIC PIPING SPECIALTIES:

A. General: Provide piping specialties complying with Division-15 Basic Mechanical Materials and Methods section "Piping Specialties", in accordance with the following listing:

1. Pipe escutcheons.
2. Dielectric unions.
3. Drip pans.
4. Pipe sleeves.
5. Sleeve seals.
6. Fire Barrier Penetration Seals.

2.5 BASIC SUPPORTS AND ANCHORS:

A. General: Provide supports and anchors complying with Division-15 "Supports and Anchors" in accordance with the following listing:

1. Adjustable steel clevis hangers, adjustable steel band hangers, or adjustable band hangers, for horizontal-piping hangers and supports.
2. Two-bolt riser clamps for vertical piping supports.
3. Steel turnbuckles and malleable iron sockets for hanger-rod attachments.
4. Concrete inserts, top-beam C-clamps, side beam or channel clamps or center beam clamps for building attachments.
5. Concrete inserts and other type hangers penetrating into or through structural members shall be submitted (by the Fire Protection Contractor) to and have the approval of the structural engineer contracted for this project.
6. Powder driven studs shall not be allowed.
7. Hangers (which are acceptable for project) and hanger spacing shall be in accordance with NFPA-13.

2.6 PIPE AND TUBING MATERIALS (INSIDE BUILDING):

A. General: Refer to Part 3 Article "Pipe Applications" for identification of systems where the below specified pipe and fitting materials are used.

B. Steel Pipe: ASTM A 53, A795 or A135, Schedule 40 or Schedule 10, U.S. manufacture, black steel pipe, plain ends. With Antibacterial Formula (ABF) or approved equal.

C. American Tube Company "Dyna-Thread-40" and "Dyna-Flow" and Allied Tube and Conduit Corporation "Super Flo" are acceptable alternates to Schedule 40 pipe. Installation shall be per manufacturer's recommendations.
D. Schedule 5 pipe shall not be allowed.
E. The Corrosion Resistance Ratio of the pipe shall be 1.00 or greater. Documentation shall be presented with product submittal.
F. Schedule 10 pipe shall only be allowed for pipe sizes 2-1/2 inches and larger.
G. Provide galvanized, schedule 40, piping system for preaction system and drain risers.
H. Pipe 2-1/2” and larger shall be cut-grooved for grooved fittings. Non-grooved pipes is not acceptable.

2.7 FITTINGS (INSIDE BUILDING):

B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 300, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1. Install steel pipe with threaded joints and fittings for 2 inches and smaller and where shown on drawings.
C. Steel Fittings: ASTM A234, seamless or welded, for welded joints.
D. Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47 Grade 32510 malleable iron; or ASTM A53, Type F or Types E or S.
E. Grooved Mechanical Couplings: Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure roll-grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.
F. Grooved Mechanical Fittings and Couplings for the entire fire protection system shall be of the same manufacturer as submitted in shop drawing equipment review.
G. Cast-Iron Threaded Flanges: ANSI B16.1, Class 250; raised ground face, bolt spot faced.
H. Cast Bronze Flanges: ANSI B16.24, Class 300; raised ground face, bolt holes spot faced.
I. Plain end, hooker type, or push-on fittings or couplings shall not be allowed.
J. Bushings and reducing couplings shall not be allowed.
K. UL listed and Factory Mutual approved segmentally welded fittings are acceptable. Friction loss and flow data shall accompany hydraulic calculations.
L. Threaded fittings are preferred in Architecturally exposed or sensitive areas.

2.8 JOINING MATERIALS:

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
B. Gasket Materials: Thickness, materials and type suitable for fluid or gas to be handled, and design temperatures and pressures.
2.9 GENERAL DUTY VALVES:

A. Gate Valves - 2 Inch and Smaller: Body and bonnet of cast bronze, 175 pound cold water working pressure - non-shock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.

B. Gate Valves - 2-1/2 Inch and Larger: Iron body; bronze mounted, 175 pound cold water working pressure - non-shock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet, and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open.

C. Butterfly Valves: 2-1/2 inches to 12 inches, grooved, ductile iron body and disc ASTM-536, disc EPDM coated, listed and approved minimum 175 psi service, actuator, self-contained supervisory switch, weatherproof approved for indoor or outdoor use.

D. Ball Valves: 1-1/2 inches and smaller shall be threaded, forged brass construction, with teflon seats and blow out proof stem. Ball shall be full port with stainless steel ball.

E. Ball Valves: 2 inches to 3 inches shall be listed to 300 p.s.i. with optional internal tamper switch. Body shall be ductile iron with corrosion resistant coating. Ball shall be 316 stainless steel, standard port design. 1-1/2” and Smaller: all bronze with screwed ends.

F. Swing Check Valves 2” and Larger: MSS SP-71; Class 175, cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

G. Double Check Valve Assembly: Double check valve assembly shall be UL listed for fire protection service and USC-CCCF approved. Installation arrangement shall be per manufacturer's recommendations.

H. Reduced Pressure Backflow Preventer:

1. Reduced pressure backflow preventers shall be used for fire suppression systems only when chemical additives such as antifreeze are present or when untreated water may be pumped into the system. Use Febco models acceptable to Facilities Management Department.

I. Preaction Valves:

1. The valve assembly including the valve, trim packages and actuation system shall be FM approved as a complete assembly.

2. The preaction valve shall be actuated and sequenced as noted in section 1.04-C.4.

3. The size of the preaction valve shall be established via the hydraulic calculations and be supplied by a pipe of an equal or larger size. The valve shall be rated for a one-hundred seventy-five (175) psi working pressure. The basic valve trim shall include manual control/activation capability, drain and test provision with trim for automatic operation via a 24 volt solenoid (to be provided under this section). Valve shall be wired normally closed or as otherwise specified by the manufacturer. The manual release switches, whether mechanical or electrical, shall be located at the exits from the protected area. Coordinate work with Division 16 when necessary.

J. Solenoid Release Valves:
1. Shall be specifically listed/approved for use in fire protection systems.

2. Shall be FM approved as compatible with the preaction valve and fire alarm control panel.

2.10 SPECIALTY VALVES:

A. Dry-Pipe Valves: Differential type, 175 psig working pressure, and have cast iron, flanged inlet and outlet, bronze seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment and fill line attachment. For low differential valves, a high water level signaling device or automatic drain shall be provided.

B. Air-(Nitrogen) Pressure Maintenance Device, Dry-Pipe Systems: An automatic device to maintain the correct air pressure in a dry-pipe system or deluge system. System shall have shut- off valves to permit servicing without shutting down the sprinkler system, bypass valve for quick system filling, pressure regulator or switch to maintain system pressure, strainer; pressure ratings 14 to 60 psig adjustable range, and 175 psig maximum inlet pressure.

C. Preaction Valves: Preaction systems shall have valves specifically listed for preaction service.

D. Preaction System Control Panel: Panels shall be single area, two area, or single area cross zoned type as indicated. Control panel shall consist of a NEMA 1 enclosure, and contains detector, alarm and solenoid valve circuitry for operation of deluge valves. Panels shall contain power supply, battery charger, standby batteries, field wiring terminal strip, electrically supervised solenoid valves and polarized fire alarm bell, lamp test facility, SPDT auxiliary alarm contacts and rectifier. Control panel shall be UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics shall be 120 volts AC, 60 Hz, with 24 volts DC Gel Cell batteries. Panel provided by Division 15. Wiring from Fire Alarm Panel and power to Control Panel by Division 16. Locate Control Panel along side Fire Alarm Panel.

2.11 BASIC METERS AND GAUGES:

A. General: Provide meters and gauges complying with Division- 15 "Meters and Gauges", in accordance with the following:

1. Water Pressure
   a. Brass bourdon tube with 3-1/2" diameter case rated for three-hundred (300) psi water pressure.
   b. Gauge Dial: From 0-300 psi in 5# increments.
   c. Equip gauges with a 1/4" stem with a 1/4" shut-off valve.

2. Air (Nitrogen) Pressure
   a. Brass bourdon tube with 3-1/2" diameter case rated for two-hundred fifty (250) psi air pressure.
   b. Gauge Dial: From 0-100 psi in 1 psi increments.
   c. Equipped gauges witha 1/4" stem with a 1/4" shut-off valve.
2.12 ALARM DEVICE AND FIRE PROTECTION SPECIALTIES:

A. General: Provide fire protection specialties, UL-listed, in accordance with the listing. Provide sizes and types which mate and match piping and equipment connections.

B. Water Flow Indicators: Vane type water flow detector, rated to 250 psig; designed for horizontal or vertical installation; have 2-SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 0.25 ampere 24 volts DC; capable of being wired in normally open position; with self reset capabilities; complete with factory-set field-adjustable retard element to prevent false signals, tamper-proof cover which sends a signal when cover is removed, and with activation time retarding capability set at 30 seconds. The setting shall be verified through the inspectors test prior to final inspection.

C. Supervisory Switches: Provide products recommended by manufacturer for use in service indicated. SPST, normally closed contacts, designed to signal valve in other than full open position. Capable of being wired in NO/NC position, and shall have automatic reset capabilities. Minimum contact rating shall be 0.25 A @ 24V DC.

D. Low Pressure Supervisory Switches:
   1. A low pressure alarm switch shall be provided for dry pipe sprinkler systems and supervised preaction sprinkler systems. The switches shall meet the following requirement:
      a. Compatible with the equipment used.
      b. \( \frac{1}{2} \)" NPT enclosure.
      c. NEMA 1 enclosure.
      d. Capable of detecting a ten (10) psi decrease in normal pressure and be adjustable.
      e. Tamper proof.
      f. Capable of operating at 24 VDC or as specified by the manufacturer.

E. Pressure Switch: Indicating low pressure trouble in sprinkler system.

F. Pressure switch: Indicating flow in sprinkler system.

G. Exterior Alarm Signals:
   1. Shall mount above the fire department connection at a height of ten (10) to fifteen (15) feet above adjacent grade.
   2. Where a FACP is available; an exterior electric bell with flashing strobe, as specified in Section 16720 powered by the FACP having a minimum audible level of 85dBA at ten (10) feet. This work shall be coordinated with Division 16.
   3. When approved by AHJ, a water motor gong with a minimum six (6) inch diameter shall be provided for sprinkler systems which are installed where there are no fire alarm panels capable of monitoring the required signals. The water gongs shall be used in construction with an alarm check valve.

2.13 AUTOMATIC SPRINKLERS:

A. Sprinkler Heads: Fusible link or frangible bulb type, and style as indicated or required by the application. Unless otherwise indicated, provide heads with nominal 1/2 inch discharge orifice, for "ordinary" temperature range with a minimum temperature of 155 degrees F. Provide "intermediate" temperature heads in Electrical and Mechanical rooms, where required as noted in NFPA 13, and as
required by the Authority having jurisdiction. Use of quick response heads is strongly encouraged where arrowed.

B. Sprinkler Head Finishes: Provide heads with the following finishes:

1. Upright, Pendent and Sidewall Styles: Factory brass, rough bronze finish for heads in unfinished spaces. Heads shall be stainless steel where installed exposed to acids, chemicals, or other corrosive fumes.

2. Recessed Style: Bright chrome, with bright chrome escutcheon plate. GEM Models FR948 and F948 recessed sprinklers are not acceptable.

3. See drawings for additional sprinkler type requirements.

C. Sprinkler Head Cabinet and Wrench: Finished steel cabinet, suitable for wall mounting, with hinged cover and space for spare sprinkler heads plus sprinkler head wrench. Provide amounts of each style per NFPA-13. Locate head cabinet on shop drawing submittal. Where temperature will not exceed 100°F, and indicate location.

D. Plastic fire sprinkler escutcheons are not acceptable.

2.14 INSPECTOR'S TEST AND DRAIN ASSEMBLY:

A. Provide an alarm test module of a manufacturer listed in paragraph 2.2.

B. Comply with NFPA-14, Section 5-11, for draining and testing of wet standpipe system.

C. Test and drain piping shall be routed to exterior. Location shall meet Owner's approval.

PART 3 - EXECUTION

3.1 SPECIFIC DESIGN PARAMETERS

A. General:

1. The “Room Design Method” and “Small Room Rule” shall not be used in the design of systems unless otherwise deemed necessary by engineer and accepted by AHJ.

2. Architect/Engineer shall determine which hydrants to test in consultation with the AHJ.

3. Water supply flow test(s) shall be conducted by the contractor and witnessed by the AHJ. Test(s) shall be conducted in strict accordance with NFPA #13 and NFPA #291. The City of Boulder Fire Department shall be invited to witness the test(s). Notify the City of Boulder Water Department of the time and location of the test(s) prior to operating hydrants. Procedures specific to each project including location, date and time shall be submitted to the AHJ for approval two weeks prior to conducting tests. Such tests may discolor water supply to buildings during the test. As such, if the test date or time coincides with uninterruptible Campus functions, such as research, the owner reserves the right to delay or otherwise reschedule the test.

4. Sprinkler systems protecting buildings classified as Ordinary Hazard shall not be connected to a 6” dead-end type supply main if the main also supplies a fire hydrant. The minimum size supply main shall be 8” for this situation (from the looped main to the hydrant).

B. Hydraulic Calculations:
1. Flow velocity in underground water mains shall not exceed sixteen (16) feet per second. Velocity in above ground sprinkler system piping shall not exceed twenty (20) feet per second.

2. Pipe sizes shall be calculated so that the combines sprinkler and standpipe system (plus domestic demand) leave a safety factor of 10 psi; see 1.04-A.6.

3. The hydraulic calculations shall be calculated back to a looped water main and be based on the available water supply flow test results. In the case of dead-end type mains, calculations shall include piping to the point where the flow test is effective.

4. The hydraulic calculations shall prove the hydraulically most remote and demanding areas of not less than 1,500 sq. ft., to allow for flexibility in building use, i.e., Room Design Method of NFPA 13 may not be used. Velocity pressure may be neglected in the hydraulic calculations. This may involve submitting auxiliary hydraulic calculations to prove that the most remote and demanding area was calculated. See item 3.01-A.1, above.

NOTE: Allowable reductions of the system’s area of operation for the Area/Design Method from NFPA 13 are acceptable and encouraged.

5. Hydraulic calculation submittals shall clearly define and annotate all devices which will cause friction loss with equivalent lengths of pipe. This includes vane type electric water flow switches (assume 10 feet of equivalent length of pipe).

6. For hydraulic calculation purposes, the friction loss coefficient for existing piping over ten (10) years in age, the Hazen-Williams design C values given in NFPA 13 shall be reduced by a factor of 10 for pipes 10 years or more in service, e.g. “C” reduced from 120 to 110. More restrictive requirements of NFPA 13 shall be implemented as applicable. This includes non-circulating water mains and above ground piping.

7. Inside Hose Streams:
   a. For Class II standpipe systems supplied from a sprinkler system, provide 50 gpm at the two most remote outlets or 100 gpm if one hose outlet exists. Flows shall be added at the point of connection to the sprinkler system for hydraulic calculation purposes.
   b. For combined standpipe/sprinkler systems, standpipe demands are added to the sprinkler system demand at the point(s) of connection.
   c. For Class I, II or III standpipe systems not supplied through a sprinkler system, the minimum demand shall comply with NFPA #14.

C. Fire Protection System(s) Design Requirements:

1. Piping C-factors for new, steel piping, above ground and underground shall be120.

2. Maximum Sprinkler Head Spacing for Light Hazard, Ordinary Hazard and Extra Hazard occupancies shall be per NFPA 13.

3.2 PREPARATION:

A. Any system piping or components which are installed, purchased or fabricated prior to the Contractor receiving a set of approved shop drawings, shall be the responsibility of the Contractor.

B. System installation shall not commence until the Contractor has obtained required approval of shop drawings.
C. Contract drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

D. Contract drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. The most restrictive requirements shall be applied.

E. Contract drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurements, contractor shall take necessary measurements and prepare the drawings.

F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained without interferences between systems, with structural elements or with the work of other trades.

G. Coordinate the installation of fire protection materials and equipment above and below ceilings with suspension system, light fixtures and other building components.
   1. Coordinate ceiling space carefully with all trades. In the event of conflict, install fire protection and electric systems within the cavity space allocation in the following order:
      a. Fire sprinkler mains and cross mains.
      b. Electrical conduit
      c. Fire sprinkler branch line piping.

H. Verify all dimensions by field measurement.

I. Arrange for chases, slots and openings in other building components to allow for fire protection installations.

J. Sequence, coordinate and integrate installations of fire protection materials and equipment for efficient flow of the work.

K. Coordinate the cutting and patching of building components to accommodate the installation of fire protection equipment and materials.

L. Where mounting heights are not detailed or dimensioned, install overhead fire protection services and equipment to provide the maximum headroom possible. Notify Engineer and Owner of any conditions where headroom of less than 7'-4" will result.

M. Install fire protection equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting and to allow minimum interference with other installations.

3.3 PIPE APPLICATIONS:

A. Install Schedule 40 steel pipe with threaded joints and fittings for 2 inch and smaller.

B. Install Schedule 10 steel pipe with cut-grooved ends and grooved mechanical couplings. For 2-1/2 inch and larger for wet systems. For preaction systems all piping shall be Schedule 40.

C. Acceptable alternates to Schedule 40 pipe shall be installed per manufacturer's recommendations.
3.4 PIPING INSTALLATIONS:

A. General: Any damages resulting from the failure of any new system components shall be replaced at no cost to the Owner.

B. Provide a minimum 5 feet 0 inches cover for all underground pipe installations. Install in accordance with AWWA C600.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated. Drawings are diagrammatic in character and do not necessarily indicate every required offset, valve, fitting, etc.

1. Deviations from approved "working plans" for sprinkler piping, require written approval of the authority having jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "working plans."

2. Slope piping in dry and preaction systems to facilitate drainage to point of supply.

D. Install sprinkler piping to provide for system drainage in accordance with NFPA 13.

E. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Welded outlet branch pipe fittings are acceptable.

F. Install unions in pipe 2 inch and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

G. Install flanges or flange adapters on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

H. For welded pipe, all cutouts (coupons) shall be removed prior to installation.

1. The end of each cross main shall be equipped with a minimum of 1-1/4" threaded capped connections to facilitate plenum. Install per NFAP 13 requirements.

I. Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake in accordance with NFPA 13.

J. Make connections between underground and above-ground piping using an approved transition piece strapped or fastened to prevent separation.

K. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 15 Section "Basic Piping Materials and Methods."

1. The system riser shall not be attached to the supply connection until the underground piping is flushed, tested and accepted by the AHJ. The two week notice requirements and rescheduling conditions, as stated under section 3.01-A.3 is applicable.

L. All piping penetrating walls to structure shall be sleeved and sealed per specification Section 15055.

M. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.
N. Install pressure gauge on the riser or feed main at or near each test connection. Provide gauge with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and where they will not be subject to freezing.

O. The fire line entry valves shall have monitoring electrical switches, the wiring from which shall be carried to the fire annunciating panel.

P. The fire protection contractor shall be responsible for the coordination of his installation with all other contractors. See Section 15010 for prioritized components.

Q. Protect adjacent area where pipe cutting and threading takes place (e.g. floors, ceilings, walls, etc.).

R. There shall be no fire sprinkler piping in electrical rooms (other than piping serving sprinklers directly in that room) or installed over any electrical panels.

S. Provide spring-loaded check valve at top of drain risers.

T. Install pressure gauges on city and system sides of fire entry valve assembly.

U. Install hangers straight and true and piping parallel to building lines.

V. Powder driven hangers shall not be used without prior AHJ approval.

3.5 PIPE JOINT CONSTRUCTION:

A. Welded Joints: AWS D10.9, Level AR-3.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

D. Mechanical Grooved Joints: Cut grooves on pipe ends dimensionally compatible with the couplings.

E. End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.
3.6 VALVE INSTALLATIONS:

A. General: Install fire protection specialty valves, fittings and specialties in accordance with the manufacturer's written instructions, NFPA 13 and the authority having jurisdiction.

1. Riser Control Valve
   a. Rooms or enclosures housing sprinkler system control valves shall be equipped with adequate heating, lighting and adequate clearance.
   b. System control valves shall be made accessible and operable from the floor, unless otherwise determined by the Engineer and agreed upon by the AHJ in writing.

B. Gate Valves: Install electronically supervised-open indicating valves so located to control all sources of water supply except fire department and roof manifolds connections. Where there is more than one control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve. Refer to Division-15 Section "Mechanical Identification" for valve tags and signs.

C. Valve at water main tap shall be underground gate valve with roadway box.

D. Install approved check valve assembly backflow preventer in each water supply connection. Provide check valve and indicating valve (with tamper switch) on the discharge side of reduced pressure backflow preventers.

E. Drain and Test Valves

   NOTE: All main drains shall discharge to the building exterior through a properly sized drain riser. Engineer to determine and specify means and routing of drain discharge. If the drain discharge shall be in a proper location inside the building, Engineer will identify the location of drain discharge and indicate on drawings.

   1. If the fire protection piping is located at a lower elevation than the adjoining building, an outside drain installed to conduit main drain tests and a system auxiliary drain piped to a floor drain is desirable. An extra valve installed on the system drain piping maybe necessary in order to isolate the system drain during tests of the two (2) inch main drain.

      NOTE: Engineer to determine

   2. Auxiliary drains and valves shall be provided as required by NFPA 13.

   3. Sight glasses shall be provided on all inspector’s test connections where discharge cannot be seen while valves are operated.

   4. The inspector’s test connection, where required, shall terminate at a fort-five (45) degree elbow with a sprinkler which has the frame and strut assembly removed; other restricted orifices listed for the same purpose are acceptable. These shall be piped to the building exterior at grade level. If installed on the building interior, it shall include a restricting orifice and discharge to an acceptable drain with adequate capacity. The orifice size shall be the same as the smallest sprinkler installed on the system.

   5. All drains located inside the building, shall be piped to the outside of the building at a point free from causing water damage, terminating with a forty-five (45) degree elbow. This includes the drain for the fire department connection piping. (Exception: Auxiliary drains).
6. Contractor shall supply and install a concrete splash block with a minimum length of four (4) feet to direct the drain or test discharge water so as not to disturb adjacent landscape.

7. All shut-off, drain and test valves which are placed in concealed spaces shall have the standard sign affixed in a visible location; see section 3.03-H. For example, if a valve is located above a ceiling, a sign indicating the location and type of valve shall be located on the wall, immediately below the ceiling.

8. Drain valves shall be made accessible and operable from floor unless otherwise proposed by the engineer and accepted by AHJ in writing.

3.7 SPRINKLER HEAD INSTALLATIONS:

A. Any sprinkler heads with any paint on them shall be replaced. The sprinkler system shall then be hydrostatically tested again at the contractor's expense.

B. Sprinkler heads shall be positioned so as to comply with NFPA-13 for any obstructions. This includes, but is not limited to, soffits, surface mounted lights and indirect lighting arrangements. The Fire Protection Contractor is responsible for identifying these obstructions and designing the system accordingly.

C. Run piping concealed above heated furred ceilings and in joists to minimize obstructions. Expose only heads.

D. Protect exposed sprinkler heads against mechanical injury with standard guards. Provide sprinkler head guards in all mechanical, electrical or storage rooms as well as exposed pendant heads which are installed less than 8 feet-0 inches A.F.F.

E. Provide 1 inch diameter nipple and 1 inch x 1/2 inch reducing fitting for each upright head. (Excluding mechanical equipment rooms.)

F. Provide heads in "pocketed" areas caused by exposed duct, piping or beams.

G. Sprinkler head deflector distance from face of finished ceiling shall not exceed 4 inches.

H. Sprinkler heads shall be located in the center of all 2 foot x 2 foot ceiling tiles and quarter points, along the center line lengthwise of 2 foot x 4 foot ceiling tiles.

I. Use proper tools to prevent damage during installations.

J. Install sprinkler piping in a manner such that mechanical equipment, ceiling tiles or lights can be accessed and easily removed. The sprinkler piping shall be installed to provide a minimum of 6 inches above the top of a finished ceiling.

K. Minimum fire sprinkler head temperature rating for sprinklers in electrical rooms shall be 212 degrees F. Keep sprinklers as far from transformers and/or panels as spacing allows.

3.8 IDENTIFICATION SIGNS:

A. Signs shall be permanently marked and constructed of weather-proof metal or rigid plastic.

B. Signs shall be secured to a device or the building wall with substantial and corrosion-resistant chains or fasteners.
C. Where sprinkler or standpipe control valves, test locations, or dry-pipe auxiliary drains are located in a room, above the ceiling, or in a concealed space, the location of the valve shall be indicated by a 2” x 6” sign. Signs shall be located as follows:

1. If a valve is located inside a room, a sign shall be placed above the door tight to the door jam directly above the door handle. Similar signs are required on all intermediate doors within rooms.

2. If a valve is located above the ceiling, a sign shall be placed directly under the access panel or proper ceiling tile to access valve. Sign shall be tight to ceiling.

3. In other locations, AHJ shall be contacted for specific direction of sign placement.

D. Where a water supply fire pump is provided, a sign shall be located near the pump indicating the minimum pressure and flow required at the pump discharge flange to meet the system demands.

E. Valves:

1. All control, drain and test connection valves shall be identified in accordance with NFP 13.

2. All main and sectional system control valves, including water supply control valves, shall have a sign indicating the portion of the system controlled by the valve.

F. Where sprinkler piping is supplied by a system with more than one system riser, a sign shall be located at each dual or multiple feed combination system riser to identify that to isolate the sprinkler system served by the control valve, an additional control valve or valves at other locations shall be shut off. The sign shall identify the location of the additional control valves.

G. The installing contractor shall provide a sign identifying the design basis of a system as hydraulic calculations or pipe schedule. The sign shall be located at the water supply control valve for sprinkler or standpipe systems.

3.9 INSTALLATION OF METERS AND GAUGES:

A. Install meters and gauges in accordance with Division-15 "Meters and Gauges".

3.10 PROJECT COORDINATION:

A. Welding, cutting and other Hot Work:

1. Cutting or of pipes using heat/ignition generating devices shall not be conducted inside any portion of existing buildings without written approval from the University. Follow the University Central Station and Hot Work Permit Procedures. Welding of pipes on-site is prohibited by NFPA 13 and only shop welding shall be allowed. Brazing and soldering of copper tubes shall not be conducted within the buildings prior to application and acceptance of hot work permits.

3.11 FIELD QUALITY CONTROL:


B. The fire sprinkler system shall not be connected to underground piping until the fire service main is tested and approved.
C. The Fire Protection Contractor shall conduct and bear the costs of all necessary tests of the fire protection work, furnish all labor, power and equipment. All piping shall be tested with water as required, the tests witnessed by the authority having jurisdiction.

D. For retrofit installations, a pneumatic test with a maximum pressure of forty (40) psi shall be conducted prior to a hydrostatic test to avoid any water damage due to leaks. This test does not replace the hydrostatic test.

E. Dry and preaction systems shall be both hydrostatically and pneumatically tested. Pneumatic test shall be in accordance with NFPA-13.

F. All fire protection piping, including air supply pipe to the Fire Department connection, shall be tested under a hydrostatic pressure of not less than 200 psig, for a duration of not less than 2 hours.

G. Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system at Fire Protection Contractor's expense.

H. All piping tests (pneumatic and hydrostatic) shall be conducted prior to the application of any painting materials. This will prevent hidden leaks and/or repainting of repaired/ altered piping.

3.12 SYSTEM CERTIFICATION:

A. The Contractor shall provide the Owner with written certification prior to final inspection, that all new equipment:

1. Has been visually inspected and functionally tested as required by the Specifications.

2. Is installed entirely in accordance with the manufacturer's recommendations within the limitations of the system's UL listings and NFPA criteria.

3. Is in proper working order.

3.13 FINAL INSPECTION AND TESTING:

A. The Contractor shall make arrangements with the Owner for final inspection and witnessing of the final acceptance tests. The Fire Protection Contractor, the Alarm System Contractor, Engineer and the Owner will conduct the final inspection and witness the final acceptance test.

B. All tests and inspections required by the referenced Codes and Standards, and the Owner shall be performed by the Contractor.

C. The inspecting committee as referenced above will visit the job site to inspect the work and witness the final acceptance tests when they have been advised by the Contractor that the work is completed and ready for test. If the work is not complete or the test is unsatisfactory, the Contractor shall be responsible for the Consultant's extra time and expenses for re-inspection and witnessing the re-testing of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.

D. After the system has been inspected and tested, a certificate, "Contractor's Material and Test Certificate Sprinkler System - Water Spray System," shall be provided by the contractor and shall be signed by him or his representative, the Owner's representative and by a representative of the fire department if appropriate. Sufficient copies shall be prepared to ensure the Engineer, Owner, all inspecting authorities and the contractor have a copy for their files. The Contractor shall prepare one (1) test report for each inspection performed whether successful or not.
E. The signing of the certificate by the Owner's representative shall in no way prejudice any claim against the contractor for faulty material, poor workmanship, or failure to comply with inspecting authority's requirements or local ordinances.

F. Contractor shall provide at least five (5) working days notice for all tests. 48 hour notice is required for cancellations, or it shall be considered a re-inspection.

G. All sprinkler supervisory initiating devices shall be functionally tested to verify proper operation.

H. All supervisory functions of each initiating device shall be functionally tested.

I. Receipt of all alarm and trouble signals, initiated during the course of the testing, shall be verified at the fire alarm control panel.

3.14 WORK BY OTHERS:

A. Wiring of all water flow switches and tamper switches on valves to central alarm panel are by Division 16.

3.15 OPERATION AND MAINTENANCE MANUAL:

A. The Contractor shall provide the Owner with a loose-leaf manual containing:

1. A detailed description of the systems.

2. A detailed description of routine maintenance required or recommended or which would be provided under a maintenance contract including a maintenance schedule and detailed maintenance instructions for each type of device installed.

3. One copy of NFPA-25.

4. Manufacturers' data sheets and installation manuals/instructions for all equipment installed.

5. A list of recommended spare parts.

6. Service directory, listing the specific equipment items and where parts can be obtained, with name, address and telephone number.

7. Full size sepias of the record drawings (stamped and signed per section 1.6).

8. Hydraulic calculations (stamped and signed per section 1.6).


B. Refer to Division 1 for additional requirements.

C. Within 15 days of the completion of the work, six (6) copies of the manual shall be submitted for approval.

3.16 RECORD DRAWINGS:

A. The Contractor shall provide and maintain on the site an up-to-date record set of approved shop drawing prints which shall be marked to show each and every change made to the sprinkler system from the original approved shop drawings. This shall not be construed as authorization to deviate from or
make changes to the shop drawings approved by the Owner without written instruction from the Owner in each case. This set of drawings shall be used only as a record set.

