**SECTION 22 0500**

**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 GENERAL**

1. DESCRIPTION
   1. This Division 22 and the accompanying drawings cover the provision of all labor, equipment, appliances, and materials and performing all operations in connection with the construction of the plumbing systems as specified herein and as shown.
   2. All work specified in this Section is governed by the Common Work Results for Plumbing 22 0500.
   3. The General Provisions and Division 1, including the general, supplementary and other conditions and other Divisions, as appropriate, apply to work specified in this Division.
2. INTENT OF DRAWINGS AND SPECIFICATIONS
   1. The implied and stated intent of the drawings and specifications is to establish minimum acceptable standards for materials, equipment and workmanship, and to provide operable plumbing systems complete in every respect.
   2. The engineering drawings are diagrammatic, intended to show general arrangement and sizes of system components, and shall not be scaled. Rather, the architectural and structural drawings shall govern space constraints, dimensions and finishes. All offsets and fittings which will be necessary to accomplish the finished installation shall be provided at no additional cost or increase in the Contract.
3. SPACE PRIORITY
   1. Ensure optimum use of available space for materials and equipment installed above ceilings. Allocate space in the order of priority as listed below except as otherwise detailed. Items are listed in the order of priority, with items of equal importance listed under a single priority number.
      1. Gravity flow piping systems
      2. Vent piping systems
      3. Recessed lighting fixtures
      4. Concealed HVAC terminals and equipment
      5. Air duct systems
      6. Sprinkler piping systems
      7. Pressurized piping systems
      8. Electrical conduit, wiring, control air tubing
   2. Order of space priority does not dictate installation sequence. Installation sequence shall be as required to install all affected trades.
   3. The work of this Division 22 shall not obstruct access for installation, operation and maintenance of the work of any other Division.
   4. All major items of equipment shall be arranged so as to provide a minimum of 28" clear aisle space. Additional space shall be provided between and around equipment for maintenance and proper operation as shown in the Equipment Manufacturer's literature.
4. COORDINATION
   1. Coordinate all work under this Division 22 with work under all other Divisions, providing adjustment as necessary.
   2. Coordination of space requirements with respect to Division 26 shall be performed such that:
      1. No equipment, piping or ductwork, other than electrical, shall be installed within 42" of switchboards or panelboards.
      2. No piping or ductwork which ever operates at a temperature in excess of 120°F shall be installed within 3" of any electrical conductor.
   3. All items mounted in or below the ceiling, and all items penetrating the ceiling, shall be coordinated with the architectural reflected ceiling plans. If any items are not shown on these plans, or any items need to be relocated for coordination purposes, prepare a reflected ceiling plan and submit it to the Architect for approval.
5. CODE COMPLIANCE
   1. All workmanship and materials provided under this Division 22 shall comply with all laws, ordinances, codes and regulations of all Federal, State and Local Authorities Having Jurisdiction.
   2. All fire suppression, plumbing, heating, ventilating, and air conditioning materials and workmanship shall comply with all local, state, and federal codes.

* 1. Secure and pay all fees associated with all permits and licenses required for execution of the Contract. Arrange for all inspections required by City, County, State and other Authorities Having Jurisdiction, and deliver certificates of approval to the Architect.
  2. The code requirements are strictly a minimum and shall be met without incurring additions to the Contract. Where requirements of the drawings or specifications exceed the code requirements, the work shall be provided in accordance with these drawings or specifications. In the event of conflict or ambiguity between the various codes, the most stringent requirement shall govern.

