part IV. (d) site and infrastructure subgroup

These guidelines shall both inform and supplement the Construction Documents. The Construction Documents shall address all applicable provisions included herein, by way of specification, general notes, detail, and instructions to the Contractor.

These guidelines are organized using the Master Specification Divisions, they are not, however, intended to replace the specification documents produced by the Architect/Engineer of Record. The language provided in the defined specification sections should be seen as supplemental to the language normally supplied by the Architect. In some cases, a full 3-PART "Guide Specification" may be provided, in those cases, the Design Professional shall modify and/or expand the language as appropriate to the project.

30.00.00 - RESERVED

31.00.00 - EARTHWORK

- See 02 32 00 GEOTECHNICAL INVESTIGATIONS

(1) Request a copy of the soil bearing/analysis report from Facilities Management.
(2) Soil nails shall not extend under any street or public right of way.
(3) Clearing – mulch spoiled tree, do not burn.
(4) The Contractor, upon encountering any underground water, springs, wells, etc., during excavation, shall immediately notify the Facilities Management Construction Coordinator and shall not proceed further until instructions are given.

31 13 00 SELECTIVE TREE REMOVAL

- See Campus Trees, Removal and Replacement | VCFA | University of Arkansas (uark.edu)

(1) Removal. Dig trees, as noted on construction plans, with firm natural balls of diameter not less than 10 inches wide for each caliper inch (24 inch minimum), and of sufficient depth to include the fibrous and feeding roots. Wrap trees with burlap according to American National Nursery Standards and place each tree in a Star Basket. Trees will not be accepted if the ball is cracked or broken during transportation. The contractor shall replace the damaged tree at their expense.
(2) Delivery. The contractor is responsible for delivering the trees to the Agriculture Experimental Farm and coordinating delivery time with Facilities Management Grounds Shop at 575-6161.

31 22 00 GRADING

(A) General

(1) Design slopes with a minimum slope of 2% to all drain inlets to ensure positive surface water drainage.

(2) Design sloped sites, not to exceed a slope ratio of 1:4 (25% slope). In areas where a more abrupt change of slope is necessary, design a series of "OGEE" terraces with grade surfaces not to exceed a ratio of 1:3 (33.3% slope)
(3) Verify slope design with Facilities Management Planning and Design Group.

(B) Maintenance considerations

(1) 0- to 15-degree (up to 26.79%) slope -- riding mowers or tractor mowers are approved for these areas.
(2) 15- to 22-degree (40.40%) slope -- tractor mowers are approved for these areas.
(3) 22-degree slope and up -- these areas are mowed with string trimmers, push mowers, or specialized equipment. Specialized equipment can be riding mowers intended for use on slopes, i.e., slope mowers.
(4) Within 5 feet of a drop-off -- a buffer zone is maintained. Only string trimmers and push mowers can be used inside this zone.

31 23 16 EXCAVATIONS

(1) It shall be the responsibility of the contractor to calculate soil and rock excavation volumes to be a part of the project. Reasonable allowances will likely be allowed in the formulation of project costs; however, the consultant should work with Facilities Management to closely control and manage excavation costs by limiting allowance overruns, or other methods.
(2) The use of explosives is not permitted.

31 23 16.13 TRENCHING

- See A.C.A. § 22-9-212

(1) When the work involves any trench that will be five feet or deeper, the project must incorporate the current edition of the Occupational Safety and Health Administration Standard for Excavation and Trenches Safety System. Comply with 29 CFR 1926 Subpart P – Excavations.
(2) Cover open trenches, ditches, and holes at night, when work is discontinued, and non-working days.

31 25 00 EROSION AND SEDIMENTATION CONTROLS

- See SECTION 01 41 00 - REGULATORY REQUIREMENTS as provided in the UA FRONT END DOCUMENTS shall be incorporated into this section of the project specifications.
- See SECTION 01 57 00 TEMPORARY CONTROLS

31 31 16 TERMITE CONTROL

(1) Treat all the soil under new buildings and around the buildings with chemicals as appropriate and meet current standards and guidelines for termite protection.
(2) Closely follow instructions on the manufacturer's label and obey all state and federal laws.
(3) WARRANTY. Provide a five-year certificate of guarantee to the University.