B. Upon completion of the work, the record set of prints shall be used to prepare complete, accurate final record drawings reflecting any and all changes and deviations made to the sprinkler system.

C. The Owner, at his option and at the Contractor's expense, may require revised hydraulic calculations depending on the extent and nature of field changes.

D. The Record Drawings and Hydraulic Calculations shall have the signed stamp of a professional engineer registered in the State of Colorado certifying the Record Drawings and the Hydraulic Calculations accurately represent the completed fire protection system.

E. Upon completion of the work, two sets of blueline record drawings shall be submitted to the Owner for review.

F. Upon review and approval, submit final drawings on computer disc to the University, in University Standard CAD format.

3.17 GUARANTEE PERIOD:

A. Guarantee: The Contractor shall guarantee all materials and workmanship for a period of one year beginning with the date of final acceptance by the Owner. The Contractor shall be responsible during the design, installation, testing and guarantee periods for any damage caused by him (or his subcontractors) or by defects in his (or his subcontractors') work, materials, or equipment.

B. Emergency Service: During the installation and warranty period, the Contractor shall provide emergency repair service for the sprinkler system within four hours of a request by the Owner for such service. This service shall be provided on a 24 hour per day, seven days per week basis.

3.18 TRAINING:

A. The Contractor shall conduct two (2) training sessions of four (4) hours each to familiarize the building personnel with the features, operation and maintenance of the sprinkler systems. Training sessions shall be scheduled by the Owner at a time mutually agreeable to the Contractor and the Owner.

3.19 WATER DAMAGE:

A. The Fire Protection Contractor shall be responsible for any damage to the work of others, to building and property/ materials of others caused by leaks in automatic sprinkler equipment, unplugged or disconnected pipes or fittings, and shall pay for necessary replacement or repair of work or items so damaged during the installation, testing or guarantee periods of the automatic sprinkler work.

END OF SECTION 15300
SECTION 15440 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of plumbing fixtures work required by this section is indicated on drawings and schedules and by requirements of this section.

B. This Section specifies the types of fixtures included but are not limited to the following: (see fixture schedule on drawings)

1.2 QUALITY ASSURANCE:

A. Codes and Standards:


3. ARI Standard 1010: "Drinking-Fountains and Self- Contained Mechanically-Refrigerated Drinking-Water Coolers"


5. UL Standard 399: "Drinking-Water Coolers."


7. NSF Standard 61: "Drinking Water Components."


B. Where fixtures are specified as handicapped, it shall be the sole responsibility for all manufacturers and/or suppliers to provide plumbing fixtures and related trim which meet or exceed the ADA requirements.

1.3 SUBMITTALS:

A. Product Data: Submit Product Data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.

B. Shop Drawings: Submit rough-in drawings with brand names on each sheet and item. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages. Coordinate requirements with Architectural Woodwork shop drawings specified in Division 6 for fixtures installed in countertops and cabinets. Furnish templates for use in woodwork shop.

C. Wiring Diagrams: Submit manufacturer's electrical requirements and wiring diagrams for power supply to units. Clearly differentiate between portions of wiring that are factory installed and field installed portions.

D. Color Charts: Submit manufacturer's standard color charts for cabinet finishes and fixture colors.
E. Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured plumbing fixtures, valves and trim. Include this data, product data, and shop drawings in maintenance manual, in accordance with requirements of Division 15.

F. Submit certification of compliance with specified ANSI, UL, and ASHRAE Standards.

G. Submit certification of compliance with performance verification requirements specified in this Section.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Store fixtures where environmental conditions are uniformly maintained within the manufacturer's recommend temperatures to prevent damage.

B. Store fixtures and trim in the manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage to the fixture on trim.

1.5 SEQUENCE AND SCHEDULING:

A. Schedule rough-in installations with the installation of other building components.

1.6 MAINTENANCE:

A. Extra Stock:

1. Furnish special wrenches and other devices necessary for servicing plumbing fixtures and trim to Owner with receipt in a quantity of one device for each 10 fixtures, minimum of one wrench and one device.

2. For each type of faucet, furnish faucet repair kits complete with all necessary washers, springs, pins, retainers, packings, O-rings, sleeves, and seats in a quantity of 1 kit for each 40 faucets, minimum one repair kit per faucet type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Acceptable Products by Manufacturer - See Section 15010 for product options and Substitutions Where allowed by this section. All fixtures and faucets and related trim shall be the product of one manufacturer only, where possible, including spare parts for all manufacturers providing product on this project.

Acceptable: The following listed manufacturers will be allowed when accepted by the Engineer. The basic parameters for each fixture or equipment item listed in these specifications, establish the color, material, gauge, finish, configuration, style, operation, performance, nomenclature and appearance to be used as the basis of equivalency by manufacturers seeking acceptance of equivalent products. Deviations of any of the above parameters will not be considered as acceptable for use on the project. Conditions of prior approval in these specifications shall prevail. Where the word Only appears, the only approved Manufacturer named will be accepted. "Value Engineered" proposals shall not be submitted nor will they be accepted for the "only" manufacturers. (Note: Not all of the following items are included in this specification for this project.)


2.2 FIXTURES: (SEE PLUMBING FIXTURE SCHEDULE ON DRAWING)
2.3 FITTINGS, TRIM, AND ACCESSORIES:

A. Supplies and Stops: polished chrome-plated, angle stop having 1/2inch inlet and 3/8inch O.D. x flexible tubing outlet, and with set screw wall escutcheon. Quantity to match trim specified. McGuire convertible only

B. Traps for Drinking Fountains, Lavatories and Bidets: 17 gauge tubular brass, 1-1/4inch adjustable "P" trap and waste to wall. Traps for drinking fountains shall be outside the wall.

C. Traps for Sinks: cast brass, 1-1/2 inch with set screw escutcheon or 2 inch adjustable "P" trap and waste to wall.

D. Escutcheons: chrome-plated cast brass with set screw.

E. All ADA Accessible lavatories, supplies and waste shall be insulated with seamless vinyl covers.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in for potable water and waste piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

B. Fasten plumbing fixtures securely to supports or building structure.

C. Install a fixture water stop valve in an accessible location.

D. Install set screw escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

E. Seal fixtures to walls and floors using silicone sealant as specified in Section 07900. Match sealant color to fixture color.

F. Visible parts of fixture brass and accessories shall be chrome plated.

G. Finishes on all trim shall not be chrome plated plastic.

H. Where possible, fixtures and trim shall be product of one manufacturer as specified under “fixtures in general” of each type fixture.

I. Install hose end faucets and hose connection with field testable back flow preventers.

J. Solidly attach floor mounted water closets to floor with hex expansion shield of cast iron closet flanges.
3.3 ADA ACCESSIBILITY:
   A. Review Mechanical and Architectural drawings to determine fixtures requiring ADA accessibility. Notify Architect/Engineer of any physical conflicts preventing full dimensional compliance prior to beginning work.
   B. Comply with the installation requirements of ANSI A117.1 and Public Law 90-480 with respect to plumbing fixtures for the physically handicapped. Arrange flush valve/flush tank handles with proper orientation to meet ADA requirements.

3.4 FIELD QUALITY CONTROL:
   A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.
   B. Inspect each installed unit for damage. Replace damaged fixtures.

3.5 ADJUSTING:
   A. Adjust water pressure at drinking fountains, faucets, shower valves, and flush valves to provide proper flow and stream.
   B. Replace of leaking or dripping faucets and stops.
   C. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.6 CLEANING:
   A. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

3.7 PROTECTION:
   A. Provide protective covering for installed fixtures, water coolers, and trim.
   B. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

3.8 MOUNTING HEIGHTS SCHEDULE:
   A. Fixture mounting height and rough-in dimensions shall be as indicated on the architectural drawings and specifications.

END OF SECTION 15440
SECTION 15782 - ROOFTOP HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of packaged rooftop heating and cooling units work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Refer to other Division 15 sections for metal ductwork, air devices, automatic temperature controls not factory-installed, and required for conjunction with packaged heating and cooling units; not work of this section.

C. Electrical Work: Refer to Division 15 section "Electrical Provisions of Mechanical Work" for requirements.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings:

1. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

C. Record Drawings: At project closeout, submit record drawings of installed systems products in accordance with requirements of Division 15.

D. Maintenance Data: Submit maintenance data and parts list for each rooftop heating and cooling unit, control, and accessory, including "trouble-shooting" maintenance guide. Include this data in maintenance manual; in accordance with requirements of Division 15.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop heating and cooling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Testing and rating of rooftop units of 135,000 btu/hr capacity or over shall be in accordance with AHRI 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".

2. Testing and rating of rooftop units under 135,000 btu/hr capacity shall be in accordance with AHRI 210 "Standard for Unitary Air-Conditioning Equipment", and provide Certified Rating Seal. Sound testing and rating of units shall be in accordance with AHRI 270 "Standard for Sound Rating of Outdoor Unitary Equipment". Units shall bear Certified Rating Seal.
3. Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

4. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1 "Energy Conservation in New Building Design".

5. Provide rooftop units which are UL listed and labeled.

6. Rooftop units shall be designed, manufactured, and tested in accordance with UL requirements.

1.4 DELIVERY, STORAGE, AND HANDLING:
   A. Handle rooftop units and components carefully to prevent damage. Replace damaged rooftop units or components with new.
   B. Store rooftop units and components in clean dry place, off the ground, and protect from weather, water, and physical damage.
   C. Rig rooftop units to comply with manufacturer's rigging and installation instructions for unloading rooftop units, and moving them to final location.

1.5 SCHEDULING AND SEQUENCING:
   A. Coordinate installation of roof mounting curb with roof structure.
   B. Coordinate roof opening locations and for mechanical and electrical connections.

1.6 WARRANTY:
   A. Warranty: Provide a full parts and labor warranty on the entire unit.
      1. Warranty Period: 5 years from date of substantial completion.

1.7 MAINTENANCE:
   A. Extra Materials: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit:
      1. One set of matched fan belts for each belt-driven fan.
      2. One set filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1. Rooftop Units:
         a. Trane
         b. McQuay

2.2 ROOFTOP UNITS (3 TO 50 TONS):
A. General Description: Units shall be factory-assembled and tested, designed for roof or slab installation, and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, condenser coil guards and dampers. Capacities and electrical characteristics are scheduled on the Drawings.

B. Casing: Manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1/2” thick thermal insulation, knockouts for electrical and piping connections and an exterior condensate drain connection and lifting lugs.

C. Roof Curbs: Manufacturer's standard construction, insulated and having corrosive protective coating, complete with factory-installed wood nailer and drain nipple. Construction shall be in accordance with NRCA Standards.

1. **Provide full perimeter spring isolation rail.**

D. Evaporator Fans: Forward-curved, centrifugal, belt-driven fans with adjustable sheaves or direct-driven fans; and permanently lubricated motor bearings.

E. Condenser Fans: Propeller-type, direct-driven fans with permanently lubricated bearings.

F. Coils:

1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.

2. Refrigerant Cooling Coils: Have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of nitrogen.

G. Compressors: Serviceable, semi-hermetic, or fully hermetic compressors, complete with integral vibration isolators and crankcase heaters.

H. Safety Controls: Manual reset type for:

1. Low pressure cutout;
2. High pressure cutout;
3. Compressor motor overload protection.

I. Economizer Control: Return and outside air dampers, outside air filter, fully modulating electric control system with dry bulb control, and adjustable mixed-air thermostat. System shall have 100 percent outside air capability. Provide automatic changeover through adjustable control devices.

J. Accessories: Units shall include the following accessories as indicated or scheduled:

1. See schedules on drawings for additional requirements.

2. Low ambient control: Furnish low ambient control for head pressure control, designed to operate at temperatures down to 0 deg F (-18 deg C).
3. Thermostat: Assembly shall provide for staged heating and cooling with manual or automatic changeover on standard sub-base.

4. Anti-Recycling Control: Furnish anti-recycling control to automatically prevent compressor restart for 5-minutes after shutdown.

5. Provide hail guards.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION:

A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

C. Electrical Connections: Refer to Section 16142 - Electrical Connections for Equipment for final connections to equipment and installation of loose shipped electrical components.

3.3 DEMONSTRATION:

A. Start-Up Services:

1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Operating and Maintenance Training:

1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division One.

2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

END OF SECTION 15782
SECTION 15891 - METAL DUCTWORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of metal ductwork is indicated on drawings and in schedules, and by requirements of this section.

<table>
<thead>
<tr>
<th>DUCT SERVICE</th>
<th>TYPE/CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangular supply air from discharge of terminal box/fan to air devices (low pressure).</td>
<td>Galvanized sheet metal/spiral round and oval or rectangular (lined as noted on drawings.)</td>
</tr>
<tr>
<td>Return air ductwork.</td>
<td>Galvanized steel (lined where noted on drawings); factory or shop fabricated.</td>
</tr>
</tbody>
</table>

B. Exterior insulation of metal ductwork is specified in other Division-15 sections, and is included as work of this section.

C. Refer to other Division-15 sections for ductwork accessories.

D. Refer to other Division-15 sections for fans and air handling units.

E. Refer to other Division-15 sections for testing, adjusting, and balancing of metal ductwork systems.

1.2 DEFINITIONS:

A. Low Pressure Duct: Duct required by the drawings, specifications, or referenced standards to be constructed to 2" or less, positive or negative pressure class.

B. Medium or High Pressure Duct: Duct required by the drawings, specifications, or referenced standards to be constructed to greater than 2" positive or negative pressure class.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with metal ductwork systems similar to that required for project.

C. References to SMACNA, ASHRAE and NFPA are minimum requirements, the Contractor shall fabricate, construct, install, seal and leak test all ductwork as described in this specification and as shown on the drawings, in addition to these minimum standard references.

D. Codes and Standards:

1. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork. Comply with SMACNA "HVAC Air Duct Leakage Test Manual" for testing of duct systems.

E. SMACNA Industrial Construction Standards.


1.4 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data and installation instructions for ductwork materials and products. Provide product data for manufactured joining systems. Include sound attenuation by octave band for sound rated flexible duct.

B. Record Drawings: At project closeout, submit record drawings of installed systems, in accordance with requirements of Divisions 1 and 15.

C. Maintenance Data: Submit maintenance data and parts lists for metal ductwork materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Divisions 1 and 15.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. By providing end caps on all open sections, bagging small fittings, surface wrapping and shrink wrapping.

B. Storage: Store ductwork inside elevated from floor on pallets. At no time shall the inside surfaces be exposed, or stored with open ends and protect from weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Duct Liner:
   a. CertainTeed Corp.
   b. Manville Products Corp. (Schuller)
   c. Owens-Corning Fiberglas Corp.
   d. Pittsburgh Corning Corp.

2. Flexible Ducts:
   a. Flexmaster
   b. Thermaflex

3. Duct Take Off Fittings
   a. Hercules Industries
   b. Flexmaster
   c. Thermaflex
Round and flat oval Ductwork (low, medium, and high pressure):

- Semco Mfg., Inc.
- United Sheet Metal Div., United McGill Corp.
- Sheet Metal Products Co.
- Spiral Pipe of Texas, Inc.
- Hercules Industries

2.2 DUCTWORK MATERIALS:

A. Exposed Ductwork Materials: Where ductwork is exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, stains, dents, discolorations, and other imperfections, including those which would impair painting.

B. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lockforming quality; with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations. Provide flat seam construction where standing seams are a hazard to the Owner's operation personnel.

C. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A 167; Type 304 or 316; with No. 4 finish where exposed to view in occupied spaces, No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation.


E. Uncoated carbon steel shall comply with ASTM A569, hot rolled steel sheet.

2.3 MISCELLANEOUS DUCTWORK MATERIALS:

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment. LEED EQc4.1: Low-Emitting Materials: All interior adhesives and sealants must meet or exceed VOC limit requirements of South Coast Air Quality Management District Rule #1168 and sealants used as fillers must meet requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

B. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15 deg. change of direction per section. Unless specifically detailed otherwise, use 45 deg. laterals and 45 deg. elbows for branch takeoff connections. Where 90 deg. branches are indicated, provide conical type tees.

C. Duct Liner: Fibrous glass, complying with Thermal Insulation Manufacturers Association (TIMA) AHC-101; of thickness indicated.

1. Unless otherwise noted, provide 1" thick, 1-1/2 lb density, fiberglass duct liner meeting ASTM C1071 Type I, NFPA 90A and 90B and TIMA (AHC-101) with minimum NRC (noise reduction coefficient) of 0.70 as tested per STM C 423 using an "A" mounting with minimum "K" factor of 0.25. Lining shall be U.L. approved, made from flame attenuated glass fiber bonded with a thermosetting resin with acrylic smooth surface treatment and factory applied edge coating. Materials shall conform to revised NFPA No. 90A Standards, with a maximum flame spread of 25 and maximum smoke development of 50.
D. Duct Liner Adhesive: Comply with ASTM C 916 “Specifications for Adhesives for Duct Thermal Insulation”.

E. Duct Liner Fasteners: Comply with SMACNA HVAC Duct Construction Standards, Article S2.11.

F. Duct Sealant: Non-hardening, non-asbestos, water resistant, UL classifies as fire resistive, compatible with mating materials. Foster 32-19, Childers CP-146 or Duro Dyne SAS UL duct sealant mastic.

G. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.

1. For exposed stainless steel ductwork, provide matching stainless steel support materials.

2. For aluminum ductwork, provide aluminum support materials except where materials are electrolytically separated from ductwork.

H. Flexible Ducts: Flexible air ducts shall be listed under UL-181 standards as Class I Air Duct Material and shall comply with NFPA Standards 90A and 90B. Minimum operating pressure rating shall be 6" W.C. through a temperature range of -20°F to 150°F; minimum working velocity rating shall be 4000 f.p.m. Contractor shall assume responsibility for supplying material approved by the authority having jurisdiction.

1. All insulated flexible ducts shall be constructed of a metalized ripstop reinforced laminate inner core, 1" thick, 3/4 lb. density fiberglass insulation with "C" factor of 0.23 or less and an outer jacket made exclusively of fire retardant reinforced aluminized material.

   a. Flexmaster Type 5M.

2. All/Where shown on drawings flexible duct shall be rated for sound attenuation. Inner core shall be black CPE supported by a galvanized steel helix, with 1" C=.23 or less insulation and metalized reinforced outer jacket. Sound attenuation shall be as scheduled below:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL (dB) 8&quot; dia.</td>
<td>13</td>
<td>31</td>
<td>36</td>
<td>35</td>
<td>38</td>
<td>21</td>
</tr>
</tbody>
</table>

   a. Flexmaster Type 8M

3. Non-insulated flexible ducts shall be constructed from dead soft aluminum sheet, spiral corrugated, or aluminum construction over a steel spring helix.

I. Duct Take Off Fittings to Individual Air Inlets & Outlets: Provide spin-in fittings at flexible or round sheet metal duct takeoffs. Where specifically shown on drawings, where the duct dimension does not allow for a conical spin-in, or at Contractor's option, provide 45° inlet rectangular to round duct take off fittings, with factory applied gasket. Fittings shall include butterfly type manual volume damper with regulator, and dual locking device. Dual locking device shall consist of two shaft mounted wing nuts, one on each side of the damper. Wing nuts shall tighten on shafts to lock butterfly in place. Shafts shall be solid metal, rolled metal shafts are not acceptable.

2.4 FABRICATION:
A. Fabricate ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated or required to complete runs. Preassemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.

B. Fabricate ductwork of gauges and reinforcement complying with SMACNA "HVAC Duct Construction Standards". Minimum 26 GA where ducts are within corridors.

C. Where the standard allows the choice of external reinforcing or internal tie rods, only the external reinforcing options shall be used.

D. If manufacturer flange joining systems are used as part of the reinforcing, the EI rating and rigidity class shall be equivalent to the reinforcing requirements of the standard. Submit manufacturer's product data.

E. Aluminum duct shall be fabricated using the aluminum thickness equivalence table in the standard. Simply increasing the thickness by two gauges is not acceptable.

F. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1.5 times the associated duct width; and fabricate to include single wall turning vanes in elbows where shorter radius is necessary. Rails shall be 2” wide for elbow up to 12”, and 4” wide for elbows over 12” wide. Limit angular tapers to 30 deg. for contracting tapers and 20 deg. for expanding tapers. Divided flow fittings shall be 45° inlet branches, stationary splitters and elbows, or as shown on drawings.

G. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division-15 section "Ductwork Accessories" for accessory requirements.

H. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners. Provide sheet metal nosing on all leading edges preceded by unlined duct, at duct openings, and at fan or terminal unit connections.

2.5 LOW PRESSURE ROUND DUCTWORK:


B. Gauge: 28-gauge minimum for round and oval ducts and fittings, 4” through 24” diameter. Minimum 26 gauge where ducts are within a corridor.

C. Elbows: One piece construction for 90 deg. and 45 deg. elbows 14” and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint. Radius to centerline shall be 1.5 times duct diameter. Spot welded and bonded construction.

D. Divided Flow Fittings: 90 deg. tees, constructed with branch spot welded and bonded to duct fitting body.
PART 3 - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which metal ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL DUCTWORK:

A. Duct Sealing:

1. Seal all low pressure ducts to SMACNA Seal Class "B".
2. Seal all medium and high pressure ducts to SMACNA Seal Class "A".

B. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling, popping or compressing. Support vertical ducts at every floor.

C. Construct ductwork to schedule of operating pressures as shown on drawings.

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

E. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

F. Routing: Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

G. Penetrations: Where ducts pass through fire rated walls and do not contain fire or smoke dampers, protect with fire stop material installed in accordance with its listing. Where ducts pass through interior partitions or exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on all four sides by at least 1-1/2". Fasten to duct only. Where ducts penetrate non-fire rated, mechanical, electrical or acoustically sensitive walls, provide 1/2" to 3/4" annular space between duct and wall, pack annular space with mineral wood insulation, and caulk both sides with non-hardening acoustical sealant.

H. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

I. Installation: Install metal ductwork in accordance with SMACNA HVAC Duct Construction Standards.
J. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.3 INSTALLATION OF DUCT TAKE-OFF FITTINGS:

A. Fully seal all joints.

B. Sheet metal screw regulator arm to duct after balance is complete. Mark and date position of regulator arm.

C. Insulation over regulator arm is not required.

3.4 INSTALLATION OF DUCT LINER:

A. General: Install duct liner in accordance with SMACNA HVAC Duct Construction Standards.

3.5 INSTALLATION OF FLEXIBLE DUCTS:

A. Maximum Length: For any duct run using flexible ductwork, do not exceed 5' - 0".

B. Installation: Install in accordance with Section III of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible". Duct shall be secured to collars with metal bands.

3.6 FIELD QUALITY CONTROL:

A. Leakage Tests: Conduct duct leakage test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Repair leaks and repeat tests until total leakage is less than the maximum permissible leakage as specified below.

B. General:

1. Ductwork pressure tests shall be observed by Architect/Engineer prior to installation of insulation.

2. Ductwork systems in 3" W.G. pressure class and higher shall be tested in their entirety for leaks. Arbitrary sections of ductwork in 2" W.G. and lower pressure class shall be tested as required by Architect/Engineer.

3. Test Failures: Duct systems shall be repaired if test pressure and leakage requirements are not met or if air noise condition is encountered. Repairs and sealing shall be done with sheet metal, tape, sealant or a combination thereof.

C. Test Equipment:

1. Portable rotary type blower or tank type vacuum cleaner with control damper. Equipment shall have sufficient capacity to properly test reasonably large duct system section.

2. Orifice assembly consisting of straightening vanes and calibrated orifice plate mounted in a straight tube with properly located pressure taps.

3. Two (2) U-tube manometers, one to measure drop across calibrated orifice and one to measure S.P. in duct being tested. Provide low differential pressure Dwyer magnehelic gauges for low leak testing in lieu of U-tube manometers.

4. Provide Dwyer magnehelic gauge with 0-.25" W.C. range for testing 0% leakage ductwork.
D. Testing Pressures and Permissible Leakage:

1. Test pressure shall be equal to the construction class. Negative pressure duct shall be tested at the equivalent positive pressure.

2. Allowable leakage shall be determined from the following equation (or figure 4-1 in the above referenced Standard):

\[ F = C_L (P)^{0.65} \]

Where:
- \( F \) = Allowable leakage factor CFM/100 Sq. Ft.
- \( C_L \) = Leakage Class
- \( P \) = Test pressure inches W.C.

3. Leakage class shall be as follows:
   a. Seal class A, Round or oval duct, \( C_L = 3 \).
   b. Seal class A, Rectangular duct, \( C_L = 6 \).
   c. Seal class B, Round or oval duct, \( C_L = 6 \).
   d. Seal class B, Rectangular duct, \( C_L = 12 \).
   e. Seal class C, Round or oval duct, \( C_L = 12 \).
   f. Seal class C, Rectangular duct, \( C_L = 24 \).

4. Record all tests using the procedure and forms in the above referenced standard.

5. All plenums and casings shall be tested by pressuring to the pressure class indicated and visually observing leakage and panel deflection.
   a. No noticeable leakage shall be allowed.
   b. Deflection shall be less than 1/8" per foot.

3.7 EQUIPMENT CONNECTIONS:

A. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors where required for service, maintenance and inspection of ductwork accessories. See section 15910.

3.8 ADJUSTING AND CLEANING:

A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances. Where ductwork is to be painted clean and prepare surface for painting.

B. Protection:
   1. Store duct a minimum of 4" above ground or floor to avoid damage from weather or spills.
   2. Cover all stored ducts to protect from moisture, dust or debris.
   3. Maintain a cover on all ends of installed ductwork at all times, except when actually connecting additional sections of duct.

C. Ductwork contaminated or damaged above "shop" or "mill" conditions shall be cleaned, repaired or replaced to the Engineer's satisfaction.
1. Ductliner pre-installed in stored duct which has become wet may be installed if first allowed to completely dry out.

2. Ductliner in installed ductwork which has become wet must be completely removed and replaced.

3. Torn ductliner may be repaired by coating with adhesive if damage is minor and isolated. Extensively damaged liner shall be replaced back to a straight cut joint.

D. Balancing: Refer to Division-15 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork; not work of this section. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION 15891
SECTION 15910 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

C. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers" and U.L. Standard 555S "Motor-Driven Fire/Smoke Dampers."


E. SMACNA Compliance: All exhaust ducts comply with "Fire Damper and Heat Stop Guide".

F. All fire dampers, smoke dampers, fire/smoke dampers and radiation dampers shall meet the latest local building code requirements.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components. Include details of construction equipment and accessories being provided.

C. Submittals for all damper types specified in this section shall include a schedule for each damper indicating net free area, actual face velocity and pressure drop (at sea level) based on net free area & the maximum air quantity which will be passing through the damper. Submittals without this information will be rejected.

D. Submit Heresite duct/equipment protective coating product data sheets and application instruction.

E. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 15.

F. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 15.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Dampers:
2. **Fire Dampers and Smoke Dampers:**
   a. Greenheck
   b. Air Balance, Inc.
   c. Phillips Industries, Inc. Conaire Division
   d. Ruskin
   e. Nailor

3. **Turning Vanes:**
   a. Aero Dyne Co.
   b. Airsan Corp.
   c. Barb-Aire
   d. Duro Dyne Corp.
   e. Environmental Elements Corp.; Subs. Koppers Co., Inc.

4. **Duct Hardware:**
   a. Ventfabrics, Inc.
   b. Young Regulator Co.
   c. Duro-Dyne Corp.

5. **Duct Access Doors:**
   a. Kess
   b. Greenheck
   c. Flexmaster
   d. Cesco-Advanced Air
   e. Duro Dyne Corp.
   f. Ventfabrics, Inc.

6. **Flexible Connections:**
   a. Duro Dyne Corp.
   b. Ventfabrics, Inc.
   c. General Rubber Corp. (Process & Exhaust Only)

### 2.2 MANUAL VOLUME DAMPERS:

**A. Low Pressure Rectangular Dampers (less than 2000 FPM and under 2” W.C. S.P. Differential):**

1. For 12” in height or larger, use multiple opposed blade type and close fitted to ducts. The frame and blades shall be constructed of 16 ga. galvanized steel with plated steel shaft mounted with synthetic bearings. Linkage shall be in-jamb fixed type located outside the airstream made of plated steel tie bar and crank plates, with stainless steel pivots. Damper panels shall not exceed 48” wide. Provide jack shafting when duct size required is greater than 48” wide. Provide
notched shaft end indicating damper position, locking quadrant to fix damper position and handle. Provide stand off bracket for insulated ducts. For flat oval and round ductwork, provide type C housing.

2. For ducts less than 12” in height, frame shall be 18 ga. blade galvanized steel, steel axle with synthetic bearings locking quadrant handle and notched shaft end indicating damper position. Provide stand off bracket for insulated ducts.

B. Low Pressure Round Dampers (less than 1800 FPM and under 1” W.C. S.P. differential):
1. For low pressure spin-in fitting dampers serving individual returns/diffusers, see 15891.
2. Dampers 4” diameter through 18” diameter shall be 20 ga. galvanized steel frame and blade, utilize multi-blade square dampers with transitions for ducts over 18” diameter.

Axle shaft shall be plated steel with retainers mounted on synthetic bearings with notched end shaft indicating damper position, locking quadrant and handle. Provide stand off brackets for insulated ducts.

a. Greenheck M80R-50 or approved equivalent.

2.3 FIRE DAMPERS:

A. Fabricated Fire Dampers: Provide dampers constructed in accordance with SMACNA "Fire Damper and Heat Stop Guide." Dampers shall be tested and labeled in accordance with UL555 and comply with NFPR 90A.

B. Fire Dampers: Provide dynamic rated type B or C fire dampers except as noted on drawings. Construct sleeve of galvanized steel with bonded red acrylic enamel finish, gauge as required by the listing. All fire dampers shall be UL labeled. Provide fusible link rated at 160 to 165 deg. F (71 to 74 deg. C) unless otherwise indicated. See architectural drawings for the separations and listings. Provide horizontal mounted fire damper with positive lock in closed position, and with the following additional features:

C. Damper Blade Assembly: Curtain Type.

D. Blade Material: Galvanized steel.

E. Provide integral sleeve type G fire dampers for sidewall air devices terminating at fire rated walls. Ruskin DIBD20-G or equivalent.

