DIVISION 23: HEATING, VENTILATING AND AIR CONDITIONING

23000 - BASIC REQUIREMENTS

A. System Design and Performance Requirements

1. Energy Conservation: Prior to the construction or renovation of any public building with a gross floor area greater than 20,000 square feet, a detailed life cycle cost analysis, including the cost of operation and maintenance, must be completed. The study shall identify measures for the conservation of energy, and shall consider the use of alternate non-fossil fuels when applicable. The analysis shall include comparisons of at least three different HVAC system types. The three different system types to be evaluated shall be reviewed and approved by the University Facilities Services Mechanical Engineer prior to beginning the analysis. A separate narrative shall be provided outlining the building envelope insulating values (for walls, glass, roof, etc.) and specific HVAC system components (i.e., plate and frame heat exchangers, variable frequency drives, compensating type kitchen exhaust hoods, etc.) as they relate to energy conservation.

2. HVAC Systems and Equipment
   a. All new buildings shall utilize heat provided by the Central Heat Plant unless directed otherwise by the Facilities Services Department (FSD).
   b. Heating and air conditioning load calculations for Reno Nevada shall be completed utilizing the following criteria:

<table>
<thead>
<tr>
<th>Indoor</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>Heating 72F</td>
</tr>
<tr>
<td>Cooling</td>
<td>ASHRAE 99% Winter Value = 13F db</td>
</tr>
<tr>
<td></td>
<td>74F</td>
</tr>
<tr>
<td></td>
<td>95 F db / 61F wb</td>
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</tbody>
</table>

   c. All equipment shall be rated for an elevation of 5,000 feet above mean sea level.

   d. Propylene glycol shall be used in any system that has a hydronic coil and uses 100% outside air such as a makeup air unit. This pertains to new systems as well as existing. Engineering calculations shall be performed on the entire new or existing hydronic system to verify that the equipment will perform satisfactorily with glycol. Glycol shall be added to the system in the amount to provide freeze protection down to 0°F, unless specifically requested otherwise by Facilities Services. The percentage of glycol added to the system shall not exceed 40%.

   e. Heating and air conditioning load calculations shall not incorporate safety factors. Safety factors shall only be applied in selecting the desired equipment.

   f. All equipment, ductwork, and piping shall be braced for the applicable seismic zone. Seismic bracing requirements shall be specifically identified in the Contract Documents.
University of Nevada, Reno  
Campus Design & Construction Standards

Section 4.0 Construction Materials Standards

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g. All equipment and equipment rooms shall be designed to ensure adequate provisions for maintenance. Special consideration shall be given to ensure proper clearances for maintenance of filters and removal of chiller and boiler tubes, fan housings, and fan shafts.

h. Access to equipment for service and maintenance shall be coordinated with FSD. Required clearances shall be specifically identified on the drawings (for equipment such as fan coils, VAV boxes, air handling units, control panels, etc.). Coordinate with other disciplines to ensure that other trades (electrical, fire sprinkler, etc.) are made aware of the required clearances.

B. Product Standards and Manufacturers

1. The following manufacturers shall be used for the equipment listed:

   a. Frequency Drives: ABB Danfoss
   b. Roof-top units: York, Carrier, Trane
   d. Modular, Copper Fin, Gas-Fired Hot Water Boilers: Lochinvar, Hydrotherm
   e. Chillers: Carrier, Trane, York, McQuay.
   f. Centrifugal Pumps: Goulds, Bell & Gossett
   g. Custom Air Handlers: Temptrol, Scott Springfield, Governair, Marcraft, Energy Labs
   h. Plate and Frame Heat Exchangers: Alfa-Laval Tranter
   i. Shell and Tube Heat Exchangers: Bell & Gossett
   j. Make-Up Air Units: Greenheck, Reznor, Modine, Trane, Rapid

