# DIVISION 15 - MECHANICAL

## Section 15000 - General Discussion

### Introduction

The work shall be in accordance with all rules, regulations, by-laws and requirements of all authorities having jurisdiction.

Refer any questions, clarifications regarding Division 15 to UA Facilities Design & Construction.

### Part 1 - General

- Codes
  - The project shall comply with the latest edition of the following codes unless otherwise stated:
    - Arizona State Fire Code
    - International Building Code (2003)
    - National Electrical Code (2002)
    - OSHA 1910, regulations 29 CFR 1910 and 1926
    - International Mechanical Code (2003)
    - International Plumbing Code (2003)
    - N.F.P.A. in total
    - Americans with Disabilities Act
    - ASHRAE 90.1 - Energy
    - IAQ Guidelines for Occupied Buildings Under Construction (SMACNA)
    - ASHRAE Standard 62 (Ventilation)
    - ANSI/AIHA Z9.5 Laboratory Ventilation
    - ACGIH Industrial Ventilation Manual of Recommended Practices
    - OSHA 29 CFR 1919.146 Confined Spaces Standard

- Working In Confined Spaces
  - Whenever work is required within a confined space, e.g., utility vaults, utility tunnels, sumps, pits, sewers, etc., contact UA Risk Management and Safety Department for details and procedures on UA Confined Space Entry Program.

- Laboratory Design Criteria
  - Refer to UA DSS Tab C-3.
  - Discuss fume hood selection and HVAC system criteria with UA Facilities Design & Construction.

- Record Drawings
  - Provide a set of prints and clearly mark, as the job progresses, all changes and deviations from that shown on Contract Drawings. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include; change orders, field instructions and all other changes.
  - Reference Division 01300 for further details.

- Buried Services
  - After inspection and approval of service lines in trenches, provide a continuous trace wire and attach to service line directly. The Mechanical Contractor shall take ‘as-built’ measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Definite measurements shall be taken for each service line. The location of buried piping shall be shown on the drawings and dimensioned from fixed points.

- Temporary Use Of Equipment

  - Permission must be obtained from Architect/U of A prior to operating any mechanical systems during construction.
  - Where the mechanical systems are operated during construction, the Mechanical Contractor shall maintain the system and equipment in proper operating condition.
  - Before any area of the building is turned over to the U of A for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition e.g., by replacing used air filters with new air filters, cleaning the air side of all coils in the air handling systems, lubricating all bearings according to manufacturer's factory standards and adjusting control systems according to specifications and/or to suit the U of A.

- Provision For Future Expansion And/Or Installations

  - Where piping, ductwork and equipment is indicated for use in future expansion of the building and/or for future installations within the building, the Contractor shall leave sufficient clear space and install the piping, ductwork and equipment in such manner that connections to the future building expansion and/or future installations within the building can be made without removing existing floors, walls, ceilings. The Contractor shall consult with the Architect/U of A whenever necessary for this purpose.

  - Any piping stub-outs provided for future connections to domestic hot and cold water piping systems shall be arranged so that “dead legs” (i.e., pipe sections where there is no water circulation) are prevented. The termination point of any piping stub-out shall be as close to the main piping flow as physically possible. Where future branch lines must extend a distance greater than six (6) branch line pipe diameters or more than 18” from the main piping flow, a valved drain port or blind flange with a valved drain shall be provided at the end of the branch piping to allow periodic flushing.

  - Abandonment of Domestic Water Piping

    - Verify routing of existing domestic hot and cold water piping systems prior to their being abandoned. Cap abandoned branch lines as close as physically possible to the main piping flow to eliminate “dead legs”. Elimination of “dead legs” shall not hinder the proper operation of any existing hot water return, i.e., recirculation, systems.

**Part 2 - Products**

- No discussion.

**Part 3 - Execution**

- No discussion.

**End of Section 15000**

# DIVISION 15 - MECHANICAL

## Section 15050 - Basic Mechanical Materials and Methods

### Introduction

Mechanical systems materials and methods of installation common to some or all of mechanical systems sections in Division 15.

### Part 1 - General

- All piping and ductwork in finished areas shall be concealed in ceiling spaces, shafts, or chases.
- Electrical conduits shall not touch or be supported via pipes or ducts.
- Ensure fire and smoke separation rating of walls and floors is maintained following penetration.
- All electrical work associated with Division 15 shall comply with requirements of Division 16.

### Part 2 - Products

- Valves
    - Sizes 6" and above shall have gear operator ball chain if located more than 7 ft. above floor.
    - Provide isolation Ball valves - 100% full-port, full-line size, bronze-body, threaded connections at all equipment and on all main branch take-offs.
    - Provide brass valve tags marked for the service. See pertinent service specification for valve type.
    - Butterfly valves shall be 100% bubble-tight shut-off. Lug type only. Iron body with bronze disk. Valves to have two year warranty. Use for throttling/balancing. Preferred manufacturers are Norris, Centerline or UA approved equal.
- Piping Labels
    - Provide at directional changes and/or each 20 ft. Labels to be pre-manufactured snap-on plastic wrap-around type sized to cover entire circumference of piping and insulation.
    - Labels to have integral color identification as established by ANSI Standard A13.1 - 1981.
    - Lettering shall be sized to be easily legible. Directional arrows shall indicate direction of flow and shall be located to point away from lettering.
- Escutcheons
    - Install in exposed locations, except in mechanical rooms.
    - Escutcheons to be hinged, chrome-plated type.
- Pipe Sleeves / Concrete Walls & Floors Above Grade
    - Shall be schedule 40 steel.
    - Sized for full dimensions of insulation and fire caulked where required.
    - Install in all exterior walls, fire walls and floors.
    - Floor sleeves to extend 1” above floor surface.
- Pipe sleeves in non-rated, non-masonry walls or partitions. Provide 24 gage galvanized steel.
- Pipe sleeves in rated non-masonry wall or partitions – provide listed approved fire-rated assemblies.
- Pipe sleeves installed below ground through exterior walls shall have mechanical type neoprene seals.

- Do not support pipe with sleeve.
- Pipe Hangers
  - Pipes on trapeze type hangers shall be firmly secured.
  - Use Vibra-Zorb cushioned supports on 1 ¼” pipe and smaller which is connected to vibrating equipment.
  - Provide piping support hangers to ensure that no sags occur. Minimum hanger rod sizing and maximum hanger spacing shall conform to following table:

| | Pipe Size | Spacing | Hanger Rod |
|---|---|---|---|
| • Steel Pipe | ½” | 6’-0” | 3/8” |
| | ¾” through 1-¼” | 8’-0” | 3/8” |
| | 1-½, 2” | 10’-0” | 3/8” |
| | 2-½” | 10’-0” | 3/8” |
| | 3” | 12’-0” | 3/8” |
| | 4” | 12’-0” | 3/8” |
| | 5” | 12’-0” | 1/2” |
| | 6” | 12’-0” | 1/2” |
| | 8-12” | 12’-0” | 5/8” |
| • Copper Pipe | ½” | 6’-0” | 3/8” |
| | ¾” , 1” | 8’-0” | 3/8” |
| | 1-¼ through 4" | 10’-0” | 3/8” |
| | 5”- 6” | 12’-0” | 1/2” |
| | 8” and above | 12’-0” | 5/8” |
| • Cast Iron | 1 ½ “- 2” | 1 ea. Joint | 3/8” |
| | 3” | 1 ea. Joint | 1/2” |
| | 4” through 6” | 1 ea. Joint | 1/2” |
| | 8” and above | 1 ea. Joint | 5/8” |

  - Vertical risers shall be supported at each floor line with steel riser clamps.
- Equipment Nameplates.
  - Provide nameplates for all pieces of equipment.
  - Nameplate shall be minimum of 3/32" thick laminated phenolic plastic.
- Access Doors
  - Minimum size 18" x 18" - provide 24” x 24” wherever possible.
- Motors shall have premium efficiency EPAC rating in accordance with IEEE Standard 112 test method B.
- Motors shall have a minimum service factor of 1.15 and the design load shall not exceed 1.0.
- Motors located in conditioned space shall have an ambient rating of 104˚ F (40˚C). Motors in unconditioned space shall have an ambient rating of 122˚F (50˚C).

**Part 3 - Execution**

- Workmanship
  - Piping to run parallel to building lines.
  - Locate groups of pipes parallel to each other, spaced to permit valve servicing.

- Particular attention must be paid to the proximity of mechanical piping and equipment to electrical conduit and cable.
- All underground utility pipe shall have a tracing wire that is electrically continuous. The wire shall be 14TW AWG stranded (green) wrapped around or buried alongside the pipe. The wire shall be terminated at either end in a box flush with the ground with 3 feet of coiled wire in the box.
- Pitch piping in direction of flow 1" per 40 ft.
- Piping to be inspected and pressure tested prior to insulation.
- Piping to be routed to allow access to equipment.
- Welding to be done by welders certified locally in the State of Arizona. Welders must have proof of certification in their possession.
- Weld inspection

  - Visual inspection on low pressure piping (CHW, Condensate, LPS, HW, etc.).
  - Visual inspection and optional radiography on medium and high pressure steam piping (MPS, HPS).

- Provide access in accordance with Manufacturer's recommendations, to all equipment to allow maintenance and servicing.

- Installation

  - Install strainers with full port ball valve size to strainer blowdown port. Install hose threaded connection on valves 3/4" and below.
  - All gauges to be installed with a single gauge manifolded with ball valves on both sides of pumps, heat exchangers, tunnel supply and return, etc.
  - Install valves with stems in vertical position except ball valves. Do not go below horizontal with ball valve stems.
  - Use 10 mil plastic wrap around copper pipe on ferrous hangers or supports.
  - Use dielectric fittings whenever joining dissimilar metals.

- Equipment Installation/Removal

  - Install to facilitate servicing, maintenance and repair or replacement of equipment components with minimum of interference with other installations.

  - Provide a means of removing any valve that is larger than 2" and is mounted six feet or more above floor level.

  - Domestic Water Piping Arrangement

    - Install to prevent the existence of sections of piping where water could stagnate, i.e., where no water circulation occurs.
    - Provide recirculating loops for all domestic hot water piping systems with pipe runs longer that 50 feet.
    - Arrange piping in such a manner that there are no "transitory dead legs", i.e., piping branch lines that contain stagnant water. All abandoned branches or futures to be as close to main as possible, but in no case longer than 6" pipe diameters or 18" for pipe over 3".
    - Refer to "Provisions For Future Expansion And/Or Installations" Section 15000 - General Discussion for the installation requirements of future connections.

**End of Section 15050**

**DIVISION 15 - MECHANICAL**

**Section 15100 - Valves**

**Introduction**

A listing of valves, their types and applications associated with the following mechanical systems:

Plumbing piping and specialties (Section 15410)
Hydronic piping and specialties (Section 15510)
Steam piping and specialties (Section 15520)
Specialty valves used only in a particular type of mechanical system may be found in design standards for that system

**Part 1 - General**

- Install valves of type and service outlined in locations outlined in this standard
- Standard products - use same manufacturer for multiple units of same type

**Part 2 - Products (Valves)**

| Service | Size | Type | Material | Connections |
|---|---|---|---|---|
| Plumbing System (15410) | All | Gate | Bronze Body | Threaded |
| Dom. Water | All | Ball | Bronze Body | Threaded |
| Dom. Water | Thru 2" | Globe Disk | Bronze Body With Teflon Disk | Threaded |
| Dom. Water | 22" & Larger | Globe Disk | Iron Body With Teflon Disk | Flanged |
| Dom. Water | All | Relief Valves | Bronze Body, Teflon Seat | Threaded |
| Natural Gas | All | Lubricated Plug Cock | Iron Or Bronze Body | Threaded |
| Hydronic Piping (15510) | Thru 2" | Ball | Bronze Body | Threaded |
| | 22" & Larger | Butterfly | Iron Body With Bronze Disk | Lug Type |
| Steam | Thru 2" | Globe Disk | Bronze Body With Teflon Disk | Threaded |
| Condensate | All | Ball | Bronze Body | Threaded |

- Ball valves shall be 100% full port, full line size.
- Butterfly valves to have 100% bubble tight-shut-off and full port sizing. Valves to have two year warrantee. Valves to be manufactured by Norris or Centerline.
- Gate valves to have non-rising stem and handwheel, inside screw and renewable composition

disk

**Part 3 - Execution**

C Workmanship

- Valves 6" and over shall have gear operator ball chain fall if located more than 7 feet above floor
- Provide butterfly valves at all equipment and on all main branch take-offs
- Provide globe disc valves at all equipment and on all main branch take-offs in steam piping system
- Provide gate valves, ball valves and globe valves at all equipment and on all main branch take-offs
- Provide relief valves on piping and equipment as needed to meet code requirements
- Provide plug cock valves at connections to gas-fired equipment and in all branch piping.