2.4 COMBINATION FIRE/SMOKE DAMPERS:

A. Dampers shall be constructed, tested and labeled in accordance with UL555 and shall comply with NFPA 90A.

B. Rectangular Fire/Smoke Dampers: 16 gauge galvanized steel frame, type 304 stainless steel side seals, combination silicone/galvanized steel edge seals, bronze oilite or stainless steel sleeve bearings, airfoil shaped galvanized steel parallel acting blades, square or horizontal plated steel axles, out of airstream in-jamb linkage with stainless steel pivots, factory sleeve, caulked and attached to damper in accordance with UL fire damper requirements.

1. Ruskin FSD-60 or approved equivalent.
2. Ruskin FSD-60V or approved equivalent where axles must be vertical.
C. Round Fire/Smoke Dampers 18” Diameter and Smaller: 20 gauge galvanized steel frame/integral sleeve, 2 layer galvanized steel butterfly blade equivalent to 14 gauge, silicone rubber seal sandwiched between blade layers, stainless steel sleeve bearings pressed into frame, retaining plates in accordance with the UL listing.

1. Ruskin FSDR-25 or approved equivalent.
2. Use rectangular damper with smooth square/round transitions for dampers over 18”.

D. Paint sleeve with red enamel finish.

E. Provide factory mounted spring return 120V electric actuator and electric heat actuated manual reset release device. The damper shall at all times be connected to the actuator. The damper closure shall be controlled to not less than 7 seconds and no more than 15 seconds. Release device shall be set at 165°F, unless otherwise noted. Replaceable, fusible elements are not acceptable. Actuator shall be suitable for 20 psi control air.

F. Electric Damper Actuators:

1. Actuator shall have microprocessor based motor controller providing:
   a. Electronic cut off at full open so that no noise can be generated while holding open. Holding noise level shall be inaudible.
   b. Shall be incapable of burning out if stalled before full rotation is reached.

2. Housing shall be steel and gears shall be permanently lubricated.

3. The actuators shall be direct coupled and employ a steel toothed clamp for connecting to damper shafts. Aluminum clamps or set-screw attachment are not acceptable.

4. Actuator shall have UL555S Listing by the damper manufacturer for a temperature equal to the damper.

5. Actuators shall draw no more than .23A at 120V running, or .1A holding at 120V (27 VA) for 70 in-# of torque.

6. Actuator shall carry a manufacturer’s 5-year warranty and be manufactured under ISO 9001 quality control.

7. Damper actuators shall be Belimo Aircontrols FSLF (30 in-#) or FSNF (70 in-#).

G. Provide factory mounted blade position switches to indicate fully open and fully closed.

H. Damper actuator shall fail close upon loss of power/control air.

I. 1 1/2 hour or 3 hour rating as required by construction type.

J. UL 555, 555S, Class II, 250°F.

K. Suitable for vertical or horizontal mounting.

L. Leakage not greater than 10 CFM per square foot at 1” W.C. pressure differential.
2.5 TURNING VANES:

A. Fabricated Turning Vanes: Provide fabricated 22 gauge, single blade 4-1/2" radius, 3-1/4" spacing turning vanes and type 2, 4-1/2" wide runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards" Fig 2.3.

B. Do not use trailing edge turning vanes.

C. Provide intermediate support rails if length of vanes exceeds 36".

2.6 DUCT HARDWARE:

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

C. Quadrant Locks: Provide for each manual volume damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.7 DUCT ACCESS DOORS:

A. Access Doors for Low Pressure Rectangular Duct: Construct of same or greater gauge as ductwork served, provide double wall insulated doors for insulated ductwork. Exposed insulation adhered to door is not acceptable. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. All access doors shall have gasket and will be air tight. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Where a hinged door can not be fully opened a removable door may be used.

B. Access Doors for Round Duct 20" and Less: Sandwich type door, constructed of an insulated double wall outer door connected to gasketed inner plate carriage bolts with hand knobs, and formed to fit the radius of the duct.

Ductmate "Sandwich" or equivalent.

C. Access Door for Round Duct Greater Than 20": 18" round insulated double wall access door in gasketed frame, attached to duct section similar to tee fitting.

2.8 FLEXIBLE CONNECTIONS:

A. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment. Shelf life shall be verified to not exceed six (6) months. Any sign of cracking on interior or exterior shall be cause for replacement immediately.

B. Use the following product types for each application accordingly:

1. Indoor Equipment Non-Corrosive Air Systems: Heavy glass fabric, double-coated with DuPont's NEOPRENE, non-combustible fabric, fire retardant coating with good resistance to abrasion and flexing. Fabric shall be 30 oz per square yard, capable of operating at -10°F to 200°F, waterproof, air tight, 6 inches wide, complies with NFPA 90 and UL Standard #214. "Ventglas" Model as manufactured by VentFabric, Inc.
2. Outdoor Equipment Non-Corrosive Air Systems (exposed to weather and sun): Heavy glass fabric, double-coated with DuPont's HYPALON, non-combustible fabric, fire retardant coating with superb resistance to sunlight, ozone and weather which has documented 20-year-old exposure tests. Fabric shall be 26 oz per square yard, capable of operating at -10°F to 250°F, waterproof, air tight, 6 inches wide, complies with NFPA 90 and UL Standard #214. "Ventlon" Model as manufactured by VentFabrics, Inc.

PART 3 - EXECUTION

3.1 INSPECTION:
   A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to the Engineer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES:
   A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
   B. Install turning vanes in square or rectangular 90 deg. elbows in supply, return and exhaust air systems, and elsewhere as indicated.
   C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
   D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.
   E. Provide duct access doors whether shown or not for inspection and cleaning upstream of all coils, fans, automatic dampers, fire dampers (minimum 16" x 24" in ducts larger than 18"), fire/smoke dampers, duct smoke detectors and elsewhere as indicated. Review locations prior to fabrication. Provide multiple access doors for large ductwork to provide adequate reach to equipment.
   F. Install fire dampers and smoke dampers in accordance with manufacturers instructions.
   G. Provide fire dampers and fire/smoke dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction.
   H. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts and as required for air balancing.
   I. Provide balancing dampers on high pressure systems where indicated. Use splitter dampers only where indicated on Drawings.
   J. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and equipment subject to forced vibration. Provide matching flanged backing frame with flexible connector where flanged fan connections are provided.

3.3 COORDINATION:
   A. Coordinate with installers of other work to ensure that operators, reset devices, and fusible links are accessible at all fire, smoke, and fire/smoke dampers.
B. Show access space on coordination drawings. Locate over lay-in ceilings and above corridors wherever practical.

C. Order right/left/top/bottom arrangement as required to minimize field modifications.

3.4 FIELD QUALITY CONTROL:

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

B. After installation, test every fire and fire/smoke damper for proper operation, provide letter to the Architect/Engineer certifying this work is complete and all dampers are functioning properly.

3.5 ADJUSTING AND CLEANING:

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-15 section "Mechanical Identification".

C. Final positioning of manual dampers is specified in Division-15 section "Testing, Adjusting, and Balancing".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.6 EXTRA STOCK:

A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION 15910
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this section.

B. Types of air outlets and inlets required for project include the following:

   Ceiling air diffusers.
   Wall registers and grilles.

C. Refer to other Division 15 sections for ductwork, duct accessories; testing and balancing; not work of this section.

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. AHRI Compliance: Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.

5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".

6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

C. Record Drawings: At project closeout, submit record drawings of installed systems products, in accordance with requirements of Division 15.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 15.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver air outlets and inlets wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Diffusers, Registers and Grilles:
   a. Anemostat Products Div.; Dynamics Corp. of America.
   b. Price
   c. Carnes Co.; Div. of Wehr Corp.
   d. Krueger; Div. of Philips Industries, Inc.
   e. Titus Products Div.; Philips Industries, Inc.
   f. Metal-Aire
   g. Nailor
   h. Tuttle and Bailey

2.2 CEILING AIR DIFFUSERS:

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide ceiling air diffusers that have, as 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 air device schedule.

2.3 REGISTERS AND GRILLES:

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

B. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as 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 registers and grilles of type, capacity, and with accessories and finishes as listed on air device schedule.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

3.3 SPARE PARTS:

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

END OF SECTION 15932
SECTION 15950 - BUILDING AUTOMATION SYSTEM (BAS) GENERAL

PART I. GENERAL

1.01 SECTION INCLUDES

A. General Requirements
B. Description of Work
C. Quality Assurance
D. System Architecture
E. Distributed Processing Units/Quantity and Location
F. Demolition and Reuse of Existing Materials and Equipment
G. Sequence of Work

1.02 RELATED DOCUMENTS

A. Section 15951 – Building Automation System (BAS) Basic Materials, Interface Devices, and Sensors

1.03 DESCRIPTION OF WORK

A. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified. Refer also to control drawings, sequences of operation, and point lists.

B. The distributed digital control (DDC) and building automation system (BAS) defined in this specification shall interface with the University private VLAN, and shall utilize open communications. Towards this end, contractor shall provide a router/gateway(s) as necessary to facilitate all specified objects and services and have them configured/mapped as applicable.

C. The systems to be controlled under work of this section basically comprise. The HVAC systems being controlled are a roof top unit and as described on the plans. This Section defines the manner and method by which these controls function.

D. All control work shall be installed by the BAS contractor, unless specified otherwise. Certain mechanical systems such as chillers, boilers, cooling towers, and energy recovery units are equipped with manufacturer furnished controls. All labor, materials, equipment, software, and services necessary for the installation of a complete integrated system shall be provided.

1.04 APPLICATION OF OPEN PROTOCOLS

A. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing BACnet. System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all building controllers, and all application specific controllers.
1.05 QUALITY ASSURANCE

A. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of [5] years since date of final completion in at least [20] installations of comparative size and complexity. Documentation of this requirement with references shall be available upon request.

B. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than [5] years. Firms with experience in DDC installation projects with point counts equal to this project and systems of the same complexity as those of this project. Experience starts with awarded Final Completion of previous projects. Documentation of this requirement with references shall be available upon request.

C. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than [three] years from date of final completion on at least [5] projects of similar size and complexity. Submittals shall document this experience with references.

D. Installer’s Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than [5] years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than [2] projects of similar [size] [and complexity]. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. The proposed individuals must show proof of the following training:
   1. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration.
   2. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.

E. Installer’s Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum [5] year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.

F. Installer’s Response Time and Proximity
   1. Installer must maintain a fully capable service facility within a [45 mile] radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
   2. Emergency response times are listed below in this section. Installer must demonstrate the ability to meet the response times.

G. Installer’s Quality Assurance Plan
   1. Installer must provide a description of their quality assurance operations from contract award through final delivery. The description shall include organizational responsibilities for each department represented within the execution of this document from installer’s to engineers, service technicians and management.

1.06 CODES AND STANDARDS

A. The following codes and standard intended to apply as applicable as not all will apply to all installations

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

C. Electronics Industries Alliance
   2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
   3. EIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
   4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
   6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
   7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
   8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
   9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications

D. Underwriters Laboratories

E. NEMA Compliance
   1. NEMA 250: Enclosure for Electrical Equipment
   2. NEMA ICS 1: General Standards for Industrial Controls.

F. NFPA Compliance
   1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
   2. NFPA 70 National Electrical Code (NEC)

G. Institute of Electrical and Electronics Engineers (IEEE)
   1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
   2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
   3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN

1.07 DEFINITIONS

A. Accuracy: As stated in Section 15951, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

B. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.

C. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).

D. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications.

F. BACnet Interoperability Building Blocks (BIBB): A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.

G. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended opr required destinations.

H. Building Automation System (BAS): The entire integrated management and control system

I. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.

J. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-2004).

K. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.

L. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

M. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.

N. Control Systems Server (CSS): This shall be a computer (or computers) that maintains the systems configuration and programming database. This may double as an operator workstation.

O. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic

P. Functional Profile: A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.

Q. Facility Maintenance Information Technology (FMIT): Reference to the facility’s Information Technology department, responsible for providing and maintaining all OI hardware.

R. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2004).

S. Hand Held Device (HHD): Manufacturer’s microprocessor based device for direct connection to a Controller.

T. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS

U. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.

V. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs and CSSs. See System Architecture below. This LAN can function as the Primary Controlling LAN.

W. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard. (ASHRAE/ANSI 135-2004).

X. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access
any data from any application, regardless of which database management system (DBMS) is handling the data.

Y. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.

Z. Operator Workstation (OWS): The user’s interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.

AA. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.

BB. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.

CC. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135-2004).

DD. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.

EE. Router: A device that connects two or more networks at the network layer.

FF. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture below.

GG. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.

HH. SQL: Standardized Query Language, a standardized means for requesting information from a database.

II. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.

JJ. University of Colorado at Boulder (UCB): Owner of the facility.

KK. UCB Ethernet: Reference to the facility’s Information Technology network, used for normal business-related e-mail and Internet communication. Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.

LL. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.08 FUNCTIONAL INTENT

A. Throughout Sections 15950 through 15955, the Sequences of Operation, and Section 15959 detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these will only be allowed with prior approval by the University.

1.09 SUBMITTALS

A. Submit under provisions of Section 15010.

B. Electronic Submittals: Control submittals and O&M information shall be provided in Adobe PDF or Microsoft Word format. Preferably documents will be converted from their native
electronic format directly to a preferred format. Any documents scanned as images must be converted to a searchable text format using OCR (Optical Character Recognition) and reduced in size prior to submission.

C. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate item above. Include QA/QC plan for all phases (design, install, Cx, warranty) along with documentation of industry standard QA/QC practices followed.

D. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.

E. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:

1. System Architecture and System Layout:
   a) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, drawing reference number, and controller type for each control unit. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.
      Indicate device instance and MAC address for each CU. Indicate media, protocol, baud rate, and type of each LAN.
   b) Provide floor plans on Adobe PDF software locating all control units, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
      Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans.

2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.

3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section 15955 - Part III for additional requirements.

5. Label each control device with setting or adjustable range of control.

6. Label each input and output with the appropriate range.

7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

8. Provide a Control Valve Schedule listing valve and actuator information including: size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, control signal, etc. Indicate normal positions of spring return valves.

9. Provide a Control Damper Schedule listing damper and actuator information including: size, material, blade arrangement, manufacturer, model number, control signal, etc. Indicate normal positions of spring return dampers.
10. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed.

11. Provide details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations. Provide panel layout drawing including power supply, control unit(s) and wiring terminals.

12. Sheets shall be consecutively numbered.

13. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.

14. Table of Contents listing sheet titles and sheet numbers.

15. Provide a symbol legend and list of abbreviations.

F. Open Protocol Information
   1. BACnet Systems:
      a) BACnet object description, object ID, and device ID, for each I/O point.
      b) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
      c) Submit PICS indicating the BACnet functionality and configuration of each controller.

G. Control Logic Documentation
   1. Submit control logic program listings to document the control software of all control units.
   2. Include written description of each control sequence.
   3. Include test plan for each unique control program.
   4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.

H. Operation and Maintenance Materials:
   1. Submit documents under provisions of Section. Documents shall be provided electronically as described above (1.10/B).
   2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
   3. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1. Only include sections for equipment and software used on this project. Do not provide entire catalog of product data with extraneous information.
   4. Submit BAS User’s Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
   5. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.

I. Controls contractor shall provide University with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches throughout the warranty period of the project.
J. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance.

K. Product Warranty Certificates: UCB shall approve all warranty start dates. Coordinate and submit manufacturers product warranty certificates covering the hardware provided once approved.

1.10 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 15010. Documentation shall be provided electronically as defined in section1.10/B above.

B. Record copies of product data and control shop drawings updated to reflect the final installed condition.

C. Record copies of approved control logic programming and database on CD/DVD. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.

D. Record copies of approved project specific graphic software on CD/DVD.

E. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring.

F. Provide record riser diagram showing the location of all controllers.

1.11 SYSTEM ARCHITECTURE

A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.

C. The system architecture shall consist of an Ethernet-based network(s) capable of expansion as specified below:

1. UC WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and contractor is not required to configure any components of this WAN. Refer to Section 15954 for requirements:

2. Local Supervisory LAN: The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power-line carrier communication shall not be acceptable for communications.

The higher level layers of this network shall be BACnet as described below:

a) BACnet Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet. Point/Object naming conventions are specified in 15955 - Part III.
3. Primary Controller LAN (‘Primary LAN’): High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Acceptable technologies include:
   a) Ethernet (IEEE802.3)

4. Secondary Controller LAN (‘Secondary LAN’): Network used to connect AACs, ASCs or SDs. These can be Master Slave/Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.

D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.

E. Remote Data Access: Coordinate remote access connectivity with FMIT (Facilities Management Information Technology) department. The system shall support the following methods of remote access to the building data.
   1. Browser-based access: A remote user using a standard browser shall be able access all control system facilities and graphics with proper password. UC shall provide the required internet connection. The following paradigms are acceptable for browser-based access:
      a) Native Internet-based user interfaces (HTML, Java, XML, etc.) that do not require a plug-in. The user interface must be compatible with the most current stable version of the supporting software (Java, etc.) without requiring the user to downgrade to a lesser version.

F. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall reconfigure LAN as necessary to accomplish these performance requirements. Generally requirements do not apply when a remote connection must be established via modem:
   1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
   2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
   3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at operator workstation.
   4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
   5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
   6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
   7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.

G. Control Systems Server (CSS): This shall be a computer (or computers) that maintain the systems configuration and programming database. This server may operate virtually under the supervision of FMIT. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Section 15952 - BAS Operator Interfaces for its requirements.
H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 15952 – BAS Operator Interfaces.

I. The BCs, AACs, ASCs, and SDs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 15953 - BAS Field Panels.

J. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.

K. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

1.12 WARRANTY MAINTENANCE

A. Contractor shall warrant all products and labor for a period of two years after Final Acceptance by UCB. Provide unit pricing for additional warranty years at discretion of UCB.

B. The University reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the University, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between the University and the Contractor on such matters shall be subject to resolution through the contract ‘Disputes’ clause.

C. At no cost to the University, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:

1. Maintenance services shall be provided for all devices and hardware specified in sections 15951 through 15954. Service all equipment per the manufacturer’s recommendations. All devices shall be calibrated within the last month of the warranty period.

2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by the University to the Contractor.
   a) Response by telephone to any request for service shall be provided within one (1) hour of the University’s initial telephone request for service.
   b) In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the University's site within two (2) hours of the University's initial telephone request for such services, as specified.

3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the University to the Contractor.
   a) Response by telephone to any request for service shall be provided within two (2) working hours (contractor specified 40 hr per week normal working period) of the
In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the University's site within three (3) working days of the University's initial telephone request for such services, as specified.
4. Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for University to call in the event of a need for service. At least one of the lines shall be attended at any given time at all times. Once contacted, a technician shall respond to every call within 15 minutes.

5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.

6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage, and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from construction work and weather.

1.14 LISTING AND LABELING

A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

PART II. PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where drawings or specs specifically allow existing materials to remain in place.

2.02 UNIFORMITY

A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.

PART III. PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION OF CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

B. Refer to additional requirements in other sections of this specification.

3.03 CONTROL PANELS, CONTROLLER QUANTITY AND LOCATION

A. Control panels shall consist of one or multiple controllers to meet requirements of this specification. Control panels shall be wall mounted within mechanical equipment rooms. In no case shall panels, other than terminal unit controllers, be located above ceilings. Control panels for lighting control may be located in the electrical equipment room served by the control panel only with prior approval from UCB.
B. Restrictions in applying controllers are specified in Section 15953: BAS Field Panels. This Contractor shall extend power to the control panel from an acceptable power panel. If the control contractor wishes to further distribute panels to other locations, control contractor is responsible for extending power to that location also. Furthermore, contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.

C. It is the Contractor's responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

D. For rooftop AHUs and ERUs, controllers rated for use outside the building envelope shall be mounted inside the unit casings. If adequate space is not available for installation of the controllers per the manufacturer’s recommendations, they shall be installed in NEMA4X enclosures adjacent to the unit served. For all other controllers serving rooftop equipment coordinate with UCB for control panel location, typically within the building envelope directly below equipment served in an accessible location.

E. Controllers for terminal equipment:
1. For equipment located in the conditioned space, controllers shall be mounted inside the unit enclosure. Where sufficient mounting space is not available inside the unit enclosure, a control panel shall be installed above the drop ceiling, inside the room, as close to the room space sensor as possible. Coordinate with UCB to clarify acceptable mounting locations.
2. For equipment located above the drop ceiling, controllers shall be unit mounted. (Notify UCB if 36” clearance in front of control panel has not or cannot be provided.) Provide adhesive backed ceiling labels, affixed to ceiling grid below all ceiling concealed controllers, affix to ceiling panel access door for solid ceilings.

F. Laminated control drawings, including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.

3.04 SURGE PROTECTION
A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no affect on hardware, software, communications, and data storage.

3.05 DEMOLITION AND REUSE OF EXISTING MATERIALS AND EQUIPMENT
A. Contractor shall assume that existing equipment that specifically is indicated to be reused is in good condition and is operable. Coordinate with UCB for clarification of reusable equipment. Contractor, during the course of work, shall inspect these devices and determine if any devices are in need of replacement or repair. Contractor shall prepare an itemized list of suggested repairs/replacement. This repair/replacement will be at the discretion of the University.

B. Existing wire, conduit, and control panel cabinets may be reused at the University Project Engineer’s discretion, but only if such materials or equipment comply with the applicable specification for new materials and equipment. Such materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service.

C. Where such materials are reused, the contractor’s shop drawings shall reflect the existing wiring designation. If existing labeling is illegible or otherwise does not comply with the applicable specification for labeling, wiring runs shall be relabeled in accordance with the requirements specified elsewhere.
D. Existing valves and dampers and their operators may be reused only when preapproved by University. Contractor shall lubricate all damper linkages of dampers being controlled under this project.

E. Other materials and equipment not specifically mentioned herein may be reused only if specifically allowed by indications on the drawings and approved by UCB.

F. For HVAC systems which are indicated to receive a new BAS, all existing materials and equipment associated with the existing pneumatic controls and EMCS shall be removed unless otherwise specified or indicated to remain, or unless reused in accordance with the above requirements, except for the following:

1. Conduit and electrical boxes (but not wiring within conduit) may remain in place if not reused (leave a pull line);
2. Inaccessible pneumatic tubing may remain in place if not reused. Tubing must be sealed and permanently labeled as “Abandoned in Place”.

Existing materials and equipment to be removed shall be removed subject to the requirements in paragraph “Sequence of Work”. For HVAC systems, which are not to receive a new DDC BAS, the existing pneumatic control system shall remain fully functional.

3.06 SEQUENCE OF WORK FOR EXISTING SYSTEMS CONVERSION

A. General: All work involving changeover of control functions from existing pneumatic control system to the new DDC BAS shall be performed in accordance with the following sequence in order to minimize the duration of equipment outages. The following descriptions are intended to indicate the sequence in which the work shall be performed, not to define fully the scope of the work.

B. Install operator’s terminal, peripherals, graphic software, and LAN prior to placing any equipment under the control of the new BAS.

C. Work which requires shutting down a pump motor, fan motor, or chiller shall be considered a utility shutdown and shall be subject to the restrictions specified in UCB’s power outage protocol “UCB Outage Notification Protocol”.

D. The following sequence applies to an individually controlled HVAC subsystem, such as an air handling unit. Only one such system shall be placed under manual control (as described below) at any given time.

1. Install controllers adjacent to (or within) existing control panel. Programming shall be complete (except for loading and debugging) prior to installation. Install all field devices, which do not require interruption of the existing control system.
2. Install all conduit, wiring, and pneumatic tubing which does not require interruption of the existing control system.
3. Remove existing controls including wiring, conduit, and tubing (except materials to be reused in accordance with provisions specified elsewhere) which must be removed to facilitate installation of new BAS materials and equipment.
4. Remove existing digital control system points (if applicable). Install and calibrate remainder of new BAS materials and equipment for this subsystem. Load controller software. Connect controller(s) to LAN.
5. Perform all field testing and calibration that does not require connection of permanent pneumatic outputs.
6. Remove remaining existing pneumatic and digital control system materials and equipment (except materials to be reused in accordance with provisions specified elsewhere). All existing digital controls equipment for those subsystems that have not yet been converted shall remain intact, on-line, and fully functional.
7. Schedule work in University occupied spaces 10 working days in advance with the University’s representative. Scheduling shall not be required for work in equipment rooms, electrical closets, and similar service areas.

3.07 CONTROL POWER SOURCE AND SUPPLY

A. Section 15950 Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Sections 15950 through 15955 and Sequences of Operation.

B. General requirements for obtaining power include the following:

1. All control panels shall be served by dedicated power circuits. BC control panels shall additionally be provided with external UPS power supplies to meet the requirements for BC power failure operation in Section 15954. Control panel shall be labeled with electrical panel & circuit source.

2. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served.

3. Standalone Functionality: Refer to Section 15953.

4. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.

5. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment’s control transformer is large enough and of the correct voltage to supply the controls it may be used. If the equipment’s control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer.

3.08 BAS START UP, COMMISSIONING AND TRAINING

A. BAS Commissioning per CU standards

3.09 SEQUENCE OF OPERATION

A. Sequences of Operation per CU standards

END OF SECTION 15950
SECTION 15951 - BAS BASIC MATERIALS, INTERFACE DEVICES, AND SENSORS

PART I. PART 1 - GENERAL

1.01 SECTION INCLUDES

1.02 RELATED DOCUMENTS

1.03 DESCRIPTION OF WORK

1.04 WORK BY OTHERS

PART II. PART 2 - PRODUCTS

2.00 APPROVED VENDORS

2.01 MATERIALS AND EQUIPMENT

2.02 GENERAL FIELD DEVICES

2.03 TEMPERATURE SENSORS (TS)

2.04 DIFFERENTIAL PRESSURE SWITCHES (DPS)

2.05 PRESSURE SWITCHES (PS)

2.06 CURRENT SWITCHES (CS)

2.07 CURRENT TRANSDUCER (CT)

2.08 ELECTRIC CONTROL COMPONENTS

2.09 NAMEPLATES

2.10 TESTING EQUIPMENT

PART III. PART 3 - EXECUTION

3.01 INSPECTION

3.02 INSTALLATION OF CONTROL SYSTEMS
PART I. PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Wiring
   B. Control Panels
   C. Sensors
   D. Electric Control Components (Switches, EP Valves, Thermostats, Relays, Smoke Detectors, etc.)
   E. Transducers
   F. Current Switches
   G. Nameplates
   H. Testing Equipment

1.02 RELATED DOCUMENTS
   A. Section - Basic Mechanical Requirements
   B. Section 15950 - Building Automation System (BAS) General

1.03 DESCRIPTION OF WORK
   A. Refer to Section 15950 for general requirements.
   B. Refer to other Division-15 sections for installation of instrument wells, valve bodies, and dampers in mechanical systems; not work of this section.
   C. Provide the following electrical work as work of this section, complying with requirements of Division-16 sections:
      1. Control wiring between field-installed controls, indicating devices, and unit control panels.
      2. Interlock wiring between electrically interlocked devices, sensors, and between a hand or auto position of motor starters as indicated for all mechanical and controls.
      3. Wiring associated with indicating and alarm panels (remote alarm panels) and connections to their associated field devices.
      4. All other necessary wiring for fully complete and functional control system as specified.

1.04 WORK BY OTHERS
   A. Controlled Equipment Power Wiring shall be furnished and installed under Division 16. Where control involves 120V control devices controlling 120V equipment, Division 16 Contractor shall extend power wiring to the equipment and control panel. Section 15951 Contractor shall extend it from the equipment to the control device and provide transformers as necessary to step the voltage down.

PART II. PART 2 - PRODUCTS

2.00 APPROVED VENDORS
   A. Vendors:
      1. Andover
      2. Automated Logic (ALC)
2.01 MATERIALS AND EQUIPMENT

A. General: Provide electronic control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for complete installation and reviewed and approved by UC. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

B. Communication Wiring: All wiring shall be in accordance with manufacturer’s requirements, National Electrical Codes and Division 16 of this specification. All wire insulation shall be color-coded and labeled for ease of identification.

1. Contractor shall supply all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals (e.g., operator workstations, printers, and modems).

2. Local Supervisory LAN: For any portions of this network required under this section of the specification, contractor shall use Fiber or Category 5e of standard TIA/EIA (100/1000BaseT). Network shall be run with no splices and in separate conduit from any other wiring.

3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any other wiring. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.

C. Signal Wiring: Contractor shall run all signal wiring in accordance with National Electric Codes, Division 16 of this Specification and within the allowances of UCB’s wiring guideline. All wire insulation shall be color-coded and labeled for ease of identification.

1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be per manufacturer’s requirements. Signal wiring shall be run with no splices and separate from all other wiring above thirty (30) volts.

2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

D. Low Voltage Analog Output Wiring: Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 16 of this Specification. All wire insulation shall be color-coded and labeled for ease of identification.

1. Low voltage control wiring shall be per manufacturer’s requirements. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

E. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.

1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.

2. Provide UL-listed cabinets for use with line voltage devices.

3. Control panel shall be completely wired prior to delivery and all electrical connections made to a labeled terminal strip. Control panel shall have standard manufacturer's color.

4. All gauges and control components shall be identified by means of nameplates.

5. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.

6. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.
2.02 GENERAL FIELD DEVICES

A. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.

B. It shall be the Contractor's responsibility to assure that all field devices are compatible with controller hardware and software.

C. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, the Contractor shall provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.

D. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, Contractor shall furnish and install proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.

E. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, non-repeatability and hysteresis.

2.03 TEMPERATURE SENSORS (TS)

A. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3°F (0.16 °C) (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

B. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
   2. Provide setpoint adjustment where indicated. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS (initial range of +/- 2ºF).
   3. Provide an occupancy override button on the room sensor enclosure where indicated. This shall be a momentary contact closure
   4. Provide current temperature indication via an LCD readout where indicated.

C. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
   1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.2°F accuracy at calibration point

D. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. Temperature range as required for resolution indicated in paragraph A.
   1. Sensing element shall be platinum RTD, or thermistor, +/- 0.2°F accuracy at calibration point.

2.04 CONTROL DAMPERS

A. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and
close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.

B. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5” w.c. (622 Pa):
1. Performance: Test in accordance with AMCA 500.
2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches (200 mm) wide by 48 inches (1219 mm) long, attached to minimum 1/2 inch (12.7 mm) shafts with set screws, 16 gauge minimum thickness.
6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
7. Linkage: Concealed in frame.
8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
9. Leakage: Less than one percent based on approach velocity of 1500 ft./min. (7.62 m/s) and 1 inches wg. (249 Pa).
10. Maximum Pressure Differential: 2.5 inches wg. (622 Pa)
11. Temperature Limits: -40 to 200 °F (-40 to 93 °C).
12. Where opening size is larger than 48 inches (1219 mm) wide, or 72 inches (1829 mm) high, provide dampers in multiple sections, with intermediate frames appropriate for installation.

DIFFERENTIAL PRESSURE SWITCHES (DPS)
C. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing
D. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.

2.05 PRESSURE SWITCHES (PS)
A. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.
B. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Johnson Controls. Substitutions shall be allowed per Division 1.

2.06 CURRENT SWITCHES (CS)
A. Clamp-On Design Current Operated Switch (for Constant Speed Motor Status Indication)
1. Range: 1.5 to 150 amps.
2. Trip Point: Adjustable.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Lower Frequency Limit: 6 Hz.
Fiske Planetarium
University of Colorado – Department of Astrophyysical & Planetary Science

5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM

B. Clamp-on Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150. Substitutions shall be allowed per Division 1.
1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.

C. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
1. Range: 1.5 to 135 Amps.
2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
4. Frequency Range: 5-75 Hz
5. Trip Indication: LED
6. Approvals: UL, CSA
7. Max. Cable Size: 350 MCM

D. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.

2.07 CURRENT TRANSDUCER (CT)

A. Clamp-On Design Current Transducer (for Motor Current Sensing)
1. Range: 1-10 amps minimum, 20-200 amps maximum
2. Trip Point: Adjustable
3. Output: 0-5 VDC.
4. Accuracy: ±0.2% from 20 to 100 Hz.
5. Acceptable Manufacturers:
   a) Veris #7222, 822, 922
   b) Substitutions shall be allowed per Division 1.

2.08 ELECTRIC CONTROL COMPONENTS

A. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.

B. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire
element, minimum bulb size of 1/8" x 20' (3.2mm x 6.1m), junction box for wiring connections
and gasket to prevent air leakage or vibration noise, DPST (4 wire, 2 circuit) with manual reset.
Temperature range 15 to 55°F (-9.4 to 12.8°C), factory set at 38°F.

C. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts,
operating temperature range of 50 to 150°F (10 to 65°C) , and a minimum 10°F fixed setpoint
differential.

D. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury
contacts, operating temperature range of 50 to 90°F (10 to 32°C), switch rating of 24 Vac (30
Vac max.), and both manual and automatic fan operation in both the heat and cool modes.

E. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and
mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum,
the following:
   a) AC coil pull-in voltage range of +10%, -15% or nominal voltage.
   b) Coil sealed volt-amperes (VA) not greater than four (4) VA.
   c) Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin
type plug.
   d) LED pilot light indication of power-to-coil and coil retainer clips.
   e) Coil rated for 50 and 60 Hz service.
   f) Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA.
      Substitutions shall be allowed per Division 1.
2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP,
shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC.
   Substitutions shall be allowed per Division 1.
3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be
provided with transient and surge suppression devices at the controller interface.

F. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor.
   ANSI/NEMA ICS 6, NEMA type I enclosure. Manufacturer shall be Square 'D', Cutler-Hammer
   or Westinghouse.

G. Control Transformers: Furnish and install control transformers as required. Control transformers
shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall
be fused in accordance with the NEC. Transformer shall be proper size for application, and
mounted in minimum NEMA-1 enclosure.
1. Transformers shall be manufactured by:
   a) Westinghouse
   b) Square ‘D’
   c) Jefferson.
   d) Veris X100, X040, X020
   e) Substitutions shall be allowed per Division 1.

H. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with
adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with
a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million
   operations. TDRs shall have solid state, plug-in type coils with transient suppression
devices.
2. TDRs shall be UL and CSA listed, Crouzet type. Substitutions shall be allowed per
   Division 1.
I. **Electric Push Button Switch**: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.

J. **Pilot Light**: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

K. **Electric Selector Switch (SS)**: Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

2.09 **NAMEPLATES**

A. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1" x 3", with minimum 1/4" high block lettering. Nameplates for devices smaller than 1" x 3" shall be attached to adjacent surface.

B. Each nameplate shall identify the function for each device.

C. For pump Variable Speed Drives (VSDs), provide an engraved nameplate at the VSD indicating the location of the controlling Remote Differential Pressure (RDP) transmitter(s). Location shall include the ‘Plan’ room number as well as the actual ‘Building’ room number.

2.10 **TESTING EQUIPMENT**

A. Contractor shall test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Contractor shall be responsible for test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).

PART III. **PART 3 - EXECUTION**

3.01 **INSPECTION**

A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 **INSTALLATION OF CONTROL SYSTEMS**

A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings. Install electrical components and use electrical products complying with requirements of National Electric Code and all local codes.

B. **Control Wiring**: The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connection of electric control devices.

1. **Wiring System**: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 16 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
2. Control Wiring Conductors: Install control wiring conductors, without splices between Terminal points, labeled with device served. Install in neat workmanlike manner, securely Fastened. Install in accordance

3. Communication wiring shall be run in separate conduit from all other wiring. Signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.

4. All WAN and LAN Communication wiring shield shall be terminated as recommended by controller manufacturer. All WAN and LAN Communication wiring shall be orange jacketed and labeled with a network number, device ID at each termination and shall correspond with the WAN and LAN system architecture and floor plan submittals.

5. All communications wiring shall be in conduit unless pre-approved by UCB.

6. All low-voltage wiring external to control panels shall be in conduit, unless pre-approved. Conduit type, sizing, and installation requirements shall conform to NEC and Division 16. The following only applies when a pre-approved exception to conduit has been granted. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be laid on the ceiling or duct. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

7. Number-code or color-code conductors appropriately for future identification and servicing of control system. Code shall be as indicated on approved installation drawings. Preferred identification system: BRADY

C. Freezestats: Install freezestats in a serpentine fashion. Provide one foot of element for each square foot of coil face area. Where coil face area exceeds required length of element, provide multiple devices, wired in parallel for normally open close on trip application, wired in series for normally closed, open on trip application. Adequately support with coil clips.

D. Space Temperature Sensors: Sensors shall be located as indicated on drawings.
   1. Mount non-adjustable sensors with centerline 60” above finished floor. Sensors with adjustable setpoints and/or override switches must be mounted 36” to 48” above finished floor; coordinate with UCB.
   2. Coordinate location of sensor with work of other trades so sensor does not conflict with or is obstructed by such items as blackboards, bleachers, bookcases, etc.
   3. Conceal all control wiring to sensors located in new finished spaces; the use of wiremold is prohibited.
   4. Thermostats located in Locker Rooms, Team Rooms, Storerooms, and Corridors shall be flush mounted type.

E. Averaging Temperature Sensors: Cover no more than three square feet per linear foot of sensor length except where indicated. Generally where flow is sufficiently homogeneous/adequately mixed at sensing location, consult AE for requirements.

F. Airflow Measuring Stations: Install per manufacturer’s recommendations in an unobstructed

G. Test Ports: Provide test ports in ductwork at each temperature and humidity sensor location to facilitate sensor calibration. Test ports shall be 3/4” diameter minimum and accessible via a 2” x 4” junction box with insulated cover.
H. Cutting and Patching Insulation: Repair insulation to maintain integrity of insulation and vapor barrier jacket. Use hydraulic insulating cement to fill voids and finish with material matching or compatible with adjacent jacket material.
SECTION 15990 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. This section covers testing and balancing of environmental systems described herein and specified under Division 15. The testing and balancing of all environmental systems shall be the responsibility of one Testing, Balancing and Adjusting firm.

1. Test, adjust and balance the following mechanical systems and the mechanical equipment associated with these systems:


b. Air Side Systems and Equipment

   1) Supply/Return Air Systems
   2) Air Handling Units

c. Hydronic Systems and Equipment

d. Refrigeration Systems and Equipment

   1) Condensing units
   2) Evaporator coils

1.2 QUALIFICATIONS OF CONTRACTOR:

A. The General Contractor shall procure the services of an independent testing and balancing agency specializing in the testing, adjusting and balancing of environmental systems to perform the above mentioned work. An independent contractor is defined as an organization that is not engaged in engineering design or is not a division of a mechanical contractor entity, which installs mechanical systems.

B. The actual fieldwork shall be performed by qualified technicians who are currently certified by the Testing, Adjusting and Balancing Bureau (TABB), the National Environmental Balancing Bureau (NEBB), or the Associated Air Balance Council (AABC) certification agencies.

C. The Testing & Balancing Contractor shall have a minimum of three years experience in testing and balancing mechanical systems.

1.3 APPROVAL OF CONTRACTOR:

A. The following firms are approved contractors to complete the work.

1. Checkpoint Balance
2. Lawrence H. Finn & Assoc.
3. Griffith Engineering
4. JPG Engineering

B. The test and balance contractor shall do the work under the general contractor, not the mechanical contractor.
1.4 CODES AND STANDARDS:

1.5 PRELIMINARY SUBMITTALS:
   A. Within ten (10) days of award of the contract the Mechanical Contractor shall submit the name of the Test and Balance Contractor who will be performing the work. The submittal shall include a complete list of all technicians who will be performing the field work and include a photocopy of their current certification by either NEBB, AABC, or TABB certification agencies. Only those technicians included in the submittal shall perform the work. Any personnel or staff used to perform the work without prior approval of the Engineer, who are not included in the submittal, shall be grounds for rejecting the test and balance report and the project in whole.
   B. Meet all requirements of Section 15010 as applicable.
   C. Submit a list of all instrumentation to be used on an individual project and include calibration dates. Submit calibration curves. If more than one instrument of a similar type is used, a comparison of individual readings should be made. The variation between instrument readings should not exceed plus or minus 5%.
   D. The contractor shall review the contract documents and submittals for location and type of balancing devices being installed by the sheet metal and mechanical contractors, and issue a letter to the engineer and UCB indicating they are adequate or shall identify deficiencies needing attention.

1.6 FINAL REPORTS:
   A. Refer to Division 1 for supplemental requirements.
   B. The Testing and Balancing Contractor shall submit six (6) bound copies of the final testing and balancing report at least fifteen (15) calendar days prior to substantial completion, unless noted otherwise in Division 1. Report contents shall be per Part 3 of this Section.
   C. Meet all requirements of Section 15010 as applicable.
   D. If more than two reports are made by the contractor, the Owner reserves the right to charge the contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the contractor.

1.7 SEQUENCING AND SCHEDULING:
   A. Notify Contractor/Engineer/Architect in writing of conditions detrimental to the proper completion of the test and balance work. Provide the Contractor/Architect/Engineer with a copy of the notification.
   B. Prepare a project schedule. Schedule shall indicate critical path of the balancing process and shall incorporate both requirements of other contractors necessary to meet test and balance commitments and process flow of test and balance work. Coordinate with general and mechanical contractors and insert critical steps into project master schedule.
PART 2 - PRODUCTS

2.1 BELTS, SHEEVES, IMPELLERS:

A. Refer to specific equipment sections and Section 15010 for additional requirements.

B. The Testing & Balancing Contractor shall coordinate with the Mechanical Contractor to supply correctly sized drive belts and sheeves.

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES:

A. Testing and balancing shall not begin until the system has been completed and is in full working order and the following project conditions have been determined suitable for start of work.

1. Preliminary Testing & Balancing Contractor requirements shall be ascertained prior to the commencement of work through a review of the project plans and specifications. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices, that they are being installed properly, and in an accessible location for the need. Report in writing any deficiencies to the Contractor/Engineer/Architect immediately.

2. Before any air balance work is done, the system shall be checked for duct leakage (obtain pressure test results), assure filters are installed, verify filters are changed if they are dirty, check for correct fan rotation, equipment vibration, and check automatic dampers for proper operation. All volume control dampers and outlets shall be wide open at this time.

3. Verify systems do not exhibit excessive sound and/or vibration levels. Report in writing any deficiencies to the Contractor/Engineer/Architect immediately.

3.2 PRELIMINARY PROCEDURES – REMODEL WORK:

A. In remodel area, a complete preliminary test and balance report shall be accomplished prior to any work. Any obvious deficiencies shall be identified at that time. A complete report of all readings, recommendations, etc. shall be submitted to the Engineer.

3.3 GENERAL SYSTEM AND EQUIPMENT PROCEDURES:

A. Balance all air and water flows at terminals within +10% to -5% of design flow quantities. Notify Contractor/Engineer/Architect in writing of conditions detrimental to the proper completion of the test and balance work. Provide the Contractor/Architect/Engineer with a copy of the notification.

B. Pressure relationships indicated on drawings shall take priority over air quantities.

C. Mark equipment settings with paint, including damper control positions, balancing cocks, circuit setters, valve indicators, fan speed control settings and similar controls and devices, to show final settings at completion of test-adjust-balance work.

D. Patch holes in insulation, ductwork and housings, which have been cut or drilled for test purposes, in a manner recommend by the original installer.

E. Measure, adjust and report equipment running motor amps and power factor, KW, rated motor amperage, listed motor power factor, voltage, and all nameplate data. Perform these measurements for all equipment operational modes.
F. Check and adjust equipment belt tensioning.

G. Check keyway and setscrew tightness. Report any loose screws and notify Mechanical Contractor prior to equipment balancing.

H. Record and include in report all equipment nameplate data.

I. Verify that all equipment safety and operating controls are in place, tested, adjusted and set prior to balancing.

J. Verify that manufacturer start-up has occurred per specification prior to balancing.

K. Replace all adjustable sheaves on multiple belt drives with fixed-speed sheaves.

3.4 AIR SIDE SYSTEMS AND EQUIPMENT PROCEDURES:

A. In addition to the procedures identified under each specific heading below, provide general data required by 3.2 above.

B. Filters shall be restricted to increase pressure drop to 50% of span between initial pressure drop and final recommended pressure drop for setting final airflows for fans. Check fan motor amps with clean filters and simulated loaded filters, and report for each piece of equipment. Equipment shall be supplied with clean filters upon completion of balance. Balance and report air quantities.

C. Supply/Return Air Systems:

1. Balance and report supply and return diffuser/grille quantities. Air diffusion patterns shall be set as noted on drawings and to minimize objectionable drafts and noise.

2. Provide full pitot traverses in duct mains downstream of supply fans, upstream of return fans, and in each zone duct downstream of a multizone unit. Balance and report air quantities.

3. Report design air device inlet or outlet size, actual inlet or outlet size, design and actual velocity through the orifice, for each terminal in the system.

4. Balance and report the above measurements in all system operational/modes.
   a. Minimum outside air and 100% outside air economizer mode.
   b. Unoccupied mode.

D. Adjust CFM to system requirements. For belt drive include sheave and belt exchange to deliver airflow within limits of installed motor horsepower and mechanical stress limits of the fan. Determine the limiting fan tip speed before increasing RPM. Final fan speed setting shall allow for filter loading (as applicable) and shall establish proper duct pressures for operation of zone CFM regulators.

1. Measure and report static pressures upstream and downstream of all fans.

2. Measure and report fan RPM. Do not increase RPM by more than 10% without prior authorization from the engineer.

3. Report design fan inlet or outlet size, actual inlet or outlet size, design and actual velocity through the orifice.

E. Air Handling Units:
1. On outdoor units, verify that positively or negatively pressurized curbs are free of leaks. Report.

2. For units with integral outside air intake and relief dampers, measure, adjust, set and report outside air, return air and relief air quantities. Perform this as specified under supply air systems.

3. Balance and report supply and return fan CFM, upstream static pressure and downstream static pressure.

4. Measure and report static pressure upstream and downstream of all AHU components such as coils, filters (clean and simulated dirty), dampers, etc.

5. After system and fan balance is complete, perform pitot traverses on all coils in 100% heating and cooling modes.

6. Units with economizers shall have all measurements performed and reported at minimum outside air, 100% outside air, and a 50/50% mixed air condition.

7. Balance all air handling unit coils and report per hydronic, gas fired, steam or refrigeration equipment portions of this section.

8. Report design fan inlet or outlet size, actual inlet or outlet size, design and actual velocity through the orifice.

9. Balance and report all temperatures of airside during normal operating modes.

10. Measure, adjust, set, balance and report outside air, return air and exhaust/relief air quantities for all air handling systems.

    Air quantities shall be determined by pitot traverse/direct airflow measuring procedures where ever possible, where duct/inlet conditions do not allow for accurate direct measurement of outside air the following method shall be used:

    \[
    \text{Outside Air CFM} = \frac{\text{Supply Fan Total CFM}}{- \text{Return Fan Total CFM}}
    \]

    In addition to the direct measuring of airflow quantities, measure and record outside air, return air and mixed air temperatures, determine thermal/mass energy balance and provide calculations to verify measured airflow quantities. Adjusting and setting the outside air quantity as a percentage of damper position will not be acceptable.

3.5 Refrigeration Systems and Equipment:

A. General.

B. Condensing Units (Air Cooled):

1. Measure and report ambient temperature, refrigerant suction and discharge pressure, oil pressure, compressor and fan KW and compressor and fan amps. Verify operation of condenser fan and head pressure controls.

2. Condensing units integral to the air moving equipment shall be measured at minimum outside air.

3. Perform all measurements at all stages of cooling.
C. Evaporator Coils:
   1. Measure and report temperature upstream and downstream of evaporator coils at all stages of cooling at all design air quantities. Calculate and report coil face velocities.

3.6 ELECTRICAL COMPONENTS ASSOCIATED WITH MECHANICAL SYSTEMS:

A. Manual and Magnetic Starters:
   1. Check all new and existing thermal overloads. Identify improperly protected equipment in report. Furnish and exchange thermals as required for proper motor protection.

3.7 REPORT OF WORK:

A. The Testing and Balancing Contractor shall submit six (6) bound copies of the final testing and balancing report at least fifteen (15) calendar days prior to the Mechanical Contractor’s request for final inspection.

B. A complete reduced set of mechanical contract drawings (showing each system) shall be included in the report with all equipment, flow measuring devices, terminals (outlets, inlets, coils, fan coil units, schedules, etc.) clearly marked and all equipment designated. The test and balance contractor can obtain drawing files from Cator, Ruma, & Associates for development of these drawings.

C. Data shall be reported per Part 3 of this Section on standard NEBB forms. Generate custom forms that contain the information in this Section when a standard NEBB form does not exist for a piece of equipment. All NEBB forms shall be fully filled out for this report. When additional information is required by this Section, it shall be provided.

D. The report shall include all test and balance data as well as information on any discrepancy from specifications or performance standards. All discrepancies shall be included in a separate section. As a minimum, the following items shall be included:

   1. Belt and drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, and amperage and voltage to all motors (in various operating modes where applicable).

   2. Static pressure drops across all components of the air systems. Static pressure profile for each air handling unit system.

   3. Required and final balanced CFM at each system terminal unit. Include the terminal size, inlet static pressure, temperature and velocities read to attain the required CFM.

   4. Refrigerant system operating amperages, pressures and temperatures.

   5. Overload protection data for all motors shall be recorded. Starter and/or VFD brand, model, enclosure type, installed overload devices, original ratings and set points (and revised device ratings and set points when applicable) shall be recorded. If the starters (and/or VFDs) were furnished by the mechanical contractor, the overloads shall be verified and changed to the correct size when necessary, and so noted in the report. If the starters were furnished by the electrical contractor, the correct overload device sizes and settings shall be noted in the report and the electrical contractor shall be advised of all discrepancies.
E. The report shall include a list of all equipment used in the testing and balancing work.

F. Report systems for excessive sound and vibration per the sound and vibration inspection and testing portions of this specification.

G. Substantial completion of this project will not take place until a satisfactory report is received. The Testing & Balancing Contractor shall respond and correct all deficiencies within seven (7) days of receiving the Engineer’s written review of the balancing report. Failure to comply will result in holding retainage of the final payment until all items have been corrected to the satisfaction of the Engineer.

H. The report shall be signed by the supervising registered professional engineer and affixed with their registration stamp, signed and dated in accordance with state law.

3.8 FIELD VERIFICATION:

A. Upon request of the Owner or Engineer, a representative of the balancing firm performing the work shall demonstrate to him fluid flow quantities shown in the report by reading back outlets or terminals selected at random. It is understood that the operating mode of the system shall be the same for readback as it was during balancing and the number of readings verified will not exceed 10% of the total in the report.

B. When deemed necessary by the Owner or Engineer, the balancing firm shall run temperature, pressure, and/or humidity recordings, and shall be prepared to verify any of the report test results in the presence of the Owner and/or Engineer when requested.

3.9 GUARANTEE OF WORK:

A. The Testing & Balancing Contractor shall guarantee the accuracy of the tests and balance for a period of 90 days from date of final acceptance of the test and balance report. During this period, the Testing & Balancing Contractor shall make personnel available at no cost to the Owner to correct deficiencies that may become apparent in the system balance.

END OF SECTION 15990
BASIC ELECTRICAL REQUIREMENTS

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 work of this section and all subsequent Division 16 sections.

1.2 SUMMARY:

   A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 16. It expands and supplements the requirements specified in sections of Division 1 through 15.

1.3 ACCESSIBILITY:

   A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.

   B. Extend all conduits so that junction and pull boxes are in accessible locations.

   C. Install access panel or doors where equipment or boxes are concealed behind finished surfaces.

1.4 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 15 for rough-in requirements.

1.5 REQUIREMENTS OF REGULATORY AGENCIES:

   A. Electrical installations, inspections, and testing shall meet, at a minimum, the versions of the following in effect at the date of these contract documents except where otherwise specified:

      1. Underwriters Laboratories (UL)
      2. Federal and State Regulations
      3. OSHA
      4. NFPA
      5. NEMA
      6. IEEE
      7. ANSI
      8. NESG
      9. CBM
      10. NECA
      11. ICEA
      12. NETA
      13. NEC
      14. UCB Standards

   B. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.
C. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

D. All materials and installations shall comply with University of Colorado Standards.

1.6 ELECTRICAL INSTALLATIONS:

A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.

D. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

E. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, luminaires and other building components. Ductwork and piping shall not be installed above electrical panelboards.

1. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, space for mechanical and electric systems within the cavity shall be allocated in the following order:

   a. Plumbing waste, vent piping and roof drain mains and leaders.
   b. Supply, return and exhaust ductwork.
   c. Fire sprinkler mains and leaders.
   d. Electrical conduit.
   e. Domestic hot and cold water.
   f. Pneumatic control piping.
   g. Fire sprinkler branch piping and sprinkler runouts.

F. Verify all dimensions by field measurements.

G. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.

H. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the space.

I. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

J. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.

K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and removal with minimum of interference with other installations.

1.7 CUTTING AND PATCHING:
A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.

B. Refer to the Division 1 Section covering cutting and patching for general requirements.

C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

D. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.

E. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

G. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work;
2. Remove and replace defective Work;
3. Remove and replace Work not conforming to requirements of the Contract Documents;
4. Remove samples of installed Work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

H. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.

I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

K. Locate identify, and protect mechanical and electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.

1.8 ELECTRICAL SUBMITTALS:

A. Refer to the Conditions of the Contract (General and Supplementary) and Division 1 Section covering shop drawings, product data, and samples for submittal definitions, requirements, and procedures.

B. The manufacturer's material or equipment listed first in the specifications or on the drawings are the types to be provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.

C. All equipment shall conform to the State and/or local Energy Conservation Standards.

D. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed unless written prior approval is obtained by the Contractor.
E. Before starting work, prepare and submit to the Architect/Engineer four (4) sets of all shop drawings, descriptive product data, and samples required for the project. Continue to submit four (4) sets, after each Architect/Engineer's action, until a "No Exception Taken" or "Make Correction Noted" action is received with the exception of Fire Alarm submittals which must be submitted until a "NO EXCEPTION TAKEN" action is received. The Engineer will complete an initial review and, if required, a single subsequent review of the resubmittal. If the submittal requires a third review or additional reviews, the University may withhold amount(s) necessary from Contractor's final request for Payment to reimburse the Engineer at their standard hourly rates. Submittals shall include the following specified materials and, in addition, any materials not listed below but which are specified in the individual sections of Division 16 which follow.

1. Raceways including surface raceways and wireways
2. Wiring devices
3. Disconnect Switches
4. Circuit breakers and fused switches for installation in existing panelboards or distribution centers
5. Lighting
6. Fire alarm and detection system
7. Supporting devices

F. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections. Identification shall contain the information as required in details and each label shall be submitted in list form with disconnects, panelboards, switchboards, overcurrent protection devices and utilization equipment.

G. All electrical submittals shall be submitted electronically.

1. Submittals shall be provided in PDF format.
2. Each submittal shall be separated by the electrical specification section it is specified in.

H. Submittals shall be provided for review within four (4) working weeks from award of contract to successful bidder.

I. Switchboards, panelboards, short circuit study, and ¼” scaled drawings of the electrical equipment layout and NEC required clearances shall be submitted as one submittal per UCB Standards for review by UCB and the engineer of record. The submittal will be considered incomplete and returned if missing any of the items mentioned above.

1.9 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. Substituted equipment will only be allowed where specifically listed in a written addendum. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.

B. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture.

1.10 SCHEDULE OF VALUES:

A. Provide preliminary schedule of values to Engineer according to the following descriptions:

1. Demolition
2. Lighting - Interior
3. Basic Materials/Devices/Equipment Connections (Mechanical)
4. Fire Alarm (Material/Installation)
   a. Building F.A. System
5. Miscellaneous

1.11 NAMEPLATE DATA:

A. Provide equipment with permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Install equipment so that nameplate is readily visible.

1.12 DELIVERY, STORAGE AND HANDLING:

A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.

D. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.13 RECORD DOCUMENTS:

A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.

C. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

D. Mark luminaire schedule on drawings to indicate manufacturer and complete catalog numbers of installed equipment.

E. Mark schedules including panelboard, mechanical, and similar equipment schedules on drawings to indicate installed equipment and materials used, and any deviations or revisions to electrical load data and calculations.

F. During construction, the contractor shall maintain at the job site a set of updated construction documents for the singular purpose of recording the above information. All record drawings shall be completed in erasable pencil. These changes shall be updated weekly.

G. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.

1. Red shall indicate new items, deviations and routing.
2. Green shall indicate items removed or deleted.
3. Blue shall be used for relevant notes and descriptions.

H. The Contractor shall have available at the job site current information on the following at all times:

1. Addenda
2. Change Orders
3. Submittals
4. Inspection Reports
5. Test Results
6. Outage Information and Requests.

I. At the completion of the project, submit these documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.

1.14 OPERATION AND MAINTENANCE DATA:

A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.

B. In addition to the information required by Division 1 for Maintenance Data, include the following information:

1. As part of the operation and maintenance manuals for the project, the Contractor shall be required to submit schematic diagrams and point-to-point wiring diagrams for the following systems. Submittal shall be in the form of blacklines, furnish reproducible copy, and AutoCAD latest version.

   a. Fire Detection/Alarm Systems

2. Description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

3. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.

4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

5. Servicing instructions and lubrication charts and schedules.

6. Complete list of parts and wiring diagrams.

7. Names, addresses and telephone numbers of the Contractor, Sub-contractors and local company responsible for maintenance of each system or piece of equipment.

8. All information shall be permanently bound in a 3-ring binder. The job name and address and contractor's name and address shall be placed on the cover and spine of each binder in a permanent manner. Dymo-tape is not acceptable.

9. Copies of all test reports shall be included in the manuals.

10. Provide manuals with dividers for major sections and special equipment. Mark neatly in ink the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
C. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, is provided and the manual is reviewed by the Architect/Engineer.

1.15 TESTING:

A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and other sections of this Division.

B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.

C. General Scope:

1. The Contractor shall hire an independent testing agent to conduct operating and acceptance tests on new electrical system components and all existing devices which are impacted by the project.

2. The Testing agent shall prepare written reports of values of all test readings and procedures. Reports shall include all breaker settings and modifications to one line drawings.

3. The Testing agent shall furnish all equipment, instruments and personnel required to conduct tests.

4. Perform field test and operational check to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer=s tolerances and is installed in accordance with design specifications.

5. The tests and operational check shall determine the suitability for energization.

6. Schedule tests and give a minimum of two weeks= advance notice to the Architect. Reschedule testing for University convenience if required.

D. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field Instruments: 6 months

2. Laboratory Instruments: 12 months

3. Leased specialty equipment: 12 months. (Where accuracy is guaranteed by lessor, i.e., Doble).

Dated calibration labels shall be visible on all test equipment. Calibration date shall be recorded on the test report for all equipment used.

E. Independent Testing Agency:

1. Hereinafter in these Specifications, the tests and/or operational check identified in this section shall be performed by a recognized independent testing agency engaged and paid for by the Contractor. Other required tests shall be accomplished and documented as identified in the individual sections as they apply.

2. The testing agency shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907. Membership in the National Electric Testing Association constitutes proof of meeting such criteria.
3. The testing agency shall be responsible for implementing all final settings and adjustments on protective devices in accordance with Owner's specified values.

4. Testing Agencies: Subject to compliance with requirements and qualifications, the following are accepted agencies:
   
a. Electro-Test, Inc.

F. Test Report: Submit three copies of the completed report to the Architect no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified.

The test report shall include the following:

1. Project information including: Building, name, address, date, and other pertinent information.
2. List of equipment tested.
3. Description of test.
4. List of test equipment used and calibration date.
5. Baseline, acceptable, or published target value for test with code or standard reference indicating where value was derived.
6. Test results that summarize all measured values with baseline values.
7. Conclusions and recommendations.
8. Appendix, including appropriate test forms that show all measured values.

G. Failure to Meet Test:

1. Any system material or workmanship which is found defective on the basis of performance tests shall be reported directly to the Architect.

2. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the Owner.

H. Field test and/or operational check shall apply to the following Division 16 sections:

1. 16475 - Overcurrent Protective Devices

I. Field tests and/or operational checks for the above equipment are listed as follows:

1. 16475 - Overcurrent Protective Devices

   a. Test and Operational Check:

      1) Check cleanliness of all parts. Remove any excess packing, shipping bolts, etc.

      2) Verify proper operating condition of all equipment mechanically and electrically including, but not limited to:

         a) Verify operation of each circuit breaker trip device with an accurately metered timed instrument (by passing 300% rated current through each pole).

