ADDENDUM NO. 1 - OUTLINE AND SUMMARY INFORMATION

Project Name: Viscom Photography Studio
Location: Visual Communications Building
Owner: 

PPA No.: 12-0123
Date: November 12, 2015

To: All Plan Holders of Record

The Plans and Specification prepared by Campus Planning Design and Construction dated November 2015, shall be clarified and added as follow. The bidder proposes to perform all the following clarifications or changes. It is understood that the Base Bid shall include any modification of Work or Additional Work that may be required by reason of the following change or clarifications.

The Bidders are to acknowledge the receipt of this Addendum by inserting its number and date into their Bid Forms. Failure to acknowledge may subject the Bidder to disqualification and rejection of the bid. This Addendum forms part of the Contract Documents as if bound therein and modifies them as follows:

I. AMENDMENTS TO THE PROJECT MANUAL
   A. Please replace the Table of Content with the attached Table of Contents showing the mechanical and electrical sections, divisions 15 and 16.

II. AMENDMENTS TO THE DRAWINGS
   A. The outlet shown on sheet E-2.2 between two tables is a ceiling outlet.
   B. No mechanical or plumbing devices require electrical connections.
   C. Contractor to field verify the location of the nearest pull station conduit run for the installation of the two new fire alarm pull stations.
   D. On sheet A1.1, the new door between hallway 117 and 112, and the existing door between hallway 117 and the building hallway (which presently has panic bar hardware) are to be outfitted with classroom mortise locksets.

III. GENERAL INFORMATION
   A. No visible asbestos has been noted. Should material be uncovered be suspected of containing asbestos testing will be performed and, if found to be positive, removal arranged by the contractor, within adjustment to the project cost and schedule.
IV. ATTACHMENTS

A. Revised table of contents

B. Specifications for divisions 15 and 16.

END OF ADDENDUM NO. 1
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**BIDDING REQUIREMENTS**
- Permit Notice ............................................................... PN
- Invitation To Bid............................................................... ITB
- Instructions to Bidders ....................................................... IB
- Bid Proposal, Form 098 ....................................................... BP

**CONTRACT DOCUMENTS**

*Included in this Project Manual:*
- Sample Standard Form of Contract, Form 110
- State of Montana General Conditions
- MSU Supplemental Conditions
- Montana Prevailing Wage Rates

The following documents are included in electronic versions but **not included in the printed project manual.**

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<thead>
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Additionally these can be downloaded from our website: [http://www.montana.edu/us/pdc/arch/DesignConstructionDocuments/](http://www.montana.edu/us/pdc/arch/DesignConstructionDocuments/) – or will be provided upon request.

**TECHNICAL SPECIFICATIONS**

**Division 1 – General Requirements**
- Summary ........................................................................... 011000
- Price and Payment Procedures ........................................... 012000
- Substitution Procedures ................................................... 012500
- Submittals ........................................................................ 013000
- Project Coordination ....................................................... 013100
- Quality Requirements ...................................................... 014000
- Temporary Facilities ....................................................... 015000
- Product Requirements ...................................................... 016000
- Executions ....................................................................... 017300
- Warranties Bonds ............................................................ 017400
- Project Closeout ............................................................. 017700
- Operations & Maintenance Manuals ................................. 017823
- Project Record Documents ............................................... 017839
- Demonstrations & Training ............................................... 017900
- Selective Demolition ....................................................... 024119

**Divisions 2 – 5** (No requirements this Division)

**Division 6 – Wood and Plastics**
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**Divisions 7 – 8** (No requirements this Division)

**Division 9 – Finishes**
- Resilient Tile Flooring .................................................... 096519

**Divisions 10 - 14** (No requirements this Division)

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## CONSTRUCTION DRAWINGS

### LIST OF DRAWINGS

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PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division 1 specifications sections, apply to this section.

1.02 SCOPE OF WORK
   A. Provide the entire mechanical work as shown and specified, including but not limited to equipment, insulation, heating, ventilating, air conditioning, and controls, all connected and ready for use in the buildings.

1.03 INTENT
   A. Intent:
      1. The intention of the Contract Documents is to include all labor and materials, tools, hoisting, scaffolding, supervision, equipment, and transportation necessary or reasonably inferable as being necessary for the execution of the work.
      2. The Contractor is responsible for providing the finished mechanical work, tested and ready for operation.
      3. By submitting a proposal, the Contractor represents that they have made a thorough examination of the site, of the work, and all existing conditions and limitations, and that they have examined the Contract Documents in complete detail and have determined beyond doubt that the drawings, specifications, and existing conditions are sufficient, adequate and satisfactory for the construction of the work under the Agreement.
      4. Where minor adjustments of the work are necessary for purposes of fabrication or installation of items or resolution of conflicts between items within the intent of the Contract Documents, the Contractor shall make such adjustments at no added expense to Montana State University. Where such adjustments affect functional or aesthetic design of the work, they shall first be submitted to the Architect for review and approval.
   B. Site conditions: The mechanical documents indicate certain site conditions to assist the Contractor. These drawings are not intended to indicate all conditions. It shall be the responsibility of the Contractor to verify all site conditions and include the removal or relocation of equipment and wiring in the Agreement.
1.04 COORDINATION

A. Contractor shall be thoroughly acquainted with the work involved and shall verify at the site those measurements necessary for proper installation of the work.

B. Contractor shall refer to architectural, structural, and electrical drawings for information and other details which affect the mechanical installation and shall confer with those trades for finish adjacent to its work and arrange to have visible portions of this work (such as access doors, grilles, sprinkler heads, escutcheons, etc.) fit in and harmonize with the finish in a manner satisfactory to the Architect.

C. Ceiling Heights: Architectural drawings shall be checked for ceiling heights, walls, and cabinets that are intended to conceal work of this section. Where conflicts occur, the Architect shall be notified prior to installation of the work. Location of exposed work such as lights, and diffusers take precedence over concealed work.

1.05 DEFINITIONS AND ABBREVIATIONS

A. All definitions within Section 01070, Abbreviations and Definitions and Part 3 of the Agreement apply to all Division 15 specifications.

B. Provide: The word “provide,” as used in these specifications, means furnish and install, complete and ready for the intended use, as defined in Section 01070, Abbreviations and Definitions.

C. Contractor: The word “Contractor,” as used in these specifications, means the general contractor.

D. Approved: The word “approved,” is defined as approved by the Project Manager.

E. Indicated: The term “indicated” refers to graphic representation, notes, or schedules on the drawings, or other paragraphs or schedules in the specifications, and similar requirements in the Contract Documents. Terms such as “shown,” “noted,” “scheduled,” and “specified” are used to help the reader locate the reference. Location is not limited.

F. “Concealed” shall mean hidden from site as in chases, trenches, furred spaces or hung ceilings.

G. “Exposed” shall mean not concealed as defined above.

H. Directed: Terms such as “directed,” “requested,” “authorized,” “selected,” “approved,” “required,” and “permitted,” mean directed by the Project Manager requested by the Project Manager, and similar phrases.

I. Specialist: Certain sections of the specifications require that specific construction activities shall be performed by specialists who are recognized experts in the operation to be performed. The specialists must be engaged for those activities, and assignments are requirements over which the Contractor has no choice or option. Nevertheless, the
ultimate responsibility for fulfilling Agreement requirements remains with the Contractor.

1. This requirement shall not be interpreted to conflict with enforcement of building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

J. Abbreviations: See drawing sheet M0.1 Mechanical Abbreviations for a complete list.

AASHTO American Association of State Highway and Transportation Officials.
AFBMA Anti-Friction Bearing Manufacturer’s Association
AGA American Gas Association
AMCA Air Moving and Conditioning Association
ANSI American National Standards Institute
APWA American Public Works Association
ARI Air Conditioning and Refrigeration Institute
ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME American Society of Mechanical Engineers
ASTM American Society of Testing Materials
AWWA American Water Works Association
AWS American Welding Society
CBC California Building Code
CISPI Cast Iron Soil Pipe Institute
FM Factory Mutual Research Corporation
MSS Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
NEC National Electric Code
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
NSF National Sanitation Foundation
OSHA Occupational Safety and Health Administration
PDI Plumbing and Drainage Institute
PS Product Standard of NBS (US Department of Commerce)
SMACNA Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL Underwriters Laboratories, Inc.
VFD Variable Frequency Drive
AHU Air Handling Unit
UH Unit Heater
WH Water Heater
FSD Fire / Smoke Damper
HP Horsepower
EF Exhaust Fan
AC Air Conditioning
HVAC Heating, Ventilation and Air Conditioning
DDC Direct Digital Control
BAC Building Alarm Cabinet
BAS Building Alarm System
VAV Variable Air Volume
RPM Revolutions per Minute
1.06 CODES, PERMITS AND INSPECTIONS

A. Work shall be installed in conformity with applicable local ordinances and state statutes. Standards and sizes, which meet or exceed preceding requirements, shall be installed as drawn or specified.

1. Building Codes:
   a. 2009 International Building Code
   b. 2009 International Mechanical Code
   c. 2011 National Electric Code
   d. 2009 Uniform Plumbing Code
   e. 2009 International Energy Conservation Code

B. Give necessary notice, obtain permits and pay taxes, fees and other costs, including utility connections or extension for the work. File necessary plans, prepare documents and obtain necessary approvals of governmental departments having jurisdiction. Apply for and pay for all meters and gauges required. Obtain required certificates of inspection for work and deliver to the Architect before request for acceptance and final payment for the Work.

C. Comply with laws, ordinances, rules, regulations, and lawful orders of any public authority bearing on the performance of the work. If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify the Architect in writing and any necessary changes shall be accomplished by appropriate modification. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to the Architect, he shall assume full responsibility, and shall bear all costs.

D. Material and equipment within the scope of the UL testing laboratory service shall be listed by the Underwriters Laboratories for the purpose for which they are used and shall bear their listing mark.

E. Contractor shall call for all inspections by the city and county when they become due and shall not cover any work until approved by these governing authorities.

1.07 QUALITY ASSURANCE

A. Unless otherwise indicated or specified, all materials shall be new. Contractor shall properly store all materials and equipment for protection from physical damage or damage due to corrosion.

B. Standardization of Manufacturer: This Contractor shall make every effort to furnish all equipment of any equipment type such as fans, motors, motor controls, pumps, valves, etc. from one manufacturer.

C. Rigging and Appliances: Provide all rigging, scaffolding, staging, and ladders required for complete installation of all equipment.
D. Manufacturer's Directions: Each material for which the manufacturer issues directions shall be used according to its manufacturer's directions, as approved and if not at variance with these specifications.

E. Drawings and specifications shall be taken together. Provide work specified and not indicated or work indicated and not specified as though mentioned in both.

F. Drawings:

1. Drawings are diagrammatic, indicating the general arrangement of systems and work, and do not attempt to show exact details or all offsets in piping and ductwork. Do not scale drawings. Examine the architectural drawings for exact location of fixtures and equipment. Where they are not definitely located, obtain this information from the Architect.

2. Follow drawings in laying out work and check drawings of other trades to verify spaces in which work will be installed. Install piping and ducts in such a manner as to conform to structure, avoid obstructions, and keep openings and passageways clear. Lines that must pitch, or that must have a constant elevation, shall have the right-of-way over lines not so restricted. Maintain maximum headroom. If space conditions appear inadequate, notify the Architect before proceeding with the work. Make reasonable modifications in the work without extra cost as needed to prevent conflict with work of other trades and for proper execution of the work.

G. Examination of site and drawings: Submittal of bid shall indicate the Contractor has examined the site and drawings and has included all required allowances in the bid. Bid shall include costs for all required drawings to meet space requirements and code requirements.

H. Any information described or shown not clear to the mechanical subcontractor shall be referred to the Architect for clarification before bids are submitted. The mechanical subcontractor will be obliged to install the work without additional cost as directed by the Architect if no question is raised prior to the opening of bids.

1.08 SUBMITTALS, APPROVALS AND REVIEWS

A. Shop Drawings and Product Data:

1. Comply with the applicable requirements of Section 01300, Submittals.
2. Verify all dimensional information to insure proper clearance for installation of equipment.
3. Check all materials and equipment after arrival on the job site for compliance with the Contract Documents.
4. Failure to submit shop drawings and submittal data in ample time for checking and review shall not entitle the Contractor to an extension of Agreement time.

B. Observe the following rules when submitting the shop drawings and brochures:

1. Shop drawings shall be provided for all sheet metal work.
2. Shop drawings shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the deviations.

3. Brochures to be submitted shall be published by the manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs, which describe several different items in addition to those items to be used, unless all irrelevant information is marked out or unless relevant information is clearly marked. All submittals shall be reviewed by Contractor and stamped approved before forwarding to Architect. Contractor shall establish quantities, verify space requirements, dimensions, and possible interferences with other trades. Brochures shall include all specified materials, but not be limited to, information on the following materials:
   a. Air ducts
   b. Diffusers, registers, and grilles
   c. Mechanical insulation
   d. Hangers and supports
   e. Testing and balancing
   f. Air balancing

4. Each brochure must include all of the specified items. Submittals of individual items, or those that do not follow specified format, will not be accepted unless approval is granted by the Architect.

C. Shop Drawings:

1. Contractor agrees that shop drawing submittals processed by the Engineer are not change orders, that the purpose of shop drawing Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept and demonstrates its understanding by indicating which equipment and material it intends to furnish and install and by detailing the fabrication and installation methods it intends to use.

2. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Engineer, the design drawings and specifications shall control and shall be followed.

3. Shop drawings for equipment shall be reviewed by the manufacturer before submitting to Architect to determine whether the product is being correctly used.

1.09 **CONSTRUCTION COORDINATION DRAWINGS**

A. Coordination Drawings:

1. Provide construction coordination drawings for all congested areas requiring close coordination with other trades and the general construction. It shall be the Contractor's responsibility to work out and coordinate all conflicts and to provide all offsets and special fittings required to facilitate installation of work. Failure to provide the drawings, when required, shall be considered non-performance, and
progress payments will be suspended until the drawings are reviewed and accepted by the Architect.

2. Prior to installation, where conflicts cannot be worked out due to space restrictions, and where agreement modifications are required, the Contractor shall notify the Architect and obtain written instructions.

3. The construction coordination drawings shall be submitted to the Architect for review prior to commencement of any related work. Drawings shall be executed on sheets sized the same as the Contract Documents and shall be produced using CAD. Drafting shall be the same quality as the Contract Documents.

4. The construction coordination drawings shall show all related trades, structure, and ceilings, walls, and partitions. Provide cross sections of congested areas.

5. The construction coordination drawings shall be continuously updated during the execution of the work. The drawings shall be submitted at the completion of the project for record purposes.

1.10 RECORD DRAWINGS, DATA

A. The Contractor shall, during the progress of the work, keep a current and careful record of all changes where the actual installation differs from that shown on the construction drawings. Record Drawings (As-built) shall be maintained in the project office for inspection by the Architect at any time.

B. Upon completion of the installation, the Contractor shall furnish one complete set of as-built drawings on reproducible transparencies to the Architect. Outside utilities must be accurately located by dimension-to-permanent construction. Contractor shall obtain transparencies of the drawings from the Architect and pay all costs.

C. Systems designed by Contractors, such as, but not limited to, controls, and fire protection, shall also include an AutoCad diskette showing design of system.

