DIVISION 33 – UTILITIES

33 00 00 UTILITIES

CONSULTANT DESIGN GUIDELNE

PIPE CHEMICAL CLEANING PROCEDURE

The following cleaning procedure pertains to steam and condensate piping systems, chilled water piping systems, tower water piping systems, and hydronic heating and cooling piping systems. Notify the Construction Coordinator 24 hours before beginning the cleaning procedure to permit witnessing by Central Utilities Plant personnel; IF THE OPPORTUNITY FOR WITNESSING IS NOT GIVEN THERE WILL BE NO TESTING NOR APPROVAL OF CLEANING.

1. Contractor shall provide all materials and products to perform the pipe cleaning steps.

2. Provide means to circulate water and a cleaning solution throughout the steam and condensate piping, and separately throughout the chilled water piping. Contractor shall furnish all material and labor to provide said means, including temporary cross-overs pipes such as adjacent to new piping connection to existing piping, the removal of any temporary provisions, and cleaning of permanent strainers after successful testing. If a building Chilled Water pump is provided it may be used for pumping the cleaning solution, however the pump’s mechanical seal must be replaced after the cleaning operation.

3. The piping system shall first be flushed by circulating city water at a sufficient rate for the purpose for a minimum of one hour and then drained into sanitary sewer system. Any strainers shall be cleaned.

4. The piping system shall next be filled with a solution of hot water and trisodiumphosphate-based cleaner, in accordance with instructions from the cleaner manufacturer for the application. Pump solution throughout the piping at a rate necessary to remove oil, mill scale, etc. Circulate the solution for 24 hours, maintaining proper strength of chemical, drain the solution into sanitary sewer, fill with city water and circulate for a minimum of one hour. Samples for testing shall be drawn by University of Arkansas Central Utilities personnel while the circulation is still occurring.

5. Tests shall be performed by University of Arkansas Central Utilities personnel for Iron content and the presence of oil. If Iron is present in excess of 2.0 PPM, or if ANY oil is indicated as present using the camphor technique, the system must be drained and steps 3 and 4 repeated until the results of both tests are acceptable.

6. The condition of all drainage into sanitary sewers shall meet regulatory agency chemical and physical requirements, such as pH, limits of regulated parameters, etc.

University of Arkansas
Facilities Management Department
October 27, 1997

END OF SECTION

33 01 00 Operation and Maintenance of Utilities
33 01 10 Operation and Maintenance of Water Utilities
33 01 20 Operation and Maintenance of Wells
33 01 30 Operation and Maintenance of Sewer Utilities
  33 01 30.13 Sewer and Manhole Testing
  33 01 30.16 TV Inspection of Sewer Pipelines
  33 01 30.51 Maintenance of Sewer Utilities
  33 01 30.52 Pond and Reservoir Maintenance
  33 01 30.61 Sewer and Pipe Joint Sealing
  33 01 30.62 Manhole Grout Sealing
  33 01 30.71 Rehabilitation of Sewer Utilities
  33 01 30.72 Relining Sewers
33 01 50 Operation and Maintenance of Fuel Distribution Lines
  33 01 50.51 Cleaning Fuel-Storage Tanks
  33 01 50.71 Lining of Steel Fuel-Storage Tanks
33 01 60 Operation and Maintenance of Hydronic Steam Energy Utilities
33 01 70 Operation and Maintenance of Electrical Utilities
33 01 80 Operation and Maintenance of Communications Utilities

33 05 00 Common Work Results of Utilities
33 05 13 Manholes and Structures
  33 05 13.13 Manhole Grade Adjustment
33 05 16 Utility Structures
  33 05 16.13 Precast Concrete Utility Structures
  33 05 16.53 Rebuilding Utility Structures
33 05 19 Pressure Piping Tied Joint Restraint System
33 05 23 Trenchless Utility Installation
  33 05 23.13 Utility Horizontal Directional Drilling
  33 05 23.16 Utility Pipe Jacking
  33 05 23.19 Microtunneling
  33 05 23.26 Utility Impact Moling
  33 05 23.29 Cable Trenching and Plowing
33 05 26 Utility Line Signs, Markers, and Flags

33 06 00 Schedules for Utilities
33 06 10 Schedules for Water Utilities
33 06 20 Schedules for Wells
33 06 30 Schedules for Sanitary Sewerage Utilities
33 06 40 Schedules for Storm Drainage Utilities
  33 06 40.13 Storm Drainage Schedule
33 06 50 Schedules for Fuel Distribution Utilities
33 06 60 Schedules for Hydronic and Steam Energy Utilities
33 06 70 Schedules for Electrical Utilities
33 06 80 Schedules for Communications Utilities

33 08 00 Commissioning of Utilities
33 08 10 Commissioning for Water Utilities
33 08 20 Commissioning of Wells
33 08 30 Commissioning of Sanitary Sewerage Utilities
33 08 40 Commissioning of Storm Drainage Utilities
33 08 50 Commissioning of Fuel Distribution Utilities
33 08 60 Commissioning of Hydronic and Steam Energy Utilities
33 08 70 Commissioning of Electrical Utilities
33 08 80 Commissioning of Communications Utilities

33 09 00 Instrumentation and Control for Utilities
33 09 10 Instrumentation and Control for Water Utilities
33 09 20 Instrumentation and Control for Wells
33 09 30 Instrumentation and Control for Sanitary Sewerage Utilities
33 09 40 Instrumentation and Control for Storm Drainage Utilities
33 09 50 Instrumentation and Control for Fuel Distribution Utilities
33 09 60 Instrumentation and Control for Hydronic and Steam Energy Utilities
33 09 70 Instrumentation and Control for Electrical Utilities
33 09 80 Instrumentation and Control for Communications Utilities

33 10 00 Water Utilities
33 11 00 Water Utility Distribution Piping

CONSULTANT DESIGN GUIDELNE

The City of Fayetteville shall approve the design of any potable water supply distribution piping intended to serve a new or remodeled facility. Concurrent with that, all domestic potable water supply systems shall have the approval of the Arkansas State Department of Health. This procedure applies to domestic use and fire lines intended to supply fire suppression systems.

A copy of plans that involve water infrastructure must be sent to FM Global for review.

33 11 13 Public Water Utility Distribution Piping
33 11 16 Site Water Utility Distribution Piping
33 11 19 Fire Suppression Utility Water Distribution Piping

33 12 00 Water Utility Distribution Equipment
33 12 13 Water Service Connectors
   33 12 13.13 Water Supply Backflow Preventer Assemblies

CONSULTANT DESIGN GUIDELNE

   Backflow preventers shall be installed to protect the public water supply as specified by the City of Fayetteville and the University of Arkansas.
See attachment in this folder for Facilities Management Cross-connection Program Interconnections and Recommendations.

| 33 12 16 | Water Utility Distribution Valves |
| 33 12 19 | Water Utility Distribution Fire Hydrants |
| 33 12 23 | Water Utility Pumping Stations |
| 33 12 33 | Water Utility Metering |

**CONSULTANT DESIGN GUIDELNE**

**Utility Metering**

General: All utilities including water, steam, chilled water, and natural gas shall be metered. Meters shall be purchased using the UAF IDIQ contracts except for water meters that are furnished by the City of Fayetteville. The cost of a utility will be based on all costs of owning and operating the campus energy distribution systems to the buildings by the automatic metering and cost allocation (AMCA) system using cost of service based rate schedules and actual metered consumption.

| 33 13 00 | Disinfecting of Water Utility Distribution |
| 33 16 00 | Water Utility Storage Tanks |
| 33 16 13 | Aboveground Water Utility Storage Tanks |
| 33 16 13 13 | Steel Aboveground Water Utility Storage Tanks |
| 33 16 13.16 | Prestressed Concrete Aboveground Water Utility Storage Tanks |
| 33 16 16 | Underground Water Utility Storage Tanks |
| 33 16 19 | Elevated Water Utility Storage Tanks |

| 33 20 00 | Wells |
| 33 21 00 | Water Supply Wells |
| 33 21 13 | Public Water Supply Wells |
| 33 21 16 | Irrigation Water Wells |

| 33 22 00 | Test Wells |

| 33 23 00 | Extraction Wells |

| 33 24 00 | Monitoring Wells |
| 33 24 13 | Groundwater Monitoring Wells |

| 33 25 00 | Recharge Wells |

| 33 26 00 | Relief Wells |

| 33 29 00 | Well Abandonment |
Specify the method of making joints and the materials for sewer lines. Materials used for sewer joints shall prevent excessive infiltration and entrance of roots.

Specify leakage tests with the leakage outward (with the trench dry) or the infiltration, in case of wet trenches, not to exceed 500 gallons per inch of sewer diameter and smaller, and a flat rate of 12,000 gallons per day per mile for all larger sewers. Pressure pipe sewer leakage allowance should not exceed 200 gallons per inch diameter per mile per day under a test head appropriate to the local condition.
33 40 00 STORM DRAINAGE UTILITIES

33 41 00 Storm Utility Drainage Piping
33 41 13 Public Storm Utility Drainage Piping

33 42 00 Culverts
33 42 13 Pipe Culverts
   33 42 13.13 Public Pipe Culverts
33 42 16 Concrete Culverts
   33 42 16.13 Precast Concrete Culverts
   33 42 16.16 Cast-In-Place Concrete Culverts

33 44 00 Storm Utility Water Drains
33 44 13 Utility Area Drains
   33 44 13.13 Catchbasins
33 44 16 Utility Trench Drains
33 44 19 Utility Storm Water Treatment
   33 44 19.13 In-Line Strom Water Filters
   33 44 19.16 Catch Basin Insert Utility Storm Water Filters
   33 44 19.19 Utility Oil and Gas Separators

33 45 00 Storm Utility Drainage Pumps

33 46 00 Subdrainage
33 46 13 Foundation Drainage
   33 46 13.13 Foundation Drainage Piping
   33 46 13.16 Geocomposite Foundation Drainage
33 46 16 Subdrainage Piping
   33 46 16.13 Subdrainage Piping
   33 46 16.16 GeocompositeSubdrainage
   33 46 16.19 Pipe Underdrains
33 46 19 Underslab Drainage
   33 46 19.13 Underslab Drainage Piping
   33 46 19.16 GeocompositeUnderslab Drainage
33 46 23 Drainage Layers
   33 46 23.16 Gravel Drainage Layer
   33 46 23.19 Geosynthetic Drainage Layers
33 46 26 Geotextile Subsurface Drainage Filtration
33 46 33 Retaining Wall Drainage

33 47 00 Ponds and Reservoirs
33 47 13 Pond and Reservoir Liners
   33 47 13.13 Pond Liners
   33 47 13.53 Reservoir Liners
33 47 16 Pond and Reservoir Covers
   33 47 16.13 Pond Covers
   33 47 16.53 Reservoir Covers
Exterior buried natural gas pipe and fittings shall be ASTM #D2513 thermoplastic. Fuse weld all joints. Do not mix steel and plastic pipe and fittings except where the riser to the building shall have a fitting to connect the plastic pipe to the interior steel pipe. Flexible or bellows type pipe is not permitted.

Above ground exterior and interior natural gas pipe shall be schedule 40 black. Fittings 2” and smaller shall be standard weight black malleable iron. All fittings and joints 2½” and larger shall be welded. Flexible or bellows type pipe is not permitted. Do not permit plastic pipe for gas piping inside the building.

Joint compound shall be Teflon tape or non-hardening type compound applied to the male pipe threads.
Install unions, shut off cocks, and dirt legs on all natural gas piping at all gas fired appliances and equipment. Where the gas pipe is manifold to serve a group of appliances, a single dirt leg installed at the bottom of the drop to the manifold is acceptable.