1. ELECTRICAL REQUIREMENTS AND INTERFACE
   1. All electrical equipment and wiring provided under this Division 22 shall comply with the electrical system characteristics indicated on the electrical drawings and specified in Division 26.
   2. Electric controls, contactors, starters, pilot lights, push buttons, etc., shall be provided complete as part of the motor, heater or other equipment which it operates. All electrical components shall be in conformance with the requirements of the National Electrical Code and Division 26. Starters shall be wye-delta, closed transition type. Reference Division 26 and the electrical engineering drawings for those motor starters provided under that Division 26. All starters not shown shall be provided under this Division 22. Unless specified otherwise under other individual equipment Sections, motor starters shall conform to the following minimum requirements:
      1. Starters for motors 1/3 horsepower or smaller shall be manual unless remote or automatic starting is required, in which case the starters shall be magnetic, full voltage, non-reversing, single-speed, unless otherwise indicated. All other starters shall be magnetic.
      2. Each starter for a three-phase motor shall be furnished with three (3) overload relays sized for the full load running current of the motor actually provided. Provide an external "HAND-OFF-AUTO" selector switch with red "RUNNING" light. Provide a green pilot light to indicate motor "STOPPED". Each pilot light shall have a legend plate indicating reason for signal.
      3. Each overload relay shall have a normally open alarm contact which will close only when actuated by an overload (not to be confused with N.O. or N.C. auxiliary contacts). These contacts shall be properly wired to their respective blue pilot light provided on the starter front cover and having a "TRIPPED" legend plate.
      4. Individually mounted motor starters shall be in a NEMA Type 1 general purpose enclosure in unfinished areas and shall be flush mounted in all finished areas. All starters mounted in exterior areas shall have a NEMA 3R enclosure. Each starter shall have a laminated nameplate to indicate equipment unit number, function and circuit number.
      5. All motor starters, push buttons and pilot lights shall be of the same manufacturer as the switchboard and shall be General Electric, Square D, Siemens I.T.E., or Westinghouse.
   3. Motor starters for the following equipment shall be provided under this Division 22 by the Manufacturer of the equipment:
      1. Packaged booster pump systems
      2. Pumps without VFDs
      3. Other equipment hereinafter specified in other Sections to be provided with integral starters
   4. Unless otherwise noted or specified in individual Sections, all 3-phase motors shall be standard NEMA continuous duty "B" type, with Class B insulation, open drip-proof frame for indoor service, TEFC for outdoor service and a service factor of 1.15. All motors 5 HP and larger shall be U.S. Motors Hi-Efficiency Model or Reliance XE Hi-Efficiency Model.
   5. All power wiring and final connections to equipment shall be provided under Division 26.
   6. Control components, all interlocks (control valves, leak sensors, etc.) and control wiring (120 volt, single phase and less) shall be provided under this Division 22 as required to achieve the specified control sequences.
   7. All control wiring over 30 volts shall be installed by a Licensed Electrician working under this Division 22.
2. SLEEVES, SEALS AND ESCUTCHEONS
   1. Sleeves shall be provided through all pipe penetrations of concrete or masonry walls, elevated floors and roofs, except those plumbing piping penetrations for fixtures, vents, etc.
   2. Sleeves shall be fabricated from Schedule 40 steel pipe through 10" and Standard Wall steel pipe for sleeve sizes 12" and larger. All sleeves penetrating exterior walls, underground walls, pit or vault walls shall be provided with a 3" x 3/8" thick waterstop ring welded completely to the midpoint of the sleeve.
   3. All sleeves penetrating exterior walls, underground walls, pit or vault walls and elevated floors shall be packed and sealed watertight.
   4. Sleeves through roofs shall extend above the roof surface and be flashed watertight.
   5. Sleeves through walls shall be cut and finished flush with each surface of the wall in which they are installed.
   6. Sleeves through elevated floors shall extend at least ½” above the finished floor and be sealed waterproof between the sleeve and slab.
   7. Sleeves shall be sized to provide a minimum of 1/2" clearance between the inside surface of the sleeve and the outside finished surface of the pipe plus any insulation specified.