230900 – INSTRUMENTATION AND CONTROL FOR HVAC

A. System Design and Performance Requirements

1. Building Management Systems (BMS) DDC Control Modules

   a. All new buildings shall use BACnet standard MS/TP, TCP/IP bus protocol ASHRAE Standard-135 or ALC Arcnet. Additions to existing buildings may be BACnet, MSTP, or ALC Arcnet. Alternatives will be considered on a case by case scenario with the UNR Controls Department. When installing a Metasys
system, NAE’s shall be the Network Controller installed on all new buildings and building additions. If ALC is being installed, ALC Land Gate Routers shall be used. BACnet IP shall be used for the Global level communications. All new construction must provide graphics with accompanying text fields for all pertinent data along with user view trees (contact University Controls Department for any questions). Servers are used as part of the BMS for extensive archiving of system configuration data, trending, operator transactions, and alarming purposes. These functions shall be performed through the use of virtual servers for the Metasys and ALC systems. All shall use SQL databases.

b. The control system shall provide direct digital control with a Windows-based user interface. The DDC shall include surge suppressors, operating software. All software should be updated to the latest revision. Check with the University Controls Department before performing any upgrades.

c. BMS Software and Programming Requirements

I. The Temperature Control Contractor shall program the eleven State Holidays into the EMCS software for the five years following the date of the installation.

II. A separate occupied/unoccupied schedule shall be provided for each air handling unit, fan coil unit, exhaust fan, and/or other individual air handling system.

III. Outside air temperature sensors capable of sensing both temperature and humidity shall be programmed to display dry bulb temperature, wet bulb temperature, and relative humidity. The campus is divided into climatic zones. The Temperature Controls Contractor shall map the point from the applicable climatic zone in addition to installing a new sensor. The system shall be programmed to use the global sensor as primary outside air conditions and, upon failure of the primary, switch to the buildings local sensors.

IV. Each zone shall be capable of being set to either a global set point or a remote set point with adjustable dead bands for each. The global set point can be utilized to set/adjust the temperature in all associated zones with a single set point. Each air handling unit and its associated zones and/or each floor of fan coil units shall have a separate global set point. The strategy for global set point assignment shall be confirmed with the University Controls Department prior to programming. The remote set point is an individually adjustable set point for each zone provided by the Controls Department. All zones shall also be capable of being put into local control with the occupant having the ability to change the zone setpoint +/- 2°F (adjustable).
V.  30-minute point history samples will be provided on all analog points and all inputs and outputs involved in control loops for 72 hours of first in first out data trends. Binary inputs and outputs to trend change of state.

2. Graphic Displays

a. Campus Graphic

I. The campus graphic shall show all University buildings. The main campus graphic shall be updated to include any new buildings added to campus.

II. Each building footprint shall be a link to that building’s main screen.

III. If an alarm is present anywhere in a building, the footprint shall be red. If it is a critical alarm, it shall flash red 2-times per second.

b. Common Main Screen/Sub-screen Items

I. Begin all graphics with the default screen layout for “graphic without navigation tree” (980W x 652H).

II. The first letter of each word and all acronyms shall be capitalized.

III. All text shall be standardized as Arial 12pt. except for:

   i. Equipment labels: Arial/12pt/bold adjacent to equipment (above if possible)

   ii. Links: Arial Unicode MS/12pt/bold/underlined/left justified, located at top left of page. Links should reflect screen names, but may be abbreviated.

   iii. Building names: Arial/14pt/bold/center justified, located at top center.

   iv. Date & Time: Arial Unicode MS/12pt/yellow, locate the date and time on the top center below the screen name. The date (format: month/day/year) followed by day of week. The time follows date (format: hour/minute/am, pm) all on a single line.

IV. If a screen is a thermographic floor plan, it shall follow the guidelines under “Main Screen”.

V. Variable formatting: All temperatures, pressures, flows, energy readings and analog outputs shall exclude decimal places with the following exceptions:
i. Zone, OSA DB, OSA WB temperatures, and water loop differential pressures shall have a single decimal place.

ii. Duct and filter pressures shall have two decimal places.

iii. Building static pressure shall have three decimal places.

c. Main Screen

I. Building picture (small) to be located at top right quadrant with OSA-DB, %RH and Sun/cloud symbol. This is the only page where %RH shall be shown except for humidifiers, and zone humidification sensors.