Risers shall be wrapped steel. Coat or wrap underground natural gas piping risers and provide with cathodic protection in accordance the requirements of the Arkansas Plumbing Code. Repair any coating or wrapping damaged during installation of pipe and coat or wrap fittings. Coating shall be Scotchkote™ Protective Resin #202, or approved equal. Clean joints and fittings, prime with Scotchrap™ pipe primer, and wrap with Scotchrap™ vinyl tape (½ lapped). Do not coat pipe fittings and joints until the pipe has been tested, approved, and thoroughly cleaned.

Install gas pipe dielectric fittings, such as couplings, unions, or flanges, to isolate pipes and tanks of dissimilar metals. Accomplish installation by non-metallic, unthreaded sleeves or gaskets or a combination of both. Design fittings so that the installing tool cannot contact the insulating material.

Materials shall withstand a pressure of 125 PSIG and a temperature of 300°F. Install such fittings where underground gas lines rise to enter the building.

Clean, prime, and paint flat black exposed gas pipe located in finished spaces.

A 12-gauge (solid) tracer wire shall be installed in the ditch beside the plastic piping in order to locate the pipe with a metal tracing device.

END SECTION
CONSULTANT DESIGN GUIDELINE

1.0 **Chilled Water System**

1.01 **Introduction**

1.01.01 **Type:** The central campus chilled water system is of the variable primary type with “booster” chilled water pumps located in each building.

1.01.02 **Chilled Water Plants:** The system includes four (4) chilled water plants connected together to form a district chilled water system. The Southwest Plant includes 3 - 1000 ton electric centrifugal water chillers and a hydronic free cooling system. The Bud Walton Arena Plant includes 2 - 800 ton electric centrifugal water chillers. The North Plant includes a 1,200 ton electric centrifugal water chiller. The Main Plant includes a 1000 ton electric centrifugal Heat pump water chiller/heater, and 3 – 2,250 ton electric centrifugal water chillers.

1.01.03 **Automatic Temperature Control System:** The water chillers and their related equipment are sequenced and controlled by a Carrier Comfort Network (CCN) central energy management system. The CCN sequences the water chillers, hydronic free cooling system, and chilled water pumps based upon the total campus load and other factors. The primary chilled water chiller water pump speeds are modulated as required to maintain the minimum system differential pressures and as required to uniformly load the water chillers that are in operation.

1.02 **Mode of Operation:**

1.02.01 **Mode of Operation:** Building chilled water systems can be designed to operate in the “pressure control” mode of operation, “temperature control” mode of operation, or both modes of operation.

1.02.02 **Pressure Control Mode of Operation:** The “pressure control” mode of operation is a direct primary arrangement where the building chilled water pumps operate intermittently as needed to “boost” the differential pressure provided by the primary chilled water pumps in the plant and low flow / high T performance is provided by the control valves at the chilled water coils.

1.02.03 **Temperature Control Mode of Operation:** The “temperature control” mode of operation is a decoupled arrangement where the building chilled water pumps operate continuously and a minimum T is provided by modulating the building chilled water control valve.

1.02.04 **Application:** In general, the “pressure control” mode of operation is preferred and shall be used in new construction. In renovations involving buildings with fan coil
units equipped with 3-way control valves, the “temperature control” mode of operation may be used. In renovations involving buildings with existing 2-way chilled water control valves, the system shall be designed to permit operation in both the “pressure control” mode and the “temperature control” mode. Under normal circumstances, these buildings shall be operated in the “pressure control” mode. In the event of a low $T$ that cannot be readily diagnosed and corrected, the building shall be temporarily converted to the “temperature control” mode until such time as the low $T$ problem is identified and corrected.

1.03 General: Building cooling and dehumidification shall be provided by a chilled water piping system connected to the campus district chilled system. A typical building chilled water system service entrance shall include isolation valves, building chilled water control valve, flow meter, temperature sensors, chilled water pumps, chilled water pump bypass, differential pressure transmitters, and minimum flow control valve. Building chilled water systems that are designed to operate in the “temperature control” mode continuously or as a back-up to the standard “pressure control” mode shall also be equipped with a decoupler. The decoupler shall include an isolation valve. Building chilled water piping systems shall not include air separators, make-up water connections, or expansion tanks.

1.04 System Pressure: The maximum campus chilled water system pressure is approximately 160 psig.

1.05 System Differential Pressures: The primary pump speeds are modulated to maintain the minimum building service entrance differential pressure$^1$ at 5 psig. Building service differential pressures typically range from 5 psig minimum to 30 psig maximum in the summer and from 5 psig minimum to 15 psig maximum in the winter.

1.06 Chilled Water Supply and Return Temperatures: Chilled water system supply temperatures range from 38 deg. F in the summer to 48 deg. F in the winter when the hydronic free cooling system is in operation. The system has been specifically designed to function as a low flow / high $T$ system. During the summer when the chilled water supply temperature is 38 deg. F, building chilled water return temperatures are expected to be in the range of 54 to 62 deg. F. During the winter when the chilled water supply temperature is 48 deg. F, building chilled water return temperatures are expected to be in the range of 54 to 58 deg. F.

1.07 Acceptable Manufacturers

1.07.01 Chilled Water Pumps: Acceptable manufacturers of chilled water pumps are PACO, Bell & Gossett, Armstrong, Peerless, and Aurora.

1.07.02 Strainers: Acceptable manufacturers of strainers are Armstrong, Sarco, and Yarway.

1.07.03 Check Valves: Acceptable manufacturers of check valves are Nibco and Stockham.

$^1$ The CCN monitors and controls the building service entrance chilled water differential pressures in Poultry Science, Reid Hall, Walton College of Business, Graduate Education, Razorback Stadium East, and Arkansas Union West.
1.07.04 Suction Diffusers: Acceptable manufacturers of suction diffusers are Armstrong, Bell & Gossett, Thrush, Taco, and Amtrol.

1.07.05 Flexible Pump Connectors: Acceptable manufacturers of flexible pump connectors are Armstrong, Keflex, Taco, and Thrush.

1.07.06 Isolation Valves
   1.07.06.01 Ball Valves: Acceptable manufacturers of ball valves are Nibco and Stockham.
   1.07.06.02 Gate Valves: Acceptable manufacturers of gate valves are Nibco and Stockham.
   1.07.06.03 Butterfly Valves: Acceptable manufacturers of butterfly valves are Nibco and Stockham.

1.07.07 Air Vents: Acceptable manufacturers of air vents are Bell & Gossett, Armstrong, and Spirotherm.

1.08 Chilled Water Metering
   1.08.01 General: The chilled water volumetric flow (GPM), refrigeration demand (tons), volumetric consumption (MGallons), and refrigeration consumption (ton-hours) of each building shall be metered. The metering arrangement shall consist of a flow meter and temperature sensors.

   1.08.02 Flow Meter: The flow meter shall be of the magnetic flow tube type. Flow meter size shall be determined based upon the peak system flow requirement in accordance with manufacturer recommendations. The flow meter shall be purchased in accordance with the UAF IDIQ water meter contract. Refer to Appendix Q for a copy of the UAF IDIQ water meter contract.

   1.08.03 Installation: The flow meter and temperature sensors shall be connected to the Controls Contractor central energy management system. The flow meter shall be installed in accordance with manufacturer recommendations.

1.09 Building Chilled Water Control Valve: Building chilled water control valves shall be of the butterfly type with pneumatic or electronic actuators depending upon the application. Building chilled water control valves shall be sized for a maximum of 3 psig at the peak system flow requirement. The peak system flow requirement shall be the maximum of the peak building flow requirement with 45 deg. F chilled water supply temperature and all energy recovery equipment in operation or the peak building flow requirement with 38 deg. F chilled water supply temperature and the highest capacity energy recovery unit not in operation. Building chilled water control valves shall have a minimum dynamic close-off rating of 100 psi.

2 Chilled water flow meters are not "line-sized".
1.10 Chilled Water Coil Control Valves

1.10.01 Fan Coils

1.10.01.01 Type: Fan coil unit chilled water coil control valves shall be of the 2-way, motorized ball type.

1.10.01.02 Actuator: Actuators shall be electric 2-position with spring return.

1.10.01.03 Selection: Fan coil unit chilled water coil control valves shall be selected to provide a maximum water pressure drop of 3 psig at the coil design flow rate with 45 deg. F chilled water supply temperature.

1.10.01.04 Ratings: Fan coil unit chilled water coil control valves shall have a minimum pressure rating of 150 psig and a minimum dynamic close-off rating of 100 psi.

1.10.02 Air Handling Units

1.10.02.01 Type: Air handling unit chilled water coil control valves shall be of the 2-way, modulating, rotary segmented port type equal to Kele Max Cap Series V.

1.10.02.02 Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

1.10.02.03 Sizing: Air handling unit chilled water coil control valves shall be sized based upon a maximum water pressure drop of 5 psig at the coil design flow rate with 45 deg. F chilled water supply temperature.

1.10.02.04 Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic with rangeability (defined as the fully open valve flow at 1 psi water pressure drop divided by the minimum controllable flow at 1 psi water pressure drop) of 200 to 1 or greater. Valve leakage rating shall be ANSI Class VI.

1.10.02.05 Pressure and Temperature Ratings: Valve pressure rating shall be a minimum of 200 psig with water temperature of 400 deg. F.

1.10.02.06 Close-off Ratings: Valve close-off ratings shall be a minimum of 150 psi.

1.10.02.07 Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

1.10.02.08 Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be carbon steel, with stainless steel v-notch rotary plug, stainless steel shaft, low friction bearings, low friction graphite seal, and spring-
loaded self-adjusting Teflon v-ring packing. Valve shall have a permanent seal retainer (valve may be removed and re-installed without replacing the internal seal retainer gasket). Valve body shall have a pressure recovery chamber downstream of the rotary trim, for minimizing cavitation and noise. Valve shall have integral 4-bolt universal actuator mounting pad, and have double-D keyed shaft connection.

1.10.02.09 Warranty: Valves shall be warranted (parts and materials only) to be free of defect for a period of 5 years beginning on the date of shipment to the job site.

1.10.03 Minimum Flow Control Valves

1.10.03.01 Application: Minimum flow control valves are not required in building chilled water systems that are not designed to operate in the “temperature control” mode. Minimum flow control valves shall not be installed in these applications.

1.10.03.02 Location: Minimum flow control valves shall be installed in the same mechanical room as the chilled water pumps.

1.10.03.03 Minimum Chilled Water Flow: The minimum flow shall be equal to 25% of the design chilled water pump flow rate.

1.10.03.04 Type: Minimum flow chilled water coil control valves shall be of the 2-way, modulating, rotary segmented port type equal to Kele Max Cap Series V.

1.10.03.05 Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

1.10.03.06 Sizing: Minimum flow chilled water coil control valves shall be sized based upon a maximum water pressure drop of 5 psig at the minimum chilled water flow.

1.10.03.07 Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic with rangeability (defined as the fully open valve flow at 1 psi water pressure drop divided by the minimum controllable flow at 1 psi water pressure drop) of 200 to 1 or greater. Valve leakage rating shall be ANSI Class VI.

1.10.03.08 Pressure and Temperature Ratings: Valve pressure rating shall be a minimum of 200 psig with water temperature of 400 deg. F.