   8. Fire-stops shall be provided as specified herein. All annular spaces between piping and sleeves which do not require fire-stops shall be packed with mineral wool and caulked.
   9. Fire-stopping or packing at elevated floor penetrations shall be level with or above the elevation of the top of sleeve to prevent any water ponding on top of the sleeve.
   10. Provide round, chrome-plated escutcheons on all exposed piping penetrations passing through walls, floors, partitions and ceilings.
   11. All penetrations through rated slabs, walls, etc. shall be in accordance with UL listed systems. Provide rated box-out, fire caulking, etc. as needed to ensure fire rating is maintained in compliance with UL listed systems.
3. FIRESTOPS
   1. Where piping, conduit, etc. pass through fire partitions, fire walls and floors, a firestop shall be provided that will ensure an effective barrier against the spread of fire, smoke and gases. Firestop material shall be packed tight and completely fill gaps between the ductwork, piping, conduit, etc. and the perimeter of their rough openings.
   2. All penetrations shall be in accordance with UL 1479 or ASTM E 814 listed systems, and products used shall be specifically applicable for the appropriate installation conditions. Assemblies shall provide a minimum rating equal to the construction penetrated. Products shall be by HILTI, 3M, or ProSet.
   3. Installation shall be by a Qualified Installer. Installer shall be certified, licensed, or otherwise qualified by the Firestopping Manufacturer as having the necessary training to install the Manufacturer’s specific product.
   4. Installer shall have at least one of the following qualifications:
      1. FM 4991 Approved Contractor
      2. UL Approved Contractor
      3. HILTI, 3M, or ProSet Accredited Fire Stop Specialty Contractor
   5. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach label permanently on both sides of penetrated construction in a visible location. The label shall include the following:
      1. The words “Warning – Through Penetration Firestop System-Do Not Disturb”
      2. Through Penetration firestop system designation and Manufacturer
      3. Date of Installation
4. CORE DRILLING
   1. Cutting of holes through concrete and masonry shall be by diamond core or concrete saw. Pneumatic hammer, impact electric and hand or manual hammer type drills will not be allowed, except as permitted by the Architect where required by limited working space. Locate holes such that they will not affect structural sections such as ribs or beams. Holes shall be laid out well in advance of the installation. These layout locations shall be approved by the Architect prior to drilling.
5. IDENTIFICATION OF PIPING
   1. All aboveground plumbing systems piping and valves sized 3/4" and larger which are installed in accessible locations (including piping above removable ceilings and behind access panels) shall be identified in strict conformance with the "Scheme for the Identification of Piping Systems" (ANSI A13.1).
   2. Piping labels in exposed areas shall be oriented and located in coordination with the Architect.
   3. System names shall, at minimum, uniquely identify the system and performance category - i.e. 140°F Hot Water Supply, High Pressure Cold Water, etc.
   4. Specialized piping (grease waste, acid waste, fuel piping, etc.) installed underground shall be labeled. The label shall be corrosion resistant or shall be permanently marked.
   5. Each identification marker shall include the following:
      1. Proper color-coded background
      2. Proper color of legend in relation to background color
      3. Proper legend letter size
      4. Proper marker length
      5. Direction of flow arrow shall be included on each marker
   6. Locations for pipe markers shall be as follows:
      1. Adjacent to each valve and fitting
      2. At each branch and riser take off
      3. At each pipe passage through walls, floors and ceilings
      4. On all straight pipe runs every 25 feet except that piping underground required to be labeled shall be labeled every 10 feet or more often as required by the AHJ
   7. Identification markers may be stenciled or shall be Setmark Pipe Markers, as manufactured by Seton Name Plate Corporation.
   8. All valves shall be identified with the appropriate service designation and valve number brass valve tags. Each valve tag shall be 19 gauge brass with 1/4" black-filled letters over 1/2" black-filled numbers. Tags shall be fastened to valves with brass "S" hooks or brass jack chain. Brass tags and fasteners shall be as manufactured by Seton Name Plate Corporation.
   9. Provide charts of all valves. Valve charts shall include the following items:
      1. Valve identification Number
      2. Location
      3. Purpose/Material