1.11 SAFETY AND PROTECTION

A. Safety measures to be taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences, or procedures required for the Contractor to perform its work. The Contractor will be solely and completely responsible for conditions of the jobsite, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The Architect's observations of the Contractor's performance are not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site. It shall be the Contractor's responsibility to comply with Safety and Health Regulations for Construction, Volume 36, No. 75, Part 11 of the Federal Register by the U.S. Department of Labor. Contractor shall be responsible for providing all such safety measures and shall consult with the state or federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether it is or is not in compliance with state or federal regulations.
1.12 SUBSTITUTIONS

A. Brand names: The use of brand names is for the purpose of description and establishing quality and does not eliminate the requirements of meeting specifications.

B. Exceptions: Other brands will be allowed except where an item or class of material is specified exclusively by trade name and followed by word "only."

C. Requests for substitutions: Requests for substitutions, complete with catalog data and proposed reduction in cost, should be furnished not later than ten working days prior to bid date or request may not be considered. Any substitutions approved shall be included in the submittals described below. All substitutions approved shall be described in an addendum issued prior to bid date. Approval of alternative and/or substitute products will be considered only under terms and conditions specified in Section 01630, Product Options and Substitutions.

D. Changes due to substitutions: Design is based on equipment as listed in the equipment schedule and/or specified elsewhere in Division 15. Provide redesign to any part of the work resulting from the use of equipment and material other than specified or shown on the drawings. Obtain approval of redesign from the Architect. Redesign cost and additional construction cost resulting from the redesign shall be at the Contractor's expense.

1.13 SCHEDULE OF VALUES

A. Provide preliminary schedule of values for each project to the Engineer according to the following descriptions:

1. Electrical Devices for Mechanical Equipment.
2. Insulation.
3. Ductwork / Air Devices.
5. Demolition.
6. Commissioning.
7. Other.

1.14 OPERATION AND MAINTENANCE MANUALS

A. General: Prepare instruction manuals describing the operation, servicing, and maintenance requirements of all mechanical equipment provided and complete parts lists.

B. Equipment described in the manual: Include the following sections, each with separate tab index:

1. Diffusers.

C. Information Contained in the Manual: Catalog data on each item installed and not the complete "line" of the manufacturer. Supplementary drawings for servicing and
maintenance points. Index all contents listed in an orderly presentation. Include tabulations describing the type of equipment, frequency of service, type of service, and description of all lubricants required. Lubrication and lubricants especially shall be detailed separately for all equipment and presented for ready reference.

D. Include copies of final air balancing reports, copies of all certificates by the inspectors representing authorities having jurisdiction, and copies of all warranties.

E. Include names and emergency telephone number for persons to be contacts for emergency response to equipment failures during the guarantee period, see paragraph 1.16C.

F. Binding: Binding and number of copies shall be in compliance with Section 01700, Project Closeout.

1.15 OPERATING PERSONNEL INSTRUCTION

A. General: Provide field instruction of facility operating personnel sufficiently prior to facility acceptance, upon mutually satisfactory arrangement with MSU.

B. Instruction: Instruction shall include proper operation and limitations of the system during full and part load modes of operation, indoor air quality (IAQ) Control, energy conservation, and emergency procedures. Review and use of the operations and maintenance manuals is part of training. Proper operation, adjustment, and maintenance of the DDC control system shall be implemented. Training schedules shall be submitted to MSU at least 14 days prior to final acceptance.

1.16 TEMPORARY SERVICES

A. Light, Heat, Cooling, Power, Etc.:

1. The contractor shall be responsible for providing temporary electricity, heating and cooling, and other facilities.

B. The Contractor shall be responsible for the maintenance operation and servicing of all new mechanical systems which are to be used by Montana State University during the time of any occupancy and use of any areas within the construction limitations before final completion or acceptance of the systems. A written record of maintenance operation and servicing shall be turned over to Montana State University prior to final acceptance.

C. The Contractor shall be responsible for providing temporary cooling and the associated electrical power if the cooling system is taken out of service for any period greater than one hour. An MOP shall be provided. The Contractor shall coordinate electrical power with the Engineer.
D. Air systems: Do not use new air systems during construction. Cover duct and grille openings with taped-on plastic sheet or equivalent to keep all construction dust possible out of the ductwork.

E. Repair of damages to underground utilities: The exact location of existing underground utilities is not definitely known. Should any underground utilities be damaged in excavations, restore such utilities, both temporarily and permanently, as required, without any additional cost to MSU. Correct any damage resulting there from.

F. Cleaning: Promptly remove all waste material and rubbish. At completion of the work, clean all dirt and construction debris such as paint, plaster, glue, cement, mastic, tar, paper, tape, and dirt from the mechanical installation including equipment, piping, ductwork, and plumbing fixtures. In finished areas to be occupied, keep equipment covered during course of construction. Where this is not practical, clean and/or refinish item to new condition.

1.17 PROJECT CLOSEOUT

A. General: Comply with all Division 1 requirements.

B. Requirements for final inspection: All of the following items shall be completed prior to final inspections. No exceptions will be made and no approval for final payment will be made until all items are completed.

1. Cleaning equipment and premises.
2. Operating instructions and maintenance manuals.
3. Testing, adjusting and balancing.
4. Record Drawings (As-Builts).
5. Guarantee.

C. Guarantee:

1. All work performed under this Agreement shall be guaranteed against faulty and improper materials and workmanship for a period of one year from the date of final acceptance by MSU, except that where guarantees or warranties for longer terms are specified herein, such longer term shall apply, and this Contractor, at no additional cost to MSU, shall promptly correct any deficiencies which occur during the guarantee period, all to the satisfaction of MSU and Architect. This Contractor shall require similar guarantees from its subcontractors and shall be the single-point responsibility for all work in Division 15.

2. All equipment and installation shall be guaranteed by the Contractor to be in compliance with OSHA regulations.

3. During the guarantee period, this Contractor shall provide 24 hour a day response for warranty work on all mechanical systems and equipment. Names and emergency telephone numbers of emergency contact persons shall be provided in O&M Manuals.

D. Functional Testing: Provide full functional test of control system, air distribution systems, and all other mechanical components and systems. Test to be conducted in the
presence of the Engineer and the Project Manager. Written verification of test to be signed by Project Manager.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 15010
SECTION 15050 – MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division 15 specifications sections, apply to this section.

1.02 WORK INCLUDED

A. This Section includes the following basic mechanical materials, and methods to complement other Division 15 sections.

1. Labeling and identifying mechanical systems and equipment is specified in Section 15075, Mechanical Identification.
2. Installation requirements common to equipment specification Sections.
3. Cutting and patching.
4. Touchup painting and finishing.

1.03 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, spaces above ceilings, crawl spaces, and tunnels.

B. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 SUBMITTALS

A. General: Submit the following per the Division 1 Specification Sections.

B. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
1.05 QUALITY ASSURANCE

A. Equipment and pipe identification shall conform to ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

1.06 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work.

E. Coordinate connection of electrical services.

F. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8.

G. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 FIRESTOPPING

A. Firestopping: See part 3.09 of this section for coordination of firestopping and division of work. Firestopping products are specified in Section 07270.
PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION -COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, except where otherwise indicated.

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment, giving right-of-way to piping systems installed at a required slope.

3.02 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 Structural Welding Code-Steel.

3.03 ANCHORAGE AND BRACING OF MECHANICAL SYSTEMS

A. General: Provide complete seismic anchorage and bracing for the lateral and vertical support of piping, ductwork and mechanical equipment as required by code. Seismic restraints are specified in Section 15070, Mechanical Sound, Vibration, and Seismic Control.

B. Piping and Ducts: Seismic bracing and anchorage of piping and ducts shall be provided in accordance with the requirements of Guidelines for Seismic Restraints of Mechanical Systems (sheets 1-13), published by SMACNA. Details for systems excluded from the aforementioned standard shall be provided as detailed on the drawings.

C. Anchorage of Equipment: It is not known which of the specified manufacturers of mechanical equipment the Contractor intends to furnish. The Contractor shall detail equipment anchorage and bracing and submit shop drawings and calculations to the Architect for approval. Installation of equipment shall not commence until anchorage and equipment bracing is approved.
3.04 SEALING THROUGH AIR PLENUMS, SHAFTS AND FLOORS

A. General: Provide all sealing around pipes, ducts, fire damper sleeves and frames, motorized damper frames, and other mechanical work penetrating walls and slabs which are boundaries for recirculating and exhaust air.

B. Sealing of Sleeves: Where pipe or duct/fire damper sleeves are used, the annular space around pipes or ducts shall be 1/2". Pack the annular space with an approved UL listed packing, leaving 1-1/2" depth for caulking compound. Apply sealing compound filling this remaining annular space out to a point flush to the wall line.

C. Sealant: Silicone acoustical sealant or non-hardening butyl, suitable to withstand moderate joint movement.

3.05 FIRESTOPPING

A. Mechanical penetrations shall be firestopped using materials and methods specified in section 07270. Firestopping of mechanical penetrations may be performed by the Mechanical Contractor, General Contractor, or a special Firestopping Contractor. Division of work is a coordination issue between Contractors. Coordinate coverage of firestopping with General Contractor; change orders will not be accepted to cover omission of firestopping from mechanical scope.

3.06 CUTTING AND PATCHING

A. Provide all formed openings required in the building construction for ducts, pipes, or equipment. Accurately locate all such openings and coordinate work with the Contractor in order to properly complete this work within the Contractor's time schedule. Cutting or patching made necessary through the neglect of the mechanical subcontractor, shall be done by the Contractor at the expense of mechanical subcontractor. All additional openings required through existing slabs or walls shall be drilled with a diamond core drill, and in no case shall any structural member be cut without approval of the Engineer.

1. Holes through other walls shall be accomplished by use of a hole saw.
2. Openings at sleeves through walls or partitions separating conditioned and unconditioned spaces shall be packed with watertight and airtight caulking.

B. Patching: All patching shall be by the Contractor. During the bidding period, notify the Contractor the extent of patching required.

3.07 PROVISIONS FOR LATER INSTALLATION

A. Where any mechanical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures, or devices necessary to permit installation later. Lay out any chases, holes, or other openings that must be provided in masonry, concrete, or other work.
B. Verify nature and arrangement of materials and construction to which this work attaches or passes through.

END OF SECTION 15050
SECTION 15060 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, Division 1 specifications sections, Sections 1510, Mechanical Work – General and 15050, Materials and Methods apply to this section.

B. Related Sections include the following:

   1. Section 15010, Mechanical Work – General.
   2. Section 15050, Materials and Methods.

1.02 WORK INCLUDED

A. Work under this section shall include furnishing and installing hangers and supports common to the mechanical piping and duct systems specified elsewhere in Division 15 and shall include, but not be limited to:

   1. Duct hangers and supports.
   2. Expansion devices.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

      a. A525 General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process.

   2. Manufacturers Standardization Society (MSS):
      a. SP-58 Pipe Hangers and Supports -Materials, Design and Manufacture.
      b. SP-69 Pipe Hangers and Supports -Selection and Application.
      c. SP-89 Pipe Hangers and Supports -Fabrication and Installation Practices.
      d. SP-90 Guidelines on Terminology for Pipe Hangers and Supports.

   3. Underwriters Laboratories Inc.(UL):

4. Factory Mutual Research (FM):

1.04 SUBMITTALS

A. Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work - General.

B. Submit product information on all hangers, hanger rods, inserts, anchors, expansion shells, beam clamps, and other hanger or support attachments.

1.05 QUALITY ASSURANCE

A. Codes and Regulations:
   1. Anchor Bolts: Comply with the International Building Code and resist lateral seismic forces and overturning forces (applied to the center of gravity).
   2. Overturning force calculations for certain equipment shall be prepared and submitted and shall be used to determine anchor bolt size and locations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Guides and Anchors: Adsco, Advance Thermal Systems, M-Grinnell, Keflex, or Elen.

B. Bolted Metal Framing Systems: B-Line, Unistrut, Superstrut, or Michigan Hanger Co. "OSTRUT".

2.02 STRUCTURAL ATTACHMENTS

A. Structural Steel Clamps: Beam clamps, brackets, channel clamps, and bar joist clips shall be selected to suit structural systems and meet loading recommendations of manufacturer. All clamps shall be provided with retaining clips.

2.03 INTERMEDIATE ATTACHMENTS

A. Hanger Rods: Continuous threaded rod, cadmium plated. Do not use chain, wire, or perforated strap.

B. Maximum Hanger Rod Loading:
# Rod Size and Maximum Load Table

<table>
<thead>
<tr>
<th>Rod Size (Diameter in Inches)</th>
<th>Maximum Load (Pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8</td>
<td>610</td>
</tr>
<tr>
<td>1/2</td>
<td>1130</td>
</tr>
<tr>
<td>5/8</td>
<td>1810</td>
</tr>
<tr>
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<td>2710</td>
</tr>
<tr>
<td>7/8</td>
<td>3770</td>
</tr>
<tr>
<td>1</td>
<td>4960</td>
</tr>
</tbody>
</table>

## C. Inserts:

1. Inserts For Strap Hangers: 14-gauge sheet steel drive clips, Dayton Sure Grip or Bowman Bow-Rib, galvanized, driven into the formwork.
2. Inserts for Rod Hangers: Malleable cast iron, Unistrut Cat. No. M-24, B-Line B2500, or Elcen No. 88 modified for hot-dip galvanized steel.

## D. Trapeze Pipe Racks:

Fabricate from structural angles or channels or Unistrut channels to suit weight of piping to be supported. Size for a minimum safety factor of 5.

## E. Expansion Shells and Bolts:

1. Expansion shells for hangers, self-drilling Phillips Red Head, Gregory Bulldog, OMARK Drill Anchors, Rawl Sabertooth or Fastite Shells.
2. Expansion bolts for equipment shall be USM Molly Parabolt, or McCullough Kwick Bolt or Phillips Wedge Anchors.

## 2.04 DUCT HANGERS AND SUPPORTS

### A. Hanger Rods and Channel Supports:

Continuous threaded rod and nuts, cadmium plated steel. Do not use chain, wire, or perforated strap.

### B. Strap and Rod Sizes:

Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

### C. Steel Cables for Galvanized-Steel Ducts:

Galvanized steel complying with ASTM A 603.

### D. Steel Cable End Connections:

Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

### E. Duct Attachments:

Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

### F. Trapeze and Riser Supports:

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

G. Structural Steel Clamps: Beam clamps, brackets, channel clamps, and bar joist clips shall be selected to suit structural systems and meet loading. Provide seismic restraining strap on all beam clamps.

2.05 SEISMIC-RESTRAINT DEVICES

A. Approved Manufacturers or equivalent: Subject to compliance with requirements, provide products by one of the named manufacturers or an approved equivalent product. The Architect/Engineer will be the sole judge of equivalency. Substitution requests are not required in advance of bid, but may be submitted at Contractor's option. When substitution requests are not submitted, the Architect/Engineer will evaluate equivalency during submittal review.

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
5. Loos & Co.; Cableware Division.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.
PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. General: Comply with SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports" where the provisions of this specification section are more stringent. Use only hanger rods and channel supports for ducts exposed to view and ducts over 30” wide.

B. Seismic Bracing:
   1. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger
   2. Restrain round ducts with diameters of 28” or larger.
   3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
   4. No bracing is required if the duct is suspended by hangers 12” or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached.

C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Drill and epoxy inserts.
   3. Do not use powder-actuated concrete fasteners.

D. Support Placement: Comply with Chapter 5 of the SMACNA’s "HVAC Duct Construction Standards - Metal and Flexible" for maximum hanger spacing and as follows:
   1. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
   2. Place supports as near as possible to concentrated loads, and when practical, immediately adjacent to changes in direction.
   3. Support ducts so as to maintain alignment, prevent grade reversals and prevent sagging in excess of 0.1 inch.
   4. Refer to earlier note in this specification section.