1.10.03.09 Close-off Ratings: Valve close-off ratings shall be a minimum of 150 psi.
1.10.03.10 Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

1.10.03.11 Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be carbon steel, with stainless steel v-notch rotary plug, stainless steel shaft, low friction bearings, low friction graphite seal, and spring-loaded self-adjusting Teflon v-ring packing. Valve shall have a permanent seal retainer (valve may be removed and re-installed without replacing the internal seal retainer gasket). Valve body shall have a pressure recovery chamber downstream of the rotary trim, for minimizing cavitation and noise. Valve shall have integral 4-bolt universal actuator mounting pad, and have double-D keyed shaft connection.

1.10.03.12 Warranty: Valves shall be warranted (parts and materials only) to be free of defect for a period of 5 years beginning on the date of shipment to the job site.

1.11 Building Chilled Water Pumps

1.11.01 Number of Pumps: Two (2) chilled water pumps shall be installed in each building.

1.11.02 Type of Pumps: Pumps shall be of the flexible coupled end suction or vertical in-line type.

1.11.03 Flow Requirements: The design flow requirement for each pump shall be equal to 50% of the peak system flow requirement. The peak system flow requirement shall be the maximum of the peak building flow requirement with 45 deg. F chilled water supply temperature and all energy recovery equipment in operation or the peak building flow requirement with 38 deg. F chilled water supply temperature and the highest capacity energy recovery unit not in operation.

1.11.04 Head Requirements: The design head requirement for each pump shall be equal to the system head loss at the peak system flow requirement (sum of building control valve, piping, coil control valve, and coil water pressure drops) less the minimum differential pressure provided to the building by the central plant primary pumps (approximately 5 psig). Mechanical designers shall be careful to avoid over estimating the pump head requirements.

1.11.05 Motor Selection: The pump motors shall be selected to be non-overloading anywhere on the pump curve at maximum pump speed.
1.11.06 Variable Frequency Drives: Each pump shall be equipped with a variable frequency drive. Manual bypass contactor arrangements are not required for these variable frequency drives.\(^3\)

1.11.07 Other Considerations: Mechanical system designers shall select chilled water pumps based upon efficiency, net positive suction head requirements, runout, unloading characteristics, and other factors. Refer to the Appendix G for a sample chilled water pump selection.

1.11.08 Drip Rim Base: End suction chilled water pumps shall be equipped with a drip rim base. Base shall be equipped with a drain connection. A sheet metal drain pan with drain connection shall be installed below vertical in-line pumps.

1.12 Isolation Valves

1.12.01 General: Isolation valves in piping 2-1/2” or less shall be ball valves. Isolation valves in 3” and 4” piping shall be gate valves. Isolation valves in piping 6” and larger shall be butterfly valves.

1.12.02 Ball Valves: Ball valves shall be have bronze 2-piece body with chrome plated brass ball, TFE seats, threaded ends, and raised lever handle for insulation.

1.12.03 Gate Valves: Gate valves shall be iron body with bronze trim, bolted bonnet, non-rising stem, handwheel, solid wedge disk with bronze seat rings, and flanged ends.

1.12.04 Butterfly Valves: Butterfly valves shall be cast or ductile iron body with resilient replaceable EPDM seat, lug ends, stainless steel trim, 316 bronze disk, and infinite position gear operator. Butterfly valves shall rated for bi-directional, bubbletight, deadend service.

1.12.05 Chain Wheel Operators: Isolation valves in mechanical rooms that are more than 7 feet above the floor shall be furnished with chain wheel operators.

1.13 Air Vents: Automatic air vents shall be installed in mechanical rooms only. Discharge of automatic air vents shall be routed to a floor drain. Automatic air vents shall be brass or semi-steel body with copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat, and isolating valve.

1.14 Strainers: A strainer shall be installed in pump bypass piping. Strainers 2-1/2” and smaller shall be screwed brass or iron body, y-pattern with stainless steel perforated screen and threaded ends. Strainers 3” and larger shall be iron body, y-pattern with stainless steel perforated screen and flanged ends.

1.15 Check Valves: Check valves shall be located at the discharge of each chilled water pump. A check valve shall also be installed in the pump bypass piping. Check valves shall be of the

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\(^3\) In the event of a VFD failure, the remaining pump should be capable of accommodating the peak chilled water flow requirement at the design conditions with 38 deg. F chilled water supply temperature and all energy recovery equipment in operation.
swing check type. Check valves 2-⅝” and smaller shall be bronze body with bronze trim, y-pattern, and threaded ends. Check valves 3” and larger shall be iron body, bronze trim, bronze or bronze faced swing disc, renewable disc and seat, and flanged ends.

1.16 Flexible Pump Connectors: Flexible pump connectors shall be installed at the suction and discharge connections to each pump. Flexible pump connectors shall have flanged ends.

1.17 Suction Diffusers: Suction diffusers shall be installed at the suction of each chilled water pump. Suction diffusers shall be angle pattern, cast or ductile iron body with inlet vanes, cylinder strainer, disposable fine mesh start-up strainer, adjustable foot support or base support boss, bottom blowdown tapping, and gage tapping in side.

1.18 Thermal Expansion: Chilled water systems shall be designed to accommodate thermal expansion using pipe bends and offsets.

1.19 Chilled Water Pipe Sizing

1.19.01 General: Chilled water piping shall be sized in accordance with good engineering practice based upon velocity and water pressure drop. The maximum acceptable velocity is 12 feet per second for chilled water mains and 10 feet per second for branch piping. The maximum acceptable water pressure drop for chilled water mains and branch piping is 6 feet w.g. per 100 feet of pipe.

1.19.02 Building Chilled Water Mains: Building chilled water mains shall be sized based upon the peak system flow requirement. The peak system flow requirement shall be the maximum of the peak building flow requirement with 45 deg. F chilled water supply temperature and all energy recovery equipment in operation or the peak building flow requirement with 38 deg. F chilled water supply temperature and the highest capacity energy recovery unit not in operation.

1.19.03 Branch Piping to Fan Coil Units: Branch piping to fan coil units shall be sized based upon the flow requirement associated with 45 deg. F chilled water supply temperature.

1.19.04 Branch Piping to Air Handling Units: Branch piping to air handling units shall be sized based upon the maximum of the 45 deg. F chilled water supply temperature with energy recovery equipment in operation requirement or the 38 deg. F chilled water supply temperature with energy recovery equipment not in operation requirement.

1.19.05 Chilled Water Piping DRAINS:

NOTE: Larger main line drains are needed. The University will always have a need to drain chilled water transport lines from time to time for maintenance and repair. Draining a large line can be very time consuming with a ¾” drain line.

Chilled Water Transport Lines main service drains shall consist of a 3000 lb Forged Steel thread-o-let, Sch 80 nipple (length to clear insulations), CL 300 MI Ells and piping to clear mains per detail w/ SS ball valve, equal to APOLLO 76-100, with
locking SS level handle. Insulate back to Main with closed cell insulation (Armaflex type).

Provide 1-1/2” for line sizes 6” and below

Provide 2” for line sizes 8” and above.

The intent is to create enough of a pipe length away from the main to clear the insulation both on the main line and the drain tap, and to create a dead leg to allow the water to warm up to reduce sweating. It also will allow us to swing the valve out away from under the line where we can get to it more easily. Our experience is that what fails is the nipple from sweating corrosion from the outside.

Orient the handle in the vertical plane, handle up so that the lock will set and it cannot be easily opened by accident.

See drawing number 201 in Appendix I for more information.

High Point Vents: Provide UA Standard Main Chilled Water Line Air Vent Assembly for each line inside the vault on the system side of the isolation valves in the vault.

This is now our standard main system vent assembly which allows us to isolate close to the header if we need to, but provides a manual vent when we are filling or draining the system, and a normal operating automatic vent.

See drawing number 202 in Appendix I for more information.

Vault Lighting – Install (2) ceiling mounted units inside the vault – Canlet Ceiling Mount 68-02IFC(screw base) -01-OG-09 [ceiling mount, with incandescent screw base, with clear glass globe and cage guard]

Install (1) wall mounted unit outside in the pit – Canlet Wall Mount 68-02IWF-01-01-01 + 68WME02 [wall mount, with incandescent screw base, with reflector, clear glass globe and cage guard with white reflector + wall mount extension bracket]

Lighting should be switched from inside the vault on the line side of the GFCI if that is allowed so that nuisance trips on the GFCI do not kill the lighting.

CFL lighting is desired but not with a separate ballast. Fixed ballast fixtures are not recommended, but rather screw base CFLs. Otherwise when a ballast fails, we have to get an electrician to fix it as opposed to just changing the bulb.

Condensate must be piped to the sanitary sewer system, not to the storm water system. We understand most cities ask that cooling condensate be placed in the storm sewer system as a matter of city ordinance. However, when designing a system where the coil contains chilled water from our utility system, or a remote closed loop system, we intend to treat the loop water with the proper chemistry.
This water could be introduced into the storm sewer system if a leak were to occur. Therefore it shall be standard practice to introduce condensate water into the sanitary system.

1.20 Chilled Water Pipe and Pipe Fittings

1.20.01 Above Grade and in Tunnels: Chilled water piping 2-½” and smaller shall be ASTM B 88, hard drawn, Type L copper tube with cast brass or solder wrought copper fittings and lead free solder. Chilled water piping 3” and larger shall be standard weight black steel with welded joints.

1.20.02 Direct Buried: Direct buried chilled water piping shall be HDPE, SDR 11 (160 psig at 73 deg. F) with fused joints.

1.21 Balancing Valves: Balancing valves shall not be installed in chilled water systems.

1.22 Reverse Return Piping Arrangements: Reverse return piping arrangements are encouraged.

1.23 Process Cooling: Process cooling systems connected to the campus chilled water system shall be discussed with Facilities Management.

1.24 Condensate Drain Piping: Condensate drain piping shall be ASTM B 88, hard drawn, Type L copper tube with cast brass or solder wrought copper fittings and lead free solder.

1.25 Sequence of Operation

1.25.01 Mode of Operation: Mode of operation for the building chilled water system will be either be “Pressure Control” or “Temperature Control”. Mode of operation shall typically be “Pressure Control”\(^4\). Mode of operation will be manually adjustable by the operator. When mode of operation is “Pressure Control”, manual valve in decoupler must be closed. When mode of operation is “Temperature Control”, manual valve in decoupler must be open.

1.25.02 Building Remote Chilled Water Differential Pressure Setpoint: Building remote chilled water pressure setpoint shall be reset from a minimum of 4 psig up to a maximum of 8 psig based upon the position of the most open chilled water coil control valve. When the most open chilled water coil control valve is more than 95% open, the setpoint shall be increased. When the most open chilled water control valve is less than 85% open, the setpoint shall be decreased.

1.25.03 Building Chilled Water Volumetric Contract Demand (GPM): Building chilled water volumetric demand shall be adjustable.

\(^4\) “Temperature Control” mode of operation will only be used in the event of a low building chilled water temperature difference that cannot be immediately rectified.
1.25.04 Building Chilled Water Refrigeration Contract Demand (tons): Building chilled water refrigeration contract demand shall be adjustable.

1.25.05 Building Chilled Water Control Valve

When building cooling is disabled, building chilled water valve shall be closed. Building cooling shall be enabled and disabled based upon operator command.

“Pressure Control” Mode:

When in the “Pressure Control” mode, building chilled water valve shall be modulated as required to maintain the building remote chilled water differential pressure\(^5\) at setpoint. Valve control shall be overridden as required to prevent the building chilled water flow from exceeding the building chilled water volumetric contract demand. On weekdays during the summer period of the electric utility (May through September) during the time period from 8:00 AM to 9:00 PM, building chilled water valve control shall also be overridden as required to prevent the building chilled water refrigeration from exceeding the building refrigeration contract demand.