**PART 2 PRODUCTS**

1. BID BASIS AND SUBSTITUTION PROCEDURES
   1. Manufacturer names, series and model numbers, as noted or specified, are for the purpose of describing type, capacity, and quality of equipment, materials and products to be used. Unless "or equal" is specifically stated, bids shall be based only on the specified "basis of design" Manufacturer. The listing of a particular manufacturer as an "equal" or "acceptable substitute" manufacturer shall not be misconstrued as approving, nor allowing the substitution of, that Manufacturer's standard product in place of the basis of design. No consideration will be given to a product which would require dimensional, spatial or aesthetic changes to the project. "Acceptable substitute" and "equal" manufacturers shall only bid those products which exactly match the size and other characteristics of the specified basis of design. Any changes to other disciplines and trades of work required by an "or equal" or "substitute" product shall be duly considered and priced accordingly prior to bidding or pricing. The decision as to whether or not a proposed substitute or "equal" product is actually equal to that specified shall rest solely with the Architect.
   2. Requests to provide "equal" products in lieu of those specified shall be submitted to the Architect in writing at least ten (10) days prior to final pricing and execution of the Contract. No consideration will be given to substitute products after final pricing and execution of the Contract.
   3. Any "or equal" product or proposed product substitution which will cause a change in the appearance, dimensions or design of any part of the building, structure, electrical system, or any other engineered systems shall be accompanied by a scaled drawing and written description of the required change(s) for approval by the Architect. If deemed necessary by the Architect, design changes shall be signed and sealed by a registered Professional Engineer, currently licensed in this State. This shall be performed under the Contractor selecting the substitution’s scope.
   4. Any and all changes due to a substitution of basis of design equipment including but not limited to electrical connection, physical size, access, piping connections, controls, etc. shall be solely the responsibility of Contractor selecting the substitution.
2. MINIMUM STANDARDS
   1. Every piece of energy consuming equipment, all fire suppression products and life safety equipment shall comply with the following standards as applicable; especially in regard to prevailing codes:
      1. Factory Mutual Laboratories (FM)
      2. Industrial Risk Insurers (IRI)
      3. Underwriters Laboratories, Inc. (UL)
      4. ADC: Air Diffusion Council
      5. AGA: American Gas Association
      6. AMCA: Air Moving and Conditioning Association, Inc.
      7. ANSI: American National Standards Institute
      8. API: American Petroleum Institute
      9. AHRI: Air Conditioning, Heating, and Refrigeration Institute
      10. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers
      11. ASME: American Society of Mechanical Engineers
      12. ASTM: American Society of Testing and Materials
      13. AWWA: American Water Works Association
      14. IBR: Institute of Boiler and Radiator Manufacturers
      15. MSS: Manufacturers Standardization Society
      16. NBBPVI: National Board of Boiler and Pressure Vessel Inspectors
      17. NEMA: National Electrical Manufacturer's Association
      18. OSHA: Occupational Safety & Health Administration
      19. PDI: Plumbing Drainage Institute
      20. PPI: Plastic Pipe Institute
      21. CISPI: Cast Iron Soil Piping Institute
3. PIPE HANGERS AND SUPPORTS
   1. Pipe hangers, hanger rods, trapeze type hangers, upper attachments and other supports shall be selected based on pipe size (plus insulation of pipes specified to be insulated) and the weight of the medium being transported or the medium used for testing, whichever is greater. Provide all hangers and rods, turnbuckles, angles, channels, and other structural supports to support the piping systems. Rods for pipe hangers shall be full size of the Hanger Manufacturer's catalog listed rod size for each type hanger specified. Hangers and supports shall be Michigan, ITT Grinnell or B-Line.
   2. All material utilized for the hanging and support of the piping systems shall be manufactured products which are specifically intended for the purpose of hanging piping systems. The use of wire, steel straps, plastic ties, etc. is strictly prohibited.
   3. Pipe hangers selected for supporting horizontal insulated piping shall be sized to fit around the outside of the pipe insulation. Insulated piping shall be supported on galvanized shields.
      1. Shields shall be as follows:
         1. Pipes 2" and smaller: 18 gauge x 12" long
         2. Pipes 2 1/2" and larger: 16 gauge x 18" long
      2. Shields shall be 180 degrees around the lower half of the pipe at all pipe hangers, except that on trapeze hangers, pipe racks and floor supported horizontal pipes, shields shall be 360 degrees around the entire pipe.
   4. Pipe hangers touching copper piping shall be copper plated or the piping shall be dielectrically isolated from any steel hangers or clamps that are used. Note the requirement for domestic water piping requires the hangers to be installed over the insulation.  
      Steel rods, framing and clamps shall be plated or primed to prevent rust formation.
   5. All piping installed outside the building shall be secured to the structure. Coordinate with the Structural Engineer as needed. It is the Contractor’s responsibility to design and coordinate all supports. All supports shall be designed to withstand all code-required wind and seismic loads.
   6. Wind and seismic roof supports for piping shall be Mifab CZ or approved equal.