1.16 DEMOLITION/REMODEL WORK:

A. Refer to Division 1 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 2 section on selective demolition. The following are additions and modifications.
B. The project involves renovation and remodel of the existing building. On the drawings, work may be denoted by showing items as bold or light line weight and certain renovation symbols are used. These indications and symbols are amplified as follows:

1. **Bold Print (when used):** Work included in this contract is denoted in bold print or line weight.

2. **Light Print (when used):** Work shown lightly indicates existing conditions to remain.

**Existing item to remain in place:** Contractor shall perform the following function based upon the item to remain:

- **Luminaires:** Leave in place.
- **Switches:** Maintain circuit continuity.
- **Receptacle:** Remove devices if required for new work and reinstall.
- **Clock:** Clean and reinstall.

**Existing items to be removed:** Contractor shall remove the existing item and the associated existing wiring back to the source or next existing to remain device. Where the raceway serving the equipment is accessible (via removal of suspended ceiling, crawl space, etc.) the raceway shall also be removed in its entirety back to the source. Where the removal of a raceway leaves visible evidence on an existing surface which is not being repaired or replaced by the General Contractor, this contractor shall repair the surface. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank coverplate installed. Where the concealed raceway is uncovered by demolition performed by the General Contractor, the raceway shall be removed (or extended to new location if appropriate).

**ER =** Existing item to remain in place: replace device. Contractor shall perform the following function based upon the item to remain:

- **Luminaires:** Clean and install new lamps.
- **Switches:** Remove and replace with new in existing box.
- **Receptacles:** Remove and replace with new in existing box.
- **Clock:** Clean and replace.

**RL =** Existing item to be relocated: Contractor shall remove the existing item, and store in a safe place. The existing item shall be relocated to the new position as called for on the drawings. At Contractor's option, the existing wiring may be extended, or new wiring may be run from the source. Based upon the item to be relocated, the Contractor shall perform the following function:

- **Luminaires:** Clean and install new lamps.
- **Switches:** Replace.
- **Receptacles:** Replace.
- **Clocks:** Clean and relocate.

C. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner and be delivered for disposition unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Items which are removed and not wanted by the Owner shall become the property of the Contractor and shall be removed from the site.

D. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.

E. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment in adjacent areas shall be left intact.
F. Where remodeling interferes with existing circuits and equipment which are not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.

G. Where remodeling interferes with circuits serving areas outside of the project limits circuits shall be reworked or temporary circuits provided as required.

H. Existing equipment and circuiting shown are based on field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.

I. Coordinate the routing of all conduits with the existing mechanical and plumbing systems in order to avoid conflicts with ducts, pipes, etc. Where existing electrical boxes, conduit, or equipment interfere with installation of new ducts, plumbing, walls, soffits, luminaires, outlets, etc., the Contractor shall resolve the conflict with the appropriate trade.

J. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated on the drawings or allowed under the appropriate section of the specifications.

K. Electrical Outages: Electrical outages must be held to a minimum and requested two (2) weeks in advance. The Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum length of time, the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based on the MOP. Due to the critical implications of power outages, the Owner may direct the Contractor as to the time of day or night and date an outage may take place at no extra charge to the Owner.

1. The Contractor will be responsible for providing temporary power required for the duration of the outages. The required outages to connect and disconnect the temporary power will require a MOP as described above.

L. When called for in the specifications, or on the drawings, the Contractor shall meter the points indicated for seven consecutive days using a three phase digital analyzer (Dranetz #808, BMI 3030 or equal). The analyzer shall be set up to record volts, amperes, kw, and power factor for each phase at 15 minute intervals. Also recorded shall be the demand for each 15 minute interval. The maximum daily demands shall be listed in a summary printed once a day at midnight. The Contractor shall compile a summary report listing maximum readings and submit the report and tape to the Electrical Engineer. The analyzer shall have been calibrated within the previous 60 days. Submit documentation of the calibration to the Engineer.

M. Contractor is responsible for sending removed lamps to University of Colorado Environmental Health and Safety to be recycled.

N. The existing load shed capabilities of the building shall be maintained unless otherwise indicated on the drawings.

1.17 WARRANTIES:

A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 16, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
C. Provide complete warranty information for each item. Information to include product or equipment
description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and
telephone numbers and procedures for filing a claim and obtaining warranty services.

1.18 CLEANING:

A. Refer to the Division 1 Section on project closeout or final cleaning for general requirements for final
   cleaning.

B. Clean all luminaires, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

1.19 PROJECT CLOSEOUT:

A. The contractor shall be responsible for providing the items listed on the checklist prior to final observation.
   Required test reports shall be included in the O & M manuals. (Checklist is located at the end of this section.)

B. Punch Lists:

   1. Final payment will not be authorized until all items on the final punch list have been completed, and
      routine maintenance procedure and spare parts have been received.

C. Cleaning and Painting:

   1. Clean all electrical equipment, such as switches, panelboards, luminaires, etc., of construction dirt,
      dust, paint smears, etc., and touch-up or repaint all scars, blemishes, rust spots, etc., to original state of
      finish.

D. Operation and Maintenance Manuals:

   1. Compile a complete list of product data and shop drawings, acceptance tests, warranties, certificates,
      sub-contractor and supplier information (i.e. name, address, and phone no.).

E. Guarantees and Warranties:

   1. Furnish to the Owner a formal warranty covering the electrical system installed under this contract, to
      be free from defective materials and workmanship for a period of one year after date of acceptance of
      installation by Owner. During this period provide all labor and new materials required to repair or
      replace all defects to the satisfaction of the Owner at no cost to Owner.

1.20 SPECIAL ELECTRICAL PROVISIONS:

A. Bidding Requirements:

   1. The bidder shall give evidence of being able to be bonded to (1-1/2 times job value). A letter shall be
      provided by the bonding agency assuring capability of bonding this level and associated rates.

   2. The successful firm shall be capable of starting work immediately upon receipt of contract award and
      have the resources to complete the total project in accordance with the general contractor’s
      construction schedule. (Allowance will be made for material delays caused by problems outside of
      contractor’s control, with proper documentation.)

B. Qualification Requirements:

   1. Contractors bidding this project must complete AIA Document A305-1986 Contractor’s
      Qualification Statement® and submit it with their proposal for information purposes.
C. General Requirements:
   1. The successful firm shall provide a project supervisor of proven experience, and be willing to leave
      him (or her) on the project for the duration of the project, unless acceptable alternative arrangements
      are made with the University.
   2. The successful firm must have a business office which is staffed during normal working hours (8:00-
      5:00 Monday through Friday).
   3. The project manager of the successful firm shall have paging capability during normal working hours.

D. Craftsman Regulations:
   1. Contractors shall include no more than one indentured apprentice per journeyman electrician. Apprentices
      shall be under the direct supervision of a licensed electrician at all times.
   2. Helpers may be assigned to the project as required to do laboring type tasks, but may not do any
      installation type electrical work.

1.21 CONSTRUCTION REQUIREMENTS:

   A. The contractor shall maintain and have available at the jobsite current information on the following at all
      times:
   1. Construction Plans and Specifications
   2. Addenda
   3. Change Orders
   4. Submittals
   5. Inspection Reports
   6. Test Results
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END SECTION 16010
SECTION 16110 - RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.

   1. Types of raceways specified in this section include the following:

      a. Electrical metallic tubing (EMT).
      b. Flexible metal conduit.
      c. Liquid-tight flexible metal conduit.
      d. Surface metal raceways.
      e. Prohibited Materials

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Submit dimensioned drawings of surface metal raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

   1. EMT Conduit:

      a. Allied
      b. Republic
      c. Triangle
      d. LTV

   2. Steel Fittings:

      a. O/Z Gedney
      b. Raco
      c. Appleton
      d. EPT
      e. Midwest
      f. Picoma
2.2 METAL CONDUIT AND TUBING:

A. Electrical Metallic Tubing (EMT):
   2. Fittings: Steel compression fittings for raintight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2" and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

B. Flexible Metal Conduit:
   1. Conduit: Continuous spiral wound, interlocked, zinc-coated steel, approved for grounding.
   2. Fittings: Cadmium plated, malleable iron. Straight connector shall be one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. Angle connectors shall be two piece body with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. All fittings shall be terminated with threaded bushings having nylon insulated throats.

C. Liquid-Tight Flexible Metal Conduit:
   1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinylchloride (PVC) jacket, approved for grounding.
   2. Fittings: Cadmium plated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings. Fittings shall provide electrical continuity for grounding purposes.

2.3 CONDUIT BODIES:

A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.

C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.4 SURFACE METAL RACEWAYS:

A. General: Sizes and channels as indicated. Provide fittings that match and mate with raceway. All circuits either factory or field installed shall have a separate neutral conductor.

1. Multi-outlet assembly, divided for power and communication, nominal 4-3/4" x 1-3/4" with (2), 2-3/8" compartments and flush, snap-on cover. Install devices and circuits as indicated on the drawings.

2. Surface Metal Raceway: Galvanized steel with snap-on cover. Provide raceways of suitable size based on fill for circuits indicated on the drawings. Provide all necessary boxes, covers, extensions, fittings, etc. to form a complete assembly. Coordinate factory finish paint with the UCB Department of Facilities Management.

B. Boxes for Surface Raceways: Designed, manufactured and supplied by raceway manufacturer for use with specified raceway.

2.5 CONDUIT SIZES:

A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on insulation type RH, RHW, RHH and the number of conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:

1. Rigid, Intermediate, and EMT Conduit: 3/4" for all runs.

2. Flexible and Liquid-Tight Flexible Conduit: Minimum ½" for all runs. Runs shall be limited to 3 feet except lighting connections which may be a maximum of 6 feet. 3/8" flexible conduit is permitted if furnished as part of a manufactured equipment connection (including lighting equipment).

3. Conduits used for home runs shall contain only the conductors for the circuits indicated on the drawings. Combining multiple home runs into a single conduit will not be permitted.

2.6 PROHIBITED MATERIALS:

A. Aluminum conduit

B. ENMT

C. MC and AC cable

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
3.2 CONDUIT SCHEDULE:

A. Raceways in locations subject to mechanical injury: Rigid steel galvanized conduit. Locations subject to mechanical injury include, but are not limited to, the following:

1. Exposed conduits outdoors.

B. Motor, Mechanical Equipment and Lighting: Flexible metal conduit or PVC jacketed liquid-tight flexible metallic conduit with liquid tight connectors in outdoor, wet, damp, corrosive locations or subject to oil drip.

C. Raceways in all other areas shall be electrical metallic tubing unless otherwise noted.

D. Use flexible metal conduit inside movable partition wireways, from junction boxes to devices and between devices in casework, from outlet boxes to luminaires, and for “fishing” of existing walls.

E. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:

1. Conceal all conduit unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

2. Elevation of Raceway:

   a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.

   b. Route raceway as close to structure as possible.

3. Complete installation of electrical raceways before starting installation of conductors within raceways.

4. Provide supports for raceways as specified elsewhere in Division 16.

5. Prevent foreign matter from entering raceways by using temporary closure protection.

6. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bend is not visible above the finished slab.

7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Bends in conduit larger than 1-1/4" shall be factory-made elbows unless otherwise specifically approved. Bends in 1-1/4" and 1" runs shall be made in an approved bending machine or factory made. Hickey bends will not be permitted in conduits larger than 3/4".

8. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints and in every 200 foot of linear conduit run. A flexible bonding jumper at least three-times the nominal width of the joint shall be installed.
9. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

10. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

11. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.

12. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.

13. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.

14. Tighten set screws of threadless fittings with suitable tool.

15. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RGC and IMC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded nylon bushings from 1/2" to 1". 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at panelboards, pull boxes, etc.

16. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

17. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the record drawings.

18. Telephone and Single System Raceways: Coordinate requirements with the CU ITS Department.

19. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

   a. Where required by the NEC.

20. Flexible Connections: Use short length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, (maximum of 3 ft.) for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections.
21. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Architect/Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.

22. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.

23. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3-piece union or solid coupling.

24. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.

25. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with a mastic acceptable to the Architect/Engineer.

26. Install an insulated ground conductor in all conduits.

27. Where individual conduits penetrate existing fire-rated walls and floors, pack void around conduit with fire rated insulation and seal opening around conduit with UL listed foam silicone elastomer compound. Where conduits penetrate exterior walls, new floors, or roof, provide pipe sleeve one size larger than conduit, pack void around conduit with fire rated insulation, and seal opening around conduit with UL listed foam silicone elastomer compound. Conduits on trapeze type support system shall require fire taping only.

28. Provide separate raceway systems for each of the following:
   a. Lighting
   b. Power Distribution
   c. Communications and Data
   d. Fire Alarm
   e. Temperature Control

29. Paint new exposed conduits to match surface mounted upon. Use paint appropriate for conduit application.

3.4 INSTALLATION OF SURFACE RACEWAYS:

A. Surface Raceways: Mechanically assemble metal enclosures and raceways to form continuous electrical conductor and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.

1. Where practicable, avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.

2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.

3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. Field bends of raceway sections are not permitted.

4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
5. Use boxes as supplied by raceway manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., are not permitted for use with surface raceway installations.

6. Install an insulated grounding conductor in all surface raceways. Bond grounding conductor to all and surface raceways.

7. Surface raceways are acceptable only where specifically indicated on the drawings. The proposed use of surface raceways shall be submitted for review by the Engineer prior to installation.

3.5 ADJUSTING AND CLEANING:

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris.

END OF SECTION 16110
SECTION 16120 - WIRES AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

C. Conform to applicable code regulations regarding toxicity of combustion products of insulating materials.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

1. Wire and Cable:

   a. Triangle - PWC
   b. American Insulated Wire
   c. Anaconda-Ericsson Inc; Wire and Cable Div.
   d. Belden Div; Cooper Industries.
   e. Brand-Rex Div; Pyle National Co.
   f. General Cable Corporation.
   g. Hitemp Wires, Inc.
   h. Phelps Dodge Cable and Wire Co.
   i. Rome Cable Corp.
   j. Southwire Company
2. Connectors:
   a. O-Z/Gedney Co.
   b. AMP, Inc.
   c. Burndy Corporation.
   d. Ideal Industries, Inc.
   e. 3M Company
   f. Thomas and Betts Corp.

2.2 WIRES AND CABLES:

   A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed. Building wire shall be insulated with THW/THHN/THWN/RH/RHW/RHH/XHHW insulation, rated 600 volt.

   B. Conductors: Provide solid conductors for power and lighting circuits 12 AWG and smaller. Provide stranded conductors for 10 AWG and larger.

   C. Conductor Material: Provide copper for all wires and cables.

   D. Class 1, 2, or 3 remote control or signal cable shall be copper conductor with 300 volt insulation rated 60°C and PVC jacket. Remote control and signal cable shall be run in conduit.

      1. Portable Cord - Type S0: Sizes 14 AWG through 2 AWG, copper conductors with 600 volt thermoset insulation 0.1 resistant insulation.

2.3 CONNECTORS:

   A. General: Provide UL-type factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE:

   A. Building Wire: Install all building wire in raceway regardless of location.

   B. Portable Cord: Use for flexible pendant leads to luminaires, outlets, and equipment where indicated and in compliance with codes.

3.2 INSTALLATION OF WIRES AND CABLES:

   A. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

   B. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.

   C. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation. Conduits shall be swabbed clean before wire is pulled.
D. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.

E. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder, control or fire alarm wiring. Connect unspliced wire to numbered terminal strips at each end.

F. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

G. Use splice and tap connectors which are compatible with conductor material.

H. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A for copper and 486B for aluminum.

I. Support cables above accessible ceilings, do not rest on ceiling tiles. Use spring clips and hanger rods independent from the ceiling suspension system to support cables from structure.

J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled to individual circuits. Make terminations so there is no bare conductor at the terminal.

K. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

L. Use copper compression connectors for copper wire splices and taps, 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.

M. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

N. Thoroughly tape the ends of spare conductors in boxes and cabinets.

O. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

P. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.

Q. Branch circuits whose length from panel to first outlet exceeds 75 feet for 120 volt circuits shall be #10 or larger, as required to comply with the National Electrical Code.

R. Parallel conductors shall be cut to the same length.

S. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip.

T. Each branch circuit serving receptacles or multi-outlet assemblies shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted for non-receptacle circuits and where specifically noted.

U. At least 6" of free conductor shall be left at each outlet, junction box and switch for splices or connection of fixtures and devices.
V. In a multi-wire branch circuit where a circuit extends through a receptacle, all conductors shall be pigtailed so downstream load does not go through receptacles.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors. The megger values obtained shall be compared to the minimum values listed in NETA. All phase conductors and cables shall be meggered after installation, and prior to termination.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COLOR CODING SCHEDULE:

A. Color code secondary service, feeder, and branch circuit conductors as follows:

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<tr>
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<td>C</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
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<tr>
<td>Green</td>
<td>Ground</td>
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B. Conductors 10 AWG and smaller shall be solid color for entire length.

C. Conductors 8 AWG and larger shall be black with color coding at each termination and in each box or enclosure. For a distance of 6 inches use half-lapped 3/4” plastic tape in the specified color. Do not cover cable identification markings. Adjust tape locations to prevent covering of markings.

END OF SECTION 16120
PART 1 - GENERAL

1.1 SUMMARY:

A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:

1. Outlet and device boxes.
2. Pull and junction boxes.
3. Cabinets.
4. Hinged door enclosures.

B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 16 Section on Raceways.

1.2 DEFINITIONS:

A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.

B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.

C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.

D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.

E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.

F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or of switches for controlling electrical circuits.

1.3 SUBMITTALS:

A. Submit product data for cabinets and enclosures with classification higher than NEMA 1.

B. Shop drawings for floor boxes and boxes, enclosures and cabinets that are to be shop fabricated, (nonstock items). For shop fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Cabinets:
   b. Erickson Electrical Equipment Co.
   c. Electric Panelboard, Inc.
2.2 CABINETS, BOXES, AND FITTINGS, GENERAL:

A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations. Cabinets over 12" in any dimension shall also have 1/4 turn latches.

2.3 MATERIALS AND FINISHES:

A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
D. Cast Metal for Boxes, Enclosures, and Covers: Copper-free aluminum except as otherwise specified.
E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.
G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.4 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES:

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs. Minimum size box shall be 4" square by 2" deep with plaster ring. Gang boxes for number of outlets or switches shown.

C. Cast-Aluminum Boxes: Copper free aluminum threaded raceway entries, and features and accessories suitable for each location including mounting ears, threaded screw holes for devices and closure plugs.

D. Malleable or Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.

2.5 PULL AND JUNCTION BOXES:

A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.

C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

D. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A 167, "Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.

E. Cast-Aluminum Boxes: Molded of copper free aluminum, with gasketed cover and integral threaded conduit entrances.

F. Malleable or Cast-Iron Boxes: Molded of iron alloy with gasketed cover and integral threaded conduit entrances.

2.6 CABINETS:

A. Comply with UL 50, "Electrical Cabinets and Boxes."

B. Construction: Sheet steel, NEMA 1 class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24-inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24-inches apart and not over 6-inches from top and bottom of door. For flush cabinets, make the front approximately 3/4 inch larger than the box all around. For surface mounted cabinets make front same height and width as box. For television, telephone and other communication cabinets provide 3/4" thick plywood backboard painted matte white.

C. Doors: Double doors for cabinets wider than 24-inches. Telephone cabinets wider than 48-inches may have sliding or removable doors.

D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking.

2.7 STEEL ENCLOSURES WITH HINGED DOORS:

A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."

B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.

C. Doors: Hinged directly to cabinet and removable, with approximately 3/4-inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24-inches. Provide multiple doors where required.

D. Mounting Panel: Provide painted removable internal mounting panel for component installation.
E. Enclosure: NEMA 1 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For all enclosures of class higher than NEMA 1, use hubbed raceway entrances.

2.8 CAST METAL ENCLOSURES WITH HINGED DOORS:

A. Copper free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.

B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

C. Support and fasten items securely in accordance with Division 16 Section on Supporting Devices.

D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

E. Remove sharp edges where they may come in contact with wiring or personnel.

F. Provide blank cover plates on unused boxes.

3.2 APPLICATIONS:

A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.

B. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.

C. Hinged Door Enclosures Outdoors: NEMA Type 4. Install drip hood, factory tailored to individual units.

D. Hinged Door Enclosures in Corrosive Locations: NEMA type 4X nonmetallic enclosure.

E. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:

1. Interior Dry Locations: Sheet steel, NEMA Type 1.

2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.

3. Wet Locations: NEMA Type 4 enclosures.

F. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

3.3 INSTALLATION OF OUTLET BOXES:

A. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.
B. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:

1. Exterior locations.
2. Where exposed to moisture laden atmosphere.
3. Where indicated.

C. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports for electrical boxes installed on metal studs.

D. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4-inches square by 2-inches deep, minimum.

E. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.

F. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

G. Extension rings are prohibited on new construction.

H. Existing Outlet Boxes: One extension ring is permitted on remodel work to extend existing installations. Where more than one box is needed to flush out installation, provide a large (i.e. 6"x6") box to flush out the existing box and nipple over to a new box.

I. Existing Outlet Boxes: Where extension rings are required to be installed, drill new mounting holes in the rings to align with the mounting holes on the existing boxes where existing holes are not aligned.

J. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and 24" in acoustical walls.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

<table>
<thead>
<tr>
<th>Size of Largest Conductors in Box</th>
<th>Maximum no. of Conductors in Box</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4/0 AWG</td>
<td>30</td>
</tr>
<tr>
<td>250 MCM</td>
<td>20</td>
</tr>
<tr>
<td>500 MCM</td>
<td>15</td>
</tr>
<tr>
<td>Over 500 MCM</td>
<td>10</td>
</tr>
</tbody>
</table>

B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30-inches inside boxes.

C. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling.
D. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:

A. Mount with fronts straight and plumb.
B. Install with tops 78-inches above floor.
C. Set cabinets in finished spaces flush with walls.
D. Provide protective pocket inside front cover with schematic diagram, connection diagram and layout drawing of control wiring and components within enclosure.
E. Provide recessed cabinets in all finished areas.

3.6 GROUNDING:

A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.7 CLEANING AND FINISH REPAIR:

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.
C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating. Pull and junction box covers shall be painted as follows:

1. Fire Alarm Red
2. Telephone Green

END OF SECTION 16135
SECTION 16142 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. From electrical source to motor starters.
2. From motor starters to motors.
3. To lighting equipment.
4. To master units of communication, signal, alarm, clock, public address, sound, and video systems.
5. To miscellaneous equipment noted.
6. Other connections as shown.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

1.4 DEFINITIONS:

A. Load voltage wiring shall be defined as:

1. Conduit and wiring required to carry power to motors and other equipment or devices. Wiring from control devices to equipment that carry power to drive that equipment such as line voltage thermostats, etc., shall be included as load voltage wiring. Wiring that provides power to control panels, control transformers, control relays, time clocks, etc., shall also be included as load voltage wiring.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.

B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.
C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide circuit and motor disconnects by one of the following:

1. Square D Company
2. Cutler-Hammer Inc.
5. Westinghouse Electric Corp.

2.2 GENERAL:

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 16 Section on Overcurrent Protective Devices, with OCPDs adapted to equipment connection installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

B. Provide motor controllers that are horsepower rated to suit the motor controlled.

C. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75°C.

D. Overload relays shall be ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full load current of the specific motor to which connected with appropriate adjustment for duty cycle and power factor correction supplied with the motor.

2.3 MATERIALS AND COMPONENTS:

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division-16 section on Raceways.

C. Wires, Cables, and Connectors:

1. General: Provide wires, cables, and connectors complying with Division-16 section on Wires and Cables.

2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.

4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

5. Cord and Plug Connected Equipment: Where indicated, contractors shall provide a length of SO cord complete with a straight blade or twist-lock receptacle for connection of equipment. Cord and plug rating shall be suitable for the connected equipment load and rating of the branch circuit overcurrent protective device. Plug shall match receptacle configuration included on the plans and cord length shall be as required. Contractor shall connect cord to equipment.

2.4 MANUAL MOTOR STARTERS:

A. Manual starters shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Manual starters shall be complete with properly sized overload protection and neon pilot light. Manual starters shall be Square D Class 2510 or Allen-Bradley Bulletin 600 with stainless steel plates.

B. Motor starter shall have a spare set of auxiliary N.O. and N.C. contacts supplied with starter.

2.5 CIRCUIT AND MOTOR DISCONNECT SWITCHES:

A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. All equipment with maximum fuse size listed in nameplate shall have fusible disconnect switch provided. Provide NEMA 1 enclosure. For outdoor switches and switches indicated as weatherproof, provide NEMA 3R enclosures with raintight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.

B. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses. All disconnect switches shall be fusible unless otherwise noted. Provide UL type "HD" 100% duty rated switches.

C. Accessories:

1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.

2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:

D. Handles shall be lockable in open and closed position without modification. Provide override screw to permit opening front cover with switch in “on” position.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:
A. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

I. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.

J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.

K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.

M. Provide each motor with a horsepower rated disconnect switch and external thermal overload protection.

N. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.
O. Provide 4" concrete housekeeping pads for new motor control sections and floor mounted starters.

3.3 FIELD QUALITY CONTROL:

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

3.4 EQUIPMENT CONNECTION SCHEDULES:

A. Mechanical Equipment:

1. Refer to Mechanical Equipment Schedule on the drawings.

2. All load voltage wiring shall be provided under Division 16.

3. Unless otherwise indicated, it is suggested that all equipment motors and control shall be furnished, set in place, and wired in accordance with the schedule contained herein. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of this schedule is to have the Contractor responsible for coordinating all wiring as outlined, whether or not specifically called for by the Division 15 or Division 16 drawings and specifications. Comply with the applicable requirements of Division 16 for all electrical work which is not otherwise specified. No extras will be allowed for contractor’s failure to provide for these required items. Contractor shall refer to the Division 16 and Division 15 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FURNISHED BY</th>
<th>SET BY</th>
<th>CONTROL WIRING (non-load voltage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mechanical Equipment</td>
<td>M</td>
<td>M</td>
<td>--</td>
</tr>
<tr>
<td>Motors</td>
<td>G</td>
<td>G</td>
<td>--</td>
</tr>
<tr>
<td>2. Special Equipment (i.e., elevators, etc.)</td>
<td>E</td>
<td>E*</td>
<td>--</td>
</tr>
<tr>
<td>a. Motors</td>
<td>E</td>
<td>E</td>
<td>--</td>
</tr>
<tr>
<td>b. Magnetic Motor Starters</td>
<td>E</td>
<td></td>
<td>--</td>
</tr>
<tr>
<td>c. Disconnect Switches</td>
<td>E</td>
<td>E</td>
<td>--</td>
</tr>
<tr>
<td>Thermal OL Switches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual Operating Switches</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Motor Starters, combination motor starter/disconnect and Variable Frequency Drives
   a. Automatically controlled, with or without HOA switches.
   b. Manually controlled.
   c. Starters integral with motor control centers including control relays and transformers.
   d. Combination Starter/Disconnects

4. Pushbutton stations, pilot lights

5. Disconnect switches, thermal overload switches, manual operating switches.

6. Multi-speed switches

7. Control relays, transformers.

8. Load voltage control items such as line voltage thermostats not connected to control panel systems.

9. Non-load voltage control items.

10. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.

11. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.

12. Control circuit outlets

13. Fire protection controls (Including flow switches)

14. Duct smoke detectors, including relays for fan shutdown.

15. Temperature Control Panel

16. Interlocks

G = General, Division 13 or 14
M = Mechanical, Division 15
E = Electrical, Division 16
* For factory pre-wired equipment specified under other Divisions, all wiring within the equipment shall be by the manufacturer. Connection to the equipment shall be by Division 16, as shown on electrical drawings.

Manufacturer’s equipment provided under other divisions which varies from what is shown on Division 16 drawings shall be the responsibility of the Contractor to complete and pay for any costs for those variations.

** Fire alarm system control modules and wiring from fire alarm contacts to fire alarm system under Division 16. See details.

*** Integral control wiring under Electrical Division as manufacturer supplied equipment. Control wiring for automatic control portion under Mechanical Division.

4. Owner Furnished Equipment:
   a. Refer to Owner Equipment Schedule on drawings.
   b. Refer to System Coordination Schedule on drawings.

END OF SECTION 16142
SECTION 16143 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

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 electric energy.

B. Types of electrical wiring devices in this section include the following:

1. Receptacles.
2. Ground-fault circuit interrupters.
4. Wallplates.

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical 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's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.

C. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's data on electrical wiring devices.

B. Operation and maintenance data for materials and products specified in this Section to include in the "Operating and Maintenance Manual" specified in Division 1.

1.4 COORDINATION:

A. Wiring Devices for Owner Furnished Equipment: Match devices to plug connectors for Owner-furnished equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide wiring devices of one of the following:

1. Devices:

   a. Hubbell Inc.
   b. Others only by approval of the University of Colorado
2.2 WIRING DEVICES:

A. Receptacles:

1. All duplex, single, and special receptacles shall be heavy duty, specification grade listed by Underwriter's Laboratories, and have a metal mounting strap with self-grounding and have a hex-head green grounding screw and be side and back wired. Each device shall bear the UL/FS (W-C-596E) Label.

2. Convenience Receptacle Configuration: NEMA WD 1; Type 5-20R, specification grade with ivory nylon face. All receptacles connected to emergency circuits shall have a red face. Color selection shall be verified with Architect/Engineer prior to ordering. Dedicated outlets shall be gray.

3. Specific-use Receptacle Configuration: NEMA WD 1 straight blade; as indicated on drawings, black face.

4. Receptacles shall be in accordance with the following schedule where indicated on plans.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Hubbell Catalog No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex receptacle, 20A, 125V</td>
<td>5362</td>
</tr>
<tr>
<td>Duplex receptacle, 20A, 125V, Isolated Ground</td>
<td>IG-5362</td>
</tr>
<tr>
<td>Duplex receptacle, 20A, 125V, Ground Fault</td>
<td>GF-5362</td>
</tr>
<tr>
<td>Single receptacle, 50A, 250V, Locking</td>
<td>CS-6370</td>
</tr>
<tr>
<td>Single receptacle, 15A, 125V</td>
<td>5262</td>
</tr>
<tr>
<td>Single receptacle, 30A, 125V, Ground Fault</td>
<td>IG-9308</td>
</tr>
<tr>
<td>Single receptacle, 20A, 125V</td>
<td>5361</td>
</tr>
<tr>
<td>Single receptacle, 60A, 250V</td>
<td>9460</td>
</tr>
<tr>
<td>Single receptacle, 30A, 125V</td>
<td>9308</td>
</tr>
<tr>
<td>Single receptacle, 30A, 125/250V</td>
<td>9430</td>
</tr>
<tr>
<td>Single receptacle, 30A, 250V</td>
<td>9330</td>
</tr>
<tr>
<td>Single receptacle, 50A, 250V</td>
<td>9367</td>
</tr>
<tr>
<td>Single receptacle, 50A, 125/250V</td>
<td>9450</td>
</tr>
</tbody>
</table>

B. Switches:

1. Wall Switches for Lighting Circuits: NEMA WD1; FS W-S-896E; AC quiet type specification grade listed by Underwriter's Laboratories with toggle handle, rated 20 amperes at 120-277 volts AC, unless noted otherwise. Mounting straps shall be metal and be equipped with a green hex-head ground screw. Each switch shall bear the UL/FS Label.