32.00.00 - EXTERIOR IMPROVEMENTS

Design Professionals shall submit schematic landscaping, planting, and irrigation plans for review and approval by Facilities Management. Landscape plans shall bear the seal of a Landscape Architect registered in the State of Arkansas according to the Arkansas State Board of Landscape Architects.

- See HARDSCAPE GUIDELINES
- See Criteria For Campus Parking Areas

32 16 00 CURBS, GUTTERS, SIDEWALK, AND DRIVEWAYS

(1) Stamp "S" on the edge of concrete curbs or concrete walks to indicate the location of sleeves.
(2) Special emphasis should be given when specifying mix requirements for flatwork exposed to ambient outside weather conditions. Northwest Arkansas aggregate sources can have a high content of chert which has a deleterious effect on concrete surfaces over time.
(3) There may be occasions where concrete flatwork is desired to have a durable surface, free from future defects, but where we do not intend to engrave the surface. In these cases, provide a minimum of 3500 psi.

32 16 24 SENIOR WALK

- See 32 16 24 SENIOR WALK (doc.)
- See detail Pavement - senior walk

32 80 00 IRRIGATION

(1) Before the preparation of design development drawings, Facilities Management will review the irrigation system. The review will allow the cost of an irrigation system to become a part of the preliminary cost estimate.
(2) Design irrigation systems to be fully operational. Install control wiring in PVC schedule 40 conduits. The sprinkler system considered shall be equal to the Rainbird series shrub head and Hunter rotary heads. All water lines shall be PVC schedule 40. Sized main and lateral lines, all quick couplers, automatic drain valves, shrub risers, manual drain valves, backflow preventers, water meters, and other equipment necessary to provide a complete system shall be included. Indicate all required items, locations, and sizes on the drawings.
(3) A separate meter and backflow prevention is required for the irrigation system.

32 90 00 PLANTING

- See Landscape Character Zones and approved plant lists.
- See Tree Protection Plan
- See 31 13 00 Selective Tree Removal

32 35 00 SCREENING DEVICES

Indicate on site plans locations for permanent screened trash dumpsters in an area adjacent to the building. Verify the number and size of dumpster units with Facilities Management.

32 91 19 LANDSCAPE GRADING

The contractor shall supply samples of soil that are intended to be used for imported fill or for other purposes. Topsoil must be approved by Facilities Management and consulting landscape architect before being placed.

(1) Topsoil shall be fertile, well drained of uniform quality, free of foreign materials, oil or chemicals, rocks, sticks, noxious weeds, or grasses (Bermuda grass, Nutgrass, Bindweed, Johnson grass, and Kudzu).
(2) Submit soil test of proposed topsoil verifying amounts of nitrogen, potassium, and phosphorus.
(3) Before the start of final grading, remove all construction debris and construction materials from the site.
(4) Till lawn areas to a depth of 6", hand rake, and leave in friable condition. Before placing soil, sample sections of the native soil. Dig a ditch 1'0" wide by 1'0" deep by 30'0" long to determine the conditions of the native soil before finish grading. The landscape architect will determine the location of sampling.
(5) Amend soil as instructed by landscape architect.
(6) Backfill all areas for planting of shrubs and/or ground cover with a grass-free top soil to a depth of 12".
(7) Bring all areas to a finished grade (hand-raked surface) not to exceed 1" below all walks and/or doorways of buildings. The finished grade shall be in physical condition for landscape planting as approved by Facilities Management Construction Coordinator.
(8) All ground cover, plantings, mulch, sod, and permanent stabilization required prior to substantial completion.