**PART 3 EXECUTION**

1. GENERAL
   1. All piping, valves, and fittings shall be products of a domestic Manufacturer and made in the USA.
   2. Flexible piping connections shall be provided and installed at all suction and discharge connections of packaged booster pumps and at any pump 2.0 HP and above. Flexible piping connections shall be suitable for 300 psi working pressure or the system pressure at the installation location, whichever is greater, and be suitable for the temperature of the system. Flexible connections shall be stainless steel braided hose type, with a length not less than their pipe diameter. Provide and install restraining rods if recommended by the Manufacturer for the installation location and application.
   3. Provide and install shut-off valves at any and all equipment including water heaters, domestic booster pumps, recirculation pumps, storage and pressure tanks, etc. and at any locations required by code, such as branch lines from risers serving more than one fixture. Shut-offs shall be in addition to those specifically shown or noted in the Contract Documents.
   4. All materials and equipment shall be listed according to Landmark’s Construction Appendix A – Product Selection.
2. SUBMITTALS
   1. Before preparing submittals, study all Contract Drawings and specifications in detail, obtain manufacturer's recommended instructions, and have submittals prepared based on specific equipment and material proposed for installation. An officer of the contracting firm shall sign all shop drawings (certifying conformance with plans and specifications) before submitting to the Architect or releasing to the field.
   2. The submittal process shall not be utilized as an avenue to substitute products after the execution of the contract. Should an unspecified or unequal product be submitted, it will be rejected. If a second attempt at substitution is made during the resubmittal of the same product, then no more reviews of that product will be performed without direct compensation to the Engineer being paid for the additional services required for the third review and any further reviews.
   3. All submittals shall be submitted and returned electronically.
   4. Submittals will not be accepted for review unless they:
      1. Comply with the requirements of Division 1.
      2. Include complete information pertaining to all appurtenances and accessories.
      3. Are submitted as complete packages which pertain to all related items in Division 22. Separate packages shall be submitted as follows:
         1. All plumbing equipment, piping, specialties, and components
         2. All plumbing fixtures
      4. Are properly marked with equipment, service or function identification as related to the project and are marked with pertinent specification paragraph number.
   5. Submit catalog information, factory assembly drawings, field installation drawings and certifications as required for complete explanation and description of all items of equipment. The submittal data shall provide ample, unquestionable compliance with the Contract Documents.
   6. Review of submittals shall not be construed as authorizing any deviations from the plans and specifications unless such deviations are clearly identified and separately submitted in the form of a letter that is enclosed with the submittals.
   7. Submittals are required on all manufactured equipment, especially energy consuming equipment. Submittals shall include, but are not limited to, the following items of equipment:
      1. Piping and Piping Specialties
      2. Insulation
      3. Heat Tracing
      4. Water Heaters
      5. Pumps
      6. Plumbing Fixtures
      7. Compressed Air, Vacuum, and Gas System Piping Shop Drawings and Equipment
      8. Piping Shop Drawings
      9. Generators
      10. Remote Fuel Fill Stations for Generators
      11. Firestopping Products and Applicable UL Firestop Details
3. EXCAVATION, TRENCHING AND BACKFILLING
   1. Perform all excavation, trenching and backfilling for underground work under this Division 22. During excavation, the excavated material shall be piled back from the banks of the trench to avoid overloading, slides or cave-ins. Do not exceed the angle of repose unless written approval is obtained in advance from the Architect for shoring, bracing or other alternate excavation methods. All excavated material not used for backfilling shall be removed from the building and disposed of as indicated or directed by the Architect. Take measures to prevent surface water from flowing into trenches and other excavations and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. Tunneling shall not be allowed.
   2. The bottom of all trenches shall be evenly graded to provide firm support and an even bearing surface. Pipe shall be laid on firm soil, laid in straight lines and on uniform grades. Provide bell holes so that the barrel of the pipe rests evenly on the bottom of the trench along the entire length of the pipe.
   3. Pipe shall be inspected and tested prior to backfilling. Trench shall be handfilled to a minimum of 12" above the top of pipe with suitable earth (free of rocks, trash, large clods and organic material) and compacted to a minimum 95% proctor. After the first layer is completed, subsequent layers shall be filled and compacted the same as the first layer. Settling the backfill with water shall not be permitted.
4. INSTALLATION REQUIREMENTS
   1. All equipment shall be installed in strict conformance with the recommendations of the Equipment Manufacturer, as indicated on the Drawings, and as specified.
   2. Provide installation manuals for each piece of equipment. Submit in separately bound volumes after review of submittals.
   3. Provide supplementary steel framing and welded steel equipment support stands as required for proper hanging and support of the plumbing systems. Steel angles, channels and tubing utilized for such framing shall be selected for a maximum deflection of 1/360th of the span.