**End of Section 15100**

**DIVISION 15 - MECHANICAL**

**Section 15200  Sound And Vibration Control**

**Introduction**

Equipment associated with the insulation and attenuation of airborne and impact sound.

Mechanical equipment, ductwork and pipework shall be isolated to ensure that applicable noise criteria curves as outlined in current ASHRAE Handbook are not exceed.

**Part 1 - General**

Standard products - use same manufacturer.

**Part 2 - Products**

**Part 3 - Execution**

- Provide vibration isolation for all mechanical motor driven equipment and for all horizontally suspended fan coil units.
- Provide neoprene side snubbers or restraining springs where side torque or thrust may develop.
- Spring mounts for equipment with operating weight different from installed.
- Provide adjustable limit stops on spring mounts for equipment with operating weights different from installed weight.
- Provide spring isolators on piping connected to isolated equipment as follows:
    - Up to 4" diameter - first 3 points of support
    - to 8" diameter - first 4 points of support
    - diameter and larger - first 6 points of support
- First point of support shall have a static deflection of twice the deflection of the isolated equipment.
- Isolators located outdoors or in a moist environment shall have 'hot-dipped' galvanized housings and 2 coats of neoprene on springs.
- Isolators shall not have less than 30% reserve capacity.

- <u>Flex Connections</u>

- Provide in piping connections to all reciprocating and/or rotating mechanical equipment.
- Provide in duct connections to AHU's.

- Silencers
  - Silencers to have rounded inlets and tapered diffuser outlets.
  - Absorption media to be bacteria and fungus resistant.

**End of Section 15200**

**DIVISION 15 - MECHANICAL**

**Section 15250 - Mechanical Insulation**

**Introduction**

Insulation products associated with:

- PIPING, DUCTWORK

**Part 1 - General**

- Use wrapped supply ductwork, except in acoustically critical applications where liner may be used only after written permission is given by the U of A/FDC. Lined ducts shall not be used in medical areas, clean rooms, all high velocity supply ductwork.

**Part 2 - Products**

- Pipe Insulation Schedule (minimum)

| Fluid Design Operating Temperature Range, ºF | Conductivity Range Btu•in./(h•ft²•ºF) | Mean Rating Temperature ºF | Nominal Pipe Diameter (in.) 1" and less | 1 ½" - 2" | 2 ½" - 4" | 5" - 6" | 8" and Larger |
|---|---|---|---|---|---|---|---|
| | | | Minimum Insulation Thickness (in.) | | | | |
| 251-350°F | 0.29-0.31 | 200 | 2.0 | 2.5 | 2.5 | 3.5 | 3.5 |
| 201-250°F | 0.27-0.30 | 150 | 1.5 | 1.5 | 2.0 | 2.0 | 3.5 |
| 141-200°F | 0.25-0.29 | 125 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| 105-140°F | 0.24-0.28 | 10 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |
| 40-55°F | 0.23-0.27 | 75 | 0.5 | 0.75 | 1.0 | 1.5 | 1.5 |
| Below 40°F | 0.23-0.27 | 75 | 1.0 | 1.5 | 1.5 | 1.5 | 1.5 |

- Duct Insulation (minimum)
  - 2" fiberglass with foil back wrap with a minimum density of 0.75 lb./ft3.
  - 1" fiberglass duct liner with heavy duty surface, (see Part 1 - General).

- Pipe Insulation Jacket
  - Interior, concealed - fiberglass, All Service Jacket (ASJ).
  - Interior exposed or in equipment rooms – cover piping less than 10 feet above finish floor with 8 oz. Canvas jacket sealed with water based lagging adhesive and sizing compound, like Foster 30-30.
  - Tunnel piping and exterior piping - fiberglass ASJ covered with embossed aluminum jacket with banding at joints and sealed with 25 year clear silicone.
  - Any insulated pipework installed within an air handling unit to be covered with PVC jacket.

- Equipment Insulation
  - Rigid, foil faced, fiberglass with a minimum density of 3.0 lb./ft.3.

  Misc. Product

  - Closed cell foam insulation which meets smoke developed/flame spread ratings of 50/25 may be used only for interior refrigerant service applications

**Part 3 - Execution**

- Provide fitted insulation which can be removed and reused around equipment, valves, flanges, etc.
- Use Z-strips on all leading edges of duct liner, (when permitted).
- Insulated fittings, i.e., elbows, tees, Y's to be packed and fitted with PVC covers.
- Install insulation per latest edition SMACNA Duct Construction Standards.
- Use welded pins for ductwork insulation attachment. No mechanical or glued attachments allowed.
- For pipe sizes greater than 1¼" provide calcium silicate inserts and metal shields to protect the insulation at each support.
- Domestic hot water piping shall be insulated.
- Cooling system condensate drain lines shall be insulated, including roof and area drains carrying condensate.
- Piping carrying fluid below 65˚F and all steam piping to be insulated continuously through clamping, support and sleeving.

**END OF SECTION 15250**

**DIVISION 15 - MECHANICAL**

**Section 15300 - Fire Sprinkler Systems**

**Introduction**

This work shall be in strict accordance with all rules, regulations, by-laws and requirements of all authorities having jurisdiction including, but not limited to; NFPA codes, Arizona State Fire Code, U of A Department of Risk Management and Safety.

**Part 1 - General**

- Hydraulic calculations shall be prepared and sealed by a registered professional engineer in the State of Arizona, and Sprinkler System Shop drawings to be submitted to the State Fire Marshal for approval.

- Hydraulic design calculations, shall include an allowance for a 10PSI pressure drop for the future installation of a back-flow preventer.

- Engineer and Contractor to conduct water supply static and residual tests, witness by the UA, and provide fire flow information on shop drawings and hydraulic calculations.

- In new construction or where space allows in renovation projects, provide a “pipe spool piece” to accommodate the future installation of a back-flow preventer.

- Provide an 8 ½" x 11" Map Key Plan for each floor of building, indicating the location of the following:

    - Main Control Valves
    - Fire Alarm Panel
    - Fire Dept. Connection
    - Back Flow Preventer (if provided)
    - Fire Alarm Bell
    - Auxiliary Drain Valves
    - Inspectors Test Connections

- Key Plan shall be provided at main control/zone valve location. See Typical Detail 15300-D1.

- All valves shall be readily accessible for maintenance.

- Provide system signage and identification in accordance with NFPA 13.

- Provide an additional copy of system “as-built” drawings for use of U of A Fire Safety Dept.

- To facilitate the annual fire pump test required by NFPA all fire pump installations shall include a valved by-pass. This by-pass is in addition to the by-passes normally prescribed for the jockey pump and suction supply pressure line, both of which employ a check valve. The testing by-pass allows the test to be performed without flooding the streets. A small valved drain should also be provided with this testing by-pass to remove some of the heated water generated by the pump test.

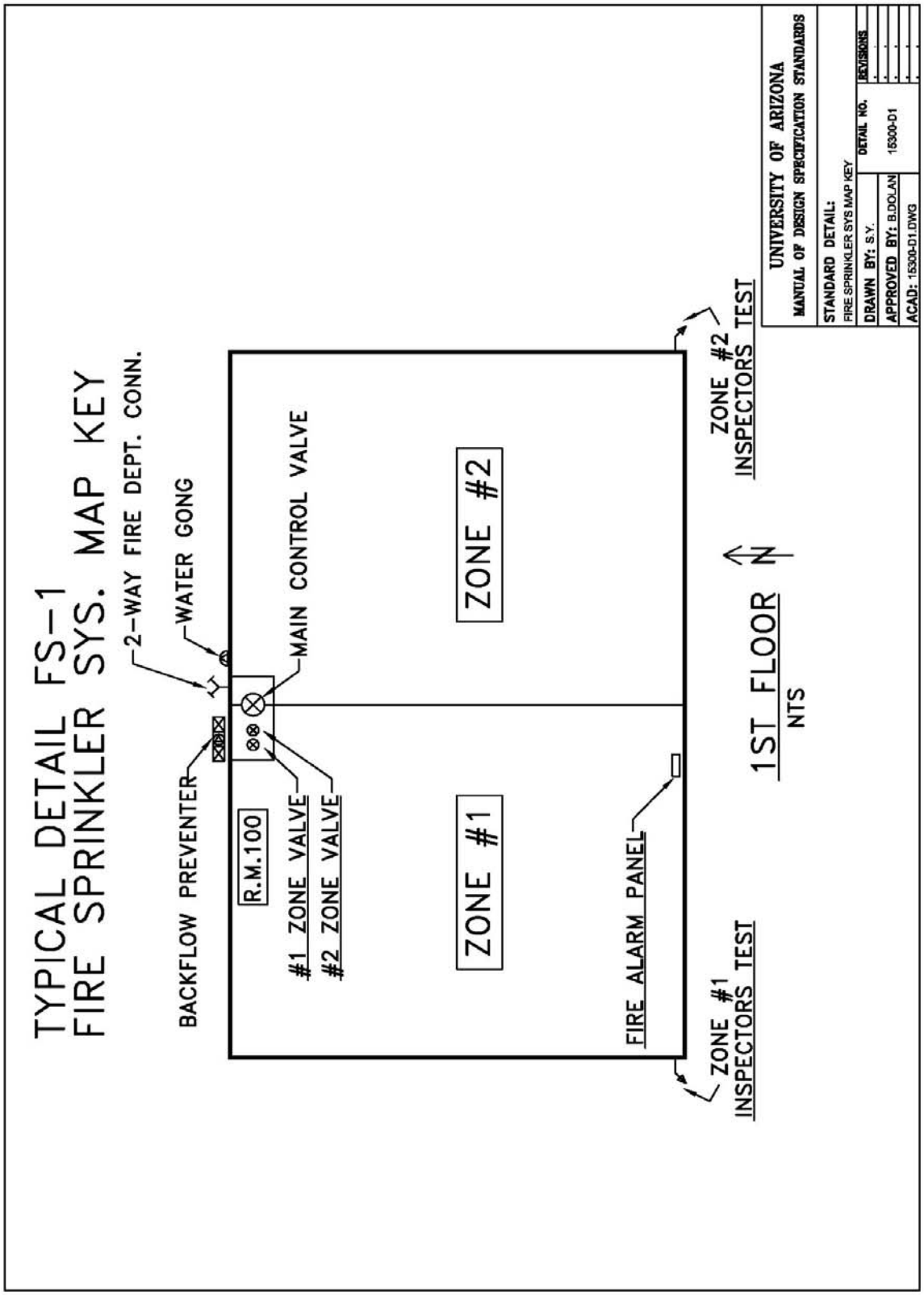
**Part 2 - Products**

- Piping shall be schedule 40 ASTM A-53 Grade A or B.

- All grooved fittings shall be manufactured by Victaulic.

**Part 3 - Execution**

- In areas subject to freezing provide minimum pipe size of 2".
- U of A Risk Management and Safety and UA Fire Safety Dept. to be notified 48 hours in advance of all system tests, e.g. underground flushing, hydrostatic test, flow alarm test, fire pump test (if applicable), fire alarm/final acceptance test.
- No saddle type fittings shall be used on fire protection systems.
- Inspector's Test Connections and main drain shall be piped to a suitable location outside of building. (Confirm location with U of A Fire Safety Dept.). Do not pipe to a floor drain, janitor's mop sink or similar.
- System piping should not be buried beneath building slabs on grade.
- In all new construction the entire system shall have a final heads on 2 hour 200 psig pressure test through the FDC.
- Check valves, sprinkler valves and flow switches and main drain valve shall be readily accessible.
- At check valves, support piping independent of valve to allow for service removal without additional pipe support.
- FDC shall be wall mounted to the building structure.
- Locate the inspector's tests at the most hydraulically remote points in the system.
- Make provisions to drain all trapped water in dry standpipe systems.
- Provide post indicating valves on all systems. Indicating valves shall be equipped with a tamper switch connected to the building fire alarm control panel.
- Local bell shall be powered and supervised by the fire alarm panel.
- On new installations, do not use saddle tees. Use grooved fittings or welded outlets only.
- Do not enclose Victaulic fittings within construction.
- All pendant sprinkler heads in suspended ceilings to be installed at quarter points or center of ceiling tile.
- Floor zone valves should be located together at ground level in a room accessible from the outside. Confirm location with owner.
- Shop drawings shall incorporate all of the design features shown on the contract drawings. Any deviations deemed necessary by the designer shall be clearly identified on the shop drawings, ie: clouded.
- Contractor shall submit shop drawings to the Architect/ Engineer and FDC project manager for review and approval, prior to submittal to the State Fire Marshal.
- All new construction shall be fully sprinklered and equipped with class A fire alarm system.