2. Handle: Ivory for normal power circuits, red for emergency power circuits. Verify color with Architect/Engineer prior to ordering.

3. Switches shall have color coded bodies as follows:
   - 20A - Red
   - 30A – Green

4. Switches shall be in accordance with the following schedule where indicated on plans.

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Hubbell Catalog No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single pole switch</td>
<td>1221</td>
</tr>
<tr>
<td>Single pole switch with pilot light (120V - load on)</td>
<td>1221-PLC</td>
</tr>
<tr>
<td>2-pole switch</td>
<td>1222</td>
</tr>
</tbody>
</table>
3. WIRING DEVICE ACCESSORIES:

A. Wallplates: Provide wallplates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates. Identify all wall plates used for receptacles with branch circuit number per requirements of section on Electrical Identification. Provide blank wall plates for all cable, data, telephone and junction and outlet boxes. Where cables are routed through the wallplate, provide grommets in wallplate openings to protect cables. Provide plates possessing the following additional construction features:

1. Material and Finish:
   a. Smooth Metal: 0.04" thick, type 302 satin finished stainless steel in laboratories.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES:

A. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC 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 with other work.

C. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

D. Install wiring devices after wiring work is completed.

E. Install wallplates after painting work is completed.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A.

G. Provide GFCI type outlets for each above counter duplex receptacle shown within 6'-0" of sinks/lavatories. For above counter multi-outlet assemblies which do not contain duplex receptacles that can be replaced with GFCI devices, provide GFI circuit breakers on the branch circuit(s) feeding the assembly.

H. Provide circuit and panelboard identification on the outside of all wall plates with electronic label maker.
3.2 PROTECTION OF WALLPLATES AND RECEPTACLES:

A. Upon installation of wallplates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING:

A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.4 CLEANING:

A. Internally clean devices, device outlet boxes and enclosures. Replace stained or improperly painted wall plates or devices.

3.5 TESTING:

A. Prior to energizing circuitry, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements. Operate each operable device at least six (6) times.

B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

C. Replace damaged or defective components.

END OF SECTION 16143
Fiske Planetarium
University of Colorado – Department of Astrophysical & Planetary Science

SECTION 16190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

A. Product data for each type of product specified.

1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

B. Shop drawings indicating details of fabricated products and materials.

C. Engineered Design consisting of details and engineering analysis for supports for the following items:

1. Trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Slotted Metal Angle and U-Channel Systems:
   a. Allied Tube & Conduit
   b. B-Line Systems, Inc.
   c. GS Metals Corp.
   d. Unistrut Diversified Products

2. Conduit Sealing Bushings:
   a. O-Z/Gedney
   b. Cooper Industries, Inc.
   c. GS Metals Corp.
   e. Madison Equipment Co.
   f. Raco, Inc.
   g. Spring City Electrical Mgf. Co.
   h. Thomas & Betts Corp.

2.2 COATINGS:

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:
A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps. Use of caddy 8/ZMB/8 to support conduit is prohibited.

B. Fasteners: Types, materials, and construction features as follows:
   1. Expansion Anchors: Carbon steel wedge or sleeve type.
   2. Toggle Bolts: All steel springhead type.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: 12-gage steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

F. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
   1. One-Hole Conduit Straps: For supporting 3/4" and smaller rigid metal conduit; galvanized steel.
   2. Two-Hole Conduit Straps: For supporting 1" and larger rigid metal conduit, galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
      - 3-inch and smaller: 20-gage.
      - 4-inch to 6-inch: 16-gage.
      - over 6-inch: 14-gage.
   2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
   3. EMT, IMC, or Rigid Conduit.
2.5 FIRE SEALS:

A. Material: Firestopping material shall be asbestos free, 100% intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.

B. Flame Spread: 25 or less, ASTM E84

C. Fire Resistance and Hose Stream Tests: Firestopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

   (F) 3 (T) 3 Time-rated floor or wall assemblies.
   (F) 3 (T) 3 Openings between floor slabs and curtain wall.

D. Manufacturers: Subject to compliance with requirements, provide fire seals of the following:

   1. 3M Company
   2. Tremco

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:

   1. Conform to manufacturer's recommendations for selection and installation of supports.
   2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
   3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
   4. Use #9 ceiling wire to support individual conduits up to 3/4" with spring steel fasteners. Use of ceiling support wires is unacceptable.
   5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8" diameter or larger threaded steel rods for support.
   6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2" or larger conduits provide 3/8" minimum threaded steel rods with pipe hangers.
7. Space supports for raceways in accordance with NEC. When there are 4 or more 2" conduits in a trapeze, supports shall be spaced 5' O.C.

8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.

D. Horizontal Conductor Supports: Comply with the NEC and the following requirements:

1. Support individual conductors or cables by separate clamps with rubber or plastic grommet and fasten using a non-metallic bolt and nut. Secure clamps to unistrut supports anchored to structure. Multiple clamps may be secured to a single unistrut support.

2. Space supports of horizontal conductors not more than 3' o.c.

3. Install simultaneously with installation of conductors.

E. Vertical Conductor Supports:

1. Support individual conductors or cables by separate clamps with rubber or plastic grommet and fasten using a non-metallic bolt and nut. Secure clamps to unistrut supports anchored to structure. Multiple clamps may be secured to a single unistrut support.

2. Space supports of vertical conductors not more than 5' o.c.

3. Install simultaneously with installation of conductors.

F. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

G. In open overhead spaces, support metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

H. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section "Joint Sealers." See Architectural plans for location and extent of fire rated assemblies.

I. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder
charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

a. Anchoring methods as follows:

1) Hollow Masonry: Toggle Bolts.
2) Solid Masonry: Lead expansion anchors or preset inserts.
3) Metal Surfaces: Machine screws, bolts or welded studs.
4) Wood Surfaces: Wood screws.
5) Concrete Surfaces: Lead expansion or self-drilling anchors.
6) Metal Studs: Sheet metal screws.

b. Raceways shall be supported every 10 feet and within 36 inches of each outlet, ell, fitting, panel, etc.

c. Conduit shall not be supported or attached from ceiling support wires.

d. Raceways or equipment shall not be suspended from piping or ductwork.

e. Drilling of structural steel members is prohibited.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

K. Communication and Telephone Cable Supports: Use No. 9 ceiling wire to support individual or small bundles of cables run above accessible ceilings.

L. Install free standing electrical equipment on concrete pads.

M. Enclosures and panelboards shall be supported with a minimum of four anchors. On exterior concrete walls below grade provide 1" steel channel standoffs for cabinets and raceways.

N. Vibration isolation pads shall be provided for vibrating equipment such as transformers.

3.2 PERSONNEL PROTECTION:

A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.

B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.

3.3 FIRESTOPPING LOCATIONS:

A. Preparation:

1. Coordination: Coordinate the work with other trades. Firestopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of firestopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.
2. Surface Preparation: Surface Preparation to be in contact with firestopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.

B. Installation: Install firestopping materials in accordance with the manufacturer's instructions and the requirements of Division 7 Section “Firestopping”.

C. Cleaning: After completion of firestopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces not to receive firestopping shall be cleaned of deposits of firestop materials.

D. Inspection: The architect may select and the Owner will pay an independent testing laboratory to examine firestopped areas to ensure proper installation prior to concealing or enclosing the firestopped areas.

END OF SECTION 16190
SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Identification labeling for raceways, cables, and conductors.

2. Equipment labels and signs.

1.2 SUBMITTALS:

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data for each type of product specified.

2. Schedule of identification nomenclature to be used for identification signs and labels for each piece of equipment shall include, but not be limited to, the following equipment types as specified in Division 16.

   a. Cabinets and enclosures
   b. Panelboards
   c. Disconnect switches
   d. Fire alarm system panels and all ancillary cabinets and equipment

3. Samples of each color, lettering style and other graphic representation required for identification materials; samples of labels and signs.

4. Identification required in this section shall apply to equipment furnished in Division 16 and any other applicable Divisions including Division 15.

1.3 QUALITY ASSURANCE:

A. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Markal Corp.
4. Panduit Corp.
5. W.H.Brady, Co.
6. 3M Company

2.2 ELECTRICAL IDENTIFICATION PRODUCTS:
A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal and white letters on red face for emergency, black letters on yellow face for UPS and punched for mechanical fasteners. Where required for ground connections, provide engraved legend in white letters on green face. Identification shall be the name of the device, panelboards, etc. in ½” high letters. The “voltage, load served” line also shall include the name of the feeding panel, switchboard, etc. in 1/4” high letters.

B. Baked-Enamel Warning and Caution Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.

C. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, preprinted cellulose acetate butyrate signs with 20-gage, galvanized steel backing, with colors, legend and size appropriate to the location. Provide 1/4-inch grommets in corners for mounting.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F. Provide ties in specified colors when used for color coding.

F. Adhesive Marking Tape for Device Cover Plates: Kroy tape or Brother labels with 3/16 inch minimum height letters. Kroy tape shall have black letters for normal and red letters for emergency. Brother labels shall be white letters on black background for normal and on red background for emergency. Embossed Dymo-Type labels are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Degrease and clean surfaces to receive nameplates and labels.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment using screws or rivets. Locate nameplates on outside face of panelboard doors in finished locations.

D. Electronic labels will be permitted only for identification of disconnects, individual wall switches (in unfinished areas), control station devices and starters, and on outside face of receptacles and wall switch plates.

E. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

F. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

G. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

H. Conduit Identification: Use adhesive marking tape labels at 10 foot intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible. Labels for multiple conduits shall be aligned. Use the following colors:
1. **600 Volt and Below Normal**: White letters on black background indicating feeder identification and voltage.

2. **Fire Alarm**: Red letters on white background indicating "FIRE ALARM".

3. **Temperature Control**: White or black letters on blue background indicating "TEMP. CONTROL."

4. **Ground**: White or black letters on green background indicating "GROUND" and equipment and designation.

Where conduits enter or exit a panelboard, pull or junction box, switchboard, or other distribution equipment, conduit labels shall include circuit number in addition to feeder identification and voltage.

**I. Identify Junction, Pull and Connection Boxes**: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Color code shall be same as conduits for pressure sensitive labels. Use self adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes. Junction box covers shall be color coded according to the following schedule:

1. **Fire Alarm** - Red
2. **Telephone** - Green
3. **Television** - Violet
4. **Computer Data** - Blue

**J. Circuit Identification**: Tag or label conductors as follows:

1. **Future Connections**: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.

2. **Multiple Circuits**: Where multiple branch circuits, control wiring or communications/signal conductors are terminated or spliced in a box or enclosure, label each conductor or cable with circuit number. For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

**K. Install equipment/system circuit/device identification as follows**:

1. **Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
   a. Panelboards, electrical cabinets and enclosures.
   b. Dimmers.
   c. Fire alarm master station or control panel.
L. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.

M. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

N. Tag all grounding electrode conductors, associated bonding conductors, and C.O. grounding conductors at their point of attachment to any ground bus and grounding electrode (where possible) with a 2" inch diameter round green phenolic nameplate. Lettering shall be 1/4 inch high with 1/5 inch between lines centered on the tag stating "DO NOT DISCONNECT," "MAIN (OR C.O.) GROUND." Nameplate shall attach to conductor with a short length of small chain.

O. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

P. Provide tape labels for identification of individual receptacle wallplates. Locate tape on front of plate and identify branch circuit serving the receptacle.

END OF SECTION 16195
SECTION 16470 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

   A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

1.2 DEFINITIONS:

   A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.3 SUBMITTALS:

   A. Product data for each type panelboard, accessory item, and component specified.

   B. Shop drawings from manufacturers of panelboards including dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

      1. Enclosure type with details for types other than NEMA Type 1.

      2. Bus configuration and current ratings.


      4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

   C. Wiring diagrams detailing schematic diagram including control wiring, and differentiating between manufacturer-installed and field-installed wiring.

   D. Report of field tests and observations.

   E. Panel schedules for installation in panelboards. Submit final versions after load balancing.

1.4 QUALITY ASSURANCE:

   A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

      1. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.

   B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

   C. Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing panelboards similar to those required for this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:
A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. General Electric Co.
2. Westinghouse/Cutler-Hammer, Inc.
3. Siemens-ITE
4. Square D Co.

2.2 PANELBOARDS, GENERAL REQUIREMENTS:

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 16 Section on Overcurrent Protective Devices, with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

B. Enclosures: Cabinets, flush or surface mounted as indicated. NEMA Type 1 enclosure, except where the following enclosure requirements are indicated. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

1. NEMA 3R: Raintight
2. NEMA 3S: Raintight and dust tight.

C. Front: Hinged door-in-door type, secured to box with 1/4-20-large head slotted captive screws except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box except as otherwise specified. Provide fronts with hinged door-in-door construction with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges on inner door, piano hinge on outer trim door, and door swings as indicated. Door-in-door enclosure shall contain two quarter turn latches.

D. Directory Frame: Metal, mounted inside each panel door with card and clear plastic cover.

E. Bus Material: Provide tin plated hard-drawn copper of 98% conductivity.

1. All 120/208 volt panelboards shall be provided with main breakers.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

G. Provide copper lugs for incoming feeders.

H. Service Equipment Approval: Listed for use as service equipment for panelboards having main service disconnect.

I. Provide minimum short circuit current ratings as indicated.

J. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

K. Special Features: Provide the following features for panelboards as indicated.

1. Hinged front cover: entire front trim hinged to box with standard door within hinged trim cover.
2. Skirt For Surface-Mounted Panels: Same gauge and finish as panel front with flanges for attachment to panel, wall, and floor.
3. Provide 173% sized neutral bus and ground bus for all 120/208 volt panelboards.

4. Provide two bolt compression lugs for incoming feeders on main lug only (MLO) panelboards.

5. Main breaker shall be bolted to ends of bus. Back connected breakers are not acceptable.

2.3 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS:

A. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Double-Width Panels: Where more than 42 poles are indicated, provide two panelboards of equal dimensions and with individual fronts on each panelboard. Fronts shall not overlap.

C. Doors: In panel front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.4 IDENTIFICATION:

A. General: Refer to Division 16 Section on electrical identification for labeling materials.

B. UL nameplates shall be provided for all panelboards. Information shall include, but not be limited to, manufacturer, model number, serial number, plant or manufacturing location, ampere rating, voltage rating, wire and phase identification and bus short circuit bracing rating.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.


C. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.

D. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Obtain approval before installing. All spares and spaces shall be neatly written on panel directories in erasable pencil.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups, bundle, and wrap with wire ties after completion of load balancing.

G. Mounting heights: Top of trim 6'-2" above finished floor, except as indicated.

H. For every three (3) spare breakers, stub one (1) 3/4" empty conduit out of flush mounted panelboards into accessible areas.

I. Panelboards shall be provided full of circuit breakers. Refer to panelboard schedules for sizes and quantities.
3.2 IDENTIFICATION:
   A. Identify field-installed wiring and components and provide warning signs in accordance with Division 16 Section on electrical identification.

3.3 GROUNDING:
   A. Connections: Make equipment grounding connections for panelboards as indicated.
   B. Provide ground continuity to main electrical ground bus indicated.

3.4 CONNECTIONS:
   A. Tighten electrical connectors and terminals, including grounding connections, in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL:
   A. Upon completing installation of the system, perform the following tests:
      1. Make insulation resistance tests of panelboard buses, components, and connecting supply, feeder, and control circuits.
      2. Make continuity tests of circuits.
   B. Procedures: Make field tests and inspections and prepare panelboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
   C. Schedule tests with at least one week in advance notification.
   D. Reports: Provide report written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.
   E. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.
   F. Visual and Mechanical Inspection: Include the following inspections and related work:
      1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
      2. Exercise and perform of operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
      3. Check panelboard mounting, area clearances, and alignment and fit of components.
      4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   G. Electrical tests: Include the following items performed in accordance with manufacturer's instruction:
      1. Insulation resistance test of buses. Insulation resistance less than 100 megohms is not acceptable.
2. Ground resistance test on system and equipment ground connections.

3. Test main and subfeed overcurrent protective devices in accordance with Section "Overcurrent Protective Devices."

H. Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization at no additional cost to Owner. Verify by the system tests that the total assembly meets specified requirements.

3.6 CLEANING:

A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marks of finish to match original finish.

END OF SECTION 16470
SECTION 16475 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes overcurrent protective devices (OCPDs) rated 600 V and below and switching devices commonly used with them.

B. Panelboards and Switchboards: Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment are specified in other Division 16 sections.

1.2 DEFINITIONS:

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 SUBMITTALS:

A. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

B. Create schedule of equipment to indicate ratings of disconnects and fuses for each item of equipment.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of overcurrent protective devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Each type of OCPD shall be the product of a single manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. Cartridge Fuses:
   a. Bussmann Div., Cooper Industries, Inc.
   b. Gould Shamut
   c. Littelfuse Inc.

2. Fusible Switches:
   a. General Electric Co.
   b. Westinghouse/Cutler Hammer
   c. ITE/Siemens
d. Square D Co.

3. Molded-Case Circuit Breakers:
   a. Square D Co.
   b. General Electric Co.
   c. Siemens Energy & Automation, Inc.
   d. Westinghouse Electric Corp.

4. When mounting overcurrent protective devices in switchboards, switchgear, panelboards, MCC's, etc., provide equipment of same manufacturer as equipment into which they are being mounted.

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDS), GENERAL:

A. General: Provide OCPDs in indicated types, as integral components of panelboards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.

B. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

C. Where OCPDs are to be installed in existing panelboards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment. If this is not possible, provide devices which are compatible with the existing equipment and when installed will not void the U.L. label or reduce the short circuit rating of the equipment.

D. Provide 100% rated equipment and feeder breakers unless otherwise noted.

E. Provide standard rated branch circuit breakers unless otherwise noted.

F. All overcurrent devices shall be individually rated for the available fault current unless otherwise noted. Series ratings of equipment will only be allowed where specifically called out.

2.3 CARTRIDGE FUSES:

A. General: NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.

B. All fuses used for main, feeder, or branch-circuit protection shall be Underwriters Laboratories listed, current-limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be U.L. approved or component recognized for such purposes. All fuses provided shall be furnished by the same manufacturer. Should equipment provided require a different U.L. Class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.

C. Fuses over 600 amperes shall be U.L. Class "L" fuses; and shall have minimum time-delay of 10 seconds at 500% rating.

D. Provide spare fuses per UCB Standards.

E. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.

F. Class L Fuses: UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type."
G. Class RK1 and RK5 Dual Element Time-Delay Fuses: UL 198E, "Class R Fuses."

H. Class J Low-Peak dual Element Fuse: UL 198C

2.4 FUSIBLE SWITCHES:

A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.

B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.

C. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.

D. Operation: By means of external handle with override screw to permit opening front cover with switch in "ON" position. Handle lockable in "OFF" position.

E. Fuse Clips: Rejection type.

F. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting where indicated.

G. Enclosure for Independent Mounting: Provide NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.

H. Contacts shall be NEMA rated 75°C.

I. Provide fuses for safety switches and other equipment of classes, types, and rating needed to fulfill electrical requirements for services indicated.

J. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

2.5 MOLDED-CASE CIRCUIT BREAKERS:

A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."

B. Construction: Bolt-in type, except breakers 225-ampere frame size and larger may be plug-in type if held in place by positive locking device requiring mechanical release for removal.

C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical for 120 and 208 volt devices, unless a greater rating is indicated or required to match existing devices or equipment.

D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole.

E. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.

F. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting in switchboard or panelboards where indicated.

G. Enclosure for Switchboard or Motor Control Center Mounting: Provide individual mounting where indicated.
H. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.

2.6 OCPD ACCESSORIES:

A. Lock-Out Devices: Provide padlocking provisions on each overcurrent protective device, lockable in the open or closed position. Provide 3 sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks and all accessories necessary.

PART 3 - EXECUTION:

3.1 INSTALLATION:

A. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions. Install OCPDs level and plumb.

B. OCPDs in new distribution and branch circuit equipment shall be factory installed. OCPD's in existing distribution and branch circuit equipment shall match existing for type and be provided with features as listed herein.

C. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.

3.2 IDENTIFICATION:

A. Identify components in accordance with Division 16 Section on electrical identification.

3.3 CONTROL WIRING INSTALLATION:

A. Install wiring between OCPDs and control/indication devices.

3.4 CONNECTIONS:

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.5 GROUNDING:

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL:

A. Reports: Prepare written reports on tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include complete records of repairs and adjustments made. Tests shall be made on all new and existing OCPD's provided and/or connected under this project in accordance with this section.

B. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.

C. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.
D. Upon completing installation of the system, perform the following tests:

1. Visual and mechanical inspection: Include the following inspections and related work.
   a. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters.
   b. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
   c. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
   d. Check tightness of electrical connections of OCPDs with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
   e. Clean OCPDs using manufacturer's approved methods and materials.
   f. Verify installation of proper fuse types and ratings in fusible OCPDs.

2. Electrical Tests: Perform the following tests in accordance with manufacturer's instructions:
   a. Insulation resistance test of fused power circuit devices, insulated-case, and molded-case circuit breakers, 600-ampere frame size and over at 1000 V d.c. for one minute from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.
   b. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
   c. Make continuity tests of circuits.

E. Make adjustments for final settings of adjustable-trip devices.

F. Activate auxiliary protective devices such as ground fault or undervoltage relays, to verify operation of shunt-trip devices.

G. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.

H. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.

I. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.

J. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPDs by testing organization. Verify by the system tests that specified requirements are met.

3.7 CLEANING:

A. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 DEMONSTRATION:
A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPDs and train Owner's maintenance personnel.

B. Conduct a minimum of one day of training in operation and maintenance as specified under in the Project Closeout Section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.

C. Schedule training with at least seven days' advance notification.

END OF SECTION 16475
PART 1 - GENERAL

1.1 SUMMARY:

A. Extent, location, and details of lighting work are indicated on drawings and in schedules.

B. Types of lighting in this section include the following:

1. Fluorescent.

2. LED (Light Emitting Diodes)

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's product data and installation instructions on each type of luminaire and component.

B. Shop Drawings: Submit layout drawings of lighting and their spatial relationship to each other. In addition, submit shop drawings in booklet form with separate sheet for each luminaire, assembled by "luminaire type" with proposed luminaire and accessories clearly indicated on each sheet. Submit details indicating compatibility with ceiling grid system. Submit shop drawings from manufacturers detailing luminaire dimensions, weights, methods of field assembly, components, features and accessories.

C. Wiring Diagrams: Submit wiring diagrams for lighting showing connections to electrical power panels, switches, dimmers, controllers, and feeders. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

D. Samples: Submit one complete operating unit for each type of custom luminaire specified.

E. Maintenance Data: Submit maintenance data and parts list for each luminaire and accessory; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with general requirements of Division 1.

F. Illumination Data: Provide isofootcandle (isolux) plot diagram of footcandles on horizontal pavement surface which shows composite values of illuminance projected from the arrangement of light sources from indicated luminaire locations and heights. Show on the graphic plots the locations, spacings and heights of luminaires.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with lighting work similar to that required for this project.

1.4 DELIVERY, STORAGE, AND HANDLING:

A. Deliver lighting in factory-fabricated containers or wrappings, which properly protect luminaires from damage.
B. Store lighting in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.

C. Handle lighting carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.5 SEQUENCING AND SCHEDULING:

A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of lighting with other work.

B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Luminaire Manufacturers: Subject to compliance with requirements, provide luminaires as listed in the luminaire schedule or elsewhere on the drawings or specification.

B. Manufacturers:

1. Fluorescent Lamps:
   a. General Electric
   b. Phillips
   c. OSRAM/Sylvania
   d. Others only by approval of the University of Colorado

2. LED Manufactures:
   a. Philips Lighting Co.
   b. Lumiled
   c. CREE
   d. Nichia
   e. Osram Sylvania

3. Electronic Ballasts:
   a. Motorola
   b. Advance
   c. Magnetek
   d. Others only by approval of the University of Colorado

2.2 EQUIPMENT:

A. General: Provide lighting of sizes, types and ratings indicated; complete with, but not limited to housings, energy-efficient lamps, lamp holders, reflectors, energy efficient ballasts, starters and wiring. Ship luminaires factory-assembled, with those components required for a complete installation. Design luminaire with concealed hinges and catches, with metal parts grounded as common unit, and so constructed as to dampen ballast generated noise and as to disconnect ballast when door is opened for HQI lamps.

B. Wiring: Provide electrical wiring within luminaire suitable for connecting to branch circuit wiring as follows:
1. NEC Type TFN for 120 and 277 volt and shall be minimum No. 18 AWG.

C. Lamps:
   1. Fluorescent: Provide T-8 Energy Saving fluorescent lamp types or as specified in the luminaire schedule and types compatible with luminaires. Lamps shall be low mercury type. Provide 3500°K color temperature lamps unless otherwise noted in schedules or on drawings. Lamps shall have a color rendering index (CRI) or 73 or greater.

   2. Provide LED’s that retain 70% of lamp life after 50,000 hours. LED’s shall be binned to NEMA standard SSL 3-2010. *Indoor luminaires shall have remote phosphors. The LED light assembly shall be replaceable separate from the luminaire housing. The LED driver shall be dimming where indicated on the drawings. The dimmer switch shall be compatible with the driver, unless otherwise noted.*
      a. *Indoor luminaires shall have remote phosphor technology for “white” LED’s.
      b. *All LED products to be in accordance with IES Standards LM79 & LM80.

D. Fluorescent Electronic Ballasts:
   1. Provide electronic ballasts for all fluorescent lamps with voltage as indicated on the plans and luminaire schedule. The ballast shall deliver normal lamp life and must be interchangeable with electromagnetic ballasts. The light output shall not vary in response to an input voltage variance of less than 10% rated voltage. Drive output shall be greater than 25 KHz with lamp flicker less than 2%.

   2. The ballast total harmonic distortion shall be less than 10% with the third harmonic (180 Hz) distortion less than 8%.

   3. The ballast shall have a crest factor of less than 1.5 and shall have transient protection which meets IEEE 587, Category A (ANSI C62.41) requirements.

   4. The ballast shall have a power factor of 0.98 or higher, and shall have a ballast efficiency of 90% or higher.

   5. The ballast shall be UL listed Class P and shall have a sound rating better than A.

   6. The ballast electromagnetic interference shall be less than 54 db from 450 KHz to 30 MHz (FCC CFR 47, Part 18 requirements).

   7. The ballasts shall be Advance. All other manufacturers shall request prior approval and supply test data from an independent testing laboratory and comparison report to substantiate compliance with specifications and specified equipment.

   8. The ballast shall contain no PCB's.

   9. The manufacturer shall provide a full three year warranty beginning at time of substantial completion. The manufacturer shall replace any and all failed ballasts within 48 hours of notification. The manufacturer shall provide the labor for warranty replacements, phone and fax number to report these outages and updates of those numbers.

PART 3 - EXECUTION
3.1  EXAMINATION:

A.  Examine areas and conditions under which lighting is to be installed, and substrate for supporting lighting. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2  INSTALLATION:

A.  Install lighting at locations and heights as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fulfills requirements.

B.  Provide luminaires and/or outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Architect.

1.  Luminaires shall be positively attached to the suspended ceiling system. The attachment device shall have a capacity of 100% of the luminaire weight acting in any direction.

2.  When intermediate systems are used, No. 12 gauge hangers shall be attached to the grid members within 3" of each corner of each luminaire.

3.  When heavy-duty systems are used, supplemental hangers are not required if a 48" modular hanger pattern is followed. When cross runners are used without supplemental hangers to support luminaires, these cross runners shall provide the same carrying capacity as the main runner.

4.  Luminaires weighing less than 56 pounds shall have, in addition to the requirements above, two No. 12 gauge hangers connected from the luminaire housing to the structure above. These wires may be slack.

5.  Luminaires weighing 56 pounds or more shall be supported directly from the structure above by four No. 12 gauge hangers connected from the luminaire housing to the structure above. These wires may be slack.

C.  Install flush mounted luminaires properly to eliminate light leakage between frame and finished surface.

D.  Fasten luminaires securely to structural supports; and ensure that pendant luminaires are plumb and level. Provide individually mounted pendant luminaires longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch vertical adjustment. Mount continuous rows of luminaires with an additional stem hanger greater than number of luminaires in the row.

1.  Pendant hung luminaires shall be supported directly from the structure above with No. 9 gauge wire or approved alternate support without using the ceiling suspension system for direct support.

E.  Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B, and the National Electrical Code.

F.  Support surface mounted luminaires greater than 2 feet in length at a point in addition to the outlet box stud.
G. Set units plumb, square, level and secure according to manufacturer's written instructions and shop drawings. Refer to specification section 16503, "Poles and Standards" for other requirements.

3.3 FIELD QUALITY CONTROL:

A. At Date of Substantial Completion, replace lamps in lighting which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Architect.

1. Refer to Division-1 sections for the replacement/ restoration of lamps in lighting where used for temporary lighting prior to Date of Substantial Completion.

B. Furnish stock or replacement lamps amounting to 15%, but not less than 4 lamps in each case, of each type and size lamp used in each type luminaire. Deliver replacement stock as directed to Owner's storage space.

3.4 ADJUSTING AND CLEANING:

A. Clean lighting of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses and reflectors.

B. Protect installed luminaires from damage during remainder of construction period.

C. Adjust aimable luminaires to provide required light intensities.

3.5 GROUNDING:

A. Provide equipment grounding connections for lighting as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

B. Ground luminaires according to Section 16452, "Grounding," and Section 16503, "Poles and Standards."

3.6 WARRANTY:

A. The Contractor shall guarantee all equipment including ballasts, lamps, luminaires, wiring, etc. free from inherent mechanical and electrical defects. Warranty period shall be from date of acceptance as set forth in the general conditions with periods as follows:

1. Lamps - Per Paragraph 3.3
2. Luminaires, wiring, etc. - 1 year
3. Ballasts - The manufacturer shall provide a full five year warranty beginning at time of substantial completion. The manufacturer shall replace any and all failed ballasts within 48 hours of notification. The manufacturer shall provide the labor for warranty replacements.