E. Hangers Exposed to View: Threaded rod and angle or channel supports.

F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 10 feet.

G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Provide seismic restraint straps at all beam clamps.
3.02 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

F. Drilling for and Setting Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.03 INSTALLATION OF HANGERS, ANCHORS, SUPPORTS

A. Sway Bracing: Sway bracing shall be in compliance with seismic restraints specified in Section 15070, Mechanical Sound Vibration, and Seismic Control.

B. Support Placement: Place supports as near as possible to concentrated loads, and when practicable, immediately adjacent to changes in direction.

C. Provide sufficient hanger rod lengths to limit rod displacement from thermal expansion to 4 degrees from vertical.

D. Expansion Shells and Expansion Bolts:
   1. Install anchor bolts for all mechanical equipment, piping, and ductwork as required. Tightly fit and clamp base-supported equipment anchor bolts at all equipment support points. Provide locknuts where equipment is hung.
2. Provide expansion shells and expansion bolts where necessary to hang piping or equipment from existing concrete slabs or walls.

3. Expansion Shells for Hangers: Provide in holes drilled in structural concrete. Provide clips bolted to expansion shells for strap hanger; bolt strap hangers thereto.


E. Provide hangers and supports for all horizontal ducts. Hangers and supports for ducts shall comply with SMACNA HVAC Duct Construction Standards, 1995 Edition, Chapter 4, Hangers and Supports.

END OF SECTION 15060
SECTION 15080 – MECHANICAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and Conditions of the Agreement, including General Requirements Division 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Section 15010, Mechanical Work – General.
2. Section 15050, Materials and Methods.
3. Section 15060, Hangers and Supports.
4. Section 15075, Mechanical Identification.
5. Section 15810, Ducts.
6. Section 15820, Duct Accessories.

1.02 WORK INCLUDED

A. Description: Work under this section shall include furnishing all labor, material, tools and equipment necessary for the complete installation of all mechanical insulation including:

1. Duct insulation.

B. Revisions and Alterations: Work shall include the insulation of all existing pipes and ducts that are revised. The Contractor shall replace existing insulation on piping or ducts damaged by the new work.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. International Mechanical Code Vol. 11, Section 1005, Insulation of Ducts.


D. American Society for Testing and Materials (ASTM):

1. ASTM B209 Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM C547 Mineral Fiber Preformed Pipe Insulation.
4. ASTM C533  Calcium Silicate Block and Pipe Thermal Insulation.
5. ASTM C534  Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
6. ASTM C552  Cellular Glass Block and Pipe Thermal Insulation.

E. National Fire Protection Association (NFPA):

F. Underwriters Laboratories, Inc. (UL):


1.04 SUBMITTALS
A. Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work - General.
B. Submit product information for all insulation, jackets, adhesives, closure devices, strapping, and special covers for fittings, valves, and pumps.

1.05 QUALITY ASSURANCE
A. Definitions: Definition of concealed shall include work installed within pipe shafts, duct spaces, above furred or hung ceilings, or otherwise built into the building and not exposed to view. Work in mechanical rooms, equipment rooms, and all occupied areas is included as work regarded as exposed.
B. Fire Hazard Rating: All insulation, facings, coatings, adhesives, and other accessories shall have a fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed; ratings determined by UL Standard No. 723, NFPA Standard No. 255, or ASTM Standard No. E-84. UL labeled listing or satisfactory test results from the approved testing laboratory shall be available to indicate that fire hazard ratings for materials do not exceed the above amounts.
C. Approval of a manufacturer of insulation is not to be taken as approval of the manufacturer's usual or regular accessory materials, such as facings, adhesives, etc.

D. Manufacturer's Stamp or Label: Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use must have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Mechanical Fasteners: Weld pins, weld studs and washers, aluminum, AGM Industries, Inc. Staples: Outward clinching type, ASTM A167, type 304 or 316 stainless steel.

B. Flexible Fiberglass Blanket Duct Insulation: Flexible glass fiber blanket insulation shall meet ASTM C553 and shall be factory-laminated to a reinforced foil/kraft vapor barrier retarder facing, secured with UL listed pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic as needed. Insulation thickness shall be 1.5 inch, 1.5 lb./cu. ft. density; minimum installed thermal resistance shall be R=4. Manufacturer: Manville Microlite type 75, or Owens/Corning all service duct wrap, or equal.

2.02 DUCT INSULATION

A. General: Duct insulation shall be provided for all ductwork listed below. Materials shall conform to paragraph titled Insulation Materials, listed above. Ductwork shall be insulated according to system type and duct exposure to the conditioned space.

B. Thickness: Thickness of duct insulation for each application shall be in accordance with the following table:

<table>
<thead>
<tr>
<th>Minimum Thickness for Duct Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
</tr>
<tr>
<td>Supply Ductwork (Concealed)</td>
</tr>
<tr>
<td>Return, Exhaust and Transfer Air Ductwork (All)</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 INSULATION WORK-GENERAL

A. General: Except as specified, material shall be installed in accordance with the recommendations of the manufacturer.
1. Do not apply insulation until leak testing is complete and surfaces are clean, dried, and inspected.
2. Insulation shall be kept dry and clean at all times.
3. Insulation shall be continuous through interior walls except at fire walls.
4. All work shall be performed at ambient and equivalent temperatures as recommended by the manufacturers.
5. Joints shall be staggered on multi-layer insulation.
6. Do not apply insulation until heat tracing specified elsewhere in other sections of this specification is completed and tested.
7. Provide insulation with vapor barrier jackets.
8. Finish with tape and vapor barrier jacket.

### 3.02 DUCT AND PLENUM INSULATION

A. General: Insulate duct work to prevent heat transfer and condensation. Seal seams in insulation to maintain a continuous vapor barrier.

B. Supply Ducts:
   1. Concealed supply ducts: Flexible glass fiber blanket with FSK jacket. Apply pressure sensitive tape and/or outward clinch expanding staples and vapor barrier mastic at joints to maintain a continuous vapor barrier. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Return ducts:
   1. Return ducts in return air plenums: no insulation.
   2. Exposed return ducts: no insulation.

D. Exhaust ducts: No insulation.

### 3.03 JOB CONDITIONS

A. Existing Conditions: Cover equipment and finished floors to protect such items from insulation fiber and dust. Leave all areas in a broom clean condition at the end of each day. Take precautions in these areas to prevent glass fiber and insulation dust from entering ventilating systems, or equipment areas.

END OF SECTION 15080
1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part 1, Special Conditions and Forms, and Division 1 specifications sections, apply to this section.

B. Related Sections include the following:

1. Section 15010, Mechanical Work - General.
2. Section 15050, Materials and Methods.
3. Section 15075, Mechanical Identification.
4. Section 15105, Pipe and Fittings.
5. Section 15110, Valves.
7. Section 15950, Equipment Testing.

1.02 WORK INCLUDED

A. Work under this section shall include furnishing and installing domestic water piping systems, including piping, fittings, piping specialties, and associated components, as specified or indicated. This Section also includes the following:

1. Disinfecting domestic water piping.
2. Potable water piping.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. American National Standards Institute (ANSI):

2. B16.3 Malleable-Iron Screwed Fittings, 150 and 300 pounds.
5. B16.22 Wrought Copper and Bronze Solder-joint Pressure Fittings.

C. American Society of Sanitary Engineers (ASSE):
1. **1001 Performance Requirements, Pipe-Applied Atmospheric-Type Vacuum Breakers.**
2. **1011 Performance Requirements for Hose Connection Vacuum Breakers.**
3. **1018 Performance Requirements for Trap Seal Primer Valves.**
4. **1020 Performance Standards for Vacuum Breakers, Anti-Siphon, Pressure Type.**

**D. American Society for Testing and Materials (ASTM):**
1. **A53** Black and Hot Dipped Galvanized Welded and Seamless Pipe.
2. **B32** Solder Metal.
3. **B88** Seamless Copper Water Tube.

**E. Plumbing and Drainage Institute (PDI) Standard:**
1. **PDI-WH 201** Water Hammer Arresters.

**F. Plumbing Code as adopted by the State of Montana and amended by the City of Bozeman.**

**1.04 SUBMITTALS**

**A.** Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work - General.

**B.** Submit product information for each item of equipment, component, or specialties required for the domestic water piping system. Include construction material description, pressure and temperature classification, pipe connection details, dimensions and required clearances, and installation instructions.

**1.05 QUALITY ASSURANCE**

**A.** Single Source Responsibility: Comply with the requirements specified in Division 1 Section 15010.

**B.** MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

**C.** Standardization: Provide components of the same manufacturer throughout where possible.

**D.** Identification: Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
PART 2 - PRODUCTS

2.01  WATER PIPE AND FITTINGS (POTABLE WATER)


C.  Fittings, Copper Tube: ANSI B16.99 wrought copper or ANSI B16.18 cast bronze.

D.  Fittings, Dielectric: Specified in Section 15105, Pipe and Fittings.

2.02  PIPING SPECIALTIES

A.  Unions, Copper Piping: 125-lb. wrought copper or cast bronze, solder joint type; ANSI B16.97 or ANSI B16.18.

B.  Flanges in Copper Piping: Bronze or wrought-copper companion flange with tubing shoulder, 125-lb. ASME rating with 1/16-inch thick red rubber gasket per ANSI B16.21.

C.  Through-Wall Supply Pipes: Through-wall supply pipes which connect to exposed stops at wall faucets shall be brass pipe, 85% minimum copper content, Schedule 40, all exposed surfaces chrome-plated finish.

PART 3 - EXECUTION

3.01  PIPING INSTALLATION, GENERAL

A.  Basic piping installation requirements are specified in Section 15105, Pipe and Fittings.

3.02  DOMESTIC WATER PIPING INSTALLATION

A.  General: Comply with all requirements for the installation of water piping, specified in Section 15105, Pipe and Fittings.

1.  The handling of piping system materials and installation of the work shall be performed in a manner that will minimize possible contamination and minimize the necessity of sterilization.

2.  All pipe, tubing, fittings, valves, equipment and accessories shall be clean and free of all extraneous foreign material before being installed into their respective systems. Pipe shall be cleaned by hammering, shaking, swabbing, purging and flushing or by a combination of methods.
3. At completion, all lines shall be flushed with water. Arrange for disposition of all flushing water.

B. Leaks in Piping: Repair or replace piping immediately if a leak appears.

C. Temporary Piping: Provide all temporary pipe, valves, fittings, etc. required to provide temporary service for construction.

D. Unions: Install at connections to all equipment downstream of valves, at all equipment specialties, and wherever else required to permit easy connection and disconnection. Do not conceal unions in walls, partitions or inaccessible ceilings.

E. Dielectric Fittings: Provide dielectric type unions, fittings or flanges where pipe sections made of dissimilar metals are to be joined to prevent metal to metal contact.

F. Piping:
   1. Support at Connections to Equipment: Piping connected to equipment shall be installed to provide flexibility for thermal stresses and for vibration and shall be adequately supported and anchored so that strain from weight and thermal movement of piping is not imposed on the equipment.
   2. Changes in Pipe Size: Reducing fittings shall be used for changes in pipe size; the use of bushings will not be permitted. In horizontal lines, reducing fittings shall be of the eccentric type to maintain the top of the lines in the same plane.
   3. Shutoff Valves: Shutoff valves shall be installed at the base of each plumbing riser serving more than one fixture, in each branch line serving more than one fixture, and elsewhere as shown. Shutoff valves shall be ball-type valves as specified in Section 15110, Valves. All valves shall be installed in positions accessible for operation and repair.
   4. Grading of Piping: All piping shall be graded so that it can be drained. Hose end drains shall be provided at low points that cannot drain through fixtures or hose bibbs.
   5. Copper Tubing: Joints for tubing shall be made with solder-type fittings. Flared or sweated tubing shall be cut square, and burrs shall be removed. Flared joints shall be made using flared fittings. Outside of tube where engaged in the fittings and inside of the fitting in contact with the tube shall be cleaned with an abrasive material before sweating. Soldering, soldering preparation and procedures for joints shall be in accordance with ANSI B31.1 and as outlined in the Copper Tube handbook published by the Copper Development Association. Solder shall conform to ASTM B32, 95/ 5 tin-antimony type for pressures up to 150 psig, silver solder with a melting point of approximately 1100°F for pressures 150 psig and greater.

G. Connections to Fixtures:
   1. General: Anchor supply connections at fixtures to steel straps secured to studs. At flush valves provide fitting with lugs secured to strap. At lavatories and other fixtures, secure piping directly to strap. For through-wall nipples on copper piping, use schedule 40 brass pipe. Sweat-type stops will not be permitted.
2. Connections to Equipment and Fixtures Not Furnished by This Contractor: This Contractor shall provide all necessary material and labor to connect to the plumbing system all fixtures and equipment having plumbing connections and which are furnished by Montana State University or are specified in other sections of these specifications. {The supply line to each item of equipment or fixture, except faucets, flush valves or other control valves that are supplied with an integral stop, shall be equipped with a shutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. Supply piping to all fixtures shall be anchored to prevent movement.}

3. Water Hammer Arresters: Install on hot and cold water piping, located as close as practicable to each faucet, control valve, flush valve, or any other type quick closing valve. Sizing and placement shall conform to the requirements of PDI-WH201. Arresters shall be fully accessible.

4. Partition-Type Stops: Provide on water supply to fixtures which are not connected through individual exposed stops, integral stops, or stops in pipe space.

H. Water Connection to Traps: Provide individual primers at traps serving floor drains, funnel drains, funnel floor drains, floor sinks, each primer connection size not less than 1/2". Connect primer lines for each trap to a toilet flush pipe, through mechanical primer. Install primers in an accessible location. Do not prime shower drain traps. Primers shall be installed in strict compliance with the manufacturer's recommendations.

END OF SECTION 15140
SECTION 15150 – SANITARY WASTE AND VENT PIPING

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part 1, Special Conditions and Forms, and Division 1 specifications sections, apply to this section.

B. Related Sections include the following:

1. Section 15010, Mechanical Work-General.
2. Section 15050, Materials and Methods.
3. Section 15105, Pipe and Fittings.
4. Section 15950, Equipment Testing.

1.02 WORK INCLUDED

A. Work under this section shall include furnishing and installing sanitary waste and vent systems, including piping, fittings, piping specialties, and associated components, as specified or indicated. This Section also includes the following:

1. Backflow valves.
2. Floor drains.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. American National Standards Institute (ANSI):

1. A112.1.2 Air Gaps in Plumbing Systems.
3. A112.21.1M Floor Drains.
4. A112.36.2 Cleanouts.
5. B16.3 Malleable-Iron Screwed Fittings, 150 and 300 pounds.
10. B16.23 Cast Bronze Solder-joint Drainage Fittings-DWV.
C. American Society for Testing and Materials (ASTM)-.
   1. A53  Black and Hot Dipped Galvanized Welded and Seamless Pipe.
   4. B88  Seamless Copper Water Tube.
   5. B306 Copper Drainage Tube (DVVV).

D. Cast Iron Soil Pipe Institute (CISPI):
   1. CISPI 301  Hubless Cast-Iron Sanitary System with C.I. No-Hub, Pipe and Fittings.
   2. HSN-72  Neoprene Rubber Gaskets for Hub and Spigot Cast-Iron Soil Pipe and Fittings.
   3. Pamphlet 100  Installation Suggestions for No-Hub Pipe and Fittings.

E. Plumbing and Drainage Institute (PDI) Standard:

F. Conform to City of Boise plumbing code and ordinances.

1.04 SUBMITTALS

A. Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work - General.

B. Submit product information for each item of equipment, component, or specialties required for the sanitary waste and vent piping system. Include construction material description, classification, pipe connection details, dimensions and required clearances, and installation instructions.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility: Comply with the requirements specified in Division 1 Section, Materials and Equipment.