**End of Section 15300**

**DIVISION 15 - MECHANICAL**

**Section 15410 - Plumbing Piping And Specialities**

**Introduction**

Piping and specialties associated with plumbing systems including:

DOMESTIC WATER SYSTEMS, SANITARY SEWER AND WASTE PIPING SYSTEMS, LABORATORY WASTE SYSTEMS, NATURAL GAS

**Part 1 - General**

- Refer to 15050 for common piping materials and methods.
- Single stack waste vent systems (sovent) shall not be designed into any facility.
- Refer to meter requirements (attachment to Section 15970).

**Part 2 - Products**

- Pipe Schedule - Above grade

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Domestic Water | Up to 2" | Copper - Type "L" Seamless Hard Drawn | Wrought Copper or Cast Brass | 6% Silver Solder |
| | 2 1/2" and larger | Copper - Type "L" Seamless Hard Drawn | Wrought Copper | 15% Silver Brazed |
| Natural Gas | Up to 2" | Schedule 40 Black Steel | Black Steel | Threaded |
| | 2 1/2" and larger | Schedule 40 Black Steel | Black Steel | Beveled Weld |
| Drainage/Vent Piping, except Lab waste | All | Cast Iron, Service Weight | Cast | Hubless With Husky SD 2000 Assemblies-or UA approved equal. |
| Sanitary Sewer/Waste Below Grade | All | Cast Iron, Service Weight | Cast Iron | Hubless With Husky SD 4000 assemblies. |
| Sanitary Sewer/ Waste /Vents Above Grade | All | Cast Iron, Service Weight | Cast | Hubless With Husky SD 4000 assemblies, or approved equal |

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Laboratory Waste/Vent | All | Polypropylene (Fuseal) | Polypropylene DWV | Fusion Welded |
| Laboratory Waste Vents (In plenums) | | PVDF | PVDF | Fusion Welded |

- Pipe Schedule - Below Grade

| Service | |
|---|---|
| Domestic Water | Same as for above grade except use type "K" copper for below ground and 15% silver brazed joints. |
| Natural Gas | Same as for above grade with sealed coating. |
| Drainage Piping-except Lab waste | Same as for above grade, use Husky SD4000 or UA approved equal couplings.. |
| Laboratory Waste | Same as for above grade<br>Duration for high temperature waste (auto clave, cage washer etc.) |

- Back Flow Prevention: Backflow prevention standards will be equal to or greater than USC's Foundation For Cross-Connection Control and Hydraulic Research Manual #9, or the newest edition printed.

- Hose Bibbs: Keyless in public areas.

- Wall Hydrant: Automatic-draining, anti-backflow type. Provide one operating key.

- Floor Drains: Cast iron body. Floor drains for use as area drains in exterior slab on grade shall be furnished with anchor flange. Inlet fittings shall be cast iron with threaded inlet and threaded or spigot outlet and trap seal primer valve connection. Airgap fittings shall be cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet. Provide seepage flange at all floor drains in suspended slabs. Provide trap primers at all floor drains.

- Floor sinks: Acid resistant enamel coated cast iron. Strainer/grating shall be chosen appropriate for service.

- Roof Drains and Overflow Drains: Cast iron roof drain with cast metal dome strainer.

- Roof Flashing Assemblies: construct of four pound per square foot lead (min. of 24" x 24" cut for drain and clamped at collar).

**Part 3 - Execution**

- Maintain a minimum of 50% penetration of brazed joints.

- Excavation for buried piping shall be graded to provide a smooth foundation throughout length of piping. Bedding with clean sand to indicated level. Dig bell holes at each pipe joint to relieve protrusions of loads and to ensure continuous bearing of pipe barrel on foundation.

- Install sanitary building drain piping at a minimum slope of ¼" per foot (2 percent).

- For natural gas piping, provide dirt leg at each point of connection to equipment.

- Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of 1/8” inch per foot (1 percent) and connect to floor drain body, trap, or inlet fitting. Trap primers must be accessible.

- Install cleanouts in drain piping as required by the plumbing code and at each sewer main change in direction of 90°, at minimum intervals of 50 feet for piping 4 inches and smaller and 100 foot minimum intervals for larger piping. Install cleanouts at the base of each vertical soil or waste stack. Exterior cleanouts shall be two-way.

- Extend wall cleanouts out to finished wall.

- Reduced pressure backflow preventors shall be installed at service into building, at connections between potable and non-potable water systems.

- Double check backflow prevention assemblies shall be installed at applications such as photo labs, etc.

- Anti-siphon, pressure type vacuum breakers shall be installed at connection to irrigation systems.

- Install laboratory waste piping in an accessible pipeway.

- Install strainer on building potable water supply after building shut-off and prior to backflow preventor.

- Install ball valves with hose end threads for system drains.

- Water hammer arrestors to be sized according to number of fixture units and installed
  Between last 2 fixtures of branch with quick closing devices (e.g. flush valves, solenoid valves, etc.).

- Provide floor drains for all wet areas. Floor sinks shall be used for indirect waste only. Floor sinks shall be installed with rim above finished floor.

- Ball valves to be threaded ends with downstream union.

- Top of floor drain grate shall be the lowest point on the floor and shall readily drain the entire floor.

**End of Section 15410**

**DIVISION 15 - MECHANICAL**

**Section 15440 - Plumbing Fixtures**

**Introduction**

Fixtures and appurtenances associated with the use of plumbing system piping including:

DOMESTIC WATER SYSTEMS, SANITARY SEWER SYSTEMS

**Part 1 - General**

- Refer to Section 15000 “Provisions for Future Expansion and/or Installations and Section 15050 Part 3 - Execution”.
- All fixtures shall be of the “water saving type”.
- Install fixtures as required for either standard or handicapped accessible service per ADA.

**Part 2 - Products**

- Water Closets, Wall Mount shall be/provided with:
    - Vitreous china construction, white
    - Elongated bowl
    - 1 ½" inlet spud
    - Siphon jet action
    - ANSI Standard A112.19.2
- Toilet Seats shall be:
    - Open front.
    - Injection molded of high strength, impact, and chemically resistant polypropylene.
- Flushometers
    - Manufactured by Sloan (Royal # 111 for water closets 1.6 gpf, Royal #186 for urinals, 1.0 gpf)
- Faucets And Trim shall be/provided with:
    - Cast brass with polished chrome plating.
    - All faucets and trim furnished shall be by Chicago Faucet or American Standard.
    - No push button faucets.
    - Single lavatory faucet for rest rooms (no hot water).
    - Moderators
    - Plug and tailpiece: P.O. plug with 13" tailpiece. Non-removable strainer with integral spud. (No. 327)
    - DI water faucets shall be PVDF lined, self closing, with swing gooseneck.
- Wall Mount Lavatories shall be/provided with:
    - Vitreous china,with
    - Front overflow
    - Self draining deck area with contoured back and side splash shields
    - 4" centers or as required for handicapped faucets
    - Equipped for carrier

  - ANSI Standard A112.19.2

- Urinals shall be/provided with:

  - Vitreous china, construction, white
  - Waterless
  - 2" female threaded outlet
  - Two wall hangers
  - ASME Standard A112.19.2 M-95, ANSI Z 124.9-94

- Mop Sinks (Floor Service Sink) shall be/provided with:

  - Acid resisting, enameled cast iron
  - Removable vinyl-coated rim guard
  - 3" drain
  - ANSI Standard A112.19.1.M

- Service Sinks shall be/provided with:

  - Acid Resisting, enameled cast iron
  - Rim guard
  - Wall Hanger
  - Drilled for back mount faucet
  - Floor supported trap
  - ANSI Standard A112.19.1.M

- Stainless Steel Sinks shall be/provided with:

  - 18 gauge brushed stainless steel.
  - Flat back extension with centerset holes 8" on center for faucet set.

- Water Coolers shall be/provided with:

  - Single unit, installed at height for handicapped accessibility/operation.
  - One-piece stainless steel backsplash plate and basin.
  - Exterior casing to be stainless steel or vinyl coated steel.
  - 8.0 gallons per hour minimum capacity.
  - Non-CFC refrigerant.
  - Fittings, Except Faucets
    - Angle stops and other fittings shall be fabricated of brass with a polished chrome plated finish.
    - Trap piping and tailpiece shall be chrome plated finish.
    - Escutcheons: polished chrome-plated, steel shell wall flange with friction clips.

- Plumbing Fixture Supports shall be/provided with:

  - ASME rated for service.
  - Chair carriers: supports with steel pipe uprights for wall hanging fixtures. Heavy duty chair carrier shall have rectangular steel uprights.

**Part 3 - Execution**

- Refer to Section 15000 “Provisions for Future Expansion and/or Installations and Section 15050 Part 3 - Execution”.

- Installation

- Install stop valves in a readily accessible location.
- Install escutcheons at each wall and ceiling penetration in exposed locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
- Seal fixtures to walls, floors, and counters using a sanitary type, one part, mildew resistant white silicone sealant.
- Single faucets shall not be used in conjunction with cock hole covers. Provide lavatory or sink with correct hole configuration for specified service.

**End of Section 15440**

**DIVISION 15 - MECHANICAL**

**Section 15450 - Plumbing Equipment**

**Introduction**

Equipment associated with building plumbing systems including:

WATER SOFTENER, SEWAGE EJECTOR PUMPS, HOT WATER GENERATORS, WATER HEATERS, WATER PRESSURE BOOSTER SYSTEMS.

**Part 1 - General**

- For energy conservation purposes, hot water shall not be provided to rest rooms.
- Use central plant steam via heat exchangers for hot water. Consider impact of summer shutdown of steam service, (back up systems may be required) - consult with UA Facilities Design & Construction.
- Where used, water heaters shall be placed as near point-of-usage location as possible. Pumped recirculation system is required for piping systems lengths exceeding 50 feet.
- Small clear water ejector systems (fractional horsepower only) may use drop-in submersible pump.
- Autoclaves shall be connected to campus steam system and not furnished with individual steam generators. Verify adequate steam supply main pipe size and available pressure. Provide timers with over-ride button to shut off steam and water when not being used.

**Part 2 - Products**

- Water Softeners shall be dual automatic regenerating type to provide service during routine maintenance, complete with fiberglass tanks
- Sewage Ejector Pumps shall be self-priming, base mounted pump with suction line extended to sewage pit, high water alarm to U of A Campus EMCS. Provide two sewage ejector pumps for stand-by service with lead/lag control for building service application. Provide vent bleed valve per manufacturer's recommendation.
- Preferred manufacturer is Gorman Rupp or UA approved equal.
- Water Heaters - Gas fired preferred, although electric spot heaters may be used where economically justified. Lined galvanized steel tanks. 80% minimum efficiency.
- Water Pressure Booster System shall be Duplex pumping system, removable bladder type hydropneumatic pressure tank.
- Multi-plex pumps shall each have an H-O-A switch, disconnect, and overcurrent protection.

**Part 3 - Execution**

- All equipment shall be installed with isolation valves (threaded ball or flanged butterfly) - 100% full-port, full line size, bronze body at the equipment, drains, thermometers (on heat exchange equipment) and pressure gauges.
- Provide drip pans with piped drain beneath water heaters placed in areas other than in equipment rooms.
- Provide line size (2" maximum) full port ball valve blowdown on each side of plate and frame heat exchangers (typically 4).

**End of Section 15450**

**DIVISION 15 - MECHANICAL**

**Section 15480 - Plumbing Special Systems**

**Introduction**

Special plumbing systems including:

LABORATORY WATER SYSTEMS, MEDICAL GAS SYSTEMS, COMPRESSED AIR SYSTEMS, VACUUM SYSTEMS

**Part 1 - General**

No discussion

**Part 2 - Products**

- Pipe Schedule

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Laboratory RO Water | All | Sch. 80 PVC | Sch. 80 PVC | Solvent Welded |
| High Purity $H_2O$ | All | Polypropylene Type 1 Sch. 80 | Polypropylene Type 1 Sch. 80 | Fusion Weld Mech. Joint |
| Medical Gas | All | Copper Type "L" Oxygen Grade | Wrought Copper | *15%* Silver Solder |
| Compressed Air | All | Copper Type "L" | Wrought, Copper | *Less Than 0.2% Lead Alloy Solder* |
| Lab Vacuum | All | Copper Type "L" | Wrought Copper Or Cast Brass | *Less Than 0.2% Lead Alloy Solder* |

- Laboratory High Purity Water Systems
  - Utilize campus-wide RO water system where available with local filtration purifiers where required by user.
  - Where building wide high purity water is required, utilize a complete system by a single manufacturer to ensure a single point of responsibility.
  - Piping system shall be Schedule 80 PVC solvent welded for campus-wide RO system.
  - No tapered connectors shall be utilized on faucets.
  - Sterilize system before handover to U of A.