If the building remote chilled water differential pressure is more than 2 psig (adjustable) below the building remote chilled water differential pressure setpoint and the building chilled water control valve is more than 95% open (adjustable) for more than 10 minutes (adjustable), the building chilled water valve shall be fully opened, and building chilled water pump operation shall be enabled.

“Temperature Control” Mode:

When in the “Temperature Control” mode, building chilled water control valve shall be modulated as required to maintain the building chilled water return temperature at setpoint of 54 deg. F (adjustable). Valve control shall be overridden as required to prevent the building chilled water flow from exceeding the building chilled water volumetric contract demand. On weekdays during the summer period of the electric utility (May through September) during the time period from 8:00 AM to 9:00 PM, building chilled water valve control shall also be overridden as required to prevent the building chilled water refrigeration from exceeding the building refrigeration contract demand.

1.25.06 Building Chilled Water Pumps:

When building cooling is disabled, building chilled water pumps shall be off. Building cooling shall be enabled and disabled based upon operator command.

“Pressure Control” Mode:

\(^5\)Remote differential pressure transmitter shall be located approximately 2/3 the distance of the most remote chilled water coil. Differential pressure transmitter location shall be indicated on the Construction Documents.
When in the “Pressure Control” mode and building chilled water pump operation is enabled (see above), building chilled water pumps shall be operated in a lead-lag manner. Lead and lag pumps shall be automatically alternated on a weekly basis to equalize wear. Alternation of lead and lag pumps shall occur in a manner such that building chilled water flow is not disrupted (new lead pump is started and accelerated to proper speed before former lead pump is stopped). In the event of a lead pump failure, lag pump shall be automatically started and an alarm shall be generated.

Lead pump shall be started whenever building cooling is enabled and chilled water pump operation is enabled. Lead pump speed shall be modulated from a minimum of 25% (adjustable) to a maximum of 100% (adjustable) as required to maintain building remote chilled water differential pressure at setpoint. Lead pump speed control shall be overridden as required to prevent the building chilled water flow from exceeding the building chilled water volumetric contract demand. On weekdays during the summer period of the electric utility (May through September) during the time period from 8:00 AM to 9:00 PM, pump speed control shall also be overridden as required to prevent the building chilled water refrigeration from exceeding the building refrigeration contract demand.

If lead pump speed is below 35% (adjustable) and the building remote chilled water differential pressure is at or above setpoint for more than 10 minutes (adjustable), the lead pump shall be automatically stopped.

If the building remote chilled water differential pressure is more than 2 psig (adjustable) below the building remote chilled water differential pressure setpoint and the lead pump speed is within 5% (adjustable) of its maximum speed for more than 10 minutes (adjustable), the lag pump shall be automatically started. The speed of the lead and lag pumps shall be operated in unison from a minimum of 25% (adjustable) to a maximum of 100% (adjustable) as required to maintain the building remote chilled water differential pressure at setpoint. Pump speed control shall be overridden as required to prevent the building chilled water flow from exceeding the building chilled water volumetric contract demand. On weekdays during the summer period of the electric utility (May through September) during the time period from 8:00 AM to 9:00 PM, pump speed control shall also be overridden as required to prevent the building chilled water refrigeration from exceeding the building refrigeration contract demand. In the event that the pump speed is below 35% (adjustable) and the building remote chilled water differential pressure is at or above setpoint for more than 10 minutes (adjustable), the lag pump shall be automatically stopped.

“Temperature Control” Mode:

When in the “Temperature Control” mode and building cooling is enabled, building chilled water pumps shall be operated in a lead-lag manner. Lead and lag pumps shall be automatically alternated on a weekly basis to equalize wear. Alternation of lead and lag pumps shall occur in a manner such that building chilled water flow
is not disrupted (new lead pump is started and accelerated to proper speed before former lead pump is stopped). In the event of a lead pump failure, lag pump shall be automatically started and an alarm shall be generated.

Lead pump shall be started whenever building cooling is enabled. Lead pump speed shall be modulated from a minimum of 25% (adjustable) to a maximum of 100% (adjustable) as required to maintain building remote chilled water differential pressure at setpoint.

If the building remote chilled water differential pressure is more than 2 psig (adjustable) below the building remote chilled water differential pressure setpoint and the lead pump speed is within 5% (adjustable) of its maximum speed for more than 10 minutes (adjustable), the lag pump shall be automatically started. The speed of the lead and lag pumps shall be operated in unison from a minimum of 25% (adjustable) to a maximum of 100% (adjustable) as required to maintain the building remote chilled water differential pressure at setpoint. In the event that the pump speed is below 35% (adjustable) and the building remote chilled water differential pressure is at or above setpoint for more than 10 minutes (adjustable), the lag pump shall be automatically stopped.

1.25.07 Minimum Flow Control Valves: If the mode of operation is “pressure control”, minimum flow control valve shall be closed. If the mode of operation is “temperature control” and a chilled water pump is not in operation or both chilled water pumps are in operation, minimum flow control valve shall be closed. If the mode of operation is “temperature control” and a single chilled water pump is in operation, minimum flow control valve shall be modulated as required to prevent the chilled water pump speed from decreasing below minimum pump speed setpoint of 30% (adjustable).

1.26 Sample Chilled Water Equipment Schedules: Refer to Appendix F for sample chilled water pump schedule.

1.27 Sample Chilled Water Equipment Specifications: Refer to Appendix J for sample chilled water equipment specifications including isolation valves, check valves, flexible pump connectors, suction diffusers, strainers, chilled water pump, and air vents.

1.28 Sample Chilled Water System Piping Diagrams: Refer to Appendix H for sample building and central chilled water plant piping diagrams.

1.29 Sample Chilled Water System Details: Refer to Appendix I for sample chilled water details including air vents and chilled water pumps.

2.0 Heating Water System

2.01 General: Building heating shall be provided by a closed loop hydronic system that includes an air separator, expansion tank, make-up water connection with water pressure regulating
valve, heating water converters (steam-fired), flow meter, heating water pumps, and minimum flow control valve.

2.02 Acceptable Manufacturers

2.02.01 Heating Water Converters: Acceptable manufacturers of heating water converters are Bell & Gossett, Armstrong, and Wheatley.

2.02.02 Expansion Tanks: Acceptable manufacturers of expansion tanks are Amtrol, Bell & Gossett, and Wheatley.

2.02.03 Air Separators: Acceptable manufacturers of air separators are Spirotherm, Amtrol, and Wheatley.

2.02.04 Water Pressure Regulating Valves: Acceptable manufacturers of water pressure regulating valves are Bell & Gossett and Armstrong.

2.02.05 Water Pressure Relief Valves: Acceptable manufacturers of water pressure relief valves are Bell & Gossett, Armstrong, and Kunkle.

2.02.06 Heating Water Pumps: Acceptable manufacturers of chilled water pumps are PACO, Bell & Gossett, Armstrong, Peerless, and Aurora.

2.02.07 Strainers: Acceptable manufacturers of strainers are Armstrong, Sarco, and Yarway.

2.02.08 Check Valves: Acceptable manufacturers of check valves are Nibco and Stockham.

2.02.09 Suction Diffusers: Acceptable manufacturers of suction diffusers are Armstrong, Bell & Gossett, Thrush, Taco, and Amtrol.

2.02.10 Flexible Pump Connectors: Acceptable manufacturers of flexible pump connectors are Armstrong, Keflex, Taco, and Thrush.

2.02.11 Isolation Valves

2.02.11.01 Ball Valves: Acceptable manufacturers of ball valves are Nibco and Stockham.

2.02.11.02 Gate Valves: Acceptable manufacturers of gate valves are Nibco and Stockham.

2.02.11.03 Butterfly Valves: Acceptable manufacturers of butterfly valves are Nibco and Stockham.

2.02.12 Air Vents: Acceptable manufacturers of air vents are Bell & Gossett, Armstrong, and Spirotherm.

2.03 Heating Water Metering
2.03.01 General: The heating water volumetric flow (GPM), heat transfer (MBH), volumetric consumption (MGallons), and energy consumption (MMBtu) of each building shall be metered. The metering arrangement shall consist of a flow meter and temperature sensors.

2.03.02 Flow Meter: The flow meter shall be of the magnetic flow tube type. Flow meter size shall be determined based upon the peak system flow requirement in accordance with manufacturer recommendations\(^6\). The flow meter shall purchased in accordance with the UAF IDIQ water meter contract. Refer to Appendix Q for a copy of the UAF IDIQ water meter contract.

2.03.03 Installation: The flow meter and temperature sensors shall be connected to the Controls Contractor central energy management system. The flow meter shall be installed in accordance with manufacturer recommendations.

2.04 Make-Up Water Pressure Setting: The make-up water pressure regulating valve setting shall be equal to the elevation difference between the highest heating water coil and the make-up water connection in feet divided by 2.31 plus 5 psig.

2.05 Water Pressure Relief Valve Pressure Setting: The water pressure relief valve setting shall be equal to 125 psig less the heating water pump shut-off pressure.

2.06 Heating Water Converters: Each building shall include 2 heating water converters. Each converter shall be capable of heating the peak building heating water flow rate from 150 deg. F to 180 deg. F using 2 psig saturated steam. Heating water converters shall be of the shell and tube type.

2.07 Make-up Water Piping: The make-up water connection shall include a dedicated backflow preventer, pressure regulating valve, and “quick-fill” bypass\(^7\).

2.08 Water Pressure Regulating Valves: Water pressure regulating valves shall be brass body construction with threaded connections. Pressure settings shall be adjustable.

2.09 Water Pressure Relief Valves: Water pressure relief valves shall be brass or iron body construction with threaded connections. Relief valves shall be EPDM diaphragm operated or diaphragm assisted. Relief valves shall comply with ASME requirements.

2.10 Expansion Tanks: Expansion tanks shall be of the diaphragm or bladder type. Expansion tanks shall be sized based upon 60 deg. F minimum water temperature, 200 deg. F maximum water temperature, minimum pressure equal to the water pressure regulating valve setting, maximum pressure equal to the water pressure relief valve setting, and the estimated volume of water in the heating water system. Expansion tanks shall be of the complete acceptance type.

2.11 Heating Water Coil Control Valves

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\(^6\) Heating water flow meters are not “line-sized”.

\(^7\) 2” minimum pipe size.
2.11.01 Fan Coils

2.11.01.01 Type: Fan coil unit heating water coil control valves shall be of the 2-way motorized ball type.

2.11.01.02 Actuator: Actuators shall be electric 2-position with spring return.

2.11.01.03 Selection: Fan coil unit heating water coil control valves shall be selected to provide a maximum water pressure drop of 3 psig at the coil design flow rate.

2.11.01.04 Ratings: Fan coil unit heating water coil control valves shall have a minimum pressure rating of 150 psig and a minimum dynamic close-off rating of 100 psi.

2.11.02 Air Terminals

2.11.02.01 Type: Air terminal heating water coil control valves shall be of the 2-way motorized ball type.

2.11.02.02 Actuators shall be electronic modulating type. Floating 3-wire and “wax top” actuator valves shall not be used.

2.11.02.03 Selection: Air terminal heating water coil control valves shall be selected to provide a maximum water pressure drop of 3 psig at the coil design flow rate.

2.11.02.04 Ratings: Air terminal heating water coil control valves shall have a minimum pressure rating of 150 psig and a minimum dynamic close-off rating of 100 psi.