B. Standardization: Provide components of the same manufacturer throughout where possible.

PART 2 - PRODUCTS

2.01 SANITARY WASTE AND VENT PIPING

A. Soil, Waste and Vent Piping Above Ground: ASTM A74, service weight hubless cast-iron soil pipe and fittings, conforming to CISPI 301, with heavy duty couplings as manufactured by Clamp-All Corporation or Anaco Husky series 4000 constructed of 24-
gauge type 304 stainless steel. Coupling clamps: clamp-all high torque, tightened to 100-125 inch pounds of torque or Anaco Husky series 4000 tightened to 80 inch pounds of torque. Coupling gaskets shall be made of ASTM C564 neoprene (R) and shall interlock with the housing assembly to make a slip-free joint.

1. ASTM A53, Schedule 40, galvanized pipe, with ANSI B16.12 galvanized fittings is also permitted for aboveground soil, waste and vent piping.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION, GENERAL

A. Basic piping installation requirements are specified in Section 15105, Pipe and Fittings.

3.02 INSTALLATION, BUILDING DRAINAGE SYSTEMS

A. General: Comply with all applicable requirements for the installation of drainage piping as specified in Section 15105, Pipe and Fittings.

B. Drainage and Vent Piping: Main vertical soil and waste stacks shall be extended full size to the roof line and above as vents, except where otherwise specifically indicated. Where practicable, two or more vent pipes shall be connected and extended as one pipe through the roof.

1. Vent pipes in roof spaces shall be run as close as possible to the underside of the roof without forming traps in pipes, using fittings as required.
2. Vertical vent pipes may be connected into one main vent riser above vented fixtures.
3. Horizontal waste lines receiving the discharge from two or more fixtures shall be provided with end vents, unless separate venting of fixture is noted.
4. Horizontal waste lines shall be sloped to drain at 1/4" per foot unless otherwise indicated or approved.
5. Provide vent for each trap and fixture as required by code.

C. Fittings: Changes in pipe size on soil, waste, and drain lines shall be made with reducing fittings. Changes in direction shall be made by the use of fittings.

D. Jointing: Union Connections: Slip joints permitted only in trap seals or on the inlet side of the traps. Hub drainage fittings shall be used to make union connections where possible; use of bushings not permitted.

E. Joints: Installation of pipe and fittings shall be made in accordance with the manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipes for tees will not be permitted. Threaded joints, American National Taper, with graphite or inert filler and oil, with an approved graphite compound, or with polytetrafluoroethylene tape applied to the male threads only.

F. Copper Tube DWV: Joints for tubing shall be made with solder-type fittings. Tube shall be cut square with burrs removed. Outside of tube when engaged in the fitting and inside of the fitting in contact with the tube shall be cleaned with an abrasive material before
sweating. Care shall be taken to prevent annealing of tube and fittings when making connections. Joints shall be made with a noncorrosive paste flux and solid-string or wire solder; core solder not permitted. Joints 2-1/2" and larger shall be made with heat applied uniformly around entire circumference of the tube and fittings by a multiflame torch.

G. Drain Installation:

1. Floor drains shall be installed according to manufacturer's recommendations.
2. Drains in general shall be furnished with caulk outlets. Caulking shall be furnished and installed by the contractor.
3. Drains with No-Hub outlets may be used. No Hub couplings are specified elsewhere in Section 15105.

H. Cleanouts:

1. Provide same size as the pipe.
2. Cleanouts installed in connection with cast-iron soil pipe shall consist of a long-sweep 1/4 bend or one or two 1/8 bends extended to the place shown.
3. Cleanouts in connection with other pipe, where indicated, shall be tee pattern, 90° branch drainage fittings with plugs of same size as pipe.
4. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks, on each building drain outside the building, 50' maximum spacing on all below-grade runs, and elsewhere as required by local codes and ordinances or as indicated.
5. Where clean out plugs are installed in hubless cast iron piping systems jointing procedure and installation shall comply with CISPI and IAPMO No-Hub installation directives.
6. Cleanout Covers: Cleanouts on pipe concealed in partitions shall be provided with flush-type access cover plates. Cleanouts installed in finished floors shall be provided with a cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface.

I. Flashings:

1. Pipes passing through waterproofing membrane shall be flashed. A sheet-lead flashing shield shall be provided for pipe sleeves with integral clamping devices that penetrate a membrane.
2. Flashing shield shall be made from sheet lead not lighter than 4 lbs., and extend not less than 8" from the sleeve in all directions, but not less than 24" square.
3. Flashing shall be inserted into the clamping device and made watertight.
4. Lead flashing shields, and roof flanges of lead or copper flashing with integral flange, shall be set over membrane in a solid coat of a bituminous cement and strip-flashed.
5. Pipes passing through pitched roofs shall be flashed using lead or copper flashing with an adjustable integral flange of adequate size to extend not less than 8" from the pipe in all directions, but not less than 24" square and lap into the roofing to provide a watertight seal.

END OF SECTION 15150
SECTION 15810 – DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division 1 specifications sections, apply to this section.

B. Related Sections include the following:
   1. Section 15010, Mechanical Work -General.
   2. Section 15050, Materials and Methods.
   3. Section 15820, Duct Accessories.

1.02 WORK INCLUDED

A. Work under this section shall include furnishing all materials and labor for installation of the air ducts, including specialties and associated components, as specified or indicated, all connected and ready for use. This Section includes the following:
   1. Metal ducts.
   2. Flexible ducts.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. Air Moving and Conditioning Association, Inc. (AMCA):
   2. 210 Test Code for Air Moving Devices.

C. American Society for Testing and Materials (ASTM):
   1. A123 Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
   3. A527 Zinc Coated (Galvanized) Carbon Steel Sheets for Lock Forming Quality.

D. Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA):
E. Underwriters Laboratories, Inc. (UL):
   2. 181 Factory-Made Air Duct Materials and Duct Connectors.

F. National Fire Protection Association (NFPA):
   1. 70 National Electrical Code.
   2. 90A Air Conditioning and Ventilating Systems.

G. Underwriters Laboratories, Inc.:

1.04 SUBMITTALS

A. Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work -General.

B. Submit product information for ducts and duct fittings. Include construction material description, pressure and temperature classification, duct connection details, dimensions and required clearances, and installation instructions.

1.05 QUALITY ASSURANCE

A. Ducts: Install in accordance with the details and notes indicated and the recommendations and printed instructions of the manufacturer for each item.

B. Protection: Equipment shall be covered and stored to prevent damage or weathering prior to installation.

C. Installation of ducts shall conform to local codes and ordinances.

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. General: Sheet metal materials specified hereinafter shall conform to the following material requirements.

B. Galvanized Steel Sheets: ASTM A527, weight of galvanized coating shall be not less than 1-1/4 oz. total for both sides of one square foot of a sheet; US Steel, Bethlehem, Youngstown, or Republic manufacturer.

C. Galvanized Steel Hot-Dipped After Fabrication: Comply with requirements of ASTM A123.
2.02 1” PRESSURE CLASS DUCT WORK

A. 1” pressure class, seal class C per SMACNA HVAC Duct Construction Standard. Applies to:

   1. Ductwork serving administrative areas.

B. Construction: Metal gauges shall comply with SMACNA and IBC. Duct construction. Ducts shall not pulsate or vibrate when in operation. Ductwork shall be constructed of galvanized steel.

C. Seams: Comply with SMACNA construction recommendations. Do not use standing seams for ducts other than plenums. Snaplock-type seams made on lockformer tools will be acceptable where Pittsburgh seams are called for.

D. Transverse joints: Transverse joints may be made with SMACNA T24 flanged mechanical joint, caulked or gasketed, Ductmate system or Engle system, installed in strict accordance with manufacturer's printed instructions and installation manuals.

E. Diagonal Creasing: Provide on all panels wider than 18”. At Contractor's option, in place of diagonal creasing required for panels wider than 18”, all such panels may have machine-formed transverse ribbed stiffening on 12” centers, provided such stiffening accomplishes stiffness and freedom from buckling or breathing, and does not lessen airtightness at seams and joints.

F. Elbows: Elbows on supply ducts; inside radius equal to maximum width of elbow. Elbows on exhaust ducts; inside radius 1/2 the duct width; 6” minimum.

G. Square Corner Inserts: Provide turning vanes at all square corner elbows.

   1. Riveting: Unless sheet metal screws are called for, use rivets for attachment purposes for sheet metal; blind rivets where required, USM Pop, Duro-Dyne Pinriveter, or Cherry Commercial.

2.03 FLEXIBLE DUCTS

A. General: Flexible duct shall not be installed on the 2” pressure class systems. Flexible duct, including connectors, shall comply with UL 181, Class 1, and NFPA 90A. Polymer flexible ductwork shall be used only above suspended ceilings in administration areas. Duct shall not be more than 5 feet long, and without intermediate joints. Installed duct shall not erode, delaminate or impart odors into the air-stream.


C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; vapor-barrier film.

   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.04 JOINT SEALANTS

A. Joint Sealant: Duro-Dyne SZ, Ductmate No. 795, Hardcast Sealing System, or fire-retardant, high bonding type sealer with Class I flame spread rating as manufactured by United Sheet Metal Company, Inc., Mon-Eco Industries, Inc., or approved equal. Adhesive-backed cloth or metallic tape will not be acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION-DUCTS

A. General: The installation of the air ducts shall conform to NFPA 90A and SMACNA HVAC Duct Construction Standards. Mounting and supporting of ducts, equipment, accessories and appurtenances shall be provided, including but not limited to structural supports, hangers, vibration isolators, stands, clamps and brackets, access doors and dampers. Duct accessories are specified in Section 15820.

B. Ductwork shall be installed in accordance with manufacturer’s instructions where SMACNA HVAC Duct construction standards do not apply.

C. Installation of Ductwork: Elbows, vaned elbows, take-offs, branch connections, transitions, splitters, duct volume dampers, flexible connectors, and access doors shall conform to SMACNA. Ductwork shall be installed so that its operation shall be free of chatter and vibration. Ductwork shall be airtight so that no dust marks from air leaks will show at connections or outlets. Electric isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion.

D. Field Changes to Ductwork: Changes such as those required to suit the size of factory-fabricated equipment actually furnished shall be designed to minimize losses in pressure and performance due to sudden expansion and contraction. Transitions shall be used in field changes as well as modifications to connecting ducts.

E. Offsets in Ductwork: All offsets necessary in ductwork are not shown on the drawings. Provide all offsets required without additional cost to Verizon Wireless. Offset angles to be as small as possible.

F. Routing of Ductwork: Route ductwork above suspended ceilings to avoid contact with all support and framing for the ceiling suspension system.

G. Duct Sizes: Sizes shown refer to clear dimensions inside acoustical lining.
H. Joint Sealing: Seal the longitudinal and transverse joints of all low-pressure supply, exhaust and recirculated air ducts to meet requirements of SMACNA, seal class C. Seal all high-pressure duct joints with high-pressure duct sealant to meet requirements of SMACNA, seal class A.

I. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

3.02 HANGERS FOR DUCTWORK

A. General: Provide hangers, supports and anchor bolts for all sheet metal ducts and equipment. Comply with the requirements of SMACNA HVAC/DCS.

B. Flex Ducts: Provide 2" wide sheet metal strap hangers.

3.03 PRESSURE TESTING FOR LEAKAGE

A. Not required.

END OF SECTION 15810
SECTION 15820 – DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division I specifications sections, apply to this section.

B. Related Sections include the following:
   1. Section 15010, Mechanical Work - General.
   2. Section 15050, Materials and Methods.
   3. Section 15810, Ducts.

1.02 WORK INCLUDED

A. Work under this section shall include furnishing all materials and labor for installation of duct accessories, including specialties and associated components, as specified or indicated, all connected and ready for use. This Section includes the following:
   1. Dampers.
   2. Flexible duct connections.
   3. Turning vanes and extractors.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. Air Moving and Conditioning Association, Inc. (AMCA):
   2. 210 Test Code for Air Moving Devices.

C. American Society for Testing and Materials (ASTM):
   1. A123 Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.
   3. A527 Zinc Coated (Galvanized) Carbon Steel Sheets for Lock Forming Quality.

E. Underwriters Laboratories, Inc. (UL):
   2. 181 Factory-Made Air Duct Materials and Duct Connectors.

F. National Fire Protection Association (NFPA):
   1. 70 National Electrical Code.
   2. 90A Air Conditioning and Ventilating Systems.

G. Underwriters Laboratories, Inc.:

1.04 SUBMITTALS

A. Submit each item specified in this Section per Division 1 Specification Sections and Section 15010, Mechanical Work - General.

B. Submit product information for all duct accessories. Include construction material description, pressure and temperature classification, duct connection details, dimensions and required clearances, and installation instructions.

1.05 QUALITY ASSURANCE

A. Duct Accessories: Install in accordance with the details and notes indicated and the recommendations and printed instructions of the manufacturer for each item.

B. Protection: All equipment shall be covered and stored to prevent damage or weathering prior to installation.

C. Installation of all ducts shall conform to all local codes and ordinances.

PART 2 - PRODUCTS

2.01 TURNING VANES AND EXTRACTORS

A. Square Corner Inserts: Provide turning vanes at all square corner elbows, finned type, Tuttle & Bailey Ducturns, or approved.
2.02 FLEXIBLE CONNECTORS

A. General: Provide flexible connectors between fans and ducts or casings, fans and plenums, and where ducts are of dissimilar metals, as indicated and where required.

B. Flexible Material: Connectors shall be made of neoprene-coated glass fabric weighing approximately 30 oz. per square yard; Ventfabs Inc. Ventglas or approved equal manufacturer. Materials shall be UL labeled, Class 1. Flexible connections shall be securely fastened by zinc-coated iron cinch-type draw bonds for round ducts. For rectangular ducts, the flexible connections locked to metal collars shall be installed using normal duct construction standards and according to SMACNA HVAC/DCS.

2.03 VOLUME DAMPERS AND QUADRANTS, LOW PRESSURE DUCTS

A. General: Provide dampers and quadrants in ductwork as required to balance the systems to produce the air quantities shown.

B. Dampers are not shown generally. Provide a damper in the duct to each supply and exhaust opening, except ducts at outlet of any terminal unit which serves a single diffuser; also in each branch duct where the pressure loss is lower than other branch ducts leading from the same trunk duct; elsewhere as shown.

C. Location of Dampers: At a point where the duct is accessible, if possible; axis of the blade the long dimension; as far from the outlet as possible.

D. Acoustic Performance: Dampers shall be free from any sharp edges which would produce excessive turbulence, which would prevent obtaining the acoustic performance in the rooms served, as specified hereinbefore.

E. Basis of Design: Ruskin MD-15 or equivalent.

F. Ratings: Maximum 2.5 inch water gauge pressure differential at 1,500 fpm velocity. Tested and rated per AMCA 500 and bearing AMCA’s certified ratings seal.

G. Suitable for horizontal or vertical applications.

H. Frames:

1. Hat-shaped, galvanized steel channels, 0.064-inch minimum thickness.
2. Mitered and welded corners.
3. Flanges for attaching to walls and flangeless frames for installing in ducts.