- Compressed Air Systems shall be/provided with:
  - Oil-less compression for medical application.
  - Automatic drain valve c/w isolation valve.
  - Refrigerated air dryer c/w air dryer bypass valve.
  - Conditioned inlet air preferred.
  - Filter inlet.
  - Chilled water "after cooler" before refrigerated air dryer.
  - Oil and moisture separators.

**Part 3 - Execution**

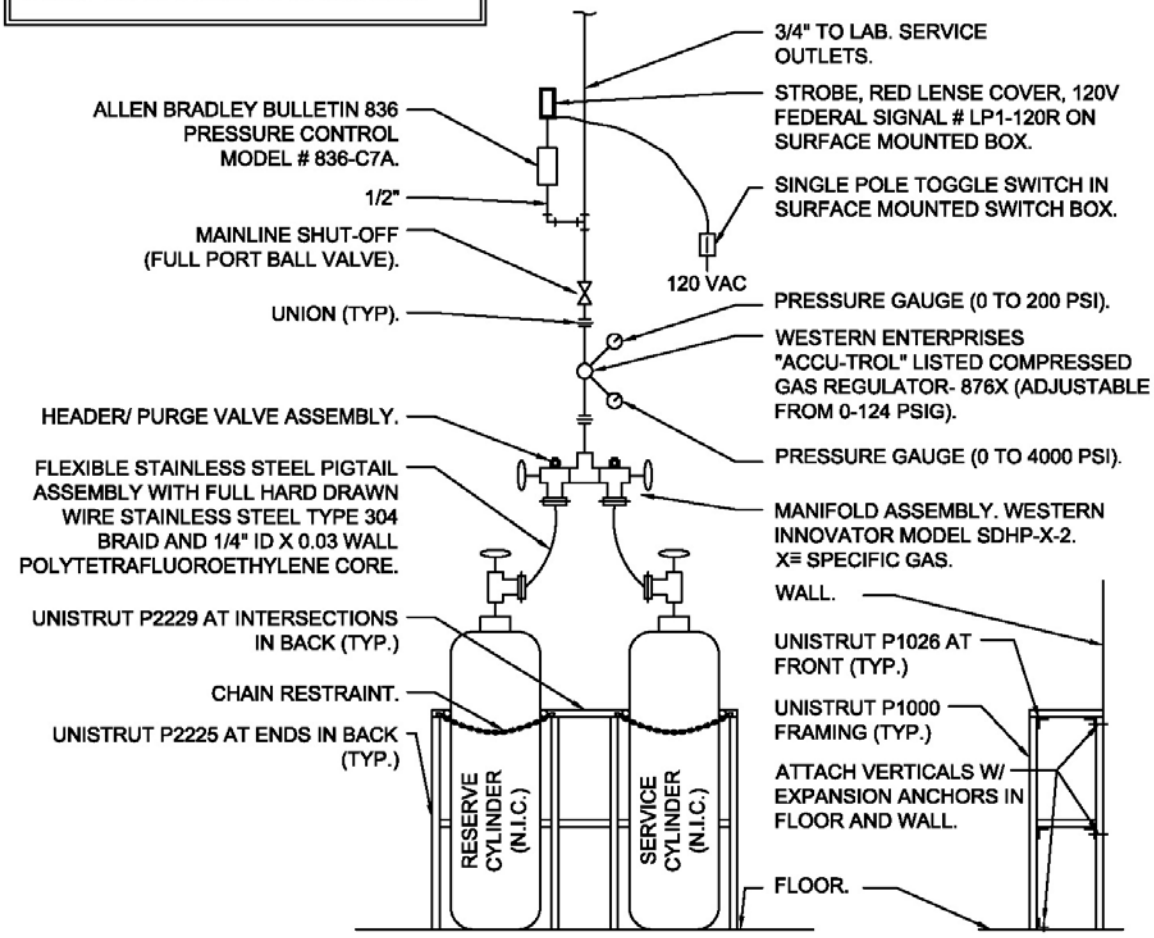
- Workmanship

  - Piping pressure test shall be 150% of maximum operating pressure (or 100 psig minimum) for 4 hours
  - System Cleaning - fill laboratory water systems and hold water for 24 hours prior to flush. Flush clean 3 times.
  - All vacuum pumps must be vented to the exterior of the building.
  - Vacuum pump tanks must be drained to waste container.
  - Provide bypass around filter assembly for servicing.
  - Purge medical gas systems with nitrogen during soldering.

## SPECIAL GASES MANIFOLD DIAGRAM

NOTE:

RACK PIPING MANIFOLD/ HEADER ASSEMBLY & COMPONENTS ON WALL W/ UNISTRUT.




NOTE:

PRESSURE SWITCH/ CONTROL SHALL ENERGIZE STROBE WHEN MAIN LINE PRESSURE IS 15 PSIG LESS THAN SYSTEM DISCHARGE (SETTING) AT PRESSURE REGULATOR.

NOTE:

WALL MOUNTED CYLINDER BRACKET SIMILAR TO GRAINGER SERIES 4ZH MAY BE USED INSTEAD OF UNISTRUT SUPPORT WITH USER'S PERMISSION.

### SERVICE SCHEDULE

| SERVICE | PIPE SIZE | PRESSURE |
|---|---|---|
| ARGON | 3/4" | 80 PSI |
| HELIUM | 3/4" | 80 PSI |
| NITROGEN | 3/4" | 80 PSI |

DRAWING 15480

UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS

STANDARD DETAIL:
SPECIAL GASES MANIFOLD DIAGRAM

| | | |
|---|---|---|
| DRAWN BY: KML | DETAIL NO. | REVISIONS |
| APPROVED BY: S. H. | 15480-D1 | |
| ACAD: 15480 | | |

**End of Section 15480**

**DIVISION 15 - MECHANICAL**

**Section 15510 - Hydronic Piping and Specialties**

**Introduction**

Piping and specialties associated with heat transfer equipment including:

CHILLED WATER, PROCESS COOLING WATER, CONDENSER WATER, HEATING WATER

**Part 1 - General**

- Install a strainer with differential pressure transmitter to EMCS on building side of isolation valve for chilled water supply from tunnel system. Install a single pressure gauge across strainer (see Section 15050 requirements).
- Use reverse return piping concept and eliminate balancing devices for all banked coil application and wherever practical.
- Use circuit setting devices in closed loop systems. Preferred design is a variable flow pumping system controlling system differential pressure and using externally adjustable pressure dependent circuit setters at each point of use.
- Provide 3-way valves in heating water piping at end of branch line units only.
- Design heating water systems with a 40°F temperature differential. – (140°F- 180°F)
- Refer to meter requirements (attachment to Section 15970).

**Part 2 - Products**

- Pipe Schedule - Above Ground

| Size | Pipe | Fittings | Joints |
|---|---|---|---|
| Up to 2" | Copper Type "L" seamless hard drawn | Wrought copper | Less Than 0.2% Lead Alloy Solder |
| 2 ½" larger | Copper Type "L" seamless hard drawn<br>Or<br>Schedule 40 Black Steel | Wrought copper<br>Or<br>Forged carbon steel | 15% silver brazed<br>Or<br>bevel welded |

- Pipe Schedule - Below Ground

| | | | |
|---|---|---|---|
| Up to 2" | Copper Type "K" seamless hard drawn | Wrought copper | 6% silver solder |
| 2 ½" & larger | Copper Type "K" seamless hard drawn<br>Or<br>Ductile iron cement lined | Wrought copper<br>Or<br>Ductile iron cement lined | 15% silver brazed<br>Or<br>Push-on or mechanical |

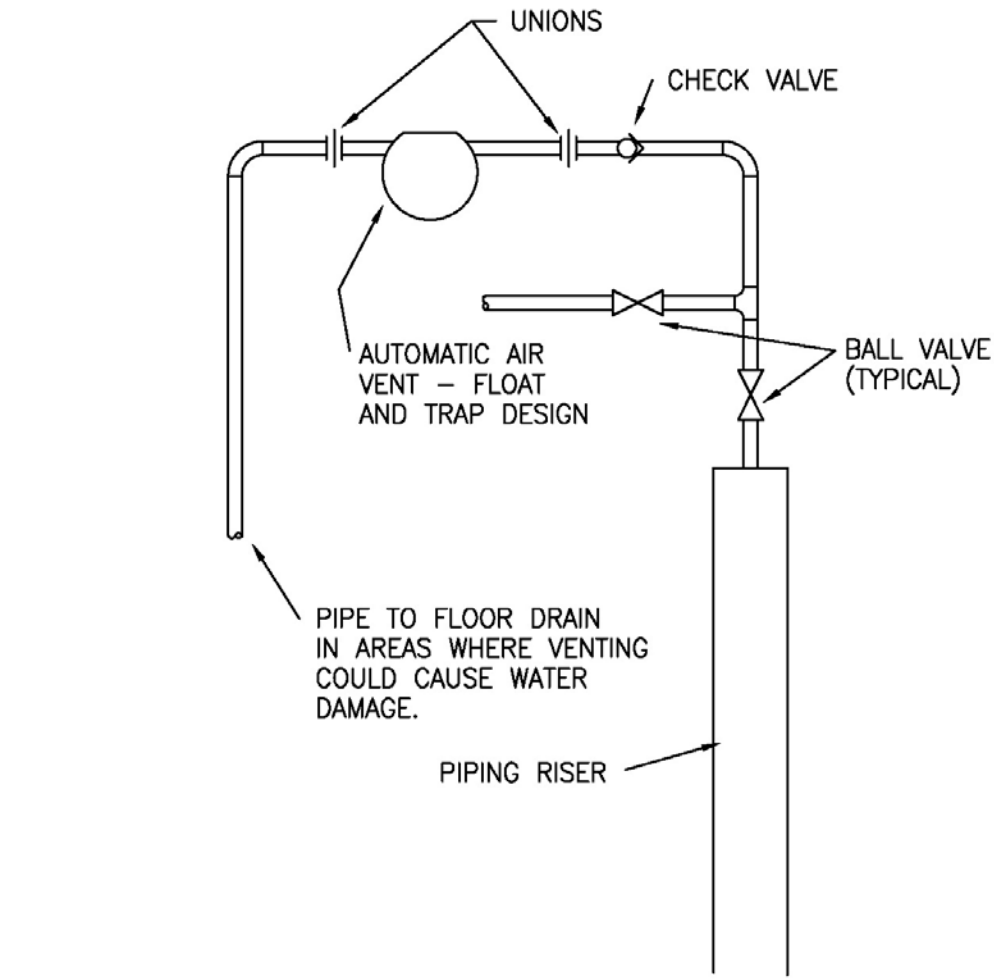
- Pipe Gasketing - Water Services - Garlock or UA approved equal.

- Valve Types: Butterfly, Globe or Ball. No Gate Valves shall be used.
- Preferred manufacturers are Norris, Centerline or UA approved equal.
- Thermometers
  - Adjustable angle type 9" die cast aluminum thermometer with separable well. Select with normal operating range at the midpoint of the scale. Install thermometer on both sides of each flow stream across coils, heat exchangers, etc.
- Pressure Gauges
  - Cast aluminum with 4 ½" dial. Select with normal operating range at the midpoint of the scale. Provide with pressure snubber and shutoff valve. Provide gauges at each pump, coil, heat exchanger, etc. Use a single gauge manifold with valving on each side of equipment.
- Expansion Tanks
  - Provide diaphragm-type compression tank with replaceable diaphragm.
- Air Vents
  - Provide automatic float and trap air vents in mechanical rooms only.
- Expansion Joints
  - Provide bellows type. Type 316 stainless steel.
- Pressure Regulators
  - Brass body, threaded connections.
- Flow Regulating Devices
  - Circuit setter with external adjustment and indicator with threaded connections only.
  - Pressure independent flow balancing - restrict use to areas approved by U of A.
- Hoses
  - High pressure, braided stainless steel and rated for temp and pressure requirements.

**Part 3 - Execution**

- Weld inspection: see Specification 15050 Part 3 Execution.
- Maintain a minimum of 50% penetration of brazed joints.
- Perform a minimum of three passes on weld joints (root, filler, cap).
- Route piping to allow sufficient access to all equipment, valves, controls, etc., for maintenance.
- In general, piping shall be installed below electrical conduits not requiring maintenance access.
- Piping shall be secured at each trapeze hanger or support.
- Install piping sufficiently below structure to allow top air vents.