   4. All roof curbs shall be a minimum of 12" high and selected for the various roof pitches. Curbs installed on roofs having pitches of not more than 1/4" per foot may be standard curbs shimmed level with steel channels or Zs to provide suitable support and flashing surfaces.
5. CLEANING, LUBRICATION AND ADJUSTMENT
   1. The exterior surfaces of all plumbing equipment, piping, conduit, etc., shall be cleaned and free of all dirt, grease, oil, paint splatter, and other construction debris.
   2. Bearings that require lubrication shall be lubricated in strict accordance with the manufacturer’s recommendations.
   3. All control equipment, valves, equipment settings, pressure tanks, etc. shall be adjusted to the settings required for the performance specified.
   4. All materials, equipment, etc. subject to weather, corrosion, dust, debris, water etc. to be installed or utilized for the project shall be fully protected. This is inclusive of piping and duct openings and internal fan ventilation intakes and discharges. This Division’s scope includes protection and remediation of any and all Division materials, etc. including cleaning, vacuuming, dusting, etc. required for a clean system and operation. Insulation and equipment with electrical connections subject to water shall be replaced in their entirety. Coordinate with all other trades and schedules.
6. PAINTING
   1. All uncoated and uninsulated steel surfaces exposed to sight inside the building, such as piping, equipment hangers and supports, which are not provided with factory prime coat or galvanizing, shall be cleaned and painted with one coat of rust inhibiting primer. In addition, all surfaces in finished spaces shall also be painted with two coats of finish paint in a color selected by the Architect.
   2. Steel items exposed outside the building, such as equipment supports, uninsulated piping and hangers which are not factory painted or galvanized shall be cleaned and painted with one coat of rust inhibiting primer and two coats of asphaltic base aluminum paint. Insulated steel pipes outside the building shall be cleaned and painted with one coat of rust inhibiting primer before installing insulation.
   3. Factory painted equipment that has been scratched or marred shall be repainted to match the original factory color.
7. PIPING LEAK TESTING
   1. Sanitary, waste, storm, and vent piping shall be tested with water before installing fixtures. Water test shall be applied to the system either in its entirety or to the individual sections. Each opening except the highest opening of the section under test shall be plugged, and the section shall be filled with water and tested with a head of water of at least ten (10) feet above the highest point in the system. The water shall be kept in the portion under test, for at least thirty (30) minutes; no drop in the water level will be acceptable.
   2. The water piping systems shall be tested at a minimum pressure of 125 psi, or 1.5 times the system operating conditions, whichever is greater, and proved tight at this pressure for not less than thirty (30) minutes or longer if required to permit inspection of all joints. No loss in pressure will be permitted.
   3. All compressed air piping shall be tested pneumatically and proved tight at a pressure of not less than 100 psi for a period of not less than two (2) hours. No loss in pressure will be permitted.
   4. All leaks shall be repaired by tightening, remaking joints, or replacing pipe and fittings. Caulking of joints shall not be permitted.
   5. See specification section 23 1123 for testing requirements of natural gas and liquid propane gas piping. System shall be part of Division 22 scope unless otherwise arranged within the Contract. Coordinate with Division 23.
8. RECORD (AS-BUILT) DRAWINGS
   1. At the completion of the project, provide a set of reproducible prints to the Architect which reflects all changes, deviations and revisions made to the original design documents. Locations of all underground piping and utilities shall be clearly shown and dimensioned from permanent reference points such as building column lines. Record drawings shall be produced in electronic format compatible with AUTOCAD. Furnish electronic copies of all drawings in dwg. format, and two (2) bond copies of all drawing sheets. As-Builts for electronic incorporation by the Design Team, as applicable, shall be redline mark-ups of the Construction Documents.
9. OPERATING AND MAINTENANCE MANUALS AND INSTRUCTIONS
   1. Complete operating and maintenance manuals shall be provided to the Owner. Four copies shall be provided. Each copy shall be bound in a separate 3-ring, loose leaf notebook. Operating instructions shall be provided for each plumbing system, and shall each include a brief system description, a simple schematic and a sequence of operation. Operating and maintenance instructions shall be provided for each piece of equipment. A control system wiring diagram shall be included in each operating and maintenance manual.
   2. Prior to final acceptance or beneficial occupancy, provide the services of a Competent Technician for not less than one (1) day to instruct the Owner in the operation of the plumbing systems.
10. MINIMUM HANGER SPACING
    1. Pipe hangers or supports shall be provided within 18" of each horizontal fitting, equipment connection, valve, etc. and within 18” of the centerline of horizontal or vertical changes in direction summing to 90° or more. Specific attention is called to turns into vertical risers.
    2. Piping supports shall be provided, at a minimum, in accordance with the greater of the below or code minimum. Where the below or code does not address support for specific piping, supports shall be in accordance with manufacturer’s requirements.