2.11.03 Air Handling Units

2.11.03.01 Type: Air handling unit heating water coil control valves shall be of the 2-way, modulating, rotary segmented port type equal to Kele Max Cap Series V.

2.11.03.02 Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

2.11.03.03 Sizing: Air handling unit heating water coil control valves shall be sized based upon a maximum water pressure drop of 3 psig at the coil design flow rate with 180 deg. F heating water supply temperature.

2.11.03.04 Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic with rangeability (defined as the fully open valve flow at 1 psi water pressure drop divided by the minimum
controllable flow at 1 psi water pressure drop) of 200 to 1 or greater. Valve leakage rating shall be ANSI Class VI.

2.11.03.05 Pressure and Temperature Ratings: Valve pressure rating shall be a minimum of 200 psig with water temperature of 400 deg. F.

2.11.03.06 Close-off Ratings: Valve close-off ratings shall be a minimum of 150 psi.

2.11.03.07 Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

2.11.03.08 Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be carbon steel, with stainless steel v-notch rotary plug, stainless steel shaft, low friction bearings, low friction graphite seal, and spring-loaded self-adjusting Teflon v-ring packing. Valve shall have a permanent seal retainer (valve may be removed and re-installed without replacing the internal seal retainer gasket). Valve body shall have a pressure recovery chamber downstream of the rotary trim, for minimizing cavitation and noise. Valve shall have integral 4-bolt universal actuator mounting pad, and have double-D keyed shaft connection.

2.11.03.09 Warranty: Valves shall be warranted (parts and materials only) to be free of defect for a period of 5 years beginning on the date of shipment to the job site.

2.11.04 Minimum Flow Control Valves

2.11.04.01 Application: Minimum flow control valves are required in all heating water applications.

2.11.04.02 Location: Minimum flow control valves shall be installed at the end of the heating water mains. The location of the minimum flow control valve shall be indicated on the Construction Documents.

2.11.04.03 Minimum Heating Water Flow: The minimum flow shall be equal to 25% of the design heating water pump flow rate.

2.11.04.04 Type: Minimum flow heating water coil control valves shall be of the 2-way, modulating, rotary segmented port type equal to Kele Max Cap Series V.

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8 The purpose of the minimum flow control valve is to allow proper ΔP control at the minimum allowable pump speed.
2.11.04.05 Actuator: Actuators shall be modulating electronic or pneumatic depending upon the application.

2.11.04.06 Sizing: Minimum flow heating water coil control valves shall be sized based upon a maximum water pressure drop of 5 psig at the minimum chilled water flow.

2.11.04.07 Valve Performance: Valve flow characteristic shall be modified equal percentage characteristic with rangeability (defined as the fully open valve flow at 1 psi water pressure drop divided by the minimum controllable flow at 1 psi water pressure drop) of 200 to 1 or greater. Valve leakage rating shall be ANSI Class VI.

2.11.04.08 Pressure and Temperature Ratings: Valve pressure rating shall be a minimum of 200 psig with water temperature of 400 deg. F.

2.11.04.09 Close-off Ratings: Valve close-off ratings shall be a minimum of 150 psi.

2.11.04.10 Connections: Valve connections shall be flanged, soldered, or threaded as required by the application.

2.11.04.11 Construction: Valve stems shall be polished stainless steel. Valve trim shall be polished stainless steel or brass. Valve bodies shall be carbon steel, with stainless steel v-notch rotary plug, stainless steel shaft, low friction bearings, low friction graphite seal, and spring-loaded self-adjusting Teflon v-ring packing. Valve shall have a permanent seal retainer (valve may be removed and re-installed without replacing the internal seal retainer gasket). Valve body shall have a pressure recovery chamber downstream of the rotary trim, for minimizing cavitation and noise. Valve shall have integral 4-bolt universal actuator mounting pad, and have double-D keyed shaft connection.

2.11.04.12 Warranty: Valves shall be warranted (parts and materials only) to be free of defect for a period of 5 years beginning on the date of shipment to the job site.

2.12 Heating Water Pumps:

2.12.01 Number of Pumps: Two (2) heating water pumps shall be installed in each building.

2.12.02 Type of Pumps: Pumps shall be of the flexible coupled end suction or vertical in-line type.

2.12.03 Flow Requirements: The design flow requirement for each pump shall be equal to 100% of the peak system flow requirement.
2.12.04 Head Requirements: The design head requirement for each pump shall be equal to the system head loss at the peak system flow requirement. Mechanical designers shall be careful to avoid over estimating the pump head requirements.

2.12.05 Motor Selection: The pump motors shall be selected to be non-overloading anywhere on the pump curve at maximum pump speed.

2.12.06 Variable Frequency Drives: Each pump shall be equipped with a variable frequency drive. Manual bypass contactor arrangements are not required for these variable frequency drives9.

2.12.07 Other Considerations: Mechanical system designers shall select heating water pumps based upon efficiency, net positive suction head requirements, runout, unloading characteristics, and other factors.

2.13 Air Separators: Air separators shall be sized for peak flow requirement. Air separators shall not be equipped with strainers. Air separators shall be equipped with drain and air vent connections. Spirotherm?

2.14 Air Vents: Automatic air vents shall be installed in mechanical rooms only. Discharge of automatic air vents shall be routed to a floor drain. Automatic air vents shall be brass or semi-steel body with copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat, and isolating valve.

2.15 Check Valves: Check valves shall be located at the discharge of each heating water pump. Check valves shall be of the swing check type. Check valves 2-½” and smaller shall be bronze body with bronze trim, y-pattern, and threaded ends. Check valves 3” and larger shall be iron body, bronze trim, bronze or bronze faced swing disc, renewable disc and seat, and flanged ends.

2.16 Flexible Pump Connectors: Flexible pump connectors shall be installed at the suction and discharge connections to each pump. Flexible pump connectors shall have flanged ends.

2.17 Suction Diffusers: Suction diffusers shall be installed at the suction of each heating water pump. Suction diffusers shall be angle pattern, cast or ductile iron body with inlet vanes, cylinder strainer, disposable fine mesh start-up strainer, adjustable foot support or base support boss, bottom blowdown tapping, and gage tapping in side.

2.18 Thermal Expansion

2.18.01 General: Heating water systems shall be designed to accommodate thermal expansion using expansion loops, bends, offsets, pipe guides, and pipe anchors in accordance with standard engineering practice. If the anticipated expansion is too great to accommodate using pipe loops, bends or offsets, expansion joints may be used.

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9 In the event of a VFD failure, the remaining pump should be capable of accommodating the peak heating water flow requirement.
2.18.02 Thermal Expansion: The designer shall calculate the anticipated thermal expansion based upon the pipe material, length of piping between anchors, and the anticipated change in temperature. For standard heating water systems, the anticipated change in temperature is 150 deg. F and the thermal linear expansion is 1.69 inches per 100 feet of pipe for copper pipe and 1.15 inches per 100 feet of pipe for steel pipe.

2.18.03 Anchors: In general, anchors should be located in the center of heating water risers and at the ends of long runs of piping.

2.18.04 Loops: Expansion loop widths and heights shall be determined in accordance with standard engineering practice based upon the pipe size, pipe material, and total amount of expansion. In general, expansion loop widths shall be equal to the heights divided by 2. Refer to Appendix I for expansion loop selection charts.

2.18.05 Offsets and Bends: Expansion loop offsets and bends shall be designed in accordance with standard engineering practice based upon the length of the longest leg, length of shortest leg, pipe size, pipe material, and total amount of expansion. Refer to Appendix I for offset and bend selection chart.

2.18.06 Guides: Pipe guides shall be located on both sides of expansion loops, offsets, and bends in accordance with standard engineering practice. Refer to Appendix I for additional information regarding the location of pipe guides.

2.18.07 Expansion Joints: In the event that thermal expansion cannot be accommodated using loops, offsets, or bends, expansion joints may be used (risers or tunnels where insufficient room exists to install a loop, for example). If used, expansion joints may be of the packed or packless type depending upon application specific requirements.

2.18.08 Pipe Supports: In general, clevis type pipe hangers with saddles shall be used. In applications where extreme expansion is possible, roll-type hangers shall be used.

2.19 Heating Water Pipe Sizing

2.19.01 General: Heating water piping shall be sized in accordance with good engineering practice based upon velocity and water pressure drop.

2.19.02 Flow Rates: Building heating water mains shall be sized based upon the peak heating water system flow requirement considering diversity. Branch piping shall be sized based upon the sum of the peak heating water flow requirements of the coils served by the branch piping without considering diversity.

2.19.03 Maximum Velocities and Water Pressure Drops: The maximum acceptable velocity is 12 feet per second for heating water mains and 10 feet per second for branch piping. The maximum acceptable water pressure drop for heating water mains and branch piping is 6 feet w.g. per 100 feet of pipe.
2.20 Heating Water Pipe and Pipe Fittings: Heating water piping 2-\(\frac{1}{2}\)” and smaller shall be ASTM B 88, hard drawn, Type L copper tube with cast brass or solder wrought copper fittings and lead free solder. Heating water piping 3” and larger shall be standard weight black steel with welded joints.

2.21 Isolation Valves

2.21.01 General: Isolation valves in piping 2-\(\frac{1}{2}\)” or less shall be ball valves. Isolation valves in 3” and 4” piping shall be gate valves. Isolation valves in piping 6” and larger shall be butterfly valves.

2.21.02 Ball Valves: Ball valves shall be have bronze 2-piece body with chrome plated brass ball, TFE seats, threaded ends, and raised lever handle for insulation.

2.21.03 Gate Valves: Gate valves shall be iron body with bronze trim, bolted bonnet, non-rising stem, handwheel, solid wedge disk with bronze seat rings, and flanged ends.

2.21.04 Butterfly Valves: Butterfly valves shall be cast or ductile iron body with resilient replaceable EPDM seat, lug ends, stainless steel trim, 316 bronze disk, and infinite position gear operator. Butterfly valves shall rated for bi-directional, bubbletight, deadend service.

2.22 Balancing Valves: Balancing valves shall not be installed in heating water systems.

2.23 Reverse Return Piping Arrangements: Reverse return piping arrangements are encouraged.

2.24 Sequence of Operation

2.24.01 Heating Water Steam Control Valves: Steam control valves shall be modulated as required to maintain the heating water supply temperature at setpoint. Setpoint shall be automatically reset from a minimum of 100 deg. F at an outside air temperature of 80 deg. F and above to a maximum of 180 deg. F at an outside air temperature of 40 deg. F and below. Valve control shall be overridden as required to prevent individual converter leaving water temperatures from increasing above 180 deg. F.

2.24.02 Heating Water Pumps: Heating water pumps shall be sequenced in lead-standby arrangement. Lead pump shall typically be operated at all times. In the event of a lead pump failure, standby pump shall be automatically started. Lead and standby pumps shall be automatically alternated on a weekly basis to equalize wear. Lead pump speed shall be modulated from a minimum of 25% to a maximum of 100% as required to maintain the heating water remote differential pressure\(^{10}\) at setpoint. Setpoint shall be automatically reset from a minimum of 4 psig up to a maximum of 8 psig based upon the position of the most open heating water control valve. If the most open heating water control valve is more than 95% open, the

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\(^{10}\) Remote differential pressure transmitter shall be located approximately 2/3 the distance of the most remote heating water coil. Differential pressure transmitter location shall be indicated on the Construction Documents.
heating water differential pressure setpoint shall be increased. If the most open heating water control valve is less than 85% open, the heating water differential pressure setpoint shall be decreased.