I. Blades:

1. Multiple or single blade.
2. Parallel- or opposed-blade design.
3. Stiffen damper blades for stability.
4. Galvanized steel, 0.064 inch thick.
J. Blade Axles: Galvanized steel

K. Bearings:
   1. Molded synthetic.
   2. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.

L. Tie Bars and Brackets: Galvanized steel.

M. Quadrants, in General: Duro-Dyne manufacturer, catalog numbers as follows:
   1. Maximum Dimension of Blades 10” or Less: KS-145 series, dial regulator with locking nuts, round end spring-in bearing, and square end damper bearing.
   2. Maximum Dimension of Blades 11” to 20”: KSR-195 series, dial regulator with locking nut, round end spring-in bearing, and square end bearing.
   3. Maximum Dimension of Blades over 20”: KS-12 series with Shaft-Loc quadrant and 1/2” damper bearings.

N. Quadrants for Dampers in Ducts Concealed Behind Walls and Above Non-removable Ceilings: Flush-mounted concealed type, Ventfabrics Catalog Type 666, or Young Regulator No. 301; finish of all exposed parts prime painted, not chromium plated.
   1. Damper Positions: Contractor shall set and lock all dampers in the Full Open position prior to balancing work. See additional requirements specified in Section 15990, Testing, Adjusting, and Balancing.

PART 3 - EXECUTION

3.01 INSTALLATION - DUCT ACCESSORIES

A. General: Turning vanes, extractors, splinters, duct volume dampers, flexible connectors, access panels and doors, and test holes shall conform to SMACNA Standards.

B. Instrument Test Holes: Provide in ductwork and plenums or casings at inlet and discharge side of fans, filters, coils, pressure reducing dampers, terminal reheat boxes, variable air volume boxes and elsewhere as required for static pressure readings. Each test hole shall be fitted with an instrument adapter. Provide one such test hole for ducts up to 24”, two for ducts 25” to 40”, three for ducts 41” and larger; uniformly spaced. Provide additional locations as directed by persons performing balancing work and approved by Architect before installation. Omit test holes adjacent to air measuring devices.

C. Demonstrate re-setting of dampers to Project Manager.

D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators.
E. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

F. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 15820
SECTION 15850 – AIR OUTLETs AND INLETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division 1 specifications sections, apply to this section.

B. Related Sections include the following:

1. Section 15010, Mechanical Work - General.
2. Section 15050, Materials and Methods
3. Section 15810, Ducts.
4. Section 15820, Duct Accessories.
5. Section 15990, Testing, Adjusting, and Balancing.

1.02 WORK INCLUDED

A. Work under this section includes furnishing materials and labor for installation of air inlets and outlets, including specialties and associated components, as specified or indicated, all connected and ready for use. This section includes the following:

1. Diffusers.

1.03 REFERENCED STANDARDS

A. Applicable Publications: Current publications of the issues listed below, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by references thereto.

B. Air Diffusion Council (ADC):

1. 1062 R4 Equipment Test Code.
2. AD Measurement of Room-to-Room Sound Transmission through Plenum Air Systems.

C. Air Moving and Conditioning Association, Inc. (AMCA):

1. 99 1 Standards Handbook.


MSU PPA NO. 12-0123

E. American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. (ASHRAE):
   2. 113-90 Method of Testing for Room Air Distribution.

1.04 SUBMITTALS

A. Submit each item specified in this Section per Division I Specification Sections and Section 15010, Mechanical Work -General.

B. Submit product information for all air outlets and inlets and accessories. Include construction material description, air capacity data, sound data, duct connection details, dimensions and installation instructions.

C. Indicate for each grille, register, or diffuser the scheduled tag number from the GRD schedule in the drawings.

1.05 QUALITY ASSURANCE

A. The manufacturer shall provide published performance data for outlets and inlets. Diffusers shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

B. Sound Power Levels: All diffusers shall be sound rated and certified in accordance with ADC 1062 R3, in sound power level, dB ref. 10-12 watts, in octave bands 2 through 8.

C. Materials and Finishes:
   1. Materials: Diffusers shall be constructed of steel or aluminum. Exterior and exposed edges shall be rolled, or otherwise stiffened and rounded.
   2. Finish: Diffusers in acoustical tile ceilings shall be baked enamel with color to match ceiling framing members.

D. Protection: Store products indoors.

PART 2 - PRODUCTS

2.01 MODULAR CORE CEILING DIFFUSERS

A. Square Modular Core Ceiling Diffusers For T-bar Ceilings

   1. Acceptable Manufacturer:
      a. Titus – Basis of Design: Titus MCD.
      b. Carnes.
c. Krueger.

2. Devices shall be specifically designed for variable-air-volume flows.
4. Finish: Baked enamel, white
5. Face Size: See Drawings.
6. Face Style: Square steel back pan to fit 24” x 24” lay-in ceiling module, 4-way adjustable discharge pattern.
7. Neck: Square neck with 1 inch duct connection collar.
10. Accessories:

   a. Earthquake clips for attachment to lay-in ceiling grid.
   b. Field provided lined can with seismic straps to structure.

2.02 EGGCRATE RETURN GRILLES

A. Eggcrate Ceiling Return Grilles For T-bar Ceilings

1. Acceptable Manufacturer:

   a. Titus – Basis of Design: Titus 50F.
   b. Carnes.
   c. Krueger.

B. Material: Aluminum border.

C. Finish: Baked enamel, white.

D. Face Arrangement: ½ x ½ x ½ aluminum core.

E. Mounting Frame: 1-1/4 wide.

F. Mounting: Lay-in.

PART 3 - EXECUTION

3.01 INSTALLATION - AIR OUTLETS AND INLETS

A. Air Outlets and inlets: Install in accordance with the details and notes indicated and the recommendations and printed instructions of the manufacturer for each item.

B. Lay-in Ceilings: Verify profile of t-bar ceiling grid prior to ordering grilles, registers, and diffusers. Coordinate frame type to fit grid.
C. Diffusers and grilles are shown in their approximate desired location, but exact location must be compatible with the ceiling system, lighting fixtures, and other ceiling mounted devices. Coordinate diffuser and grille locations with the ceiling system subcontractor during preparation of the reflected ceiling plans and prior to the submission of the reflected ceiling plans for Architectural approval. Extra payments not will be approved for revisions or relocations of diffusers or ductwork.

D. Structural Supports: When very large diffusers are installed, sufficient structural support shall be provided to prevent sagging or distortion of the unit. Provide restraining cables to prevent injury should diffuser be dislodged from the ceiling.

END OF SECTION 15850
SECTION 15990 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Agreement, General Conditions, Supplementary Conditions, Part I, Special Conditions and Forms, and Division I specifications sections, apply to this section.

1.02 WORK INCLUDED

A. Testing, adjustment, and balancing of air systems.

B. Measurement of final operating condition of HVAC systems.

1.03 REFERENCED STANDARDS

A. AABC - National Standards for Total System Balance.

B. ADC - Test Code for Grilles, Registers, and Diffusers.


1.04 SUBMITTALS

A. Submit name of adjusting and balancing agency for approval within 30 days after award of Agreement.

B. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

C. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.

D. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.

E. Provide reports in 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air
outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

F. Include detailed procedures, agenda, sample report prior to commencing system balance.

G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, NEBB forms, forms containing information indicated in Schedules.

1.05 QUALITY ASSURANCE

A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.06 QUALIFICATIONS

A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience.

B. Perform Work under supervision of AABC certified test and balance engineer or NEBB certified testing, balancing and adjusting supervisor.

1.07 PRE-BALANCING CONFERENCE

A. Convene one week prior to commencing work of this section.

1.08 SEQUENCING

A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

3.02 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

3.03 INSTALLATION TOLERANCES

A. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Montana State University.

F. Check and adjust systems approximately six months after final acceptance and submit report.
3.05 AIR SYSTEM PROCEDURE

A. Verify system component has been installed in the correct location and record system component data.

B. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

C. Make air quantity measurements in ducts by pitot tube traverse of entire cross sectional area of duct.

D. Measure air quantities at air inlets and outlets.

E. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

F. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

G. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

H. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

I. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

L. Where modulating dampers are provided, take measurements and balance entire system at extreme conditions, measure and record minimum and maximum setpoints.

M. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately .050 positive static pressure near the building entries.

N. Check economizer mixing dampers for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

O. Where fan characteristics do not match the specified flow and pressure differential, notify the engineer prior to pulley or motor changes.
SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. Air inlets and outlets.
   2. Air terminal units.
   3. Fans.
   4. Air handling units.
   5. Air coils.
   6. Air filters.

B. Report Forms

1. Title Page:
   a. Name of testing, adjusting, and balancing agency.
   b. Address of testing, adjusting, and balancing agency.
   c. Telephone number of testing, adjusting, and balancing agency.
   d. Project name.
   e. Project location.
   f. Project Architect.
   g. Project Engineer.
   h. Project Contractor.
   i. Project altitude.
   j. Report date.

2. Summary Comments:
   a. Design versus final performance.
   b. Notable characteristics of system.
   c. Description of systems operation sequence.
   d. Summary of outdoor and exhaust flows to indicate amount of building pressurization.
   e. Nomenclature used throughout report.
   f. Test conditions.

3. Instrument List:
   b. Manufacturer.
   c. Model number.
   d. Serial number.
   e. Range.
   f. Calibration date.

4. Electric Motors:
   a. Manufacturer.
   b. Model/frame.
   c. HP/BHP.
d. Phase, voltage, amperage; nameplate, actual, no load RPM.
e. Service factor.
f. Starter size, rating, heater elements.
g. Sheave make/size/bore.

5. V-Belt Drive:

a. Identification/location.
b. Required driven RPM.
c. Driven sheave, diameter and RPM.
d. Belt, size and quantity.
e. Motor sheave diameter and RPM.
f. Center to center distance, maximum, minimum, and actual.

6. Cooling Coil Data:

a. Identification/number.
b. Location.
c. Service.
d. Manufacturer.
e. Air flow, design and actual.
f. Entering air DB temperature, design and actual.
g. Entering air WB temperature, design and actual.
h. Leaving air DB temperature, design and actual.
i. Leaving air WB temperature, design and actual.
j. Saturated suction temperature, design and actual.
k. Air pressure drop, design and actual.

7. Air Moving Equipment:

a. Location.
b. Manufacturer.
c. Model number.
d. Serial number.
e. Arrangement/class/discharge.
f. Air flow, specified and actual.
g. Return air flow, specified and actual.
h. Outside air flow, specified and actual.
i. Total static pressure (total external), specified and actual.
j. Inlet pressure.
k. Discharge pressure.
l. Sheave make/size/bore.
m. Number of belts/make/size.
n. Fan RPM.

8. Return Air/Outside Air Data:

a. Identification/location.
b. Design air flow.
c. Actual air flow.
d. Design return air flow.
e. Actual return air flow.
f. Design outside air flow.
g. Actual outside air flow.
h. Return air temperature.
i. Outside air temperature.
j. Required mixed air temperature.
k. Actual mixed air temperature.
l. Design outside/return air ratio.
m. Actual outside/return air ratio.

9. Duct Traverse:
   a. System zone/branch.
b. Duct size.
c. Area.
d. Design velocity.
e. Design air flow.
f. Test velocity.
g. Test air flow.
h. Duct static pressure.
i. Air temperature.
j. Air correction factor.

10. Flow Measuring Station:
    a. Identification/number.
b. Location.
c. Size.
d. Manufacturer.
e. Model number.
f. Serial number.
g. Design flow rate.
h. Design pressure drop.
i. Actual/final pressure drop.
j. Actual/final flow rate.
k. Station calibrated setting.

11. Air Distribution Device:
    a. Air terminal number.
b. Room number/location.
c. Terminal type.
d. Terminal size.
e. Area factor.
f. Design velocity.
g. Design air flow.
h. Test (final) velocity.
i. Test (final) air flow.
j. Percent of design air flow.
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Drawings and "General Conditions", "Supplementary Conditions", and "General Requirements" of the Contract as written and referred to here are adopted and made part of Division 16.

1.02 SUMMARY

A. The work under this Division shall consist of all labor, materials, equipment, services and related accessories, etc., necessary and required to complete all work as shown or inferred on the Drawings and in the Specifications (Contract Documents).

B. Provide equipment and/or wiring normally furnished or required for complete electrical systems but not specifically specified on the drawings and/or in specifications, as though specified by both.

C. All equipment and wiring shall be new, except where specifically shown or specified otherwise.

1.03 WORK INCLUDED IN THIS DIVISION

A. Electrical work includes, but is not limited to:

1. Alterations and additions to existing electrical systems.
2. Provide panelboards, circuit breakers, power outlets, convenience outlets, switches, and/or other equipment forming part of system.

1.04 REFERENCES

A. NEC: National Electrical Code (latest edition adopted by local authorities unless otherwise noted).


C. OSHA: Occupational Safety and Health Administration.

D. UL: Underwriters Laboratories, Inc.

E. NEMA: National Electrical Manufacturer’s Association.

F. IEEE: Institute of Electrical and Electronic Engineers.
1.05 DEFINITIONS

A. Provide: Furnish, install, connect and test until complete.

B. Wire: Furnish all necessary wiring, connect and test until complete.

C. Install: Furnish, set in place, wire and test until complete.

D. Work: Materials completely installed, connected, and tested until complete.

E. AWG: American Wire Gage.

1.06 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for all permits and inspections required for the work. Comply with all ordinances pertaining to work described herein. Pay all expenses arising from the procurement of these certificates and included in the base Contract Price.

B. Install work under this Division per drawings, specifications, latest adopted edition of the National Electrical Code, (NFPA-70) including local amendments and interpretations, Local adopted Building Codes, and any special codes having jurisdiction over specific portions of work within complete installation. In event of conflict, install work per most stringent code requirements as determined by Consultant.

1.07 DRAWINGS AND SPECIFICATIONS

A. Electrical work is shown on drawings, indicated and listed "Electrical" inclusive. Follow any supplementary drawings as though listed above.

B. Drawings and specifications are complementary. Work called for by one is binding as if called for by both. Any discrepancies between drawings and specifications shall be brought to the attention of the Consultant for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have
brought said discrepancies to the attention of the Consultant during the bidding period or by reason of any error on the Contractor’s part.

C. Drawings show general run of circuits and approximate location of equipment. The contractor shall review drawings of all trades to assure coordination prior to placement of work.

D. Layout equipment as shown on drawings as close as possible. Verify access requirements for equipment actually furnished, and adjust layout to comply with NEC 110. Right is reserved to change layout within 10 feet without additional cost.

E. Execution of Contract is evidence that Contractor has examined all existing conditions, drawings and specifications related to work, and is informed to extent and character of work. Later claims for labor and materials required due to difficulties encountered, which could have been foreseen had examination been made, will not be recognized.

F. Charges for extra work are not allowed unless work is authorized by written order from the MSU Representative approving charges for work.

G. Check all door swings so light switches are not located behind doors. Relocate switches as required with the Consultant’s review.

1.08 SEISMIC REQUIREMENTS

A. This installation is located in a seismic zone 4. All equipment shall be constructed and installed with all necessary bracing required for the installation seismic zone specified.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All material shall be new, and have a UL label where available. If UL label is not available, material shall be manufactured in accordance with applicable NEMA, IEEE and Federal Standards. Use UL labeled components in assemblies that do not have overall UL label. All equipment shall comply with the terms “listed and labeled” as defined in the NEC 70, Article 100. Submit letter stating compliance with these requirements.

PART 3 - EXECUTION

3.01 VISIT TO SITE

A. Visit site, and survey existing conditions affecting work prior to bid. Include necessary materials and labor to accomplish the electrical work, including relocation of existing services and utilities on building site in bid. No consideration shall be given to future
3.02 WORKMANSHIP

A. Work under this Division shall be first class with emphasis on neatness and workmanship. All work shall be installed square and plumb and concealed where possible. Work that is deficient, defective, poorly laid out, not perfectly aligned, or that is not consistent with the requirements generally accepted in the trade for “first class work” will not be acceptable.