Piping Material Max. Horz. Spacing Max. Vert. Spacing

Cast-iron pipe 5’ 15’

Copper pipe 12’ 10’

Copper tubing ≤ 1-1/4” dia. 6’ 10’

Copper tubing ≥ 1-1/2” dia. 10’ 10’

\*\*CPVC pipe ≤ 1” diameter 3’ 10’\*

\*\*CPVC pipe ≥ 1-1/4” dia. 4’ 10’\*

PVC pipe 4’ 10’\*

\*\*PEX 32” 10’\*

\*Midstory guide required for piping 2” diameter and smaller

* 1. Riser clamps shall be provided at each floor penetration. For pressurized piping systems, provide vibration isolation at all riser clamps with two (2) pad-type mountings consisting of a minimum 3/8" thick ribbed or waffled elastomeric pads bonded between minimum 16-gauge galvanized steel separator plates. Pads shall be sized for a deflection of 0.12" to 0.16". Pads shall be minimum 3"x3" square.

1. WARRANTY
   1. All work provided under this Division 22 shall be subject to a minimum one year warranty. The warranty shall include prompt repair or replacement of equipment or system failures and shall include all parts and labor. In addition, all compressors shall carry an additional four year parts-only warranty. Extended warranties shall be provided on all other equipment so specified in other Sections.
2. BIM MODELING AND COLLISION DETECTION
   1. The Contractor shall utilize 3D modeling for coordination and collision / interference detection software simulation. This model will be used for coordination, collision detection and inference from all trades: mechanical, plumbing, electrical, fire protection, etc. Each SubContractor is responsible for preparation of a 3D/BIM model of their system for Contractor collision detection and coordination. This model shall be used for as-built documentation for the Owner. Contractor 3D Model shall be latest version of Revit, Navisworks, or equal.
   2. Upon completion of the BIM Model, provide the Engineer a full set of shop drawings for their review. Shop drawings shall meet the below requirements.
3. SHOP DRAWINGS
   1. Shop drawings per the submittal requirements shall be submit to the Design Team with adequate time for multiple rounds of review. Shop drawings shall show “As-Built” conditions including elevations, offsets, transitions, and accessories. Shop drawings shall indicate all code and manufacturer’s recommended clearances, access, and coordinate the clearance and access requirements with all other trades.
   2. Shop drawings that use keynotes direct from the Design Documents shall not be acceptable as they do not demonstrate coordination with all other trades, necessary transitions, etc.
   3. Shop drawings shall be provided as complete packages in parallel with all trades to document coordination. Floor-by-floor or otherwise piecemeal shop drawings are generally not acceptable.
4. OWNER TRAINING
   1. Owner training shall be provided for all systems and equipment and shall include the following:
      1. 8-hours of training for each type of equipment
      2. 16-hours for overall system operational training
   2. A training summary and schedule shall be submitted to the Architect for approval within ninety (90) days of the date of substantial completion.
   3. Training timing will vary and shall be assumed to include multiple sessions as required by the Owner.
5. BID REQUIREMENTS
   1. The Contractor shall include all systems, equipment and accessories shown on the plans and specifications.
   2. The Contractor is responsible for providing all Contract Documents to all SubContractors. All systems, equipment and accessories shall be included in the bid, whether shown on the SubContractor applicable plans or other design documents.
   3. Should any discrepancy occur in the Contract Documents, the Contractor shall provide a request for clarification prior to bid or note the discrepancy in the bid and provide an appropriate cost allowance in the bid.
   4. The Contractor shall acknowledge that the Contract Documents are diagrammatic and shall provide all systems, equipment and accessories required for a complete facility. Any areas that appear to be void of systems or inappropriate systems shall be noted in the bid. No post bid change order shall be considered for areas or discrepancies not noted in the bid.
   5. All installation coordination and means and methods and labor and materials required for proper system installation shall be included.
   6. These requirements are in addition to bid procedures and requirements of the RFP or general specifications.

**END OF SECTION**