- Provide isolation valves on each side of strainers and full part ball valve on blow down. Provide hose thread connection on blow down port ¾" and below.
- Provide air vent in pipe riser. Install automatic air vents in equipment rooms and manual air vents elsewhere, with isolation valve at all system high points and piped to drain. Minimum vent piping size is ½ ".
- Provide ball valves with hose end threads for system drains.
- When an existing system “hot tap” is necessary, provide a full port ball valve to isolate the new branch line.
- Do not use circuit setter as isolation valve.
- All gauges to be installed with a single gauge manifold.




HIGH POINT AUTOMATIC AIR VENT

NO SCALE

| UNIVERSITY OF ARIZONA<br>MANUAL OF DESIGN SPECIFICATION STANDARDS | | |
|---|---|---|
| STANDARD DETAIL:<br>HIGH POINT AUTOMATIC AIR VENT | | |
| DRAWN BY: R. DOMINGUEZ | DETAIL NO. | REVISIONS |
| APPROVED BY: B. NOTARY | 15510-D1 | |
| ACAD: 15510.DWG | | |

**End of Section 15510**

**DIVISION 15 - MECHANICAL**

**Section 15520 - Steam Piping and Specialties**

**Introduction**

Piping and specialties associated with:

STEAM AND STEAM CONDENSATE SYSTEMS

**Part 1 - General**

- Refer to meter requirements (attachment to Section 15970).

**Part 2 - Products**

- Pipe Schedule -

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Steam | Up to 2" | Sch. 40 seamless black steel | Forged carbon steel | threaded, bevel weld, or welded socket |
| Steam | 2 ½ " and larger | Sch. 80 seamless black steel | Forged carbon steel | bevel welded |
| Condensate | All | Copper Type "L" seamless hard-drawn | Wrought copper | 15% silver brazing |

- Pipe Gasketing - Steam services – Spiral wound – “Flexataulic” or UA approved equal.
- Valves
  - Condensate valves to be steam rated ball valves.
  - Steam valves to be steam rated globe valves.
  - Provide valves at all equipment and on all main branch take-offs.
- Pressure Gauges Shall Be:
  - Rated for steam service.
  - Cast aluminum with 4 ½" dial.
  - Selected with normal operating range at the midpoint of the scale.
  - Furnished with pressure snubber and shutoff valve.
  - Installed on both sides of all pressure regulators and at all steam using equipment.
- Strainers Shall Be:
  - Screwed 250# cast-iron, threaded through 2".
  - Flanged (150 lb.) 2 ½" and larger cast iron.

- Size 100 mesh.
- Installed ahead of steam traps and control valves.

- Steam Traps: Preferred manufacturers are.

  - Armstrong bucket for end of line drip and main lines.
  - TLV float & thermostatic for modulating service.

- Pressure Regulators Shall Be:

  - Fisher, Industrial Type 92B.
  - Globe valve in by-pass.
  - Vented to exterior of building through relief valve.

- Expansion Joints Shall Be:

  - Yarway "Gun-Pakt"
  - Stainless steel body and travel arm.

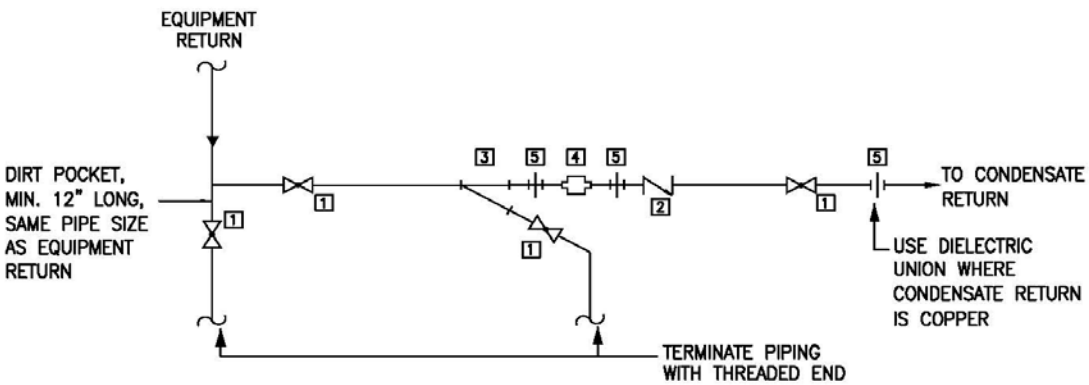
- Condensate Pumps shall be:

    - Spirax/Sarco
    - Cast-iron housing
    - Steam powered complete with compressed air back up where available.

**Part 3 - Execution**

- Workmanship

  - Avoid direct - buried steam and condensate systems.
  - Steam trap and strainer shall be piped as an assembly with isolation valve and union at each end of the assembly.
  - Terminate relief valve vent lines outdoors in safe location - verify with U of A.
  - Use eccentric reducers in steam piping to assure level bottom.
  - Pitch steam and condensate piping downward in direction of flow at ½” per 10 ft.




NOTES:

1. STEAM RATED ISOLATION BALL VALVE
2. CHECK VALVE
3. STRAINER
4. STEAM TRAP
5. UNION

| UNIVERSITY OF ARIZONA<br>MANUAL OF DESIGN SPECIFICATION STANDARDS | | |
|---|---|---|
| STANDARD DETAIL:<br>STEAM TRAP DETAIL | | |
| DRAWN BY: R.B. | DETAIL NO. | REVISIONS |
| APPROVED BY: R. B. | 15520–D1 | |
| ACAD: D:\DSS\15520–D1 | | |

**End of Section 15520**

**DIVISION 15 - MECHANICAL**

**Section 15530 - Refrigerant Piping and Specialties**

**Introduction**

Piping and specialties associated with:

REFRIGERANT SYSTEMS

**Part 1 - General**

- Do not use pre-charged line sets (e.g. Aero Equip.)

**Part 2 - Products**

- Pipe Schedule - Above grade

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Refrigerant Piping | All | Type 'L' ACR | Wrought Copper Or Cast Brass | 15% Silver Solder Brazed |

- Pipe Schedule - below grade

| Service | Size | Pipe | Fittings | Joints |
|---|---|---|---|---|
| Refrigerant Piping | All | Type "K" ACR | Wrought Copper or Cast Brass | 15% Silver Solder Brazed |

- Use long radius fittings only

**Part 3 - Execution**

- Workmanship
  - Install per ASHRAE standards
- Installation
  - Provide isolation valves between split system components.
  - Provide nitrogen purge during soldering.
  - The U of A reserves the right to cut into any two fittings to confirm the use of nitrogen purge.
  - Support piping every 6 feet.
  - Provide line size trap every 25 feet of vertical lift.
  - Provide a liquid line filter drier before any expansion valve.
  - Provide suction line filter drier before compressor.
  - Provide Shraeder valves on suction and liquid line and across filter driers.

**End of Section 15530**

**DIVISION 15 - MECHANICAL**

**Section 15540 - Heat Transfer Equipment**

**Introduction**

Equipment associated with:

HVAC HEAT TRANSFER SYSTEMS INCLUDING: WATER COILS, PLATE AND FRAME HEAT EXCHANGERS, COOLING TOWERS, AND AIR WASHERS.

Pumping equipment including the following types: vertical in-line circulating pumps, base mounted pumps.

**Part 1 - General**

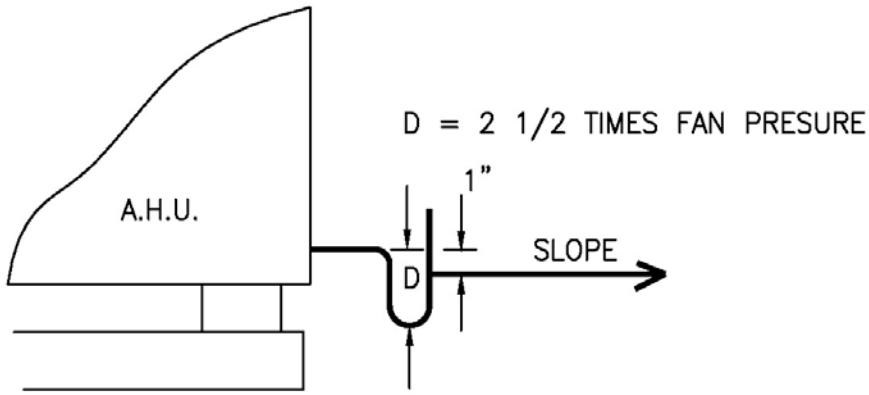
- Discuss heat exchanger type selection with UA Facilities Design & Construction.
- Design to account for water fouling factor in equipment selection.
- See water treatment section for related requirements.
- Coil Section
  - Select cooling towers at 76°F wb ambient.
  - Consider high dewpoint outside conditions when sizing cooling coils.
  - Select cooling coils with water temperatures of 44°F EWT/62°F LWT (summer) and 50°F EWT/62°F LWT (winter). Differential pressure: 15 psi minimum, 50 psi maximum.
  - Select heating coils with a 42°F water temperature differential.
  - Maximum coil face velocity 400 fpm.
  - Maximum coil pressure drop 0.5" SP.
- Vertical in-line pumps are preferred with one pump as standby for building systems. Avoid base mounted pumps when possible.
- Use premium efficiency motors. See Section 15050.
- Evaporative cooling in AHUs shall be accomplished by fixed cell Munters Fill Glasdek. Do not use water wheels.
- Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.

**Part 2 - Products**

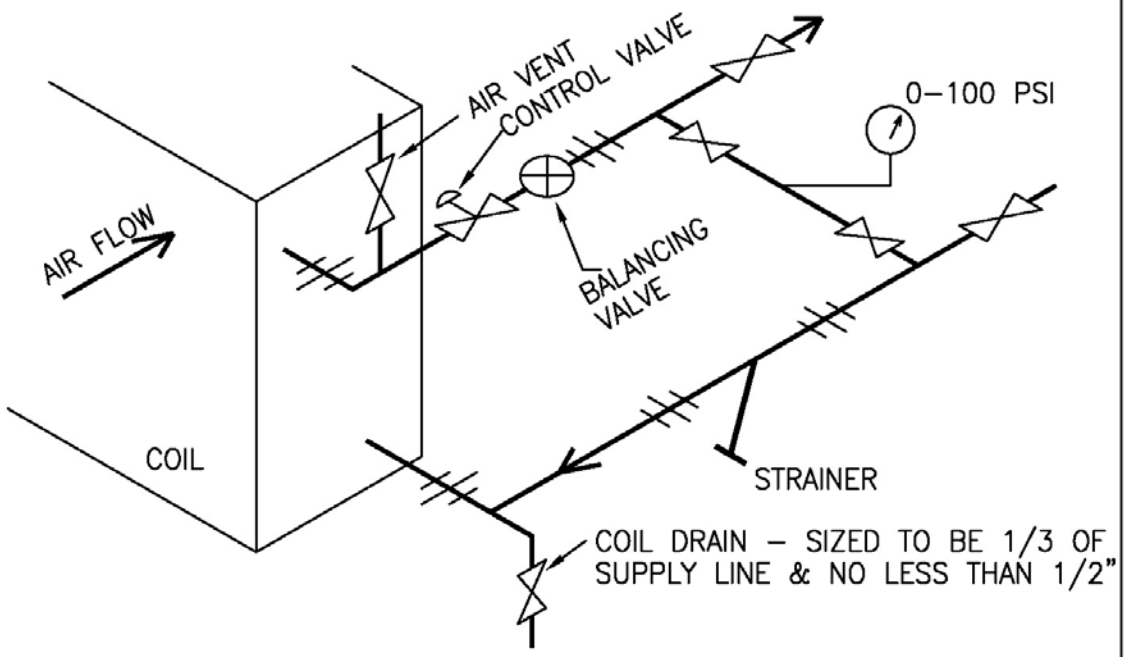
- Hydronic coils
  - To have bottom water supply and top return.
  - Use 5/8" minimum coil tube size.
- Vertical In-Line Pumps:
  - Preferred manufacturers; Grundfos, Bell & Gossett, Armstrong, Taco, Paco, Scott

**Part 3 - Execution**

- Provide full port ball type isolation valves close to equipment.
- Provide single pressure gauge indication with pressure snubber for each system component.
- Provide thermometer temperature indication for each line of each component.
- Provide Weld-o-lets installed for future monitoring on each line.
- Provide system strainers on inlet water side(s) of all coils and plate and frame heat exchangers.
- Coils shall be piped with water counterflow to coils. See coil detail.
- Comply with manufacturers recommended free air space for cooling towers.
- Provide manufacturer recommended clearances for maintainability.
- Provide coil and plate and frame heat exchanger blowdown sized at 1/3 of pipe size but not less than 1/2" on all sides of heat exchangers with full port ball valve. (See attached diagram.)
- Provide air vent on return pipe near high point with manual air vent (1/2" ball valve minimum) for all coils and plate and frame heat exchangers.