B. In addition to the materials specified elsewhere, furnish and install all other miscellaneous items necessary for the completion of the work to the extent that all systems are complete and operative.

C. All work under this Section shall be performed in cooperation with the work performed under all other Sections of the Specifications for the Project in order to avoid interference with other work and to secure the proper installation of all work. Refer the Drawings and Specifications covering the work to be performed under all Sections, so that the relation and extent of the work of this Section with respect to the work of all other Sections is understood. Give right of way to raceways and piping systems installed at a required slope.

D. Conduit systems must be complete prior to installation of wiring.

3.03 GUARANTEE

A. Obtain from the various manufacturers or vendors guarantees or warranties for their particular equipment or components, and deliver them to Owner. All guarantees and warranties provided shall be referenced to this project. Assemble into a separate set of vinyl-covered, 3-ring binders, tabulated and indexed for easy reference.

B. All guarantees and warranties shall include labor and material at the site of installation for the duration of the guarantee period. Information to include product or equipment description, date of beginning of warranty, duration of warranty, and names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty service.

3.04 OBSERVATIONS OF WORK AND DEMONSTRATION OF OPERATION (ACCEPTANCE)

A. At all observations of work, open panel covers, junction box covers, pull box covers, device covers, and other equipment with removable plates for observation. Provide sufficient personnel to expedite cover removal and replacement.

B. Contractor to demonstrate operation of new equipment and/or systems to satisfaction of Owner. Contractor to have manufacturer available for demonstration of equipment and/or systems where requested by Owner.
3.05 TESTING OF ELECTRICAL SYSTEMS

A. Test completed work as follows:

1. Perform tests required as defined in the document to indicate compliance with specifications, drawings, standards and applicable codes. Provide sufficient instruments, labor, technical support and materials for performing these tests. Tests shall be performed to the satisfaction of the Consultant and Owner. One-week prior notice of testing required.

2. Receptacles: Use Woodhead Ground Loop Impedance Tester. Test each receptacle. Record readings.

B. Record all test results in loose-leaf three ring notebooks for Owner. Test information required: Date of test; name of circuit or equipment; ambient temperature; weather conditions; final instrument readings; graph of readings for 15 minutes tests. Provide three copies of log. At completion of all tests, original test data shall be given to Owner at the conclusion of each test.

C. Additional Testing and Commissioning of electrical equipment is specified in Section 16018.

3.06 PROTECTING

A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury. All persons working around electrical equipment shall have electrical shock and flash protection per OSHA 1910.301-309 & 331-335.

B. Do not leave exposed or unprotected, electrical items carrying current. Protect visitors and workers from exposure to contact with electrically energized surfaces, parts, etc. in accordance with OSHA standards.

3.07 DELIVERY, STORAGE AND HANDLING

A. Deliver equipment and materials to job site in original, unopened, labeled container. Products shall be properly identified with names, model numbers, types, grades, compliance labels and other information needed for identification. Store to prevent damage and injury. Store materials to prevent corroding.

B. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Contractor shall verify the availability of on site storage space in building with Owner, if no on site storage space is available then the contractor shall cover the cost for off site storage. Materials stored at the project site that becomes soiled with construction dirt, concrete, or moisture shall be removed from the site and replaced with new. Do not install soiled material.

C. Protect work and materials from damage by weather, entrance of water or dirt. Cap and mark conduit during installation.
D. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.

E. Protection and safekeeping of products stored on premises is responsibility of Contractor supplying products.

F. Schedule of deliveries and unloading to prevent traffic congestion blocking of access or interference with work. Arrange deliveries to avoid larger accumulations of materials than can be suitably stored at site.

G. Install equipment per manufacturer's recommendations. Conflicts between contract documents and these recommendations shall be referred to Consultant for remedy.

3.08 ANCHORS

A. Provide anchors for all equipment, raceways, hangers, etc. to safely support weight of item involved plus 100% for dead loads. Live loads shall be considered in addition to dead loads.

3.09 CLEANING AND PAINTING

A. Clean equipment furnished in this Division after completion of work. Clean wipe the interior of all conduit, pullboxes, junction boxes, outlet boxes, and panelboard backboxes, soiled with dirt and debris prior to installation of wiring.

B. Touch-up or re-paint damaged painted finishes as determined by Owner/Consultant.

C. Remove debris, packing cartons, scrap, etc., from site daily.

3.10 SAFETY AND LOCKOUT/TAGOUT PROCEDURES

A. Safety of all personnel during work performed is the responsibility of the Contractor. Working on and around electrical equipment and circuits requires more than normal precautions. Obtain checklist for lockout and tagout of all energy driven equipment from Architect/Engineer prior to construction. This and all Contractors shall follow these procedures.

END OF SECTION 16010
SECTION 16012 – ELECTRICAL SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION OF SUBMITTAL CATEGORIES

A. The required submittals are defined below and specified in each section.

1. **Requests for substitutions** are written requests to use materials, equipment, etc., different from that specified.

2. **Shop Drawings** include fabrication, layout, wiring diagrams, erection, setting, coordination, drawings and diagrams and performance data.

3. **Samples** are units of work, materials or equipment items, showing the workmanship, pattern, trim and similar qualities proposed.

4. **Manufacturer's Data** is standard printed product information concerning the standard portions of the manufacturer's products.

5. **Certifications** are written statements, executed specifically for the project application by an authorized officer of the contracting firm, manufacturer, or other firm as designated, certifying to compliance with the specified requirements.

6. **Test Reports** are specific reports prepared by independent testing laboratories, showing the results of specified testing.

7. **Industry Standards** are printed copies of the current standards in the industry.

8. **Manufacturer's Product Warranties** are manufacturer's standard printed commitment in reference to a specific product and normal application, stating that certain acts of restitution will be performed by the manufacturer if the product fails under certain conditions and time limits.

9. **Operating Instructions** are the written instructions by the manufacturer, fabricator or installer of equipment or systems, detailing the procedures to be followed by MSU in operation, control and shut-down.

10. **Maintenance Manuals** are the compiled information provided for MSU’s maintenance of each system of operating equipment.

11. **Maintenance Materials** (spare parts) are extra stock of parts or materials for MSU's initial use in maintaining the equipment and systems in operation.

12. **Record Drawings** are accurate representations of the installed systems and wiring as recorded on a daily “as-installed” basis.

13. **Guarantees** are signed commitments to MSU that certain acts of restitution will be performed if certain portions of work fail within certain conditions and time limits.

14. **Product Data** includes manufacturer's data pertaining to the products, materials and equipment of the work.

15. **Method of Procedures** are detailed sequences of work required during interruption of service and/or connection to energized parts of systems requiring special sequences or protections.


17. **Identification** nomenclature – See Section 16014.
PART 2 - PRODUCTS

2.01 PROPOSED MATERIAL MANUFACTURERS

A. Submit to Consultant within 30 days after award of contract a complete list of proposed material manufacturers. List does not preclude submission of shop drawings. Acceptance of manufacturer on list does not constitute acceptance of specific material or equipment. If shop drawings are submitted with non-approved substitutions, the contractor will pay the expense incurred by the Consultant to review the shop drawings of any re-submittal.

PART 3 - EXECUTION

3.01 SUBSTITUTIONS

A. No material substitutions allowed, except by prior written acceptance of Consultant. Specified catalog numbers are used for description of equipment and standard of quality only. Equivalent material will be given consideration only if adequate comparison data including samples are provided. Acceptance is required prior to bid date. Submit five copies of substitution data ten five (5) days prior to bid date. Bid substituted material only if accepted in writing by Consultant.

3.02 SUBMITTAL FORM AND PROCEDURES

A. Shop and Erection Drawings:

1. Submit shop drawings and equipment product data for material and equipment furnished under Division 16 of specifications, to Consultant for review within 30 days after award of contract. Shop drawings shall be submitted on timely basis to allow adequate lead time for review, re-submission if necessary, manufacture and delivery to allow access of material to project at correct time based on schedule established by Consultant/Contractor. Include complete descriptive data with dimensions, operating data and weight for each item of equipment. Carefully examine shop drawings to assure compliance with drawings and specifications prior to submittal to Consultant. Shop drawings and submittals shall bear the stamp of approval of the Contractor as evidence that they have checked the drawings. Drawing submitted without this stamp of approval will not be considered and will be returned for proper re-submission. All shop drawings shall be submitted as a single one time complete package. Partial packages shall not be reviewed.

2. All electrical submittals shall be assembled into a single package for review. Piecemeal submittals shall not be accepted unless prior approval from the Engineer is given for long lead items.

   a. Each submittal shall be tabbed by the electrical specification section for which it is specified.

   b. An index shall be provided which includes:
1) Product.
2) Plan Code (if applicable).
3) Specification Section.
4) Manufacturer and Model Number.]

3. Any catalog cut sheets submitted shall be annotated to clearly identify sizes, colors, characteristics, accessories, etc.
4. Clearly mark each shop drawing item to correspond to drawings and specifications. Any drawings not clearly marked will be rejected.
5. Review of shop drawings does not relieve Contractor of responsibility for errors and omissions in shop drawings. Contractor is responsible for dimensions and sizes of equipment. Inform Consultant in writing of equipment differing from that specified.

B. “Record” Drawings:

1. “Record” blue line prints at the completion of job. Keep set of prints on job and record day to day changes to Contract drawings with red pencil. One complete set of blue line prints will be furnished to the Contractor to indicate actual location of conduit systems, outlets, and equipment. Turn over prints to Architect/Engineer at final inspection.
2. After receipt of "Record" prints, Consultant will correct original CAD files. Contractor shall make (and pay for) 1/2 size reproductions, laminated in 5 mil plastic (front and back).

C. Maintenance Materials:

1. Submit a list of all warranties and guarantees.
2. Submit with final close out documents a signed receipt for all maintenance materials (spare parts) specified. See Technical Sections for required materials.
3. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittals of maintenance manuals.

D. Product Warranties and Guarantees: Submit fully executed Product Warranties and Contractor Guarantees to Owner with final close out documents.

END OF SECTION 16012
SECTION 16014 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide and install required identification for the systems and equipment shown on the drawings and/or specified. The extent of identification is specified herein and in individual technical sections of work.

B. Coordinate with Consultant and Owner for proper equipment identification nomenclature. Nameplates must be approved by Consultant prior to ordering and installation.

C. Types of electrical identification include:
   1. Conduit labeling.
   2. Cable/conductor identification.
   3. Equipment/system identification labels and signs.
   4. Device labeling.
   5. Junction box labeling.
   7. Panelboards.

1.02 RELATED WORK

A. All Division 16 Sections.

1.03 SUBMITTALS

A. Labels: Provide a list of labels with actual designations as they will be printed.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION MATERIAL

A. Conform to ANSI A13.1, Table 3 for minimum size of legend letters and minimum length of color field for each raceway or cable size. Use colors prescribed by ANSI A13.7, NFPA 70 and these specifications.

B. Color-Coded Conduit Markers:
   1. Manufacturer's standard preprinted, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits. Attach with adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end.
of marker, or pretensioned snap-on. Lettering to indicate voltage, function of conductors in conduit and shall be 8" minimum length (i.e. ac power, dc power, fire alarm).

2. Colors: Orange markers with black letters.

C. Cable/Conductor Identification Bands: Manufacturer's standard vinyl self-adhesive self laminating cable/conductor markers, wrap-around type; pre-numbered plastic coated, or write-on type with clear plastic self-adhesive cover flap, lettered to show circuit identification. Similar to Panduit "Instacode" or accepted equivalent by T&B, or Tyton.

D. Engraved Signs (Nameplates):

1. Use 1/8" thick melamine plastic laminate, complying with FS LP-387, sizes as indicated, engrave with standard letter style of sizes and wording indicated (1/4" letters minimum). Punched for screws.

2. Match existing building coloring scheme. If none exists use the following:
   a. Black field with white letters for nonessential service.
   b. Red field, white letters for essential service.

3. Fasteners: Self-tapping stainless steel screws, except contact epoxy adhesive where screws cannot or should not penetrate substrate.

E. Lettering and Graphics: Coordinate names, abbreviations and other designations used with those shown or specified. Provide numbers, lettering, and wording as indicated or required for identification and operation/maintenance.

F. Device Labeling: Tape labels on device plate for switches and receptacles outlets identifying branch circuit and panel designation.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install after completion of painting.

2. Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification:

1. Use adhesive marking tape labels, Brother or Kroy labels 1" high x 12" long (min.), 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:
a. 600 Volt and Below Normal: White letters on black background indicating feeder identification and voltage.

2. 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.

3. For overhead conduits, place identification such that it can be read standing on the floor below.

C. Engraved Plastic Laminated Signs:

1. Install on each major unit of electrical equipment in the building. Provide single line of text, 1/4" high lettering on 1" high sign (1-1/2" high where 2 lines required). Matching terminology and numbering as indicated in contract documents.

2. Provide signs for each unit of the following categories:
   a. Electrical cabinets and enclosures. Indicate cabinet designation, voltage, phase and feeder origin.
   b. 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. All equipment furnished in this Division of the specifications. Indicate equipment designation, voltage, phase and feeder origin.
   c. Panelboards.

D. Install signs where indicated or most visible. Secure with at least two cadmium-plated screws. Where substrate cannot receive screws, use industrial epoxy cement to secure signs.

E. Identify all conduits installed for future use.

F. Provide tape labels for identification of individual receptacle and light switch wallplates. Locate tape on front of plate and identify branch circuit serving the receptacle. Provide tape labels for identification of individual switches or thermal overload switches which serve as equipment disconnects. Locate the type on the front of the coverplate and identify the branch circuit serving the equipment.

END OF SECTION 16014
SECTION 16018 – TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide instruments, power supplies, trained technicians, all connections, and labor to test electrical equipment as specified herein, and in Technical Sections contained in this specification referring to test procedures and/or standards listed and specified below.

1.02 TESTING STANDARDS

A. NFPA - 70 B Electrical Equipment Maintenance.
C. IEEE Standards related to equipment to be tested.
D. ANSI Standards related to equipment to be tested.

1.03 SCOPE OF WORK

A. Test all electrical equipment as identified. Specified testing shall be done in accordance with latest edition of NETA testing procedures, except as modified herein. Where no specification is included herein, obtain test values required by Test Forms using procedures outlined in latest edition NETA acceptance Testing Specification.

B. The following equipment and wiring shall be tested:

1. Cables Low Voltage 600 Voltage.
2. Circuit Breakers Low Voltage.
3. Panelboards.

1.04 RELATED WORK

A. Section 16010, Electrical General; Testing of Electrical Systems.
B. Section 16120, Conductors (Low Voltage, 600 Volts).
C. Section 16130, Outlet Boxes, Junction Boxes, Wiring Bodies, and Wiring Gutters.
3.01 TESTING ELECTRICAL SYSTEMS / EQUIPMENT

A. Safety and Precautions:

1. Safety practices shall include, but are not limited to, the following requirements:
   a. Occupational Safety and Health Act of 1970-OSHA.
   c. Applicable State and Local safety operating procedures.
   d. NETA Safety/Accident Prevention Program.
   e. National Fire Protection Association - NFPA 70E.

2. All tests shall be performed with apparatus de-energized except where otherwise specifically specified.

3. Power Circuits shall have conductors shorted to ground by a hot-line grounding device approved for the purpose.

4. In all cases, work shall not proceed until the safety representative has determined that it is safe to do so.

3.02 INSPECTION AND TEST PROCEDURES

A. General Requirements:

1. Visual and Mechanical Inspection by the Electrical Contractor:
   a. Inspect for physical damage.
   b. Compare equipment nameplate information with latest single line diagram and report discrepancies.
   c. Inspect for proper alignment, anchorage and grounding.
   d. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer’s instruction for proper foot pound levels.
   e. All doors, panels and sections shall be inspected for paint, dents, scratches and fit with particular attention to correcting missing and loose bolts, bent hinges, broken or missing lock handles or latches and warped panels.