3.7 DEMONSTRATION:

A. Upon completion of installation of lighting and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 16515
SECTION 16535 - EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 SUMMARY:

A. Types of emergency luminaires in this section include the following:

1. Unitized battery powered units
2. Exit lights

1.2 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of emergency luminaires and equipment of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with emergency lighting work similar to that required for project.

1.3 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data on emergency lighting.

B. Shop Drawings: Submit shop drawings in booklet form with separate sheet for each luminaire, assembled in luminaire "type" alphabetical, or numerical order, with proposed luminaire and accessories clearly indicated on each sheet.

C. Maintenance Data: Submit maintenance data and parts list for each emergency lighting and accessory including "trouble-shooting" maintenance guide. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Handle emergency lighting carefully to prevent damage, breaking, and scoring. Do not install damaged luminaires or components; replace with new.

B. Store in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide emergency lighting of one of the following (for each type of emergency luminaire):

1. Unitized Battery Powered Fixtures:
   a. As specified in Luminaire Schedule

2. Exit Signs:
   a. As specified in Luminaire Schedule.
2.2 EMERGENCY LIGHTING:

A. General: Provide lighting of sizes, types and ratings indicated; complete with, but not limited to, housings, energy efficient lamps, lamp holders, reflectors, energy-efficient ballasts, starters and wiring.

B. Wiring: Provide wiring within fixtures for connection to branch circuit wiring as follows:

1. NEC Type TFN for 120 & 277 volt, minimum No. 18 AWG.

C. Emergency Battery Powered Units: Provide battery powered, self-contained, self-testing, self-diagnostic units with solid-state, fully automatic charger, unit "Ready" light, transfer/brownout circuit and low-voltage battery disconnect.

1. Power Supplies:
   a. Provide unit with universal transformer for 120 or 277 VAC operation.
   b. Battery: Provide maintenance free lead-calcium battery for 12 VDC operation capable of supplying connected load for period of 1-1/2 hours to end voltage or 87-1/2 percent of nominal battery voltage.

2. Charger: Provide automatic battery charger with full recharging capability in 12 hours, or less after full discharge.

3. Enclosure: Provide enclosure constructed in accordance with NEMA 1 standards. Provide low profile brushed aluminum canopy capable of being mounted on standard 3-1/2" or 4" octagonal, or 4" square wall box, or being fastened directly to wall.

4. Lamps: Provide two, unit mounted 12-volt, 7.2 watt sealed beam lamps.

5. Accessories: Provide following accessories mounted on unit cabinet:
   a. Unit test switch
   b. Voltmeter
   c. Ammeter
   d. AC "ON" pilot light
   e. High Charge Pilot Light
   f. Battery life expectancy alarm
   g. Heavy-duty wall mounting bracket

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which emergency lighting is to be installed, and substrate which will support lighting luminaires. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF EMERGENCY LIGHTING UNITS:

A. Install emergency lighting units at locations and heights as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fulfills requirements.

B. Coordinate with other electrical work as appropriate to properly interface installation of emergency lighting with other work.
C. Coordinate mounting of test switch indicator light and ballast prior to installation.

3.3 ADJUSTING AND CLEANING:

A. Clean emergency lighting of dirt and debris upon completion of installation.
B. Protect installed units from damage during remainder of construction period.

3.4 GROUNDING:

A. Provide equipment grounding connections for emergency lighting as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.5 FIELD QUALITY CONTROL:

A. Upon completion of installation of emergency lighting and after building circuitry has been energized with normal power source, apply electrical energy to demonstrate capability and compliance with requirements. Test emergency lighting to demonstrate operation under emergency conditions. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.6 WARRANTY:

A. The Contractor shall guarantee all equipment including ballasts, lamps, luminaires, wiring, etc. free from inherent mechanical and electrical defects for five (5) years. Warranty period shall be from date of acceptance as set forth in the general conditions.

END OF SECTION 16535
SECTION 16721 - FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:
   A. Extent of fire alarm systems work is indicated by drawings, schedules, and riser diagrams.
   B. All existing electrical equipment to be reused must comply with current codes and standards and be tested as part of this project.
   C. Fire and detection system shall be of the multiple addressable peripheral network (MAPNET) type.

1.2 QUALITY ASSURANCE:
   A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems of types, sizes, and electrical characteristics required, and whose products have been in satisfactory use in similar service for not less than 5 years.
   B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with fire alarm systems work similar to that required for this project.
      1. Firm with manufacturer's factory trained personnel.
      2. Firm with factory authorized 24 hour on-call service department and complete spare parts stock within 50 miles of the University and with a 24 hour response time.
      3. Electrical journeymen shall have at least 2 years of documented fire alarm installation experience.
   C. Codes and Standards:
      1. Each and every item of the fire alarm system shall be listed as the product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratory, Inc. (UL) and shall bear the UL label on all devices, appliances and panels comprising the system. All control equipment shall be listed under the category UOJZ as a single control unit and cross listed with the base loop fire alarm system. Partial listings shall be unacceptable.
      2. The complete installation shall conform to the applicable sections of NFPA and Local Code Requirements, and the National Electrical Code with particular attention to article 760. All control equipment must have transient protection to comply with UL 864 requirements or Standard #497B as applicable.
      3. FM Compliance: Provide fire alarm systems and accessories which are FM approved.
      4. The fire alarm system and devices shall comply with ADA 1990 and UL 1971 requirements.
      7. All other applicable codes and standards.

1.3 SUBMITTALS:
Fiske Planetarium SPA Project No. 11252.000
University of Colorado – Department of Astrophysical & Planetary Science

FIRE ALARM SYSTEMS  16721 - 2

A. **Product Data:** Submit manufacturer's technical product data, including specifications, data sheets, equipment ratings, dimensions, and finishes, for each type of fire alarm system equipment. Include standard or typical riser and wiring diagrams. Submit within 30 days after award of contract.

B. **Shop Drawings:** Provide shop drawings showing system components, including panels and cabinets, locations and full schematic of system wiring showing conductor routings, color coding, quantities, and connection details. Provide updated room names and numbers that match the names and numbers as labeled at the building. Room names and numbers shown on the contract documents are not necessarily those that are currently being used in the building. The fire alarm manufacturer shall coordinate with the contractor and owner on existing and new work and survey the site on existing work to identify the proper names and numbers. All conduit routing must be submitted to, and accepted by, the Architect/Engineer. Shop drawing documents must be submitted simultaneously with sprinkler system documents prior to installation and within 30 days after award of contract.

C. This information shall be submitted on 1/8" = 1'-0" scale building floor plans. No other systems shall be included on these plans. Reproduction of contract drawing will not be acceptable.

D. Submit manufacturer's installation instructions, including outlet or back box requirements for each piece of equipment.

E. Submit manufacturer's certificate that system meets or exceeds specified requirements.

F. Submit verification of system operation by manufacturer or his authorized representative.

G. Submit back-up battery calculations.

H. All shop drawings and battery calculations shall be submitted to the authority having jurisdiction for review after review by the Architect/Engineer.

I. Submit three copies of test results and data to Architect/Engineer no later than seven days after conclusion of tests described in this section.

J. Submit graphic annunciator and/or map layouts for review by the Architect/Engineer prior to fabrication.

K. Submit device address schedule.

L. **Maintenance Data:** Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Submit within 30 days of the final accepted fire alarm test. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 **DELIVERY, STORAGE, AND HANDLING:**

A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.

B. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Provide factory dust covers installed until after the final inspection and clean-up is complete. Remove covers prior to turning over system to the University.

PART 2 - PRODUCTS

2.1 **ACCEPTABLE MANUFACTURERS:**
A. Existing Fire Alarm System - Simplex Time Recorder Co.

B. Pyrotronics Div; Baker Industries, Inc; MXL System

C. Fire Alarm Cable
   1. West Penn
   2. Belden
   3. Annixter

2.2 FIRE ALARM AND DETECTION SYSTEMS:

A. General: New equipment shall be of the same manufacture as the existing fire alarm system. Provide fire alarm and detection systems for applications indicated.

B. Wiring System Materials: Provide basic wiring materials which comply with Division-16 sections; "Raceways", "Wires and Cables", and "Electrical Boxes and Fittings".
   1. Provide wire and cable in accordance with requirements of manufacturer. Wire insulation shall comply with NEC Article 760.
   2. Provide copper conductors, solid #14 AWG minimum.
   3. Provide conductors which are UL listed for the installation and location, and approved for fire alarm usage.
   4. Initiating circuits shall be color coded red for positive, black for negative. Indicating circuits shall be color coded yellow for positive, brown for negative. Color coding shall meet UCB Standards.
   5. All conductors shall be numbered and their numbers shall correspond to the terminal block numbering they are connected to. Provide conductor wiring and terminal block numbering.
   6. Wiring styles shall be as follows: Style B-IDC, Style 4-SLC, Style Y-IAC within buildings. Style D-IDC between buildings.

2.3 ADDRESSABLE DEVICE TYPES:

A. General: Devices will be located as shown on the drawings. The location of addressable devices will be selected along with conventional devices to optimize the system layout in order to provide the level of protection, zone identification and control as shown on the drawings.

B. Duct smoke detectors shall be of the solid state photoelectric type. No radioactive materials shall be used. Detector construction shall be of the split type, that is, mounting base with twist-lock detecting head. Provide duct detectors compatible with the air velocities within the duct to be installed (ie. for low velocity ducts, provide an in-duct style detector). Duct housing couplings shall be slotted to insure proper alignment of the sampling and exhaust tubes. Detector shall have an alarm LED visible through the front cover. Each detector shall be able to be reset at the FACP. Detectors shall obtain their operating power from the supervised current in the fire alarm loop. Installation must comply with NFPA-90A.
   1. Each detector shall be provided with a remote alarm LED indicator and a keyed test switch. Mount remote indicator and keyed test switch at 6'-0" A.F.F.
2. Fan shutdown shall be accomplished through fan control modules in the Fire Alarm Control Panel. Main supply fans shall shut down on any building alarm. The Fan control module in the FACP shall give the fire department manual control to override all automatic functions; manually shut down, manually override on. LED's on the control panel shall show the status of these fans. The switches shall be arranged such that is placed in any other position except "automatic," the respective trouble indicators shall activate.

3. Provide access door(s) for in-duct style duct detectors.

PART 3 – EXECUTION

3.1 EXAMINATION:
   A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION:
   A. Install electrical identification in accordance with Division-16 Basic Electrical Materials and Methods section "Electrical Identification."

3.3 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:
   A. Install wiring, raceways, and electrical boxes and fittings in accordance with Division-16 sections; "Raceways", "Wires and Cables", and "Electrical Boxes and Fittings".
   B. Install all wiring in raceways. Install wiring concealed where possible and in exposed ivory colored surface metal raceway only where specifically noted as allowed on walls or ceilings.
   C. No other wiring or systems shall be installed within the same raceway as the fire alarm system.
   D. No AC circuitry shall be installed within the same raceway as the fire alarm system.
   E. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.
   F. Bond all shield wiring together at each device and insulate from contact with junction box or raceway.

3.4 INSTALLATION OF FIRE ALARM SYSTEMS:
   A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."
   B. Wiring: Wiring of fire alarm system is work of this section, but is not specifically detailed on drawings.
      1. Complete wiring in accordance with manufacturer's requirements. Color code wiring and install per manufacturer's point-to-point wiring diagram and cable/terminal strip schedule. Determine exact number of wires for each fire area zone from number and types of devices installed. Connect each device with sufficient wiring to complete its intended operation.
      2. Where there are a number of power requiring devices such as smoke detectors, fan relays, door holders and smoke damper operators installed in a circuit, group in numbers so power required does not exceed 80% of manufacturer's power supply rating. Provide extra wiring, or extra power supplies required to fulfill that requirement. In addition, provide extra or larger size wiring to alleviate voltage drops which makes device operate beyond voltage limits for which it
was designed. Determine above with manufacturer's representative while equipment is being installed.

3. The existing system shall remain in operation while the new systems are being installed, tested, and accepted.

C. Mount devices per UFAS

3.5 FIELD QUALITY CONTROL:

A. Connection and Supervision: Make connections to panel under manufacturer's supervision. Run wiring to main terminal cabinet located adjacent to main fire alarm panel. Complete connections from this cabinet to panel utilizing manufacturer's technicians.

B. Limit downtimes at each building as much as possible and schedule all downtimes with UCB at least 2 weeks in advance.

3.6 SYSTEM TEST AND APPROVAL:

A. System installation shall be verified as complete by contractor as follows:

1. Installation is complete with all devices.
2. Wiring is checked for opens, shorts, ground faults, improper branching, etc.
3. Fill out and sign attached Fire Alarm Certification and Description form and turn over to CU Facilities Management before 100% test. Manufacturers approved equal form will be acceptable.

B. 100% System Operation Test:

1. The 100% fire alarm test shall be scheduled only after receipt of the "Fire Alarm System Certification and Description Form" by Facilities Management Electrical Engineering and Project Manager. The 100% fire alarm test shall be scheduled by the Facilities Management Project Manager. Contractor shall notify all parties of scheduled test times, dates, and locations. All tests shall be conducted by the contractor/manufacturer and witnessed by the University. The Contractor shall submit to Facilities Management Project Manager, and electrical engineer the proposed date/agenda/schedule of the test and a letter stating proposed method of testing all devices a minimum of two weeks prior to the date of test.

C. The following tests shall be required, depending upon the particular installation, and the following parties shall be required to attend. Attendance by others indicated as optional may be desirable.

1. Fan Shutdown/Smoke Evacuation Operation (if applicable):

   a. Attendance required by:

      1) Contractor
      2) CU - Fire Alarm
      4) CU - Controls
      5) Control Contractor (on new installations)

   b. Attendance optional by:

      1) CU - Owner's Rep.
      2) CU - Mechanical Engineer
      3) CU - EH&S
2. Initiation of All Other Devices:
   a. Devices to be tested include:
      1) Smoke detectors
      2) Duct detectors
      3) Pull stations
      4) Horn/strobes
      5) Speaker/strobes
      6) Master panels and subpanels
      7) Door releases
      8) Remote annunciation
      9) Remote reset
     10) Connection to central station
     11) All other
   b. Attendance required by:
      1) Contractor
      2) CU - Fire Alarm
   c. Attendance optional by:
      1) CU - Owner's Rep.
      2) CU - EH&S

D. A punch list shall be developed during the 100% test. The final punch list will come from the design
   engineer and shall incorporate all relevant University items. The Contractor shall correct all items on
   the punch list and reschedule through the Project Manager retesting of all devices to show compliance
   with the punch list (first retest). All costs incurred for all retests above and beyond the first retest shall
   be borne and paid for by the Contractor. After all punch list items have been corrected all parties shall
   sign the "Building Fire Alarm Acceptance Form" (included at the end of this section). The Contractor
   shall turn this form over to the Facilities Management Project Manager with a copy to Facilities
   Management Electrical Engineer. The contract cannot be closed out without this form.

E. Main System Demonstration: After receipt of the signed "Building Fire Alarm Acceptance Form" the
   demonstration may take place. The intent of this demonstration would be to show how system operates
   in general terms. It would be done in conjunction with the presentation of operating and maintenance
   data and/or an instructional session. All of the above parties plus Boulder Fire Department, the
   owner/occupant and other interested parties will be invited to attend.

F. Contractor shall provide four sound meters for sound level test. While alarms are being sounded,
   readings will be taken to verify the required 70 db level at the pillow. Activation of audible devices
   shall be conducted only after scheduling with appropriate departments including "Environmental Health
   & Safety." See "System Test and Approval" above.

3.7 WARRANTY:
   A. The Contractor shall warranty all equipment, parts, wiring and labor free from inherent mechanical and
electrical defects for a period of one year from the date of acceptance as set forth in the general
conditions.
3.8 OPERATING AND MAINTENANCE INSTRUCTIONS:

A. Provide three (3) copies of Operating and Maintenance Instructions in hardback, three-ring binders covering all equipment furnished. The binders shall be broken down on a per building basis and shall be labeled. The Contractor shall turn over the manuals to the University at the time of demonstration and testing.

1. Name, address and telephone number of authorized service organization to be contacted for each equipment item. The local fire alarm supplier shall have a 24 hour telephone response service. An answering machine shall not be considered acceptable.

2. Parts list with operating and maintenance instructions for each piece of equipment.

3. Record drawings:

   a. Revised schematic, wiring, and interconnection diagrams of all circuits, internal and external, for all equipment installed and exact location for all devices.

   b. Provide manufacturer's technical information drawings and all maintenance data including cut sheets for all components, all technical wiring diagrams and schematics for all related equipment and components. These schematics shall include the conductor color coding and terminal identification system, location of all terminal boxes complete with numbering.

   c. Complete, as-installed, riser diagrams indicating the wiring sequence of all alarm-initiating devices, supervisory devices, and all signalling appliances on all signalling circuits.

   d. A complete description of the system operation.

   e. A schedule of relay abbreviations used on the drawings, list of relay functions, and the sequence of relay operation during supervisory trouble and alarm conditions.

   f. As-built point-to-point wiring diagrams depicting every device including known future devices and indicated as such, conduit routing, number of conductors per conduit, wire sizes, and all equipment locations, on CAD disks and (24" x 36") reproducible drawings with CAD backgrounds provided by the Architect or Engineer, complete with room numbers. Turnover the workman's set of fire alarm prints with their notes.

   g. Complete wiring and control diagrams for control and shutdown circuits for fan systems (including damper control).

4. Certification of equipment that it is FM and UL approved on manufacturer's letter head including FM and UL reference numbers.

3.9 DEMOLITION:

A. Upon completion of fire alarm system work, after final connections have been made, this contractor shall carefully remove all existing fire alarm apparatus where indicated, including fire alarm control panel, manual stations, audible signals, etc., and turn all such equipment over to Owner.
3.10 PAINTING AND PATCHING:

A. Contractor shall paint all exposed conduit to match adjacent surfaces. All surfaces or finishes damaged as a result of this work shall be properly patched, painted and/or repaired by trained craftsmen of the trade involved.

B. Contractor shall patch and paint where old devices are removed unless the old devices are in block walls or in concrete, where the Contractor shall provide blank plates on boxes. Blank plates shall be painted to match adjacent surfaces.

END OF SECTION 16721
University of Colorado
Fire Alarm System Certification and Description Form (11-93)

Building_________________________________________  System Installer
  System Supplier
  Service Organization

Firm Name
Representative
Telephone

Location of Test Reports:

1. Certification of System Installation: (Fill out after installation is complete and wiring checked for opens, shorts, ground faults, and improper branching, but prior to conducting operational acceptance tests).
   
   This system installation was inspected by on and found to comply with the installation requirements of:

   Chapters 6,7,8,9, and 10 of NFPA 72 and NFPA 72E (Circle any that apply)

   Article 760 of NFPA 70, National Electrical Code

   NFPA 72H
   Manufacturer's Instructions
   System is 100% operational
   Other (specify)

1. Alarm Initiating Devices and Circuits:

   Quantity and style (See NFPA 72, Table 2-6.1) of Initiating Device Circuits connected to system:

   Quantity, Style

   Types and quantities of alarm initiating devices installed:

   Manual Stations:  Smoke Detectors Photoelectric
   Noncoded,  Heat Detectors 135° Fixed
   Coded  Temperature
   Smoke Detectors Ionization  Heat Detectors 190° Fixed
   Heat Detectors, Rate of Rise
   Duct Detectors Photoelectric
   Sprinkler Flow Switches
   Preaction System Flow Switches
   Other (list)
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

Fiske Planetarium
University of Colorado – Department of Astrophysical & Planetary Science

SPA Project No. 11252.000

FIRE ALARM SYSTEMS

16721 - 10
1. **Alarm Indicating Appliances and Circuits:**
   - Quantity of indicating appliance circuits connected to system:
   - Style of wiring: (See NFPA 72 Table 6-4):
   - Types and quantities of alarm indicating appliances installed:
     - Bells: Size __ Quantity:
     - Horns: Quantity:
     - Chimes: Quantity:
     - Speakers: Quantity:
     - Visible Signals: Type Combined with audible Mounted separately Quantity:
     - Other Specify Quantity:

1. **Supervisory Signal Initiating Devices and Circuits:**
   - Quantity and Style (See NFPA 72, Table 2-6.1) of supervisory circuits:
   - Types and quantities of supervisory signal initiating devices installed:
     - Sprinkler Control Valves Quantity:
     - Preaction Control Valves Quantity:
     - Other (specify) Quantity:

1. **Signalling Line Circuits:**
   - Quantity and Style (See NFPA 72, Table 2-7.1) of signaling line circuits connected to system:

1. **System Power Supplies**
   - Primary (Main): Nominal Voltage: , Amps Overcurrent Protection: Type: , Amps Location:
   - Secondary (Standby):
     - Storage Battery: Amp-Hr. Rating
     - Calculated capacity to operate system in hrs. supervisory condition mins. alarm condition after supervisory condition.
Fiske Planetarium
University of Colorado – Department of Astrophysical & Planetary Science

SPA Project No. 11252.000

1. System Manufacturer
   System Model
   Serial Number
   Manufacturer Project Number

1. System Deviations from the Referenced NFPA Standards:
   None
   As Follows (describe fully on typed pages attached to this form.)

CONTRACTOR (FIRM NAME)

SUPERINTENDENT/FOREMAN (PRINT)

SIGNED DATE

SUPPLIER

MANUFACTURER

REPRESENTATIVE (PRINT)

SIGNED DATE
Building Fire Alarm Acceptance Form (11-93)

Building

SYSTEM MANUFACTURER

SYSTEM MODEL

Certification of System Operation:

All operational features and functions of this system were tested by on and found to be operating properly in accordance with the requirements of:

Chapters 6, 7, 8, 9, and 20 of NFPA 72 and NFPA 72E
Job Specifications
NFPA 72H
Manufacturer's Instructions
Other (specify)

CONTRACTOR
SIGNED DATE

MANUFACTURER
SIGNED DATE

DEPARTMENT OF ENVIRONMENTAL HEALTH AND SAFETY (PREACTION SYSTEM, FLOW DEVICE, AND AUDIBILITY TESTS ONLY)
SIGNED DATE

DEPARTMENT OF FACILITIES MANAGEMENT
SIGNED DATE
**M100® LED**
Linear LED Direct Surface, Pendant & Wall

## Project:

### Type: LS1 and LS2

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<tr>
<td>Series</td>
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<td>-------</td>
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*Consult factory for less than 2 ft. fixture length.

### Options

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<td>Linear</td>
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<td>DML® Dimming (0-10V)</td>
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<td>Logarithmic (DML)</td>
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<td></td>
<td>DME1 Lutron Eco-System Dimming</td>
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<tr>
<td></td>
<td>DME2 Lutron 3-Wire Dimming</td>
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<tr>
<td></td>
<td>DMD1 Digital Addressable (DALI) Dimming</td>
</tr>
<tr>
<td></td>
<td>DL Damp Location</td>
</tr>
</tbody>
</table>

### Surface (F)

1. **Housing** - Continuous, 6063-T6 extruded aluminum profile up to 12 feet long. Joined with Connector Plus Joining System for ease of installation and to ensure a uniform appearance. For use in insulated ceilings, designed for direct contact with thermal insulation.

2. **Driver** - Electronic Class 2 driver, universal for 120/277V. Standard driver dimmable with trailing edge dimmers, high efficiency, PFIC>0.95, soft start. Lutron A-Series (DM3/DME), 0-10V Linear (DM) and 0-10V Logarithmic (DML) or DALI (DMD) dimming may be specified as well.

3. **LED Light Engine** - High efficiency LED light engine equipped with brand-name LEDs, available in 3000K, 3500K, or 4000K. CCT tolerance within a 3-step MacAdam ellipse.

4. **Shielding** - LED Optimized white acrylic diffuser lens.

5. **Ø 78° Feed Hole** - Drilled at factory. See page 3 for location.

6. **Ø 9/32” Mounting Holes (2)** - Drilled at factory. See page 3 for details. Mounting hardware supplied and installed by others.

7. **Ø1/4” Threaded Rod and Mounting Hardware** - To anchor End Cap Support Bracket/Wall Bracket, supplied and installed by others.

8. **Outlet Box** - Supplied & installed by others.

9. **Wall Bracket** - 4” square aluminum wall bracket provided. Mounting Diagrams

10. **1/16” Aircraft Cable Suspension** - Supplied with chrome gripper for easy adjustment. 48” max suspension from ceiling to top of luminaire.

11. **5/8” Steel Swivel Stem or Rigid Stem Suspension** - Swivel Stem provides 30° swivel rotation and can be cut in field. Rigid Stem can not be cut in field. 48” max suspension from ceiling to top of luminaire.

**Linear Runs** - Continuous run configurations are available in 1/4” steps, starting at 8 ft. Round up length to nearest nominal foot to generate order code. Suspension points might not be symmetrical for certain run length. Please consult factory if symmetrical suspension locations are required.

**Interior Luminaire Finish** - Selux utilizes a high quality Polyester Powder Coating. All Selux luminaires are finished in our Tiger Drylac certified facility and undergo a five stage intensive pretreatment process where product is thoroughly cleaned, phosphated, and sealed. Selux powder coated products provide excellent salt and humidity resistance as well as ultra violet resistance for color retention. All products are tested in accordance with test specifications for coatings from ASTM and PCI.

Standard interior colors are White (WH), Black (BK), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide.

### 5 Year Limited LED Luminaire Warranty
- Selux offers a 5 Year Limited Warranty to the original purchaser that the M100 LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers LED driver and LED light engine when installed and operated according to Selux instructions. Fixture suitable for ambient temperature of 35°C (95°F).
- For details, see “Selux Terms and Condition of Sale.”

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TEL (845) 834-1400
FAX (845) 834-1401
WWW.selux.us
L10U121201 (sp-V2.3)

In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supersede all other printed or electronic versions.
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supersede all other printed or electronic versions.

Photometry

L10U / 350mA LED / 3500K CCT

Catalog #: L10U-1L35-35-LW-4T-120
Report #: LTL-23873-1
Lamp: 180 white LEDs
Total Lumens: 2705
Luminaire Efficacy: 82 lm/W
Max Candela: 948 @ 0.5° from Vertical
Spacing Criterion (0-180): 1.26
Spacing Criterion (90-270): 1.26
Spacing Criterion (Diagonal): 1.38

Energy Consumption for Non-Dimming Luminaires

<table>
<thead>
<tr>
<th>Fixture Length</th>
<th>1ft</th>
<th>2ft</th>
<th>3ft</th>
<th>4ft</th>
<th>5ft</th>
<th>6ft</th>
<th>7ft</th>
<th>8ft</th>
<th>RUN (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Driver</td>
<td>8.4W</td>
<td>15.9W</td>
<td>24.3W</td>
<td>33.0W</td>
<td>40.1W</td>
<td>50.8W</td>
<td>63.4W</td>
<td>69.7W</td>
<td>8.75 W/ft.</td>
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<tr>
<td>DM3/DME Drivers at 277V</td>
<td>17.7W</td>
<td>26.6W</td>
<td>38.0W</td>
<td>44.3W</td>
<td>56.9W</td>
<td>70.8W</td>
<td>77.2W</td>
<td>10.1W/ft.</td>
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<tr>
<td>DM/DMD Driver</td>
<td>17.3W</td>
<td>25.9W</td>
<td>37.1W</td>
<td>43.2W</td>
<td>55.6W</td>
<td>69.2W</td>
<td>75.4W</td>
<td>9.9W/ft.</td>
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LED CCT Prorate Table
(Values based on 4ft. 1L35 Light Engine.)

<table>
<thead>
<tr>
<th>CCT</th>
<th>Lumens</th>
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<tbody>
<tr>
<td>3000K</td>
<td>2507</td>
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<td>3500K</td>
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<td>2639</td>
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Selux Corp. © 2012
L10U-1212-02 (se-V23)
In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supersede all other printed or electronic versions.

L10 Direct Layout Dimensions

Nominal (4 foot shown) - Side view

<table>
<thead>
<tr>
<th>Suspensions</th>
<th>Equal</th>
<th>Suspensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Fit into 7/8&quot; hole</td>
<td>Fixture Length (including endcaps)</td>
<td></td>
</tr>
</tbody>
</table>

Nominal (4 foot shown) - Bottom view

1L35 Single Linear LED

<table>
<thead>
<tr>
<th>Fixture Length</th>
<th>Suspensions</th>
<th>Feed</th>
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<tbody>
<tr>
<td>1' individual</td>
<td>1 1/38&quot; (301mm)</td>
<td>1 5/8&quot; (41mm)</td>
</tr>
<tr>
<td>2' individual</td>
<td>23&quot; (583mm)</td>
<td>1 5/8&quot; (41mm)</td>
</tr>
<tr>
<td>3' individual</td>
<td>33 5/6&quot; (842mm)</td>
<td>6 1/8&quot; (155mm)</td>
</tr>
<tr>
<td>4' individual</td>
<td>47&quot; (1193mm)</td>
<td>6 1/8&quot; (155mm)</td>
</tr>
<tr>
<td>5' individual</td>
<td>54 5/6&quot; (1381mm)</td>
<td>6 1/8&quot; (155mm)</td>
</tr>
<tr>
<td>6' individual</td>
<td>71&quot; (1803mm)</td>
<td>6 1/8&quot; (155mm)</td>
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<tr>
<td>7' individual</td>
<td>86 11/16&quot; (2202mm)</td>
<td>6 1/8&quot; (155mm)</td>
</tr>
<tr>
<td>8' individual</td>
<td>95&quot; (2412mm)</td>
<td>6 1/8&quot; (155mm)</td>
</tr>
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For other lengths, lamping, continuous runs or configurations please specify overall length (in feet), accessories desired and sketch/drawing of configuration. Selux will detail project drawings upon order and supply submittal drawings for approval. Individual fixtures cannot be field joined. If you have any questions please contact Selux customer service or applications engineering for assistance (1-800-SELUX-CS).