TRAP DETAIL




COIL CONNECTION DETAIL

| UNIVERSITY OF ARIZONA<br>MANUAL OF DESIGN SPECIFICATION STANDARDS | | |
|---|---|---|
| STANDARD DETAIL:<br>COIL CONNECTION & TRAP DETAIL | | |
| DRAWN BY: SY | DETAIL NO. | REVISIONS |
| APPROVED BY: B. DOLAN | 15540-D1 | |
| ACAD: 15540.DWG | | |

**End of Section 15540**

**DIVISION 15 - MECHANICAL**

**Section 15550 - Heat Generation**

**Introduction**

Heat generation equipment including:

BOILERS, FURNACES, FUEL FIRED HEATERS – Discuss all proposed installations with UA Facilities Design & Construction.

**Part 1 - General**

- Boilers, furnaces and fuel fired heaters shall be natural gas.
- Provide equipment schedule and piping schematics for installation of boilers, furnaces, and fuel fired heaters.
- Provide access for service of equipment in accordance with code and manufacturer recommendations.
- Conform to ASHRAE 15, Safety Code for Mechanical Refrigeration, when designing a boiler installation.
- Outside air reset shall be: 80°F water when outside air is 80°F, to 140°F water when outside air is 30°F.

**Part 2 - Products**

- Boilers
    - Preferred manufacturers are Parker and Weil McLain.
    - Boiler shall be a packaged unit with a minimum efficiency of 85%.
    - Boilers shall come with low water cutoff (manual reset), dual aquastat high limit control with manual reset, remote aquastat, outside air reset, gas cock, gas pressure regulator, 100% flame safeguard with manual reset, control panel.
- Furnace
    - Preferred manufacturers are Carrier, Rheem, and Trane.
    - Furnace shall be a packaged unit with an efficiency of more than 80%.
    - Furnace shall come with control relay for air conditioning.
    - Furnace shall come with high static pressure blower.
    - Heat exchangers shall have a minimum of 20 year warranty.

**Part 3 - Execution**

- Provide temperature and pressure gauges, and expansion tank for boilers.

**End of Section 15550**

**DIVISION 15 - MECHANICAL**

**Section 15680 - Packaged Liquid Chillers**

**Introduction**

Air and water cooled chillers up to 100 tons – Discuss all proposed installations with UA Facilities Design & Construction.

**Part 1 - General**

- Equipment room - design room within existing codes, EPA regulations and ASHRAE design standards, in particular ASHRAE 15 including the separation of refrigerant and combustion equipment and provision of alarms.

**Part 2 - Products**

- Acceptable manufacturers: Trane, Carrier, York, McQuay.
- Unit Description
  - Liquid chillers can be semi hermetic or scroll compression design. Separate refrigerant circuits shall include the following: liquid line solenoid valve, filter dryer, sight glass, thermostatic expansion valve and service valves.
  - Unit efficiency shall meet ASHRAE 90.1
- Evaporator
  - Shell and tube design manufactured in accordance with ASME standard, fully insulated and equipped with a drain connection.
- Condensers
  - Copper tube aluminum fin pressure tested to ASHRAE standards. Provide head pressure control.
- Electrical
  - All electric installations shall comply with the latest NEC standard. Include motor starters with equipment.
- Controls
  - All equipment shall be complete with leaving water control and unloading capability, low/high pressure switches, low ambient, freeze stat, flow switch and motor overload safeties, low oil pressure safety switches.
- Receivers
  - Shall be capable of entire refrigerant charge pumpdown.
- Head Pressure / Load Control
  - Shall be capable of running in low load and low ambient conditions. Provide compressor cylinder unloading where applicable.

- Refrigerant
  - Use HFC refrigerants. Do not use CFC or HCFC.

**Part 3 - Execution**

- Remote Interface - provide interface with building/campus energy management system for alarms, start/stop, status, water temperatures.
- All systems are to be dehydrated, leak tested charged and tested for proper control and operation.

**End of Section 15680**

**DIVISION 15 - MECHANICAL**

**Section 15780 - Packaged Air Conditioners**

**Introduction**

Equipment associated with air conditioning systems including:

PACKAGED ROOFTOP AIR CONDITIONERS; SPLIT SYSTEM AIR CONDITIONERS; SINGLE PACKAGE HEAT PUMP; GAS/ELECTRIC AIR CONDITIONERS.

**Part 1 - General**

- All equipment shall comply with ASHRAE 90.1
- Packaged units shall be 100% factory run tested and fully charged.
- Cooling capacity ratings shall be based upon ARI and DOE test requirements.
- Size condensers for 115°F ambient temperature.
- Size evaporators for 80°F db/67°F wb indoor conditions unless Project requirements are different.
- Provide filters with a MERV of 8 or higher.

**Part 2 - Products**

- Heat Pumps
  - Provide minimum of 5kW strip heat for defrost mode where applicable.
- Roof Top Units
  - Provide filters in return ductwork or return grilles.
  - Maximum filter face velocity shall not exceed 400 fpm.
- Fans and Motors
  - Where available, specify belt driven fans with adjustable motor sheaves.
  - Use permanent split capacitor EPAC premium motors. See Section 15050.
- Gas Fired Heating Sections
  - Minimum of 20 year warranty.
- Compressors
  - Use R-22 or HFC refrigerant.
  - Use semi hermetic compressors on units of 5 tons or greater.

**Part 3 - Execution**

- Install per manufacturer stated clearances.
- Condenser clearances to obstructions to be a minimum of 2 feet or as per manufacturer recommendations.

- Provide 3 feet clearance around rooftop units or remote condensing units.
- Provide maintenance access to all equipment requiring service.

**End of Section 15780**

**DIVISION 15 - MECHANICAL**

**Section 15810 - Humidifiers**

**Introduction**

Equipment associated with air conditioning equipment.

**Part 1 - General**

- Provide only when absolutely necessary or when a special Project requirement.
- Discuss with UA Facilities Design & Construction.

**End of Section 15810**

**DIVISION 15 - MECHANICAL**

**Section 15840 - Ductwork**

**Introduction**

Ductwork Systems including:

METAL DUCTWORK, FLEXIBLE DUCTWORK, EXHAUST DUCTWORK.

**Part 1 - General**

- All exhaust ductwork within the building shall be under negative pressure. Exhaust ductwork connections to equipment shall allow for proper drainage flow. Fumehood exhaust ductwork can be manifolded only if multiple exhaust fans are used.
- Special applications of products other than those listed must be submitted to U of A for consideration.
- Restrict use of duct liner as per Section 15250 requirements.
- Ductwork downstream of air handling units shall be constructed in accordance with 100% effective duct length as per ASHRAE and latest SMACNA standards.
- Use single thickness turning vanes only in ductwork up to 2” pressure class. Install per SMACNA.
- Do not use turning vanes in reducing elbows.
- Utilize 45° branch duct entries with main duct size reduction downstream for medium and high velocity systems.
- Utilize 45° branch duct entries or full conical taps for low pressure ductwork. No Bellmouth, Flanged or Notch Spin-In connections permitted except at terminal/diffuser take-offs.
- No extractors allowed.
- Exhaust system designs shall conform to AIHA Industrial Ventilation manual.
- Design with 15° convergence and divergence preferred. Absolute maximum of 30° divergence or 45° convergence.
- Use Pittsburg construction on longitudinal seams. Button punch snaplock construction is not acceptable.

**Part 2 - Products**

- Galvanized Steel shall be ASTM A 527, G90 of lock forming quality.
    - Heating & cooling supply and return, non-chemical exhausts – minimum 24 gauge.
- Stainless Steel shall be ASTM A 240, type 316
    - Spiral or welded for fumehood applications. Fittings shall be continuously welded – liquid tight.
    - All welded seams for perchloric applications.
- Coated Galvanized Steel

  - Under special circumstances, with U of A permission, coated galvanized steel ducts may be used for manifolded general chemical exhaust plenums which are large enough to allow duct internal inspection and repair of coating.

- Flexible Ductwork

  - Ductwork to be constructed in accordance with NFPA 90A, 90B, UL181 Class 1.

**Part 3 - Execution**

- Chemical exhaust ductwork to conform with ANSI/AIHA standard 29.5 - 1992

- Ductwork to be constructed per latest SMACNA HVAC Duct Construction Standards.

- High pressure flexible ductwork shall not be used for changes in direction.

- Low pressure flexible ductwork may only be used to accommodate a total of a 45° change in direction. Hard elbows shall be used at diffusers.

- Flexible ductwork shall be secured utilizing steel draw-band clamp.

- Maximum flexible ductwork lengths - 18" on high pressure systems, 48" on low pressure systems.

- Use center radius of 1.5 times duct width (minimum) on tees, bends, elbows.

- Use Hardcast AFG-1402 Foil-Grip tape, Hardcast DT-Tape with FTA-20 adhesive, or water based paint-on duct sealant for indoor use, or RTA-50 adhesive for outdoor use, to seal all duct joints.

- Ductwork shall be stored in a clean location prior to installation. Openings shall be covered to prevent entry of dust, moisture and general construction dirt/debris. Plastic sheeting securely taped over open ends will be acceptable.

- Provide balancing dampers at all branch ducts.

**End of Section 15840**

**DIVISION 15 - MECHANICAL**

**Section 15850 - Ductwork Accessories**

**Introduction**

Equipment associated with:

AIR HANDLING SYSTEMS INCLUDING TERMINAL BOXES.

**Part 1 - General**

- Terminal Box test submittal data shall be in accordance with ADC/ARI Standard 880-89.
- Terminal Box fittings in pneumatic lines to be brass barbed type complete with rubber caps if needed.
- Terminal Box controllers to be compatible with Campus EMCS. *(See Section 15970)*
- Minimum press drop across Terminal Box to be 0.1" wg with control damper fully open.
- Terminal Boxes shall have screwed access doors if serviceable items are enclosed.
- Do not reuse existing Terminal Boxes when designing a space remodel.
- Terminal Box damper leakage shall not exceed 2% of nominal box rating at 4" static pressure.
- All Terminal Box controls shall be externally mounted.
- Fire dampers to be installed in accordance with manufacturers installation instructions.

**Part 2 - Products**

- Use only 'long' terminal boxes for any air volume control application requiring accuracy greater than +/- 25%.
- Pneumatic terminal box volume reset controller to be Johnson Controls type P3800 or UA approved equal.

**Part 3 - Execution**

- Install terminal boxes with minimum of 18" clearance access for service and maintenance.
- Allow sufficient pneumatic tubing at volume reset controller to form 3" radius.
  Do not draw tubing tight or flatten cross-sectional area.

**End of Section 15850**

**DIVISION 15 - MECHANICAL**

**Section 15855 - Air Handling Systems**

**Introduction**

Equipment associated with:

CENTRAL STATION AIR CONDITIONING AND DISTRIBUTION.

See related Sections 15540 Heat Transfer Equipment
15860 Fans
15885 Filters

**Part 1 - General**

- *Preferred* system design based on Dual Duct VAV Concept complete with dual fans. *Discuss all system selections with UA Facilities Design & Construction.*
- AHU to be 'draw-thru' type.
- Size AHU to meet latest edition of ASHRAE Standard 62-1989.
- In new construction utilize AHU to 'flush' building to reduce off-gasing of interior furnishings prior to occupancy. Fit AHU with temporary filters during this period.
- Replace filters before system balancing.
- Preferred location of OA intakes is above roof level - not ground level. However, avoid location of AHU outside air intake in vicinity of plumbing vent stacks, emergency generator stacks, loading dock areas and areas where people might congregate to smoke cigarettes.
- OA intakes to be hard ducted through Mech. Rooms unless a separate AHU room is provided.
- Ensure access is provided to both sides of AHU fans to allow bearing replacement.
- Ensure smooth, uniform inlet and discharge flow conditions to and from AHU.
- Provide 'minimum' of one fan impeller diameter upstream of fan.
- Ensure flexible connections are taut.
- Provide vibration safety switches on all Vane Axial type fans.
- When Vane Axial fans are used ensure suitable access is provided for servicing/removal.
- Control valves shall be located outside of air handler enclosure.

**Part 2 - Products**

- Provide hinged access doors to both sides of coils, fans, filters and damper sections.
- Provide removable side panels in fan sections to allow for fan and shaft removal/replacement.
- AHU shall not be constructed using porous or semi porous materials.

- AHU shall be double walled casing - minimum 18 gauge.
- AHU shall have interior inspection lights.
- Large AHU to have inspection windows in access doors.
- Utilize only 'premium efficiency' motors in AHU's. See Section 15050.

**Part 3 - Execution**

- Ensure coil drain pans and condensate pipework is pitched to drain, (minimum pitch ¼" per foot).