2. Carefully clean and carefully re-torque to manufacturer’s specifications any connection which was found loose, indicated overheating (such as discolored insulation) or appeared as a “hot-spot” under the infrared scan. While cleaning, use extreme care on plated surfaces. Replace, rather than re-use conical washers.
Some brands of non-oxidation compound are very flammable, so use as little as necessary when applying to aluminum surfaces.

3.03 CIRCUIT BREAKERS – LOW VOLTAGE (MOLDED CASE)
A. Visual and Mechanical Inspection performed by the Electrical Contractor:
   1. Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
   2. Operate circuit breaker 4-6 times without load to insure smooth operation.
   3. Inspect case and arc chutes for cracks or defects.
   4. Check tightness of connection with torque wrench in accordance with manufacturer’s recommendations.

3.04 SYSTEM FUNCTION TESTS
A. Each System having components tested as described herein shall be function tested to insure total system operation by the Electrical Contractor.
B. Upon completion of equipment component tests as defined herein, the system functional tests shall be performed. It is the intent of system functional tests to demonstrate the proper interaction of all sensing, processing and action devices to affect the desired end product or result as designed and specified.

3.05 TEST REPORT
A. The test report shall include the following:
   1. Summary of project.
   2. Description of equipment tested.
   3. Description of test.
   4. Temperature and relative humidity.
   5. Test results.
   6. Conclusions and recommendations.

3.06 OBSERVATION
A. Consultant / Owner may witness all specified testing. One week notice is required.

3.07 SAFETY
A. Personnel involved in testing shall perform tests in a safe and workmanlike manner. All existing safety practices pertaining to working in and around electrical equipment should be reviewed and carefully followed by all personnel. All areas and equipment shall be closed and safeguarded to prevent accidental damage, injury and power interruption.
B. Emergency procedures must be developed in the event a problem occurs during testing. Telephone numbers of the local power company and a knowledgeable electrical maintenance contractor should be on site for complex systems.

END OF SECTION 16018
SECTION 16110 – RACEWAYS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Installation of raceway systems for all work in Division 16 including required fittings and supports.

B. All conductors shall be installed in metallic conduit unless specified to be in PVC. Each length of conduit shall bear the manufacturer’s trademark or stamping indicating size.

1.02 RELATED WORK

A. Section 16010, Electrical General.

B. Section 16014, Electrical Identification.

C. Section 16130, Outlet Boxes, Junction Boxes, Wiring Bodies and Wiring Gutters.

1.03 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Rigid Metal Galvanized Steel Conduit, RMC, to conform to Federal Specification WW-C-581E, NEC Article 346, ANSI Standard C80.1 and U.L. Standard No. 6 for rigid metallic conduit, except hot dipped galvanized after threading. Minimum size concealed in concrete or below grade shall be ¾”. Minimum size shall be 1/2 inch.

1. Acceptable RMC Manufacturers:
   a. Allied Tube and Conduit Corporation.
   b. LTV Steel Tubular Productions Co.
   c. Armco Inc.
   d. Midwest Electric-Cooper Industries.
   e. Wheatland Tube Company.
   f. Western Tube and Conduit Corp.
   g. Triangle Wire and Cable Inc.
2. Fittings, ells, couplings, etc., galvanized threaded type meeting above standards. Threadless fittings shall not be used.

3. Terminate rigid conduit in dry locations with two steel locknuts, one inside, one outside of the cabinet, junction box or outlet box and an insulated bushing. Bushings shall be malleable iron or steel with smooth insulating ring molded into edge of bushing to prevent damage to cable. Insulated bushings shall be 150 degree C self-extinguishing thermoplastic. Provide grounding bushings on 1 ¼” conduit and larger. Construction of bushings shall be similar to steel bushings described above except provide lugs for grounding connection.

   a. Acceptable Bushing Manufacturers:
      1) Appleton.
      2) Thomas & Betts.
      3) OZ/Gedney.
      4) Midwest.
      5) Steel City.

4. Deliver conduit with thread protectors.

B. Rigid Intermediate Grade Conduit, IMC, to conform to Federal Specification WWC-581 and NEC 345, UL Standard No. 1242; hot dipped galvanized or accepted equivalent. Minimum size shall be 1/2 inch.

   1. Acceptable IMC Manufacturers:
      a. Allied Tube and Conduit Corporation.
      b. Triangle Wire and Cable Incorporation.
      c. ETP - Berger Industries.
      d. Western Tube and Conduit Corporation.
      e. LTV Steel Tubular Products Company.
      f. Wheatland Tube Company.

   2. All fittings, ells, couplings, etc., constructed to same standards as rigid steel conduit. Fittings - threaded type with all threads engaged.

   3. Conduit terminations same as rigid steel conduit.


   1. Acceptable Flexible Steel Conduit Manufacturers:
      a. Anaconda Metal Hose.
      b. Midwest Conduit and Cable Company.
      c. Electri Flex Company.
      d. MWS Incorporation.
      e. International Metal Hose Company.
      f. Steelflex Electro Corporation.
2. Connectors and fittings galvanized steel, threadless type with insulated throats, U.L. approved for grounding means.

   a. Acceptable Connector Manufacturers:
      
      1) Thomas & Betts Corporation.
      2) Steel City-Midland Ross.
      3) Midwest-Cooper Industries.
      4) ETP-Berger Industries.
      5) Appleton Electric Company.
      6) Raco Incorporation.

D. **Liquid Tight Flexible Steel Conduit** constructed similar to flexible steel conduit above, except with polyvinyl chloride jacket and conforming to UL Standard 360.

   1. Acceptable Liquid Tight Flexible Conduit Manufacturers:
      
      a. Anaconda Metal Hose Company.
      b. Electri-Flex Company.
      c. International Metal Hose Company.

   2. Fitting Assembly: Sealing type, with steel gland, nylon ring and ground cone inside locknut. All fittings with insulated throat, U.L. approved for grounding means.

      a. Acceptable Fitting Manufacturers:
         
         1) Thomas & Betts.
         2) Raco.
         3) Midwest.
         4) Steel City.
         5) Appleton.
         6) ETP.

E. **Electrical Metallic Tubing, EMT**, threadless, steel type conforming to ANSI Standard C80.3, NEC 348, and UL 797; galvanized inside and out, and with additional corrosion resistant finish.

   1. Acceptable EMT Manufacturers:
      
      a. Wheatland Tube Company.
      b. ETP-Berger Industries.
      c. Pittsburgh Tube Company.
      d. LTV Steel Tubular Products Company.
      e. Triangle Wire and Cable Company.
      f. Western Tube and Conduit Corporation.

   2. EMT Fittings, connectors, couplings, etc., for lighting and power feeders and branch circuits. Use insulated throat galvanized steel, raintight, compression type fitting. Provide grounding bushing on 1 ¼” and larger. Zinc alloy and
similar soft metal castings are not allowed. Set screw fittings are allowed for 2” and larger

a. Acceptable Fitting Manufacturers:

1) Thomas & Betts.
2) Raco.
3) Efcor.
4) Appleton.
5) ETP.
6) Steel City.
7) Midwest.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate layout and installation of raceway systems with other construction elements to ensure adequate headroom, working clearance, and access.

B. Use rigid steel conduit (threaded only) for:

1. All medium voltage feeders.
2. Circuits in hazardous locations.
3. Circuits exposed to physical damage and heavy moisture both indoors and outdoors.
4. All sleeves.
5. All motor circuits where subject to physical damage or below 10’ AFF.

C. Intermediate grade metal conduit, (threaded only), may be used in lieu of rigid steel conduit where allowed by NEC, and local ordinances.

D. Use flexible conduit, “greenfield” for:

1. Connection to vibrating equipment in dry locations between rigid conduit and connection box on equipment.
2. Final connections to equipment in dry locations.
3. Final connections to equipment requiring adjustments.
4. Final connections to recessed lighting fixtures from conduit system.
5. Connection to distribution transformers.
6. Connection to bus duct plug-in switches.

E. Use Liquidtight flexible conduit in damp or wet locations for same circuit categories listed for flexible conduit above.

F. Use Electrical Metallic Tubing, EMT, for:
1. Branch circuits in dry non-corrosive, non-hazardous locations (steel compression fittings shall be used for 1 ½” and smaller).
2. Telephone circuits (May use steel set screw fittings).
3. Auxiliary systems and controls (May use steel set screw fittings).
4. All feeders other than those indicated in Section 3.01 B above. EMT shall not be used for service feeders from the power company equipment to main switchboards or from standby AC plants to generator distribution equipment.
5. EMT shall not be installed underground and shall not be encased in concrete.

G. Comply with NEC for minimum size conduit and installation requirements. Minimum size 1/2" diameter, but no more than 3#12 and 1#12 (ground) installed in 1/2" conduit. Minimum size for non-metallic conduit shall be 1” in diameter. Conduits shall be installed complete end-to-end prior to installing conductors.

H. Furnish offsets required to meet field conditions. Make bends in conduit in accordance with the National Electrical Code, except make minimum radius of 6 times conduit diameter or 6” whichever is greater. Bend IMC conduit without deforming. Do not exceed 270° total bends in any conduit run without pullbox or acceptable conduit body.

I. Where conduit crosses expansion joints, install expansion type fittings with bonding jumper. Use expansion joint with lateral conduit movement of 4” or 8” as indicated. When both vertical and lateral movement is expected the joint shall be a 1” braided flexible coupling allowing both directional movements.

1. Acceptable Manufacturers of Expansion Joints:
   a. OZ/Gedney
   b. Appleton
   c. Crouse Hinds

J. Empty conduits, 1/2” to 1” in diameter, shall be equipped with nylon cords with blocks attached at both ends to facilitate future pulling of wires. Install pull wires in empty raceways greater than 1” diameter. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

K. Vibrating equipment and equipment requiring adjustment, i.e.: motors, transformers, etc: make final connections with short section (18”) of liquid-tight flexible metal conduit.

L. Use liquidtight flexible conduit where exposed to moisture, oil, etc.

M. Install conduit to avoid hot water pipes. Maintain 12" clearance of such pipes, unless closer crossings are unavoidable.

N. Support conduit per NEC. Support individual conduits with galvanized hangers, rods and inserts as follows:

<table>
<thead>
<tr>
<th>Conduit Size</th>
<th>Hanger/Rod/Insert Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1” diameter and smaller</td>
<td>¼” diameter rod</td>
</tr>
<tr>
<td>1-1/4” to 3” diameter</td>
<td>3/8” diameter rod</td>
</tr>
</tbody>
</table>
O. Install an insulated ground conductor in all conduits and for each conduit.

3.02 SUPPORTS

A. Supports shall be installed in accordance with Seismic standards for a class 4 location. Provide necessary side braces and swing joints as required.

B. Support EMT within twelve inches of each outlet, junction box, cabinet or fitting and every eight-foot thereafter.

1. Acceptable Individual conduit hanger manufacturers:
   
   a. Appleton
   b. Minerallac
   c. OZ Mfr. Co.
   d. Erico-Products
   e. Steel City
   f. Thomas & Betts

3.03 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches and abrasions.

END OF SECTION 16110
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK
   A. Furnish and install 600 volt conductors and associated splices, connectors and terminations for lighting, and power systems.

1.02 RELATED WORK
   A. Section 16010, Electrical General.
   B. Section 16014, Electrical Identification.
   C. Section 16018, Testing and Commissioning of Electrical Equipment.

1.03 STANDARDS
   A. ICEM S-68-516
   B. NEMA WC-8
   C. UL No. 44, 83 and 854
   D. NEC Article 310
   E. NEMA WC-3
   F. NEMA WC-5
   G. NEMA WC-7
   H. NEMA WC-26

1.04 SUBMITTALS
   A. Submit product data.
PART 2 - PRODUCTS

2.01 CONDUCTORS

A. 98% conductivity copper; lighting and receptacle circuits shall be #12 AWG (American Wire Gauge) minimum. Conductors shall be solid for #10 AWG and smaller and stranded for #8 or larger. All power and control wiring shall be ASTM Class B stranded.

B. Conductors furnished with NEC, 600 volt, insulation as follows:

1. **Dry Locations:**
   a. #10 AWG and smaller – type THW-2, THWN-2, THHN-2 or XHHW-2 (do not intermix in circuits).
   b. #8 AWG and larger – type THWN-2 or XHHW-2.

2. **Wet Locations:**
   a. #10 AWG and smaller – type XHHW-2.
   b. #8 AWG and larger – type XHHW-2.

C. Voltage rating, manufacturer, type and conductor AWG size indication shall be continuously factory-applied the entire length of each conductor. Minimally, the cable shall be marked in accordance with the NEC and any other local codes.

D. Minimum conductor size for power circuits shall be #12 AWG.

E. Color Code as follows and/or per local ordinances. Conductors #10 AWG and smaller with colored insulation. Conductors #8 AWG and larger not available in colors, color coded with colored pressure sensitive tape. Apply minimum 2" of tape to each individual phase or neutral conductor in half lapped pattern. Conductors shall be identified with color coded tape at all locations accessible including all splices and terminations. Color-code as follows:

<table>
<thead>
<tr>
<th>Phase</th>
<th>120/240 Volts</th>
<th>120/208 Volts</th>
<th>277/480 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Black</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B</td>
<td>Red</td>
<td>Red</td>
<td>Orange</td>
</tr>
<tr>
<td>C</td>
<td>Orange</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>White</td>
<td>Gray</td>
</tr>
<tr>
<td>Equipment Ground</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

F. If an existing color code is already consistently established in the facility, all color coding of new conductors shall match the existing color code, if approved by the local authorities.

G. Acceptable Manufacturers of Copper Conductors:

1. Pirelli.
2. Phelps Dodge.
3. Okonite.
4. Capital Cable.
5. Rome.
6. General Cable.
7. Southwire.
8. Cablec.

2.02 CONNECTORS AND SPLICES

A. Provide UL-listed factory-fabricated wiring connectors of size, ampacity rating, material, type and class for application and for service indicated. Select connectors to comply with Project's installation requirements and as specified in Part 3 "Applications" of this Article.

B. For Conductors #10 AWG and Smaller: Wire and cable connectors shall be solderless, twist on, 600 volts, 105°C, shall comply with UL 486A/C standards. Connectors coded for easy selection compatible with wiring to be spliced. Install connectors as recommended by manufacturer. Use proper crimping tool where crimp sleeves are used.

1. Acceptable Connector Manufacturers:
   a. 3M- "Scotchlock"
   b. Buchanan - "B Cap"
   c. Thomas & Betts - "Stak-On"
   d. Ideal - "Wing Nuts"

C. Mechanical splices and tap connectors for feeder conductors shall be mounting block type, insulated with clamp-on molded covers that accommodate the lug types specified herein.

1. Acceptable Mechanical Connector Manufacturers:
   a. Burndy Engineering Company
   b. O-Z Gedney
   c. Thomas and Betts

2. Make conductor taps #8 and larger from a second conductor with 98% conductivity bolted insulated connector, Ilsco "KUP-L-TAP" or accepted equivalent.

3. Mechanical conductor taps for #8 and larger from a second conductor shall be high strength, high conductivity copper alloy made for conductors to be connected, Burndy "QPX" or accepted equivalent.