2.24.03 Minimum Flow Control Valve: If a heating water is not in operation or both heating water pumps are in operation, minimum flow valve shall be closed. If a single heating water pump is in operation, minimum flow control valve shall be modulated as required to prevent the heating water pump speed from decreasing below minimum pump speed setpoint of 30% (adjustable).

2.25 Sample Equipment Schedules: Refer to Appendix F for sample heating water converter, heating water pump, expansion tank, air separator, water pressure regulating valve, and water pressure relief valve schedules.

2.26 Sample Equipment Specifications: Refer to Appendix J for sample heating water equipment specifications including heating water converter, heating water pump, expansion tank, air separator, water pressure regulating valve, and water pressure relief valve.

2.27 Sample Heating Water System Piping Diagram: Refer to Appendix H for sample building heating water piping diagram.

2.28 Sample Heating Water System Details: Refer to Appendix I for sample heating water details including expansion loop, pipe bend, pipe anchor, pipe guide, heating water converter, air separator, expansion tank, make-up water, water pressure regulating valve, water pressure relief valve, and heating water pump.
CONSULTANT DESIGN GUIDELINE

Specify secondary S base meters to be furnished and installed as required with type M-30 demand register.

Specify a suitable KWH electrical transducer in conjunction with the electrical meter. This transducer should have 4-20 MaDC output and the accuracy should be no greater than +/- 0.25%.

Specify that a schematic of the connections be supplied to Facilities Management by the General Contractor.

Submit meter specifications to Facilities Management for approval.

Meters located underground shall be located in concrete lockable boxes with tops of boxes at finished grade.

The specifications for the service entrance electrical gear should require the contractor to furnish gear
that has a separate metering compartment, isolated from all distribution bus work, building supply voltages, or any other hazardous conditions. The metering compartment shall be accessible without exposing service personnel to the interior of the gear, and should require no more than Level 1 PPE under NFPA 90 E for Arc Flash protection.

The gear shall come with current transformers (CT’s) ratioed for a standard 0-5 amp electrical meter, wired out to the metering compartment, and include shorting blocks and all other terminals or devices such that all that has to be done is install the meter and land the communication and CT leads to the meter.

Specifications/construction documents shall provide for bringing 110V power to the compartment for the meter power supply as well as a standard network communication drop for meter communication.

**Utility Metering**

General: All utilities including water, steam, chilled water, and natural gas shall be metered. Meters shall be purchased using the UAF IDIQ contracts if available that way. Water meters shall be furnished or specified by the City of Fayetteville meter division. All costs of owning and operating the campus energy distribution systems to the buildings by the automatic metering and cost allocation (AMCA) system using cost of service based rate schedules and actual metered consumption.

END SECTION

33 71 83 Transmission and Distribution Specialties

33 72 00 Utility Substations
33 72 13 Deadend Structures
33 72 23 Structural Bus Supports
   33 72 23.13 Bus Support Insulators
   33 72 23.16 Copper Substation Bus Assemblies
33 72 33 Control House Equipment
   33 72 33.13 Relays
   33 72 33.16 Substation Control Panels
33 72 33.23 Power-Line Carriers
33 72 33.26 Substation Metering
33 72 33.33 Raceway and Boxes for Utility Substations
33 72 33.36 Cable Trays for Utility Substations
33 72 33.43 Substation Backup Batteries
33 72 33.46 Substation Converter Stations
33 72 43 Substation Control Wiring

33 73 00 Utility Transformers
33 73 13 Liquid-Filled Utility Transformers
33 73 23 Dry-Type Utility Transformers

33 75 00 High-Voltage Switchgear and Protection Devices
33 75 13 Air High-Voltage Circuit Breaker
33 75 16 Oil High-Voltage Circuit Breaker
33 75 19 Gas High-Voltage Circuit Breaker
33 75 23 Vacuum High-Voltage Circuit Breaker
33 75 36 High-Voltage Utility Fuses
33 75 39 High-Voltage Surge Arresters
33 75 43 Shunt Reactors

33 77 00 Medium-Voltage Utility Switchgear and Protection Devices
33 77 13 Air Medium-Voltage Circuit Breaker
33 77 16 Oil Medium-Voltage Circuit Breaker
33 77 19 Gas Medium-Voltage Circuit Breaker
33 77 23 Vacuum Medium-Voltage Circuit Breaker
33 77 26 Medium-Voltage Utility Fusible Intermittent Switchgear
33 77 33 Medium-Voltage Utility Cutouts
33 77 36 Medium-Voltage Utility Fuses
33 77 39 Medium-Voltage Utility Surge Arresters
33 77 53 Medium-Voltage Utility Reclosers

33 79 00 Site Grounding
33 79 13 Site Improvements Grounding
    33 79 13.13 Electric Fence Grounding
33 79 16 Tower Grounding
    33 79 16.13 Communications Tower Grounding
    33 79 16.16 Antenna Tower Grounding
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33 79 23 Utility Substation Grounding
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    33 79 83.13 Grounding Wire, Bar, and Rod
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<th>RECOMMENDATION OF DEVICES</th>
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<tbody>
<tr>
<td>Supply to building, 1/2'' - 2''</td>
<td>RPZ, Wilkins/Zurn 975XL, Standard # 1013 or equal</td>
</tr>
<tr>
<td>Supply to building, 2-1/2'' - 6''</td>
<td>RPZ, Wilkins/Zurn 375, Standard # 1013 or equal</td>
</tr>
<tr>
<td>Fire line, 3/4'' - 2''</td>
<td>DCVA, Wilkins/Zurn 950XL, Standard # 1015 or equal</td>
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<tr>
<td>Fire line, 2-1/2'' - 3''</td>
<td>DCCA, Wilkins/Zurn 950DA, Standard # 1048 or equal</td>
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<tr>
<td>Make-up/cooling water/process water, 1/2'' - 2''</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<td>Make-up/cooling water/process water, 2-1/2'' - 6''</td>
<td>RPZ, Wilkins/Zurn 375, Standard # 1013 or equal</td>
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<td>Irrigation systems, fountains, ponds, 3/4'' - 2''</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Irrigation systems, 2-1/2'' - 6''</td>
<td>RPZ, Wilkins/Zurn 375, Standard # 1013 or equal</td>
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<tr>
<td>Building DI systems (water purification system), 3/4'' - 2''</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Building DI systems (water purification system), 2-1/2'' - 4''</td>
<td>RPZ, Wilkins/Zurn 975XL, Standard # 1013 or equal</td>
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<td>Point of use DI systems (water purification systems), 1/4'' - 1''</td>
<td>Dual check valve, Wilkins/Zurn 700, Standard # 1024 or equal</td>
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<tr>
<td>Sterilizer, 3/4'' - 2''</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Humidifier, 1/2'' - 2''</td>
<td>PBV, Wilkins/Zurn 975XL, Standard # 1013 or equal</td>
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<tr>
<td>Lab faucet, (on new gooseneck)</td>
<td>AVB, Standard # 1001</td>
</tr>
<tr>
<td>Lab faucet w/o AVB (thread on type), 3/8''</td>
<td>AVB, T&amp;S Brass B-0970, Standard # 1035 or equal</td>
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<tr>
<td>Outside wall hydrant w/ AVB, 3/4'' hose thread</td>
<td>Zum Z1000, Standard # 1019 or equal</td>
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<tr>
<td>Inside hose bibb, 3/4'' hose thread</td>
<td>HBVB_ Wilkins/Zurn 8F, Standard # 1011 or equal</td>
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<tr>
<td>Yard hydrant</td>
<td>Zum Z1000, Standard # 1019 or equal</td>
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<td>Hose bibbs on non-potable water lines: Chill water, heating</td>
<td>Tag as non-potable water</td>
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<tr>
<td>Coke machine, carbonated beverage dispensing systems</td>
<td>Carbonated beverage backflow preventer, Wilkins/Zurn 740, Standard # 1022 or equal</td>
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<td>Dishwasher drain line</td>
<td>Install air gap on top of counter or air gap at floor drain</td>
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<tr>
<td>Commerce dish machine water line</td>
<td>AVB, Wilkins/Zurn 35, Standard # 1001 or equal</td>
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<tr>
<td>Garbage disposal</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Soap pumping machines</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Fire hydrant (irrigation, make-up, etc…), (portable unit)</td>
<td>RPZ, Wilkins/Zurn 975XL, Standard # 1013 or equal</td>
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<tr>
<td>Quick fill lines for chill water, (portable unit)</td>
<td>RPZ, Wilkins/Zurn 975XL, Standard # 1013 or equal</td>
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<td>Hot box for outside enclosure</td>
<td>Standard # 1050</td>
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<tr>
<td>Water hammer arrestrons</td>
<td>Standard # 1010</td>
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<tr>
<td>Swimming pool, whirlpools, saunas</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Pressure washers, (stationary car or equipment washer)</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>Pressure washers, (portable unit)</td>
<td>HBVB_ Wilkins/Zurn 8F, Standard # 1011 or equal</td>
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<tr>
<td>Temporary water service for contractors</td>
<td>PBV, Wilkins/Zurn 750A, Standard # 1020 or equal</td>
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<tr>
<td>AVB Atmospereic Vacuum Breaker</td>
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</tr>
<tr>
<td>PBV Pressure Vacuum Breaker</td>
<td></td>
</tr>
<tr>
<td>DCVA Double Check Valve Assembly</td>
<td></td>
</tr>
<tr>
<td>DCCA Double Check Detector Assembly</td>
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<tr>
<td>RPZ Reduced Pressure Zone Assembly</td>
<td></td>
</tr>
<tr>
<td>HBVB Hose Bibb Vacuum Breaker</td>
<td></td>
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</tbody>
</table>
PACO Type LF Frame Mounted, single stage, end suction centrifugal pumps are designed and built for compactness, high performance, durability, and versatility of application.

PACO Frame Mounted pumps with their heavy frames, shafts and ball bearings are ideal for reliable heavy duty service. They are available in 6 different frame sizes to match HP requirements up to 300 HP.

Frame Mounted models feature flexible coupled drive and are available with steel or cast iron bases with drip–lip and drain tapping.

The back pull out feature allows maintenance without disconnecting system piping.

<table>
<thead>
<tr>
<th>Rotation Options</th>
<th>Clockwise</th>
<th>Impeller Washer</th>
<th>S.S., AISI–303</th>
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<tr>
<td>Base/Stand Type</td>
<td>Steel Base</td>
<td>Impeller Key</td>
<td>Steel, AISI 1045</td>
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<td>Drip Pan</td>
<td>Provided</td>
<td>Pump Shaft</td>
<td>Steel, AISI–C1045</td>
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<td>Coupling Options</td>
<td>Woods</td>
<td>Sleeve Material</td>
<td>Bronze, III932, C89835</td>
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<tr>
<td>Bearing Options</td>
<td>Sealed for life</td>
<td>Wear Ring Material</td>
<td>NiAl–Bronze, ASTM–B148, C95500</td>
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<td>Connections</td>
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<td>Packing Gland</td>
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<td>Wear Ring Type</td>
<td>Case Wear Ring</td>
<td>Lantern Ring</td>
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<td>Pump Coatings</td>
<td>Standard Paint</td>
<td>Seal Type</td>
<td>Type 21</td>
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<td>NSF–50 Certification</td>
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<td>Seal Material</td>
<td>Ceramic/Carbon/Buna</td>
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<td>NSF–61 Certification</td>
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<td>Buna N</td>
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<td>Casing</td>
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<td>Seal Flush Options</td>
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<td>Backplate/Seal Plate</td>
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<td>Seal Flush Acc.</td>
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<td>Bearing Frame</td>
<td>Cast Iron, ASTM–A48, CL 30</td>
<td>Gaskets</td>
<td>Veg. Fiber</td>
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<tr>
<td>Impeller</td>
<td>Silicon Bronze, ASTM–B584, C87600</td>
<td>Casing Bolts</td>
<td>Steel, AISI 1045</td>
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<tr>
<td>Impeller Cap Screw</td>
<td>S.S., AISI–303</td>
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Project: U A F End Suction Sample
Model: 4012A
Location: Fayetteville, AR
Rotation: Clockwise
Contractor: Fluid Solutions, Inc.
Engineer: T. M. E.