**End of Section 15855**

**DIVISION 15 - MECHANICAL**

**Section 15860 - Fans**

**Introduction**

Fan systems including:

SUPPLY, RETURN AND EXHAUST AIR SYSTEMS.

**Part 1 - General**

- Short coupled, multi-belted fans to utilize companion sheaves in lieu of variable pitched sheaves.
- Provide vibration switch on fan.
- Fan RPM to be 1200 - 1400 (except exhaust fans).
- Max RPM for exhaust fans not to exceed 1800.
- Fans to be tested in accordance with ANSI/ASHRAE STD 51 and ANSI/AMCA STD 210.
- Centrifugal fans handling more than 1,000 CFM shall have backward inclined blades.
- Fans shall be statically and dynamically balanced at the factory.
- Standard Products - use same manufacturer for multiple installations for the same type.
- *Preferred* manufacturers; Greenheck, *Loren* Cook, ILG, Trane.
- Permanently lubricated bearings are not acceptable.
- Bearings shall be heavy duty split pillow block, self-aligning ball bearings with seals and grease nipples, minimum service life of 200,000 hrs.
- Provide drain connection in bottom of fan housing - minimum size 3/4".
- Provide access doors to blower section - minimum size 18" x 18".
- Provide weather-proof package for any fan located outdoors.
- Utility fans serving fume hoods shall have minimum velocity of 3000 f.p.m. at stack discharge.
- Min. height of discharge stack to be 10'.

**Part 2 - Products**

- Don't use VFDs on forward curved fans.

**Part 3 - Execution**

- No discussion.

**End of Section 15860**

**DIVISION 15 - MECHANICAL**

**Section 15870 – Variable Frequency Drives**

**Introduction**

This specification is to cover a complete variable frequency motor drive (VFD) consisting of a pulse width modulated (PWM) inverter output waveform (VVI, six-step, and current source drives are not acceptable) designed for use on a standard NEMA Design B induction motor. The VFD shall employ a 1600 volt full wave bridge rectifier, 5% impedance AC or DC Line Reactor, EMI/ RFI filters, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device.

The drive manufacturer shall have a representative exclusively for HVAC products, both sales and service will be the same organization for sole source responsibility.

**Part 1 - General**

- Quality Assurance
  - Referenced Standards
    - Institute of Electrical and Electronic Engineers (IEEE) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
    - Underwriter Laboratories: UL508C
    - National Electrical Manufacturer's Association (NEMA) ICS 7.0, AC Adjustable Speed Drives.
    - IEC 16800 Parts 1 and 2.
  - Qualifications
    - VFD's and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
    - CE Mark- European Union Electro Magnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
    - Acceptable Manufactures- ABB ACH Series, 550.
    - Substitutions must have Consulting (Mechanical/Electrical) Engineer written approval 2 weeks prior to date of bid. Written approval does not relieve supplier of specification requirements. All exceptions to this specification shall be submitted in writing to the Consulting Engineer at that time.
    - All VFD's shall be provided by the authorized local Rep/Distributor and be of one manufacturer. All HVAC OEM'S (AHU, Pumps, Cooling towers, etc.) shall allow VFD's to be shipped to factory for mounting or HVAC OEM units are to be deigned to interface/accommodate field mounting of VFD's.
    - All VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable.
- Submittals
  - Submittals shall include the following information
    - Outline dimensions, conduit entry locations and weight, customer connection and power wiring diagrams, technical product description include a complete list of options provided.
    - Compliance to IEEE 519- harmonic analysis for particular jobsite including total harmonic distortion (BOTH VOLTAGE and TDD). Using job specific electrical information the VFD manufacturer shall provide calculations showing toal harmonic voltage distortion, is less than 5% at point of common coupling. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5 % impedance reactors, **no exceptions**.

**Part 2 – Products**

- Variable Frequency Drive

  - The VFD shall be listed ISO9001 and the package as specified herein shall be enclosed in a UL listed Type 1, 12 (indoor enclosures) or 3R (outdoor enclosure) as applicable/specified.

  - The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
    - Environmental operating conditions: -15 to 40˚C to (5 to 104˚F) ambient temperature continuous with no current de-rate. From 40˚C (104˚F) to 50˚C (122˚F) ambient temperature range, VFD current de-rate will not be greater than 10% and not exceed a rate of 1% current de-rate per 1˚C or VFD must be oversized. VFD's that can operate at 40˚C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. Enclosure shall be UL listed as a plenum rated VFD. VFD"s without these ratings are not acceptable.

  - All VFD's shall have the following standard features:
    - All VFD's shall have the same digital keypad, shall be removable, capable of remote mounting and uploading and downloading of parameter settings for start-up of multiple VFD's.
    - The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes.
    - There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays, four (4) separate, independent timer functions that have both weekday and weekend settings.
    - The VFD's shall utilize pre-programmed HVAC application macro's specifically designed to facilitate start-up.
    - The VFD shall have cooling fans designed for replacement without requiring removing the VFD from the wall or removal of circuit boards.
    - The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
    - The VFD shall automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal.
    - The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
    - The VFD shall have integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.
    - The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
    - The VFD shall be capable of sensing a loss of load (broken belt/broken coupling) and signal a warning or fault as required.
    - If there is a loss of the input reference the VFD shall give the user the option of either(1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user.

  - All VFD's shall have the following adjustments:
    - Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
    - Two (2) PID Setpoint controllers shall be standard in the drive, using the microprocessor for the closed loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog

inputs, or over the communications bus. The PID parameter values may be changed with a digital input, serial communications or from the keypad. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (i.e. valves, dampers, cooling tower bypass valve control, chilled water valve control, etc.) and be accessible from the serial communication network. The setpoints shall be available in Engineering units.

- Two (2) programmable analog inputs shall accept current or voltage signals.
- Two (2) programmable analog outputs (0-20ma or 4-20ma).
- Six (6) programmable digital inputs allowing multiple safeties, run permissive circuits for damper and valve control, etc.
- The VFD shall include a “run permissive circuit” that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
- Three (3) programmable digital Form-C relay outputs standard, expandable to (6). The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC or 250 VAC. Maximum voltage 30 VDC and 250 VAC with maximum continuous current rating 2 amps RMS. Outputs shall be true from C type contacts; open collector outputs are not acceptable.
- Seven (7) programmable preset speeds.
- The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
- The VFD shall reduce the carrier frequency on actual VFD temperature that allows highest carrier frequency without derating the VFD
- The VFD shall include password protection against parameter changes.

- The Keypad shall include a backlit LCD display be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable).

- All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three selectable values will be displayed in real time, in complete English words.

- The VFD shall include a fireman’s override input. Upon receipt of a contact closure from the fireman’s control station, the VFD shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed.

- Serial Communications
  - The VFD shall have an RS-485 port as standard. The standard protocols shall be Modbus RTU, Johnson Controls N2 bus, Siemens Building Technologies FLN and BACnet available. No additional hardware, firmware, gateways, etc. shall be required for these standard protocols. Optional protocols for Lon Works, Profibus, Ethernet, and DeviceNet shall be available, and have the protocol in each VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be “certified” by the governing authority, non-certified protocols are not allowed. If additional gateway, hardware, etc. is required to obtain the BACnet, Modbus, etc. interfaces, the VFD manufacturer shall supply one gateway, hardware device, etc. per VFD. Multiple VFD’s sharing one gateway, hardware, etc. shall not be acceptable.
  - The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4 or 76.8Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBS (BACnet Interoperability Building Blocks) defined by the BACnet standard profile for a B-ASC.
  - The drive shall have the capability of allowing the DDC (Direct Digital Control/ Building Automation System) to monitor feedback, such as process variable feedback, output speed/ frequency, etc.

monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information, remote VFD fault reset keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass(if bypass is specified) shall be transmitted over the serial communications bus. The DDC system shall also be able to monitor and start stop if the motor is running in the VFD mode or bypass mode (if bypass mode is specified).
- The VFD shall allow the DDC to control the drive's digital and analog, inputs and outputs. For example, the analog outputs may be used to modulating chilled water valves or cooling tower bypass valves, digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation.

- EMI/RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

- Bypass – All features shall be UL listed by the drive manufacturer as a complete assembly and carry a UL508 label.
  - An output contactor, bypass, contactor and VFD only disconnect/service switch and/or fuses. Overload protection and shall be provided in both drive and bypass modes.
  - Door inter-locked, pad-lockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
  - Fused VFD only disconnect (service switch) and/or fast acting fuses exclusive to the VFD to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs that incorporate fuses common to both the VFD and the by pass will not be accepted. Three contactor by pass schemes are not acceptable, as a VFD input contactor is not a NEC recognized, lockable, physical disconnect and is an unacceptable means of safely disconnecting power to VFD.
  - The drive/ bypass shall provide single-phase motor protection and under-voltage protection in both the VFD and bypass modes.
  - The following operators shall be provided: a. Bypass Hand-Off Auto; b. Drive mode selector; c. Bypass mode selector; d. Bypass fault reset.
  - The following indicating lights (LED type/ pilot light) shall be provided. A test mode or push to test feature shall be provided: a. Power-on(Ready); b. Run enable (safeties) open; c. Drive mode select damper opening; d. By pass mode selected; e. Drive running; f. Bypass running; g. Drive fault; h. Bypass fault; i. Bypass H-O-A mode; j. Automatic transfer to bypass selected; k. Safety open; l. Damper open; m. Damper end-switch made.
  - The following relay (form C) outputs from the bypass shall be provided: a. System started; b. System running; c. Bypass override enabled; d. Drive fault; e. Bypass fault motor overload or underload (broken belt); f. Bypass H-O-A position.
  - Customer Interlock Terminal Strip for connection of freeze, fire, smoke contacts, and external start command. The remote start/stop contact shall operate in VFD and bypass modes.
  - Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.
  - One mode forces the motor to bypass operation.
  - The second fireman's override mode remains as above but will also defeat all safeties and inputs (run until destruction).
  - Class 20 or 30 (selectable) electronic motor overload protection shall be included.
  - Provide capability to select manual or automatic bypass.

**Part 3- Execution**

- Installation
  - Installation shall be the responsibility of the mechanical contractor as outlined in the installation manual.
  - Power wiring shall be completed by the electrical contractor as outlined in the installation manual.

- Start-Up
  - Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and copy kept on file at the manufacturer.

- Product Support
  - Factory trained application engineering and service personnel shall be locally available at both the specifying and installation locations. A 24/365 (24 hour/ 365 days per year) technical support line shall be available on a toll- free line.
  - A computer based training CD and 4 hour on-site training shall include installation, programming, and operation of the VFD, bypass and serial communication.

- Warranty
  - Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. There shall be 24/365 support available via a toll free phone number.

**End of Section 15870**

**DIVISION 15 - MECHANICAL**

**Section 15885 - Filter**

**Introduction**

Filtration systems associated with AHU and FCU's.

**Part 1 - General**

**Part 2 - Products**

**Part 3 - Execution**

**End of Section 15885**

**Division 15 Mechanical**

**Section 15970 - Control Systems**

**Introduction**

Equipment associated with:

THE MANAGEMENT OF HEATING, VENTILATION, AND AIR CONDITIONING RELATED UTILITIES.

**Part 1 - General**

- The Energy Management Control System shall be Direct Digital Control, fully automatic, with electric and pneumatic components as required. All actuation within mechanical rooms and major air handling units shall be pneumatic. Electric actuation can be used if better performance will result. Discuss with U of A, Facilities.
- All terminal boxes, sensors and actuators shall be electronic / electric.
- System design shall be stand alone and of modular fashion to insure future expansion capabilities, whether it be additional control / monitoring points or supervisory functions.
- System shall have a minimum of 10% capacity expansion within the current equipment.
- Monitor all central utilities and emergency systems from a local and remote location.
- Metering devices to be installed per design guidelines Section 15980.
- Provide industrial linear-type chilled water pressure control valve as required by U of A, at tunnel entrance to maintain system pressures within the building.
- Provide electronic speed control for variable volume systems.

**Part 2 - Products**

- Controls must completely interface with the *Campus* existing Barber Colman/*Siebe* or Johnson Controls systems without added expense.
- *The direct digital control system shall be directly connected to the Owner's campus-wide EMCS via the EtherNet.*
- *Controls shall be microprocessor based interoperable LONMARK controllers bearing the applicable LONMARK interoperability logo on each product provided.*
- *LonTalk communications protocol will be utilized on the dedicated building communication network between EMCS controllers and other LonWorks devices to assure interoperability between all devices within the building network.*
- *The EMCS shall provide the direct integration of standard BACnet.*
- *The EMCS shall provide Ethernet communication in compliance with the ASHRAE standard 135-P for BACnet.*
- Noise, surge and spike protection: Kele model # HSP-121-B
- Shall be capable of withstanding power outages and surges for extended periods of time.
- Memories shall be non-volatile , or unit shall hold memory up to 30 days minimum on backup batteries.