Wiring

**STANDARD**

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<tr>
<th>FEED</th>
<th>DRIVER(s) (xx WATTS-LED)</th>
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**DME**

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**Lutron Eco-System Dimming**

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<th>DRIVER(s) (xx WATTS-LED)</th>
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**DM3 Dimming**

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<tbody>
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</tbody>
</table>

**DM/DML/DMD Dimming and Digital Addressable (DALI) Dimming**

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<tr>
<th>FEED</th>
<th>DRIVER(s) (xx WATTS-LED)</th>
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<tbody>
<tr>
<td>GREEN</td>
<td>WHITE</td>
</tr>
</tbody>
</table>

**Standard Wiring**

- GREEN = Ground (Green) / WHITE = Neutral (White) / BLACK = Hot (Black)
- *Where Applicable, these wire(s) are added to the STD. Above.

**DM3**

- ORANGE = 3-Wire Dimming Control

**DME**

- VIOLET = ‘E1’ Digital Link Dimming Control
- VIOLET / WHITE = ‘E2’ Digital Link Dimming Control

**DM, DML & DMD**

- GREY = ‘E1’ Digital or 0-10V Dimming Control
- PURPLE = (+) DALI or 0-10V Dimming Control

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L10U-1212-03 (ss-V23)

In a continuing effort to offer the best product possible, we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Specification sheets found at www.selux.us are the most recent versions and supersede all other printed or electronic versions.
Compatible Dimmers

Standard Drivers:
Compatible with reverse phase control, also known as “trailing edge” dimmers. Minimum dimming level down to 10%. Inrush current per driver is 4A/20μs. Please consult factory for details and compatibility.

Reverse phase control or “trailing edge.”

With reverse phase control, the dimmer starts to provide power immediately after the zero cross. Dimming is achieved by delaying the time at which the dimmer stops conducting.

DM3/DME Drivers:
Equipped with Lutron Hi-lume A-Series. Please visit Lutron’s website at www.lutron.com for further information regarding dimmer and controller compatibility. Minimum dimming level down to 1%

DM Drivers:
Equipped with 0-10V dimming drivers for linear dimming curve. Minimum dimming level preset to 0.1%. Driver manufacturer recommends the following dimmers, switches or dimming control systems.

<table>
<thead>
<tr>
<th>Dimmer &amp; Switches Manufacturer</th>
<th>Website</th>
<th>Type</th>
<th>Recommended Driver Dimming Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lutron Electronics</td>
<td><a href="http://www.lutron.com/LEDtool">www.lutron.com/LEDtool</a></td>
<td>Nova T - NFTV</td>
<td>Linear</td>
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<tr>
<td></td>
<td></td>
<td>Diva - DTV</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diva - NFTV</td>
<td></td>
</tr>
<tr>
<td>Control Systems Manufacturer</td>
<td><a href="http://www.lutron.com/LEDtool">www.lutron.com/LEDtool</a></td>
<td>GraphicEye - GRX-TVI w GRX3503</td>
<td>Linear</td>
</tr>
<tr>
<td>Lutron Electronics</td>
<td></td>
<td>Energy Savr Node - QSN-4T16S</td>
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<tr>
<td></td>
<td></td>
<td>TVM2 Module</td>
<td></td>
</tr>
</tbody>
</table>

DML Drivers:
Equipped with 0-10V dimming drivers for logarithmic dimming curve. Minimum dimming level preset to 0.1%. Driver manufacturer recommends the following dimmers, switches or dimming control systems.

<table>
<thead>
<tr>
<th>Dimmer &amp; Switch Manufacturer</th>
<th>Website</th>
<th>Type</th>
<th>Recommended Driver Dimming Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busch-Jaeger</td>
<td><a href="http://www.busch-jaeger.de">www.busch-jaeger.de</a></td>
<td>2112U-101</td>
<td>Logarithmic</td>
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<tr>
<td>Jung</td>
<td><a href="http://www.gb.jung.de">www.gb.jung.de</a></td>
<td>240-10</td>
<td></td>
</tr>
<tr>
<td>Leviton Lighting Controls</td>
<td><a href="http://www.leviton.com">www.leviton.com</a></td>
<td>IllumaTech - IP710-DLX</td>
<td></td>
</tr>
<tr>
<td>Lutron Controls</td>
<td><a href="http://www.lighttoler.com">www.lighttoler.com</a></td>
<td>ZP600FAM120</td>
<td></td>
</tr>
<tr>
<td>Merten</td>
<td><a href="http://www.merten.de">www.merten.de</a></td>
<td>5729</td>
<td></td>
</tr>
<tr>
<td>The Watt Stopper</td>
<td><a href="http://www.wattstopper.com">www.wattstopper.com</a></td>
<td>CDAFB-W</td>
<td></td>
</tr>
<tr>
<td>The Watt Stopper</td>
<td><a href="http://www.wattstopper.com">www.wattstopper.com</a></td>
<td>DCLV1</td>
<td></td>
</tr>
</tbody>
</table>
FEATURES & SPECIFICATIONS

ATTRIBUTES
Acrylic prismatic diffuser with sonic-welded, injection-molded, luminous ends. Matches LB series in appearance. Certain airborne contaminants can diminish integrity of acrylic. Click here for Acrylic Environmental Compatibility table for suitable uses.
Linear side prisms control brightness, pyramidal bottom prisms minimize lamp image.
Continuous, interlocking diffuser support prevents accidental opening and simplifies maintenance.
For surface or stem mounting, individual or row installation. Snap-in couplers permit row mounting without tools.
Available in tandem-wired lengths.
Guaranteed for one year against mechanical defects in manufacture.

CONSTRUCTION
Housing formed from cold-rolled steel. No asbestos is used in this product.
Thermally protected, resetting, Class P, HPF, non-PCB, UL listed, CSA-certified ballast is standard. Ballasts are sound rated A. Standard combinations are CBM approved and conform to UL 935.

FINISH
High-gloss, baked white enamel finish. Five-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts finished with high-gloss, baked white enamel.

ELECTRICAL SYSTEM
Fixture conforms to UL 1570 and is suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures.

ENERGY
Luminaire Efficacy Rating (LER) and Annual Energy Cost:
Calculated in accordance with NEMA standard LE-5.

LISTING
UL listed to US and Canadian safety standards (see Options). NOM Certified (see Options).
Specifications subject to change without notice.

ORDERING INFORMATION

Example: CB 2 32 MVOLT GEB10IS

<table>
<thead>
<tr>
<th>Series</th>
<th>Number of lamps</th>
<th>Lamp type</th>
<th>Voltage</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB</td>
<td>1</td>
<td>17W T8 (24&quot;)</td>
<td>347 MVOLT²</td>
<td>GEB10IS Electronic ballast, ≤10% THD, instant start</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>28T5 28W T5 (48&quot;)</td>
<td></td>
<td>GEB10PS Electronic ballast, ≤10% THD, program start</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>32W T8 (48&quot;)</td>
<td></td>
<td>EL Emergency battery pack (nominal 300 lumens See Life Safety Section)</td>
</tr>
<tr>
<td></td>
<td>Not included</td>
<td></td>
<td></td>
<td>GLR Internal fast-blow fuse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>GMF Internal slow-blow fuse</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RIF1 Radio interference filter (one per fixture)</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>CSA Listed and labeled to comply with Canadian Standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td>NOM NOM Certified</td>
</tr>
</tbody>
</table>

Accessories
Order as separate item
- SQ Swivel-stem hanger (specify in 2" increments).
- 1B Ceiling spacer (adjusts from 1-1/2" to 2-1/2" from ceiling).
- DSH24 Double stem hanger for 4’ fixtures, 24” stems.
- HRC Hooker® T-bar hanger (flush to ceiling).
- HRC1 Hooker® T-bar hanger (1-1/2" from ceiling).

Notes
1 T5 wattage requires GEB10PS ballast.
2 Specify voltage.
CB Corridor Wraparound

MOUNTING DATA
For unit or row installation, surface or stem mounting. Stem mounting not available on TCB units.

Unit installation — One double-stem (4’ only) or two single-stem hangers required.

Row installation — One hanger per fixture plus one per row required.

Hooker® (HRC) Hangers — Minimum two per channel (unit and row).

See ACCESSORIES below for hanging devices.

DIMENSIONS
Inches (centimeters). Subject to change without notice.

PHOTOMETRICS
Calculated using the zonal cavity method in accordance with IESNA LM41 procedure. Floor reflectances are 20%. Lamp configurations shown are typical. Full photometric data on these and other configurations available upon request.

CB 1 32
Report LTL 5652 – Lumens per lamp = 2900
S/MH (along) 1.3 (across) 1.4

Coefficient of Utilization

<table>
<thead>
<tr>
<th>Ceiling</th>
<th>80%</th>
<th>70%</th>
<th>60%</th>
<th>50%</th>
<th>40%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall</td>
<td>70%</td>
<td>50%</td>
<td>33%</td>
<td>20%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0</td>
<td>98</td>
<td>88</td>
<td>83</td>
<td>79</td>
<td>73</td>
<td>67</td>
<td>62</td>
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<td>88</td>
<td>83</td>
<td>79</td>
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</table>

Zonal Lumens Summary

<table>
<thead>
<tr>
<th>Zone</th>
<th>Lumens</th>
<th>%Lamp</th>
<th>%Fixture</th>
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</thead>
<tbody>
<tr>
<td>0-30</td>
<td>504</td>
<td>17.4</td>
<td>20.3</td>
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<td>839</td>
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<td>0-180</td>
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<td>100.0</td>
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</table>

CB 2 32
Report LTL 5649 – Lumens per lamp = 2900
S/MH (along) 1.3 (across) 1.4

Coefficient of Utilization

<table>
<thead>
<tr>
<th>Ceiling</th>
<th>80%</th>
<th>70%</th>
<th>60%</th>
<th>50%</th>
<th>40%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall</td>
<td>70%</td>
<td>50%</td>
<td>33%</td>
<td>20%</td>
<td>10%</td>
<td>0%</td>
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Zonal Lumens Summary

<table>
<thead>
<tr>
<th>Zone</th>
<th>Lumens</th>
<th>%Lamp</th>
<th>%Fixture</th>
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<tbody>
<tr>
<td>0-30</td>
<td>975</td>
<td>16.8</td>
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<tr>
<td>0-40</td>
<td>1625</td>
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<td>0-60</td>
<td>2722</td>
<td>46.9</td>
<td>58.4</td>
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<td>0-90</td>
<td>3691</td>
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<td>79.2</td>
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<tr>
<td>90-180</td>
<td>972</td>
<td>16.8</td>
<td>20.9</td>
</tr>
<tr>
<td>0-180</td>
<td>4663</td>
<td>80.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Lithonia Lighting
Fluorescent
One Lithonia Way, Conyers, GA 30012
Phone: 800-858-7763 Fax: 770-929-8789
www.lithonia.com

©1996-2010 Acuity Brands Lighting, Inc. All rights reserved, Rev. 5/26/10
The Ametrix Asyx is an LED asymmetric luminaire designed for both general illumination and highlighting architectural features. The sleek minimal design makes it an ideal complement to any modern space. Proprietary AccuLED optics offer precision optical control to maximize light collection and directional distribution onto the application area. The Asyx outperforms similar traditional HID fixtures with a 25% improvement in efficacy as well as a superior lifespan that will minimize maintenance costs.

**SPECIFICATION FEATURES**

**Construction**
Heavy wall, die-formed aluminum housing and heat sink has precise tolerance control and repeatability in manufacturing. Housing features vents for air flow and thermal management. Fixture is rated for +40°C ambient environment.

**Finish**
Housing is polyester powder coat paint for superior protection against fade and wear. LightBAR? cover plates are standard white and may be specified to match finish of luminaire housing. Standard colors include black, bronze, silver, and white. RAL and custom color matches available.

**LED Optics**
Asyx luminaires feature patented, high-efficiency AccuLED Optics that maximize light collection and directional distribution onto the application region. Each optical lens is precision manufactured via injection-molding then precisely arranged and sealed on the board media. LEDs: High output LEDs, 50,000+ hours life at >70% lumen maintenance, offered standard in 3000K and 4000K (+/- 275K) CCT. 3000k LEDs nominal 80 CRI, and 4000k nominal 70 CRI.

**Warranty**
Standard five-year limited warranty.

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>WL</th>
<th>IN</th>
<th>B03</th>
<th>AI</th>
<th>UNV</th>
<th>W</th>
<th>RC</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL Rating</td>
<td></td>
<td></td>
<td>Lens: Clear acrylic Lens.</td>
<td>Number of LightBARs:</td>
<td>Color Temperature:</td>
<td>Voltage:</td>
</tr>
<tr>
<td>N= None</td>
<td></td>
<td></td>
<td>N= None</td>
<td>30= 3000K</td>
<td>40= 4000K</td>
<td>UNV= Universal</td>
</tr>
<tr>
<td>Light Distribution</td>
<td></td>
<td></td>
<td>AI=Indirect Asymmetric Light Pattern</td>
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</tr>
</tbody>
</table>

**Notes:**
1. Consult factory for 80 CRI option in 4000K.

 Specifications and Dimensions subject to change without notice.
Consult your representative for additional options and finishes.

ADY121404
08/17/2012 10:53:09 AM
### Zonal Lumen Summary

<table>
<thead>
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<th>Lumens</th>
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<th>% Fixture</th>
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</thead>
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<td>90-110</td>
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<td>0-180</td>
<td>6003</td>
<td>N.A.</td>
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### Coefficients of Utilization

<table>
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<th>45-Deg</th>
<th>90-Deg</th>
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### Asyx

WL-IN-C-BO3-Al-35-W-RC
6003 lumens
70 Watts
85.8 lm/W

Test Report #ITL72651
26W Non-metallic Compact Fluorescent Vapor proof Fixture

Construction
The housing is corrosion resistant glass reinforced polyester thermoplastic. The guard is manufactured in a high impact resistant glass reinforced polymer alloy. All screws and inserts are brass. Gaskets are long life silicone.

COLORS
Gray, Black, White, Red, Blue, Green, and Yellow.

Lamp
The fixture accepts any manufacturer's 26w 4-pin compact fluorescent lamp with a GX24q-3 lamp base.
Lamp not included.

Ballast
The high frequency magnetic ballast is totally encapsulated for corrosion resistance. <15% THD, .99 power factor. 120 volt, .26 amps; 277 volt, .10 amps; 347v, .097 amps.

Installation
The ceiling box has four ¾” threaded hubs with liquid tight knockouts. Internal grounding system allows for hub to hub grounding continuity when using metallic wiring methods (lock nuts are required). Two mounting feet are spaced at 5¼". Pendant mount fixtures have a single ¾” threaded hub with a locking set screw. Use minimum 90°C rated lead wires.

Operating Temperature
-20°F to 90°F

Compliances
UL 1570    Wet location, in any Orientation
UL 595     Marine – Outside Type (Saltwater)
UL 844     Class I, Div. 2 (T2D)*
UL Listed to CSA 22.2-137, Class I Div. 2 (T2D)*

Class I Div. 2-Groups A, B, C, D
CSA approved    USCG Accepted
NEMA 4X – Suitable for hose-down areas.
New York City Department of Buildings approved.
Material meets UL 94-V-O standards for flame retardancy.
*(Only when order with a heat-treated globe.)

<table>
<thead>
<tr>
<th>1</th>
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<th>6</th>
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<tbody>
<tr>
<td>1. Fixture Color</td>
<td>01 – White</td>
<td>02 – Gray</td>
<td>03 – Black</td>
<td>04 – Red</td>
<td>05 – Blue</td>
<td>06 – Green</td>
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<td>2. Lamp Type</td>
<td>F – Fluorescent</td>
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<td>3. Configuration</td>
<td>C – Ceiling mount</td>
<td>W – Wall Mount</td>
<td>P – Pendant Mount</td>
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<td>4. Fixture Type</td>
<td>F – Fixture with Box</td>
<td>R – Retrofit kit without Box</td>
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<td>5. Lamp Wattage</td>
<td>21 – 26w, 120v</td>
<td>22 – 26w, 277v</td>
<td>23 – 26w, 347v</td>
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<td>6. Guard</td>
<td>OG-Guard without Dome Reflector **</td>
<td>09-Guard with Clear Dome Reflector **</td>
<td>00-NO GUARD</td>
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<td>Special Orders</td>
<td>39 – Clear Prismatic Polycarbonate +</td>
<td>59 – Clear Smooth Polycarbonate+</td>
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</table>

+ Available in blue, green, red, and amber
* Come with Class I, Div. 2 labels
** Guards and reflectors are only available with glass globes
Lamps not included
Model Number:
Accessories:
Job: Type:

**FEATURES**
- Enclosure constructed of rugged 20 gauge steel
- Solid 3/8" thick, vandal-resistant, polycarbonate lens
- Remote capabilities (6 volt) - up to 18 watts
- Low voltage disconnect eliminates deep discharge
- Brown-out, short circuit and voltage surge protection
- Overcharge protection
- Flasher/buzzer options to meet ADA regulations
- UL recognized maintenance-free lead acid battery
- Optional NiCad battery available
- Sealed lead calcium battery standard for combo option
- Universal mounting - ceiling or wall mount
- ETL listed 90 minute emergency run time, 24 hour recharge time
- Constant, uniform illumination by long-life, high intensity, red or green LEDs
- Fully-illuminated 6" characters with 3/4" stroke
- Optional Self-Diagnostics available (G1)
- Chevron-style, universal arrows
- 120/277V dual primary, 60Hz input
- Standard finishes: Black and white
- Complete fixture series meets American Recovery and Reinvestment Act of 2009 (ARRA) requirements and Buy American provisions

**WARRANTY**
Any component that fails due to manufacturers defect is guaranteed for 25 years with a separate 5 year pro-rated warranty on the battery. The warranty does not cover physical damage, abuse or acts of God. Manufacturer reserves the right to charge for such repairs if deemed necessary.

**ORDERING INFORMATION**

<table>
<thead>
<tr>
<th>Series</th>
<th>Power Source</th>
<th>Finish</th>
<th>Options (Factory Installed)</th>
<th>EL Option (Single Face Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>502</td>
<td>LB = AC Only</td>
<td>WH = White</td>
<td>G1 = Self-Diagnostics</td>
<td>EL2A* = PAR36 White Thermoplastic</td>
</tr>
<tr>
<td>503</td>
<td>WB = With Battery</td>
<td>BL = Black</td>
<td>DL = Downlight</td>
<td>EL2B* = PAR36 Black Thermoplastic</td>
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<tr>
<td>GS02</td>
<td>NC = NiCad</td>
<td>DR = Dam Location Rated</td>
<td>FL = Flasher</td>
<td>EL2F* = PAR36 Brushed Aluminum</td>
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<tr>
<td>GS03</td>
<td>NC = NiCad</td>
<td>FL = Flasher</td>
<td>EL2F* = PAR36 White Aluminum</td>
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<td></td>
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<td></td>
<td>BZ = Buzzer</td>
<td>EL2G* = PAR36 Black Aluminum</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>FB = Flasher &amp; Buzzer</td>
<td>EL0 = 18W Remote Capacity (No Lamps)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>A1 = Fire Alarm Interface w/FL Option</td>
<td>EL1* = (1) Remote Lamp Head</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>A2 = Fire Alarm Interface w/FB Option</td>
<td></td>
</tr>
</tbody>
</table>

**Custom Color Faceplates** (Option "C")
- C3 = Black Face w/Red Letters 2C11 = 2 Circuit Input 120/120V
- C4 = Black Face w/Green Letters 2C17 = 2 Circuit Input 277/277V
- C6 = White Face w/Red Letters 2C17 = 2 Circuit Input 120/120V
- C9 = Brushed Chrome Face w/Black Letters TR = Tamper Resistant Hardware
- C10 = White Face w/Green Letters C = Custom Color Faceplates

**Accessories** (Field Installed)
- TRHT-6H = Tamper Tool
- ER1-KIT = 1' Pendant Mount Kit
- ER2-KIT = 2' Pendant Mount Kit
- WG-1 = Wire Guard (Back Mount)
- WG-2 = Wire Guard (End Mount)
- WG-3 = Wire Guard (Ceiling Mount)
- WG-5 = Wire Guard EL w/Side Mounted Lamps (Back Mount)
- WG-6 = Wire Guard EL w/Top Mounted Lamps (Back Mount)
- XG-1 = Poly Guard (Back Mount)
- XG-3 = Poly Guard (Ceiling Mount)
- XG-EL90 = Poly Guard EL w/Side Mounted Lamps (Back Mount)
- XG-6 = Poly Guard EL w/Top Mounted Lamps (Back Mount)

1 Not available with EL option
2 LB only, for use with inverter or generator applications only
3 Continuously flashes in emergency (DC) mode - not available with EL option
4 Includes (2) 6V/5.4W PAR36 lamps
5 Consult factory
6 Order as separate line item

The 500 Series is the brightest most visible sign in the industry in both normal and smoke-filled environments. Constructed of durable 20 gauge steel, this direct view exit provides bright illumination with individual LEDs spelling the word EXIT.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE
ILLUMINATION
Illumination of the 500 series is accomplished utilizing high-intensity, long-life LEDs. Starting at only 4 watts, LEDs provide excellent illumination while maximizing energy efficiency. LEDs are a maintenance-free solution, providing up to 100,000 hours of use without failure.

CONSTRUCTION
Enclosure, cover, face plate, and mounting canopy are 20 gauge galvanized steel with baked-on, powder coated paint. Face plate has 3/4" black letters with red or green LEDs. 1/8" polycarbonate shield protects LEDs from impact. *Optional face plates are available.

INSTALLATION
Installs in minutes with easy-to-read instructions and detailed diagrams. No special hardware or tools necessary. Internally housed components and battery eliminate the use of a canopy when back mounting single faced exits. Mounting canopy included.

SELF-DIAGNOSTICS (Option: G1)
This multifunctional option automatically analyzes the operating condition of the sign every seventh day and provides a visual indication if failure has occurred.

EMERGENCY LIGHTS
Emergency lights are single or double face compatible with field selected top or side mounting. Choice of one or two 6 volt, 5.4 watt high intensity incandescent lamp heads. Flashing LED display in emergency mode is standard with emergency lights.

CONFORMANCE TO CODES & STANDARDS

DIMENSIONS
FEATURES

Application
The LZ Series is an indoor emergency lighting unit with 10 - 65W capacity utilizing a sealed lead-calcium or nickel-cadmium battery in 6 or 12 VDC. Supplied standard with two halogen MR16 lamps. High-output LED based MR16 option provides increased spacing, additional run-time and/or increased remote capacity. Matching remote heads are also offered. The integrated lamp design offers greater protection from vandalism.

Construction
Available in two housing sizes, one for standard capacity models (LZ2, LZ15) and increased depth for higher capacity models (LZ15 through LZ65). Made from UV stabilized thermoplastic with a snap-together design in white or black finish. Includes test switch and AC-ON indicator.

Installation
Unit mounts to 3½", 4" octagon or 4" square boxes. Back-plate provides a universal knockout pattern for mounting to outlet box. Keyholes provided for securing housing to wall surface. LZ2 and LZ15 can be ceiling mounted. All AC connections made inside unit housing.

Illumination
The LZ Series provides illumination with two halogen MR16 lamps positioned inside an adjustable "eyeball" style housing. Optional lamps for greater light output include 10W MR16 and maximum coverage high-output LED based MR16.

Compliances
UL 924 Listed (optional damp location listed)
NFPA 70
NFPA 101
ADA compliant (LZ standard models only)

ORDERING GUIDE

<table>
<thead>
<tr>
<th>LZ</th>
<th>Model</th>
<th>Capacity</th>
<th>Battery Type</th>
<th>Rating</th>
<th>Output Volts</th>
<th>Self-Diagnostics</th>
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<td>6 Volts</td>
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<td>65</td>
<td>65 Watts</td>
<td>2, 6</td>
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1 Available on units with capacities of 20 watts or more
2 Not available with Nickel-Cadmium battery models
3 Available only on 15, 20 or 25 Watt models
4 Must order with damp location on LZ15 in 6 VDC only
5 Not available with Lead-Calcium battery models
6 Not available with damp location models
7 Must order with damp location listing on LZ2 model
8 Not available with LZ2i and LZ15i Spectron® equipped unit
9 Not available with -03L (LED) option
10 Limited to LZ20ND-12V, LZ25N-12V, LZ30D-12V, LZ35-12V, LZ55D-12V and LZ65-12V
11 Not available on LZ2 and LZ15 models
12 Available on LZ2 only
13 Available on all models except LZ2
**LZ Series**

**Designer Emergency Lighting Unit**

**SPECIFICATIONS**

**Standard Features:**
- External push-to-test switch and AC-ON indicator
- Low voltage disconnect
- Transformer isolation
- Temperature compensated charger circuitry
- MR16 Halogen lamp with rated 200 hour life

**Optional Features:**
- Spectron® self-test/self-diagnostic circuitry monitors lamp status, lamp load transfer circuitry and battery capacity; displays any fault detected via a flashing code. Automatically runs periodic diagnostic routines to ensure unit readiness. Multicolor LED indicates fault condition and charging status.
- LED MR16 lamps rated at 50,000 hour life expectancy
- Available without integral lamp heads for added run time or remote capacity operation.

**Operating Temperature Range:**
- Standard models: 20°C to 30°C (68°F to 86°F)
- Damp location models: 10°C to 40°C (50°F to 104°F)

**Weight:**
- 4 - 12 lbs. depending on capacity

**AC Input Voltage**
- 120VAC or 277VAC: 60 Hz. operation standard
- Optional 220-240VAC: 50/60 Hz.

**Power consumption for LZ2 and LZ15**
- Maximum: 4.0W, 120VAC or 277VAC
- Normal: 1.3W, 120VAC or 277VAC

**Power consumption for LZ15N and larger**
- Lead-Acid Battery
  - Maximum: 14W
  - Normal: 1.8W
- Nickel-Cadmium Battery
  - Maximum: 14.0W
  - Normal: 2.0W

**APPLICATION DATA**

**Spacing for 5W HAL MR16 lamp**
- 1 fc average
  - 17'

**Spacing for 10W HAL MR16 lamp**
- 1 fc average
  - 40'

**Spacing for optional 3W LED MR16 lamp**
- 1 fc average
  - 43'

**DIMENSIONS**

A Standard size (LZ2, LZ15) depth is 3.625" (9.2cm).
High capacity model depth is 5.125" (13cm).
ANNOUNCEMENTS AND NOTIFICATIONS:

Prior to initiating work, repair, or replacement procedures on any portion of the fire alarm and detection systems (FADS) which will cause the FADS to not be fully functional, the following announcements and notifications are to be made:

- Building Owner, Manager and Proctor: Notify 3 working days prior to work.
- UCB Fire Systems Group of FM: Notify 3 working days prior to work.
- UCB Service Desk: Notify 24 hours prior to work and 1 hour prior to actual start of work.
- Boulder Fire Department: Notify 24 hours prior to work and 1 hour prior to actual start of work.
- Posted Announcement: Post temporary signs at each entrance to each building, each stairwell entrance, each elevator entrance and inside each elevator cab. Signs are to be posted a minimum of one hour prior to occupant entry on the day during which the work will be performed. Signs are to be a minimum 8-1/2" x 11" dimension with block letter printing using black lettering on a light red or pink background. Provide with secure attachment and means of protecting from weather damage. Remove all Posted Announcements when work is complete. Sign is to state substantially:


- Building Occupants: Immediately prior to initiating work, announce to all building occupants that the fire alarm system work is in progress. All personnel entering the building after these announcements are to be similarly advised of work in progress. When the fire alarm system work is no longer in progress and the FADS are back in service, an announcement to all building occupants is to be made that the fire alarm system work is no longer in progress and the FADS have been restored to normal operation.

PLANNED INTERRUPTIONS: Where feasible, interruptions of the fire alarm and detection systems in any buildings are to be limited to 4.0 hours when the building is occupied and 8.0 hours when the building is not occupied. The FADS may not remain interrupted at night unless fire-watcher(s) are present. One of the following three procedures is to be followed:

OPTION A:

A.1: Where feasible, contractor is to upgrade the fire alarm system one floor at a time. All full or partial fire alarm outages are to occur during minimal occupancy hours and days.

A.2: Where feasible, for replacement of the existing fire alarm panels, contractor is to leave the existing fire alarm panel “hot” and interconnect the two, new and existing panels so that they will activate each other. Then when a floor or a circuit is modified, contractor may remove it form the old and add it to the new panel. When all floors and circuits are completed, the old panel may be removed. Where this procedure is applied, fire watch requirements may be deleted in most, but not all cases.
**OPTION B:**

**B.1:** Step One; Replace the FACP when called for in the project. Temporarily connect the existing initiation and notification circuits to the new FACP. Use monitor ZAM’s where necessary to do the temporary connections.

**B.2:** Step Two; Replace notification appliances. While doing so, if a fire is annunciuated at the FACP, a person stationed at the FACP (panel-watcher) will contact the fire-watcher(s), e.g., using radios, and direct them to notify floor and building occupants using pre-established procedures. Use of portable loud speakers should be considered for large buildings.

**B.3:** Step Three; Replace initiating devices/circuits after the new notification circuit is connected to the new FACP. When the fire-watcher(s) detect a fire, the fire-watcher(s) will contact the panel-watcher and direct him/her to manually sound the building alarms from the FACP.

**B.3.1:** Step Three (clarifications); If manual pull stations are on a separate circuit from smoke and heat detectors, “Step Three” should be broken into two parts, Step 3a: Replace manual pull stations, and Step 3b: Replace smoke and heat detectors and other initiating devices. This method provides a higher degree of safety since the occupants and fire-watcher(s) can use pull stations to notify the panel-watcher of emergency conditions.

**B.3.2:** Step Three (clarifications); For fully sprinklered floors, if the water flow switch is connected and functional, the requirements of Step 3 can be substantially reduced.

**B.4:** The panel-watcher will be in contact with the Service Desk. If Service Desk receives an emergency call from occupants, they will contact the panel-watcher and direct him/her to sound the alarms and to notify the fire-watcher(s) to do their assigned duties.

**OPTION C:**

As an alternative to options A or B above, contractor may propose other methods that provide an equal or higher level of safety and obtain project team’s approval. Once project team’s approval is obtained, and owner’s representative issues written authorization, contractor is to use the approved alternative within its established limitations. Project team and owner’s representative reserves the right to reject the proposed alternative.

**UNPLANNED INTERRUPTIONS:** Unplanned fire alarm and detection system outages are to be handled on a case by case basis through consultation with the Fire and Life-Safety Group (FLS) of Facilities Management. Typically for an occupied building, some type of firewatch will be required.