P.O. # By: James Dayer
Cust Ref# Date: 8/15/2006

Rotation: Clockwise

Conditions of Service
TDH: 75.0 ft Temp: 68.00 deg F RPM: 1750 Hz: 60 Voltage: 208–230/460

Motor Data
Eff: 1.15
S.F.: 1.15

<table>
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<tr>
<th>Units</th>
<th>PED</th>
<th>FRAME</th>
<th>DISCH</th>
<th>SUCT</th>
<th>C</th>
<th>CP</th>
<th>D</th>
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<th>HB</th>
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<th>Y</th>
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</table>
LF – 4012A Configured Curve

By: James Dayer
Date: 8/15/2006

Project: U A F End Suction Sample
Tag #: P−1
P.O. #: P−1
Location: Fayetteville, AR
Model: 4012A
Contractor: Fluid Solutions, Inc.
Tag #: P−1
Qty: 1
Location: Fayetteville, AR
Model: 4012A
Cust Ref#: Contractor: Fluid Solutions, Inc.

Design Data

Flow: 500 USgpm
Fluid: Water
Suct. Press: 0.00 psi.a
TDH: 75.0 ft
Temp: 68.00 deg F
Dis. Press: 
Shutoff Head: 87.4 ft
S.G.: 0.998
Diff. Press: 
NPSHr: 15.57 ft
Visc.: 1.00 cP
BHP: 11.1 hp
Imp. Dia.: 9.41 in
Pump Eff.: 85.04
BEP: 554 USgpm
No Of Stages: 1

Motor Data

HP: 15
Voltage: 208–230/460
Eff: 
Nominal RPM: 1750
Phase: Three phase
S.F.: 1.15
Actual RPM: 1750
Hz: 60
Encl.: ODP
PART 1 – GENERAL

1.1 SCOPE
A. Types of pumps specified in this section include:
   1. Frame Mounted End Suction

1.2 RELATED WORK:
A. Pumps furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15 sections.
B. Motor starters, disconnects, and wiring of pump motors; Division 16
C. Insulation of pump housings; Section 15250
D. Sump pumps; Section 15450
E. Pump system balancing; Section 15980
F. Variable frequency drives; Section 15950

1.3 QUALITY ASSURANCE:
A. Manufacturers: Firms regularly engaged in manufacture of pumps of types and sizes required, whose products have been in satisfactory use in similar service for not less that five (5) years.
B. Provide electric motors and products which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.4 SUBMITTALS:
A. Product Data: Submit manufacturers pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.
B. Shop Drawings: Submit equipment connection and support details. Equipment connection details to indicate all piping connections with sizes and types of pipe, valves, fittings, specialties, and meter and gauges to be used. Support details to include fabricated, materials, and methods of support intended. Include detail of vibration isolation.
C. Operation and Maintenance Manual: Include maintenance data and spare parts lists for each type of pump.
PART 2 – PRODUCTS

2.1 GENERAL

A. Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump are listed in pump schedule.

2.2 END SUCTION PUMPS

A. Furnish and install, as outlined on the equipment schedule and described in these specifications, a Paco model LF frame mounted pump, or equal, designed to deliver the scheduled flow rate (in GPM), the specified total dynamic head (in feet), at the scheduled efficiency and scheduled speed (RPM).

B. Pumps shall meet or exceed the efficiency shown in the pump schedule.

C. To insure cavitation-free operation, each pump’s NPSH Requirement must be low enough to permit stable, continuous operation at 120% or greater of best efficiency point.

D. Each pump shall be capable of continuous operation without producing noise in excess of the Hydraulic Institute and OSHA guidelines

E. Pump casing shall be close grain cast iron fitted with a replaceable (lead-free, bronze, cast iron) case wear ring. Pumps with a specific speed greater than 1600 shall have double-volute casings with suction splitter to reduce radial loading and shaft deflection. All pumps shall be of the back pullout design so that the rotating element can be removed from the casing without disconnecting the suction or discharge piping.

F. Pump impeller shall be of the enclosed type of cast lead-free, bronze and shall be statically and dynamically balanced. Impeller diameter shall be trimmed for the specific design conditions.

G. The pump shaft shall be fitted with a leakless mechanical seal suitable for the temperatures and pressures indicated.

H. Motor shall be of the horsepower and speed shown in the pump schedule. Pumps requiring larger horsepowers shall not be acceptable. Pump shall be (flexible, close) coupled to a (3, 1) phase, (60, 80) Hertz, ______ volt, (horizontal, vertical), (ODP, TEFC, Explosion Proof) motor with (1.15, 1.0) service factor. 40 degree C ambient.

I. All pumps shall be supplied on a base having a drip pan with drain connection.
2.3 BEARING FRAME MOUNTED (LF)

A. Pump shall be mounted on a heavy-duty cast-in-one-piece cast iron bearing frame. Shaft shall be of carbon steel. Pump bearings shall be permanently sealed.

B. Pump and motor shall be mounted on a channel steel base, adequately reinforced against deflection. Pump shall be connected to the drive motor by a flexible coupling capable of withstanding all torsional, radial and axial loads. Coupling and exposed rotating components of the pump and motor shall be protected by an OSHA approved guard.

PART 3 – EXECUTION

3.1 INSTALLATION OF PUMPS:

A. Install pumps where indicated, in accordance with manufacturer’s published installation instruction, with recommended clearances provided for service and maintenance.

B. Install base-mounted pumps on minimum of 4” reinforced high concrete base with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

C. Provide piping; accessories; hangers, supports, and anchors; valves; meters and gauges; and equipment supports; as indicated for complete installation.

D. Pump and motor shall be realigned by the contractor, according to the standards of the Hydraulic Institute, after grouting of base and connection of piping.

E. Lubricate pumps before start-up. Start-up in accordance with manufacturer’s service representative.

F. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided.
PACO type KP, horizontal splitcase, double suction, centrifugal pumps are available with a wide selection of metallurgical and mechanical options to meet specific pumping requirements. Pump casings are horizontally split at the shaft centerline to simplify inspections and maintenance. Impellers are dynamically and hydraulically balanced. All PACO Type KP pumps are equipped with cartridge type bearing housings for ease of maintenance. Type KP splitcase pumps are available with packing and a variety of mechanical shaft seals.

| Rotation Options | Clockwise | Impeller Key | Steel, AISI 1045 |
| Base/Stand Type | Steel Base | Pump Shaft | Steel, AISI–C1045 |
| Drip Pan | None | Sleeve Material | Bronze, III932, C89835 |
| Coupling Options | Woods | Wear Ring Material | NiAl–Bronze, ASTM–B148, C95500 |
| Bearing Options | Regreaseable | Packing Gland | Not Applicable |
| Connections | 125# ANSI | Lantern Ring | None |
| Wear Ring Type | Case Wear Ring | Seal Type | Type 21 |
| Pump Coatings | Standard Paint | Seal Material | Ceramic/Carbon/Buna |
| NSF–50 Certification | Not Required | O–Rings | Buna N |
| NSF–61 Certification | Not Required | Seal Flush Options | No External flush |
| Casing | Cast Iron, ASTM–A48, CL 30 | Gaskets | Veg. Fiber |
| Seal/Bearing Housing | Cast Iron, ASTM–A48, CL 30 | Casing Bolts | Steel, AISI 1045 |
| Impeller | Silicon Bronze, ASTM–B584, C87600 | Comments | |
Project: U A F Horiz. Split Case Sample  
Model: 6012–3/4  
Location: Fayetteville, AR  
Contractor:  
Engineer: T. M. E.  
By: James Dayer  
Date: 8/15/2006

**Conditions of Service**

- Flow: 1500 USgpm
- Temp: 68.00 deg F
- Suct. Press: 0.00 psi.a
- S.G.: 0.998
- Fluid: Water
- Visc. : 1.00 cP

**Motor Data**

- HP: 40
- RPM: 1750
- Phase: Three phase
- Encl.: ODP
- Hz: 60
- Voltage: 208–230/460
- S.F.: 1.15

**KP – 6012–3/4 – 1750 RPM – Performance Curve**

**Graph Details**

- Model: 6012 or 4
- Impeller No.: 3490
- Size: 6" x 8" x 12"
- Eye Area: 50.0
- Type: KP
- Curve No.: RC 2353-1
- RPM: 1780
- Date: 4/86

**Approved by:**

[Signature]

[Date] 4/86

Project: U A F Horiz. Split Case Sample
Model: 6012–3/4
P.O. #

Location: Fayetteville, AR
Rotation: Clockwise
Cust Ref#

Contractor: Qty: 1
Agent/Rep: Fluid Solutions, Inc.
Rev. #

Engineer: T. M. E.
Service: Water
Tag # P–1

Units FRAME SUCT DISCH C CP HA HB HD HE HF HG HH HJ HP HR HS HT HZ MU U W X YY Weight
inches 324T 8 6 33.0 31.25 18.00 64.00 10.75 14.00 30.00 4.00 0.625 2.00 2.00 9.38 10.75 0.75 19.75 2.125 1.500 17.00 14.00 16.00 1784

Conditions of Service
Flow: 1500 USgpm
Fluid: Water
HP: 40
Encl.: ODP
Phase: Three phase
Eff:

TDH: 80.0 ft
Temp: 68.00 deg F
RPM: 1750
Hz: 60
Voltage: 208–230/460
S.F.: 1.15
KP – 6012–3/4 Configured Curve

By: James Dayer
Date: 8/15/2006
Rev. #

Project: U A F Horiz. Split Case Sample
Tag # P-1
P.O. #
Location: Fayetteville, AR
Model: 6012–3/4
Cust Ref#
Contractor: Qty: 1
Agent/Rep: Fluid Solutions, Inc.
Engineer: T. M. E.
Service: Water
Doc #

Design Data

| Flow: 1500 USgpm | Fluid: Water | Suct. Press: 0.00 psi.a |
| TDH: 80.0 ft | Temp: 68.00 deg F | Dis. Press: |
| Shutoff Head: 105 ft | S.G.: 0.998 | Diff. Press: |
| NPSHr: 7.71 ft | Visc.: 1.00 cP | BHP: 36.0 hp |
| Imp. Dia.: 9.60 in | Pump Eff.: 83.92 |
| No Of Stages: 1 | BEP: 1684 USgpm |

Motor Data

| HP: 40 | Voltage: 208–230/460 | Eff: |
| Nominal RPM: 1750 | Phase: Three phase | S.F.: 1.15 |
| Actual RPM: 1780 | Hz: 60 | Encl.: ODP |
PART 1 – GENERAL

1.1 SCOPE
A. Types of pumps specified in this section include:

1. Frame Mounted Double Suction Pumps

1.2 RELATED WORK:
A. Pumps furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15 sections.
B. Motor starters, disconnects, and wiring of pump motors; Division 16
C. Insulation of pump housings; Section 15250
D. Sump pumps; Section 15450
E. Pump system balancing; Section 15980
F. Variable frequency drives; Section 15950

1.3 QUALITY ASSURANCE:
A. Manufacturers: Firms regularly engaged in manufacture of pumps of types and sizes required, whose products have been in satisfactory use in similar service for not less that five (5) years.
B. Provide electric motors and products which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.4 SUBMITTALS:
A. Product Data: Submit manufacturers pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

B. Shop Drawings: Submit equipment connection and support details. Equipment connection details to indicate all piping connections with sizes and types of pipe, valves, fittings, specialties, and meter and gauges to be used. Support details to include fabricated, materials, and methods of support intended. Include detail of vibration isolation.