- All CV and VAV terminal units controls shall be DDC "smart type" for new building construction.
- Use Fisher 92B steam pressure reducing valve with the appropriate pilot.
- Use manual reset freeze stats.
- Humidity sensors: OMEGA-HX-93C.

**Part 3 - Execution**

- Supply the following monitoring and control features where applicable:
  - Building Systems

    Complete utility usage (water, steam condensate, chilled water, electric)

  - Utility Usage

    Chilled water flow in GPM, totalized energy in BTU's
    Hot water flow in GPM, totalized energy in BTU's
    Steam condensate flow in lbs./hr., totalized energy in lbs.
    Domestic water totalized in gallons
    Electric use totalized in kW hrs., real time demand in kW

    Individual equipment power and energy use where required by U of A
    Chilled water supply and return pressure and temperatures
    Steam pressures
    Domestic water pressures
    Hot water supply and return pressure and temperatures
    Status of equipment pumps and drives
    Change of set point capability for all variable frequency drives
    Provide HVAC equipment greater than 1 hp with time scheduling capability, i.e., time clocks
    Reset of hot water supply temperatures
    Chiller operational status, run times, pressures and temperatures
    Cooling tower operational status and temperatures
    Report of any EMCS component failures on critical equipment as required by U of A
    Emergency generator-run time, load, kW, kVA
    Alarms as specified in other sections
    Outside air temperature

  - Individual Unit Characteristics

    Air Handler status, start / stop
    Supply, Return and Mixed air temperatures
    Reset of hot and cold decks
    Economizer control
    Chilled water return temperature control
    Lighting controls where specified
    Filter differential pressure indication
    Air humidity status and reset when specified, high limit control.
    Status of Hot and Cold duct static pressure
    Active control strategy for maintaining outdoor air requirements, e.g, $CO_2$ sensing.

- Provide airflow measuring stations as required.
- All control valves and isolation valves are to be located outside the Air Handler enclosure.

- Chilled water control valves to fail to “open” position. Hot water control valves to fail to “closed” position.
- Provide adequate space to install all control valves with stems in the vertical position without exception.
- Provide adjustable static pressure safety switch to shut down VFD controlled fans.
- Identify all controls and wiring within pertinent control panel and provide control system drawing framed under plexiglass on inside of panel door.

**End of Section 15970**

**DIVISION 15 - MECHANICAL**

**Section 15980 - UTILITY METERS**

**Introduction**

Meters are required on chilled water, steam condensate, and domestic water.

**Part 1 - General**

- Design, specify, furnish, install, and commission all utility meters required and owned by University.
- Utility meters shall be designed and specified by the project consulting engineers. Project contractor shall furnish and install all utility meters. Utility meter commissioning shall be a joint effort between the project contractor and the project consulting engineers and The University of Arizona. The University will not accept any utility meter until it has been shown to be fully functioning and operational.
- Design shall include selecting, scheduling, and specifying each utility meter as would be done for any piece of specialized equipment.
    - Flow Meters shall be selected to handle the flow range they will encounter at present design conditions.
        - Meters shall be connected to the University's campus SCADA C3 system thru the Modbus gateway (FieldServer X-40 included in section App-16720 of the UA Design Specifications Standards manual) and shall be capable of fully monitoring the building energy and water usage. Meters shall be connected to the University EMCS thru the LON connection on the Modbus gateway. See the UA Manual of Design Standards Section 15970 and Drawing # 16720-D2 for further requirements.
        - The meter shall be selected with Modbus RTU output.
        - All meters, transducers and RTD's will be non intrusive.
        - Project control drawings and specifications shall include all the information, including, but not necessarily limited to, points, termination, and programming necessary to provide complete building energy use reporting on the University's EMCS.
        - University of Arizona shall assist in reviewing the project contractor's utility metering submittal.
        - Project drawings and specifications shall include the following utility meter information as a minimum:
            - Domestic Water, Chilled Water, and Steam Condensate, Meters:
            - Type of service (i.e., chilled water, steam condensate, or domestic water).
            - Size of meter, manufacturer, type, model number.
            - Location of meter, sensors, and remote readouts.
            - Meter shall be located, including dimensions of installation if a specific location is necessary for proper operation.
            - Meter or meter remote readouts shall be readily accessible and at a level (5'6") that can be read without using a ladder.
        - Accuracy and Repeatability to meet federal guidelines for billable meter requirement.
    - Domestic Water, Chilled Water, and Steam Condensate Meters:
        - Range: maximum flow, minimum flow, and normal flow expected at present design conditions.

    - Installation details: details shall be complete and include all necessary information, including, but not limited to, length of straight pipe required upstream and downstream, distance required from valves or fittings, any required concentric reducers and location of temperature and pressure sensors.

- Chilled Water Meters:

    - All items necessary to allow the chilled water flow sensors to function as energy meters shall be specified and shown on the drawings and included in installation details.
    - Output of energy meter shall be in BTU's and totalized in MBTU's.
    - These additional items shall include, but are not limited to, temperature sensors, BTU totalizing computer, connection requirements to the campus SCADA C3 system at the Modbus gateway with a Lon connection from the University EMCS system, programming requirements and software.
    - Delta temperature transmitters shall be platinum 1000 OHM RTD, Where 1000 ohms equals $32^0$F.
    - Delta temperature sensors shall be matched pairs of calibrated sensors with an accuracy of 0.12° F.
    - Flow transducers shall be selected for the expected flow range encountered at present design conditions, pipe size and material. Particular attention shall be made to low flow conditions.
    - For all installations an energy totalizing computer will be required.

- Steam Condensate Meters:

    - All items necessary to allow the steam condensate flow sensors to be fully functional shall be specified and shown on the drawings and included in installation details.
    - Output of energy meter shall be in BTU's and totalized in MBTU's.
    - These additional items shall include, but are not limited to, flow (in MBTU's) totalizing computer, connection requirements to the campus SCADA C3 system at the Modbus gateway with a LON connection from the Modbus Gateway to the University EMCS system, programming requirements and software.
    - Delta temperature transmitters shall be platinum 1000 OHM RTD, Where 1000 ohms equals $32^0$F.
    - Delta temperature sensors shall be matched pairs of calibrated sensors with an accuracy of 0.12° F.
    - Flow transducers shall be selected for the expected flow range encountered at present design conditions, pipe size and material. Particular attention shall be made to low flow conditions.
    - For all installations an energy totalizing computer will be required.

**Part 2 - Products (UTILITY METER REQUIREMENTS) – Discuss With UA Facilities Design & Construction**

- Domestic Water Meter:

    - Shall be clamp-on ultrasonic flow meter, Metron flow meter with 1180 series BUM, Siemens SITRANS FUS1010, or approved equal.
    - Meters shall read in gallons and totalized in KGAL.
    - Water meters shall have a local readout as well as Modbus output to report to the Campus SCADA C3 system and thru a LON connection from the Modbus Gateway to the University's EMCS system.

- Chilled Water flow sensor:

    - Shall be clamp-on ultrasonic energy meter, Metron flow meter with 1180 series BUM, Siemens SITRANS FUE1010, or approved equal.
    - Where an energy totalizing computer is required, it will use the Modbus RTU protocol for output
    - Flow transducers shall be combined with supply and return temperature sensors.
    - Transducers and temperature RTD's will be factory calibrated matched sets.
    - Meters shall be capable of local or remote reading within the building close to the meter location.
    - Provide a Modbus RTU output to the Campus SCADA C3 system Modbus gateway; from the Modbus gate way provide a LON connection to the University's EMCS.

- Condensate Meter:

    - The steam condensate meter shall be a clamp-on ultrasonic energy meter, Metron flow meter with 1180 series BUM, Siemens SITRANS FUE1010, or approved equal.
    - Where an energy totalizing computer is required, it will use the Modbus RTU protocol for output
    - Flow transducers shall be combined with supply and return temperature sensors.
    - Transducers and temperature RTD's will be factory calibrated matched sets.
    - Meters shall be capable of local or remote reading within the building close to the meter location.
    - Provide a Modbus RTU output to the Campus SCADA C3 system Modbus gateway; from the Modbus gate way provide a LON connection to the University's EMCS.

**Part 3 – Execution**

- The supply of any utility to a building shall not be activated until the specified metering is in place, functional, and has been commissioned.
- During the final phase of the project and before final close out, project contractor shall be required to prove that all utility meters are installed properly and function as designed and specified. The utility meter commissioning shall be accomplished by the contractor in conjunction with the project consulting engineers and The University of Arizona.

    - Require calibration data, O & M manuals, details, etc., to be submitted after meters accepted.

**End of Section 15980**

**DIVISION 15 - MECHANICAL**

**Section 15990 - Testing, Adjusting And Balancing**

**Introduction**

Achieving an acceptable final air and water balance is one of the most critical elements of project completion. It is therefore extremely important that the balancing and the associated report be accomplished and submitted before or at the time of substantial completion. Similarly, timely reviews by the Consultant/UofA will insure that the final balance is acceptable prior to occupancy.

**Part 1 – General**

- Vibration Testing
  - Vibration testing to be performed on all rotating equipment 3 horsepower and above in accordance with AABC Standards.
  - Equipment shall have a maximum vibration velocity reading no greater than 0.04in/sec.
- Fume Hood Testing *Discuss With UA Facilities Design & Construction*
  - Each fume hood shall be identified with a plaque indicating the location and number of exhaust fan serving the hood.
  - Each exhaust fan shall be identified with a weather-proof plaque indicating the location(s) of the fume hood(s), by room number, that the fan serves.
- Air Systems
  - All work shall be in accordance with latest edition AABC, NEEB Standards and applicable sections of ASHRAE and SMACNA HVAC systems testing, adjusting and balancing procedures.
  - The entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions).
  - Air volumes measured shall be within ± 10% of those shown on drawings unless otherwise specified for diffusers, grilles, registers where applicable and fans.
  - Ensure all temperature sensors and controls are calibrated prior to conducting test and balance procedures.
  - At the time of final inspection, recheck in the presence of the U of A/Architect, random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck shall be selected by the UofA/Architect and be approximately 10% of the report data.
  - At the time of verification measure space temperature and humidity in a representative number of rooms to verify performance. Tabulate these results and bind into certified report as an appendix.
  - Testing to be conducted on a hierachial principal, i.e. each piece of equipment for proper operation, followed by each sub-system followed by entire system, followed by inter-ties to other major systems.
  - Following final acceptance of the certified reports by the Architect, permanently mark the settings of all valves, dampers, splitters and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.

- VFD controlled fan systems to be tested in bypass mode to verify satisfactory operation of static pressure high limit sensor.

- Piping Systems

  - Test all plumbing systems in accordance with all applicable plumbing codes.
  - Test all fire protection systems in accordance with all applicable NFPA Codes.
  - Compressed air system shall be tested to a minimum of 125% and a maximum of 150% of pressure setting of relief valve, using nitrogen, for 24 hours and pressure drop shall not exceed 10% of the minimum pressure.
  - Balance the entire water system to ensure all coils, heat exchangers, etc., are operating to design conditions. Adjust the circuits by means of the balancing valves and record balance position.
  - Each pump shall be checked for design, working and shut-off head conditions and any pump that varies by more than 10% from the design conditions shall have the impeller trimmed or changed until design conditions have been met.
  - Flow through all heat exchangers, chillers, boilers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of the manufacturer's design conditions.
  - If the design conditions cannot be met by adjusting the balancing valves throughout the system, then pump impellers shall be either changed or trimmed as required.
  - Initial balancing of coils shall be to ensure that the pressure drops are within 10% of the manufacturer's design conditions. When both the air and water systems are fully operational, entering air and water and leaving air and water readings shall be taken as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Coil water working conditions shall only be taken in conjunction with the air flow working conditions for the coil.
  - Coordinate with the Contractor to ensure that all necessary valves for control and balancing are installed in all locations required. Notify the U of A/Architect in writing that this coordination has taken place. Include in this letter any recommendations made regarding valves, locations, installation, etc.
  - Testing to be conducted on a hierachial principal, i.e. each piece of equipment for proper operation, followed by each sub-system followed by entire system, followed by inter-ties to other major systems.
  - Following final acceptance of the certified reports by the Owner/Architect, permanently mark the setting of all valves and other adjustable devices so that balance set position can be restored if disturbed at any time. Do not mark such devices until after final acceptance.

- **Part 2 - Products**

- No Discussion.

- **Part 3 - Execution**

- All required balancing shall be completed and the final report submitted as a condition of substantial completion.

**End of Section 15990**