D. Compression Splices: Splice conductors #8 and larger with solid copper barrel, type fittings applied with an appropriate hydraulic tool. Splices used only where approved. Splice fittings: Burndy "Hydent". Insulate splices with 600 volt, 105°C, "heat shrink", "cold shrink" covers, or taped insulation consisting of rubber, friction and vinyl tapes applied per manufacturer for 600 volt, 105°C covering.
1. Acceptable Splice and Tape Manufacturers:
   a. Burndy
   b. Thomas & Betts
   c. Ilsco
   d. Anderson
   e. Blackburn
   f. Oz/Gedney

E. Connectors and/or Terminations for Conductors #6 AWG and larger: Tin plated, 98% copper, dual crimp long barrel compression lugs with two bolt holes, insulated with molded covers to accommodate 1/2” bolts. Apply with hydraulic tool recommended by manufacturer.

1. Acceptable Manufacturers and Products
   a. O-Z Gedney
   b. Burndy Engineering Company "Hylugs"
   c. Thomas and Betts, "Color Keyed"
   d. Anderson

F. Cable lugs of the compression-type, long-barrel, two-hole copper-type lug, shall be provided for all power and grounding cable, where feasible.

G. Mechanical Lugs Connected to Copper Bus: 98% conductivity copper or bronze Thomas & Betts "Locktite", Burndy "QA" or accepted equivalent.

H. Lugs in Dry Locations and Lugs Connected to Aluminum Bus: Heavy casting aluminum, CU/AL rated, listed under UL Standard 486B, rated 90 degrees C; plated to prevent electrolysis, Thomas & Betts, Blackburn, Ilsco or accepted equivalent.

I. Use pulling lubricant which will not be detrimental to insulation of conductors indicated by published user information.

1. Acceptable Manufacturers of Lubricant:
   a. Ideal Industries
   b. Panduit Corp.
   c. OZ/Gedney
   d. Plymouth/Bishop
   e. American Polywater Corp.
   f. Thomas & Betts

J. Insulate all live joints to 600 volts with strip rubber, friction tape, and electrical vinyl tape installed in accordance with manufacturer’s recommendations.

1. Acceptable Tape Manufacturers:
   a. 3M
   b. Plymouth
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install wiring complete with connections to equipment.

B. No branch wiring installed until after plastering, sheetrock finishing, and similar work is complete and dry.

C. Install wiring so conductors are not in tension in completed system.

D. Form wiring neatly and group in circuit. Tie grouped conductors with nylon ties, T&B "Tyrap" or approved equivalent.

E. Each conduit run shall be run complete end to end before conductors are installed.

F. Use pulling lubricant to decrease pulling tension for all feeder cables, and all difficult cable pulls of any type or size. Pull all conductors into raceway at the same time.

G. Bond circuit ground wires where installed to all devices, equipment, outlet and junction boxes, and grounding bushings (where provided) with a full size conductor and lugged type connection.

H. Securely fasten non-ferrous identifying tapes, pressure sensitive labels or engraved nameplates to all cables, feeders and power cables exposed in vaults, inside pull boxes, exposed in manholes, exposed in switchboard, termination compartments, etc. See Section 16014 for nameplates and labels.

I. Join and terminate copper conductors individually. Do not mix voltages in the same raceway.

J. Provide lugs where not furnished as part of equipment - furnish as specified above, to connect all conductors.

K. Furnish lugs for conductors #1/0 and larger with two bolt tongue or accepted equivalent single bolt tongue with anti-turn devices.

L. Mark all branch circuit conductors at panel terminations including neutrals with pressure sensitive numbers to correspond to circuit numbers connected. See Section 16014 for labels.

M. Connect circuits and feeders as shown on drawings. Drawings are diagrammatic and do not show every detail required in the wiring system. Detail wiring accomplished per NEC. Circuitry shall not be run in elevator shafts and hoistways.

N. Neutral conductors shall not be used for equipment grounding.

O. Provide a separate grounding conductor for all GFI circuits or GFI devices to ensure an adequate ground-fault return path.
P. Use #10 AWG for all 20 amp, 120 volt homerun circuits that exceed 75 feet from center of load and 150 feet for 277 volt circuits.

Q. Splice only in junction or outlet boxes. Keep conductor splices to a minimum.

R. Pull conductors simultaneously where more than one is being installed in same raceway.

S. 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.

T. 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.

3.02 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Torque test conductor connections and terminations to manufacturer's recommended values.

C. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

END OF SECTION 16120
PART 1 - GENERAL

1.01 DESCRIPTION OF WORK
   A. Outlet boxes, pull and junction boxes, conduit bodies and their installation.

1.02 RELATED WORK
   A. Section 16110, Raceways.
   B. Section 16140, Switches and Receptacles.

1.03 SUBMITTALS
   A. Product data for outlet boxes, junction boxes, wiring bodies showing configurations, finishes, dimensions, and manufacturer’s instructions.

1.04 STANDARDS
   A. ASTM No. E119.
   B. NEC Article No. 370.
   C. ASTM A 386.
   D. UL No. 5.

1.05 PERMITS
   A. Contractor shall pay for and obtain all permits, inspections, approvals, and certificates required by law. Conform to all laws, ordinances, rules and regulations applicable to the location of the Project.

PART 2 - PRODUCTS

2.01 OUTLET BOXES
   A. Provide wiring devices, fixtures and special system devices with outlet box. Use galvanized steel boxes conforming to UL Standard 514A for concealed and exposed in
dry locations. All boxes shall have matching coverplates. Welded boxes are not acceptable.

B. Concealed outlets and exposed outlets in unfinished dry spaces for lights, switches, wall receptacles, etc.; may consist of standard galvanized steel outlet boxes and plaster rings.

C. Use 1/16" thick steel boxes and covers of form and dimension adapted to its specific use and location, kind of fixture or device to be used and number, size and arrangement of connecting conduits and number of wires in outlet, all in accordance with NEC.

D. Provide 3/8" fixture studs where required for hanging or mounting fixtures.

E. Ceiling Outlet Boxes: 4" octagonal or 4-11/16" square as required, due to number of wires, and 2 1/8" deep minimum. Ceiling boxes in concrete slabs shall be UL listed for embedding in concrete. Plaster rings not required for ceiling outlet unless needed for device.

F. Paint junction boxes provided with blank covers to match surroundings, except use plaster rings and blank device plates in finished areas.

G. Switch and receptacle outlet boxes: 4" square with plaster rings as necessary. Provide multi-gang boxes where shown or required. Provide metal barriers to separate emergency and normal service wiring per NEC. 4" x 2 1/8" x 2 1/8" boxes may be used for single receptacle or switch devices. Where more than two (2) devices are shown used 4" H x 2 1/8" D x number of gangs x (2 1/8" w.) and with barriers as required per NEC. Provide box with grounding screw and connections as required by wiring method.

H. Acceptable Manufacturers:
   1. Steel City.
   2. Raco.
   3. Appleton.

2.02 LARGE PULL AND JUNCTION BOXES

A. Furnish pull, tap and cable support boxes required by NEC for excessive number of 90 degree conduit bends, conductor taps and cable supports.

B. Box construction per NEC and conforming to UL Standard No. 50, and manufactured with galvanized sheet steel, 12 gage minimum, with angle iron frame where required for rigidity; welded or bolted construction is acceptable. Install bolts to prevent damage to cables in box.

C. Boxes with removable screw type covers and plated screws. Provide split covers where necessary for access. Maximum single piece cover - 36" x 36".

D. Provide separate junction boxes for each feeder. If conduit is installed so separate junction boxes are not practical, one large pull-box may be used with each set of feeder
conductors separated by 12 gage steel barriers. Furnish junction box or each compartment in junction box with ground lug for connection of ground wire.

E. Boxes located in damp or wet locations shall be welded construction and finished white inside and gray outside with waterproof paint. Provide gasketed door and corners. Provide rain drip shields. Boxes shall carry NEMA 3R (weatherproof) or NEMA 4 (watertight) labels as specified.

F. Acceptable Manufacturers:
   1. Hoffman.

2.03 CONDUIT BODIES

A. Conduit bodies shall be installed to provide ease of pulling conductors and to provide neat appearance of conduit installation, and as shown on drawings. Conduit bodies constructed of malleable iron or copper free aluminum castings. Bodies shall be finished with standard durable exterior coatings of manufacturer specified. Provide rollers in type "C" and type "LB" bodies, 1-1/4" size and larger. Provide gasketed plated steel or malleable iron covers.

B. Provide screws-in type blanking caps for all open conduit entrance.

C. Acceptable Conduit Body Manufacturers:
   2. Killark.
   3. Pyle National.
   4. Appleton.

PART 3 - EXECUTION

3.01 IDENTIFICATION

A. See Section 16014, Electrical Identification, for the requirements for identifying the equipment in this Section.

3.02 INSTALLATION OF OUTLET BOXES (WIREWAYS)

A. Fasten outlet boxes securely to structure.

B. Set all flush outlet boxes so edge of device flange is flush with finished surface. Provide extension rings where required.
C. Open no more knockouts in outlet box than required.

D. Seal boxes during construction to prevent entrance of construction debris.

E. Stagger back to back boxes 3" minimum.

F. Support All Boxes:
   1. Outlet boxes - with 1/4" diameter galvanized rods or bolts anchored to structure.
   2. Outlet boxes for surface mounted luminaires on furred ceilings with 3/4" channel iron fastened to ceiling channels. See Section covering "Luminaires".
   3. Pull, junction and cable boxes with 3/8" diameter galvanized rods or bolts (4 minimum).
   4. Support outlet boxes in steel stud partitions with bar hangers or approved equivalent. Hangers must provide substantial support and rigidity before wall finish, i.e.: sheet rock, plaster, etc. is applied.

G. Install adjacent outlets at different levels in one vertical line where possible.

H. Provide green covered bonding jumper, screw connected to outlet box in all receptacle boxes.

I. Supports shall be installed in accordance with Seismic Standards as indicated in Section 16010.

J. Mark outlet box covers with permanent ink markers to indicate circuit number(s) and panel of origination. Use black markers for normal service circuits and orange for emergency service. Paint all fire alarm system box covers red and mark “FA”.

K. Install conduit bodies where shown or where required for sharp bends and/or aesthetics in raceway system. Do not use in lieu of pullboxes except in limited space or as directed by Consultant.

END OF SECTION 16130
SECTION 16140 – SWITCHES AND RECEPTACLES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK
A. Wiring devices, plates, and installation.

1.02 RELATED WORK
A. Section 16010, Electrical General.
B. Section 16014, Electrical Identification.

1.03 SUBMITTALS
A. Provide product data and sample of each product specified in this Section.

PART 2 - PRODUCTS

2.01 DEVICES
A. Provide devices and associated device plates shown on drawings. Catalog numbers shown establish a standard of quality.

B. Receptacles, Straight-Blade and Locking Type: Except as otherwise indicated, comply with Federal Specification W-C-596 and heavy-duty grade of UL Standard 498, “Electrical Attachment Plugs and Receptacles.”

C. Receptacles, Straight-Blade, Special Features: Comply with the basic requirements specified above for straight-blade receptacles of the class and type indicated, and with the following additional requirements.


E. Bodies: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

G. Acceptable Wiring Device Manufacturers:
   1. Pass and Seymour / Legrand.
   2. Arrow Hart.
   3. Hubbell.
   4. Leviton.
   5. General Electric.
   7. Eagle.

H. Submit list of devices with catalog number proposed for review prior to ordering.

I. Device color to match existing color, except in special areas designated by the Consultant, furnish color chart to Consultant for selection.

2.02 DEVICE PLATES

A. Furnish all device cover plates to match existing

B. Device plates manufactured by device manufacturer where available.

C. Furnish configuration of device plates required for multi-gang installations.

D. Plate-Securing Screws: Colored to match plate finish.

E. Wall Plates: Single and combination types that mate and match with corresponding wiring devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install receptacles with ground wire from ground screw connected to outlet box.

B. Install devices vertical 48”AFF for switches, off position down, and 18”AFF for receptacles unless shown otherwise. Devices shall be installed plumb and secure on all sides. Install 12” above surface of countertops.

C. Install receptacles with ground slot down.

D. Match devices to plug connectors for MSU-furnished equipment. Verify type, configuration, etc., prior to providing devices. Including all such costs in bid submission.

E. Match cord and plug sets to equipment requirements.
3.02 IDENTIFICATION
   A. Comply with Division 16, Section 16014, Electrical Identification.
   
   B. Receptacles: Identify the panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.03 FIELD QUALITY CONTROL
   A. Testing: Test wiring devices for proper polarity and ground continuity. Operate each operable device at least 6 times.
   
   B. Test ground-fault circuit interrupter operation with both local and remote fault simulations according to manufacturer recommendations.
   
   C. Replace damaged or defective components.

3.04 CLEANING
   A. General: Internally clean devices, device outlet boxes and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 16140
SECTION 16500 – LUMINAIRES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all lighting fixture locations, as shown on drawings, with a fixture the type designated and appropriate for the location.

B. Provide lighting system complete and fully operational. Conform to code and UL listing requirements.

C. Coordinate installation and connection of lighting fixtures with all other trades to provide a total system that is neat and orderly in appearance.

D. Where any fixture type designation has been omitted or cannot be determined by the Contractor, request a clarification from the Architect and provide a suitable fixture type as directed.

E. Light fixture schedule series numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, ballast, type of lamp, ceiling type, finish trim, mounting hardware, or special requirements as specified hereinafter or as required by the particular installation(s). Acceptable manufacturers and series numbers are listed. The manufacturer listed shall provide complete fixtures equaling or exceeding the written specifications. Verify these requirements and order fixtures as required to provide a complete and fully operational installation per the contract documents and per code.

F. Light fixture voltage to match voltage of circuit serving the light fixture.

G. Blemished, damaged, or unsatisfactory fixtures shall be replaced in a satisfactory manner as directed by the Architect.

1.02 STANDARDS

A. CBM, Certified Ballast Manufacturers.

B. ETL, Electrical Testing Laboratory.

C. IES, Illuminating Engineering Society.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's product data, shop drawings, and installation instructions on each type of luminaire and component, per Section 16018.
B. Maintenance Data: Submit maintenance data and parts list for each luminaire and accessory; including "troubleshooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual; in accordance with general requirements of Division 1.

PART 2 - PRODUCTS

2.01 LUMINAIRES

A. Refer to Drawings for exact lighting products.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

A. Support of luminaires shall be the responsibility of this Section.

B. Support luminaires from structural members of building, independent of ceiling.

C. Wire grid luminaires with flexible conduit individually to junction boxes. Do not wire luminaire to luminaire.

D. Connect luminaires in continuous rows other than recessed grid type connected by nipples with locknuts and bushings.

E. Mounting of Luminaires: Luminaires shall be pendant mounted from structural ceiling, 9'-6" or higher.

3.02 LOCATION

A. Locations of fixtures are shown diagrammatically. Verify exact location and spacing with reflected ceiling plans and other reference data before ordering of fixtures, and during installation.

3.03 GUARANTEE

A. All luminaires, components, accessories etc., except lamps, shall be guaranteed against defects in materials and workmanship for one (1) year from date of in service acceptance by owner. Replacement shall include parts and labor at the site of the work for the term of the warranty.

B. Lamps shall be guaranteed as specified above.
3.04 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.

3.05 SPARE LAMPS AND BALLASTS

A. Spare Lamps: Furnish stock or replacement lamps amounting to 15% but not less than 4 lamps in each case, or each type and size lamp used in each type of luminaire. Deliver replacement stock directed to Owner’s storage space.

B. Spare Ballasts: Provide six (6) of each type used on project.

END OF SECTION 16500