C. Operation and Maintenance Manual: Include maintenance data and spare parts lists for each type of pump.
PART 2 – PRODUCTS

2.1 GENERAL

A. Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump are listed in pump schedule.

2.2 DOUBLE SUCTION PUMPS

A. Furnish and install, as outlined on the equipment schedule and described in these specifications, a Paco model KP double suction, horizontal, split case, centrifugal pumps, or equal, designed to deliver the scheduled flow rate (in GPM), the specified total dynamic head (in feet), at the scheduled efficiency and scheduled speed (RPM).

To insure cavitation-free operation, each pump’s NPSH requirement must by low enough to permit stable, continuous operation at 120% or greater of best efficiency point.

B. Pumps shall have the casing divided on the horizontal centerline. The casing halves shall be accurately machined, bolted and doweled together. A non-asbestos type gasket material shall be furnished between the casing halves. The casing material shall be close-grained cast iron with a minimum tensile strength of 35,000 P.S.I. Removal of the uppercasing half and bearing housings shall permit removal of the complete rotating assembly without disturbing piping connections. Pumps shall be provided with removable bearing housings, which will permit inspection and/or replacement of the mechanical seals, shaft sleeves, and bearings without removing the rotating assembly or top casing half. Pumps with 4 inch or larger discharge flanges shall be of the double volute design.

C. Casings shall be designed for scheduled working pressure and shall be hydrostatically tested at 150% of the maximum working pressure under which the pump could operate at design speed. Suction and discharge flanges shall be drilled to ANSI Standards and be machined flat face. Pumps shall be fitted with lead-free bronze renewable case wear rings indexed with a dowel pin for fixed positioning.

D. The lead free bronze impeller shall be an enclosed Francis vane type, double suction design, hydraulically and dynamically balanced. The impeller is to be securely mounted on the pump shaft, and attached with a steel key. The impeller shall be locked in position by threaded shaft sleeves. The impeller shall be trimmed to meet the specific hydraulic requirements. Impeller trim must be equal to or less than 90% of maximum diameter, which will fit into the pump casing.

E. The pump shaft shall be made of high tensile steel, precision ground to provide a true running rotating element.
F. The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.002 inches. Bearings shall be ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads. Each bearing housing shall be bolted to the upper and lower casing halves for a full 360-degree support registered fit to insure positive alignment. Bearing shall provide a minimum life of 10-years when calculated at 50% of Best-Efficiency-point for the scheduled pump.

G. The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule. Mechanical seals, at a minimum, shall have ceramic stationary seats, carbon rotating seats, and Buna elastomers.

H. Lead-free, bronze shaft sleeves shall be firmly attached to the pump shaft through threading and locking means. Shaft sleeve design shall prevent corrosion and wear to the shaft.

I. The pumps shall be mounted on a steel base with drip pan and directly connected through a heavy-duty flexible coupling to a horizontal motor as outlined in these specifications. The pump manufacturer shall provide an OSHA coupling guard, which shall be mounted between the pump and motor and attached firmly to the base.

J. The motor shall be sized to operate continuously without exceeding the horsepower rating (as outlined on the schedule) regardless of the flow and head throughout the operating range of the “System Curve.” Efficiencies shall be as defined in Section ________. Motor shall be of the horsepower and speed shown on the pump schedule. Pumps requiring larger horsepower motors shall not be acceptable. Motor shall be open drip proof type with 1.15-service factor 40 degree C ambient high efficiency type.

K. Manufacturer: Paco or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION OF PUMPS:

A. Install pumps where indicated, in accordance with manufacturer’s published installation instruction, with recommended clearances provided for service and maintenance.

B. Install base-mounted pumps on minimum of 4” reinforced high concrete base with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

C. Provide piping; accessories; hangers, supports, and anchors; valves; meters and gauges; and equipment supports; as indicated for complete installation.
D. Pump and motor shall be realigned by the contractor, according to the standards of the Hydraulic Institute, after grouting of base and connection of piping.

E. Lubricate pumps before start-up. Start-up in accordance with manufacturer’s service representative.

F. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided.
PACO type VLS Vertical In–Line Pumps are available in a wide selection of metallurgical and mechanical options to meet specific pumping requirements.

Suction and Discharge connections are the same size to simplify piping. The type VLS design incorporates a short shaft with minimum overhang reducing shaft deflection. Back pull out design allows rotating assembly to be removed without disturbing the volute or piping for ease of maintenance and service. PACO In–Line Pumps with discharge sizes 3 inch and larger feature a double volute design to reduce radial thrust and prolong bearing life.

PACO type VLS Vertical In–Line Pumps eliminate costly installation steps. They require 1/3 the space of a conventional pump installation and drastically reduce the cost of layout foundation and piping.
VLS – 60125 – Dim. Dwg

Project: U A F Vert. Split Coupled  Model: 60125  P.O. #
Location: Fayetteville, AR  Rotation: Clockwise  Cust Ref#
Contractor:  Qty: 1  Agent/Rep: Fluid Solutions, Inc.
Engineer: T. M. E.  Service: Water  Tag # P-1

Conditions of Service
TDH: 80.0 ft  Temp: 68.00 deg F  RPM: 1750  Hz: 60  Voltage: 208–230/460  S.F.: 1.15
**VLS – 60125 Configured Curve**

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### Design Data

- **Flow:** 1000 USgpm
- **Fluid:** Water
- **Suct. Press:** 0.00 psi.a
- **TDH:** 80.0 ft
- **Temp:** 68.00 deg F
- **Dis. Press:**
- **Shutoff Head:** 103 ft
- **S.G.:** 0.998
- **Diff. Press:**
- **NPSHr:** 7.70 ft
- **Visc.:** 1.00 cP
- **BHP:** 25.2 hp
- **Imp. Dia.:** 9.75 in
- **Pump Eff.:** 80.02
- **BEP:** 945 USgpm
- **No Of Stages:** 1

### Motor Data

- **HP:** 30
- **Voltage:** 208–230/460
- **Eff.:**
- **Nominal RPM:** 1750
- **Phase:** Three phase
- **S.F.:** 1.15
- **Actual RPM:** 1750
- **Hz:** 60
- **Encl.:** ODP
PART 1 – GENERAL

1.1 SCOPE
A. Types of pumps specified in this section include:

1. Vertical In-Line Split Coupled Pumps.

1.2 RELATED WORK:
A. Pumps furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division 15 sections.
B. Motor starters, disconnects, and wiring of pump motors; Division 16
C. Insulation of pump housings; Section 15250
D. Sump pumps; Section 15450
E. Pump system balancing; Section 15980
F. Variable frequency drives; Section 15950

1.3 QUALITY ASSURANCE:
A. Manufacturers: Firms regularly engaged in manufacture of pumps of types and sizes required, whose products have been in satisfactory use in similar service for not less that five (5) years.
B. Provide electric motors and products which have been listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.4 SUBMITTALS:
A. Product Data: Submit manufacturers pump specifications, installation and start-up instructions, and current accurate pump characteristic performance curves with selection points clearly indicated.

B. Shop Drawings: Submit equipment connection and support details. Equipment connection details to indicate all piping connections with sizes and types of pipe, valves, fittings, specialties, and meter and gauges to be used. Support details to include fabricated, materials, and methods of support intended. Include detail of vibration isolation.

C. Operation and Maintenance Manual: Include maintenance data and spare parts lists for each type of pump.
PART 2 – PRODUCTS

2.1 GENERAL

A. Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size and capacity of each pump are listed in pump schedule.

2.2 Vertical In-Line Split Coupled Pumps

A. Furnish and install, as outlined on the equipment schedule and described in these specifications, a Paco model VLS vertical in-line, split coupled centrifugal pumps, or equal, designed to deliver the scheduled flow rate (in GPM), the specified total dynamic head (in feet), at the scheduled efficiency and scheduled speed (RPM).
To insure cavitation-free operation, each pump’s NPSH requirement must by low enough to permit stable, continuous operation at 120% or greater of best efficiency point.

B. Pump casing shall be gray iron and shall be constructed with back pull-out capability. Models 3” and larger shall have balanced double volute design to reduce radial thrust and to prolong seal and bearing life. Pump casing shall incorporate a suction baffle to reduce pre-rotation and improve efficiency. Suction and Discharge connections shall be the same size, flanged (125, 250) PSI rating, 180 degrees opposite on centerline for pipeline mounting. Casing shall have bronze replaceable wear ring.

C. Impeller shall be cast bronze, enclosed, statistically, dynamically and hydraulically balanced, and shall be factory trimmed to match the delivery conditions indicated above.

D. The pump shaft shall be made of high tensile steel, precision ground to provide a true running rotating element.

E. The pump shaft shall be adequately supported by the pump bearings to limit the shaft deflection to 0.002 inches. Bearings shall be ball type, grease lubricated and locked to the shaft with positive locks of ample size to withstand any axial thrust loads. Each bearing housing shall be bolted to the upper and lower casing halves for a full 360-degree support registered fit to insure positive alignment. Bearing shall provide a minimum life of 10-years when calculated at 50% of Best-Efficiency-point for the scheduled pump.
F. The pump manufacturer shall recommend the proper mechanical seal based on the pressure, temperature and liquid outlined on the equipment schedule. Mechanical seals, at a minimum, shall have ceramic stationary seats, carbon rotating seats, and Buna elastomers.

G. Lead-free, bronze shaft sleeves shall be firmly attached to the pump shaft through threading and locking means. Shaft sleeve design shall prevent corrosion and wear to the shaft.

H. The pump manufacturer shall provide an OSHA coupling guard, which shall be mounted between the pump and motor and attached firmly to the base.

I. The motor shall be sized to operate continuously without exceeding the horsepower rating (as outlined on the schedule) regardless of the flow and head throughout the operating range of the “System Curve.” Efficiencies shall be as defined in Section __________. Motor shall be of the horsepower and speed shown on the pump schedule. Pumps requiring larger horsepower motors shall not be acceptable. Motor shall be open drip proof type with 1.15-service factor 40 degree C ambient high efficiency type.

J. Manufacturer: Paco or approved equal.

**PART 3 – EXECUTION**

**3.1 INSTALLATION OF PUMPS:**

A. Install pumps where indicated, in accordance with manufacturer’s published installation instruction, with recommended clearances provided for service and maintenance.

B. Install base-mounted pumps on minimum of 4” reinforced high concrete base with anchor bolts poured in place. Set and level pump, grout under pump base with non-shrink grout.

C. Provide piping; accessories; hangers, supports, and anchors; valves; meters and gauges; and equipment supports; as indicated for complete installation.

D. Pump and motor shall be realigned by the contractor, according to the standards of the Hydraulic Institute, after grouting of base and connection of piping.

E. Lubricate pumps before start-up. Start-up in accordance with manufacturer’s service representative.
F. Ensure that pump units are wired properly, with rotation in correct direction, and that pump and motor grounding have been provided.