32 33 00 SITE FURNISHINGS

- See Appendix A – Campus Site Furnishings Standards
- See Appendix B – Campus Landscape Standards

33.00.00 – UTILITIES

(A) General

(1) 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.
(2) 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.
(3) Include meters for water and gas utilities as part of the construction contract as Contractor Provided, Contractor installed.
(4) Include the estimated demand load of water and gas on the Utilities Plan.
(5) Locate all meters outside of buildings; coordinate the location with City of Fayetteville water meter division and Facilities Management.
(6) The City of Fayetteville will furnish all water meters used on UA projects. Specify water meter installation to comply with the Fayetteville Municipal Water Department's guidelines. The City of Fayetteville reserves the right to size the water main tap and the water meter. The consultant will communicate with the City of Fayetteville engineering department to notify them of the future need and to acquire the most current design criteria for the construction of the taps, valves, and meter enclosures. In addition, the designer will contact the City of Fayetteville meter division for final approval of the planned locations of water taps, meter box sizes, and shapes, before issuance to the contractor. Field location and sizing of taps is to be avoided.
(7) Blackhills Energy will furnish and size gas meters for their lines.
(8) Meters required by the project for connection to the Campus gas line shall be The meter type shall be coordinated with Facilities Management.

33 01 00 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.

33 14 13 PUBLIC WATER UTILITY DISTRIBUTION PIPING

- See Recommended Backflow Preventers

The City of Fayetteville shall approve the design of any potable water supply distribution piping intended to serve a new or remodeled facility. Backflow preventers shall be installed to protect the public water supply as specified by the City of Fayetteville and the University of Arkansas.

(1) 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.

(2) A copy of plans that involve water infrastructure must be sent to the UA insurance carrier for review.

(3) Water Service Lines. Water service lines to each building should be of size and capacity to install present or future fire sprinkler systems. Normally parallel lines are required. If doing new installation or upgrade, check with owner to see if a parallel line should be installed to serve as a future fire line.

33 30 00 SANITARY SEWAGE UTILITIES

(1) 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.

(2) 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 51 13 NATURAL GAS PIPING

(1) 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.

(2) Above-ground exterior and interior natural gas pipe shall be scheduled 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.

(3) Joint compound shall be Teflon tape or non-hardening type compound applied to the male pipe threads.

33 51 33 NATURAL GAS (METERING)

(1) 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 pipefittings and joints until the pipe has been tested, approved, and thoroughly cleaned.

(2) 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.

(3) 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.

33 60 00 HYDRONIC AND STEAM ENERGY UTILITIES

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 chilled 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 ΔT 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 ΔT 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 ΔT that cannot be readily diagnosed and corrected, the building shall be temporarily converted to the "temperature control" mode until such time as the low ΔT 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 ΔT 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[2]. 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

[2] Chilled water flow meters are not “line-sized”.

energy recovery unit not in operation. Building chilled water control valves shall have a minimum dynamic close-off rating of 100 psi.

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 2-½" 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 2-½" 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.

[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.

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 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.

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.

[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.

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.

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.

[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.

"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:

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.

<u>"Temperature Control" Mode:</u>

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

2.11.01 Fan Coils

[6] Heating water flow meters are not "line-sized".
[7] 2" minimum pipe size.

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: 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[8].

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.

[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 drives[9].

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

[9] In the event of a VFD failure, the remaining pump should be capable of accommodating the peak heating water flow requirement.

standard engineering practice. If the anticipated expansion is too great to accommodate using pipe loops, bends or offsets, expansion joints may be used.

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 2-½" 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. 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 2-½" 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

[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.

most open heating water control valve. If the most open heating water control valve is more than 95% open, the 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.

33 71 73 ELECTRICAL UTILITY SERVICES

(1) Specify secondary S base meters to be furnished and installed as required with type M-30 demand register.
(2) 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%.
(3) Specify that a schematic of the connections be supplied to Facilities Management by the General Contractor.
(4) Submit meter specifications to Facilities Management for approval.
(5) Meters located underground shall be located in concrete lockable boxes with tops of boxes at finished grade.
(6) 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.

(7) 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.

(8) 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.

END OF DOCUMENT