II. Graphic screen links:

i. Equipment may be accessed through the actual equipment footprints as shown on the floor plans. Equipment text names shall be displayed on each floor graphic sub screen.

ii. In addition to equipment footprint links, there shall be other links in text, examples are shown below:

   • UNR Campus
   • Energy
   • Heating Hot Water
   • Chilled Water
   • AHU: 1-X
   • Fan Coils
   • Lighting
   • Miscellaneous

iii. For small projects, the thermographic floor plans and text links may all be on the main screen. For larger projects, there shall be a link to a Text Link Page following the Main Screen. The Text Link Page shall provide enough space for all the building equipment allowing the equipment to be reached either through the Text Link Page, or the floor plans.

III. Organize the tree to match the equipment link order.
IV. “Summer/Winter” mode, shall be located on the main screen under time/date.

V. Thermographic floor plans:
   i. The color code legend shall be below the floor plans with the North indicator to the right of the legend. The color code shall be as follows:
      - Green = satisfied within dead band, typically 69-77°F
      - Yellow is up to two degrees hotter than Green’s range (77-79°F)
      - Orange is up to two degrees hotter than Yellow’s range (79-81°F)
      - Red is hotter than Orange’s range (>81°F)
      - Light blue is up to two degrees cooler than Green’s range (69-67°F)
      - Dark Blue is up to two degrees cooler than Light Blue’s range (67-65°F)
      - Red is cooler than Dark Blue’s range (<65°F)
   ii. If possible, thermographic screens shall be interactive on the main screen. The floor text name will link you to a full screen interactive thermographic floor plan.
   iii. If possible, the entire zone shall be the link, not just a thermostat, or label within the zone. If there is more than one room in a zone, all rooms shall be linked.
   iv. Floor plans shall be stripped down from AutoCad floor plans, and shall include the following.
      - Room Numbers
      - Thermostat locations
      - Equipment locations and designations only if actually located in the space.
      - Roll over to show zone equipment name
d. Sub Screens

I. Screen name shall follow building name.

Example: Building Name: Screen Name

II. Screen names shall reflect depicted equipment such as: Hot Water System, Chilled Water System, AHU-1, AHU-1’s VAV’s (if all are shown), AHU-1’s VAV’s: 1-14 (if multiple screens are required), etc. (Note: each piece of equipment to be named per PM’s ACAD identifiers. Notify EH&S anytime you find their drawings not following the PM names).

III. A miscellaneous graphic shall be used for components not closely associated with other screens such as sump pumps, DW systems, EF’s, etc.

IV. An Energy screen shall display all kW and BTU meter data for each project.

V. If system has a hand/off/auto switch, it shall be located below the Date/Time text.

VI. Outside air dry bulb temperature shall be shown at top/right on each screen for all air moving equipment next to the Sun/cloud symbol. This value does not need any designation text. Outside air dry bulb, and wet bulb shall be included on all screens with evaporative cooling (cooling towers, etc.) Wet bulb temperature shall be preceded with “WB”. Note: percent relative humidity only to be shown on main screen in this format “XX%RH”.

VII. CHWS and HWS temperatures to be shown at the piping for each associated coil.

VIII. At a minimum, each sub screen shall have a link to the “Main” screen. In addition to the main screen, sub screens shall have other links as follows:

i. AHU’s shall have a link to/from the next/previous AHU, the cooling system and the heating system, and to its VAV summary page if applicable.

ii. VAV summary screens (described below) shall link back to its AHU, or to additional VAV summary pages from this AHU if applicable. Individual VAV graphic pages can be accessed either via thermographic floor plans, or the VAV summary page.

iii. Individual VAV graphics shall have links for the heating system, the cooling system, and the associated AHU.
iv. The Chilled Water System shall have a link to the Condenser Water System, and vice versa.

v. In general, all data fields shall be adjacent to their associated equipment. Any data fields not associated with a graphic item shall be located at the screen bottom in columns/rows.

vi. Commanded equipment shall follow the command or an alarm shall follow. It shall be commanded on or off with “S/S” such as “S/S On”, or “S/S Off”. A “Status” line shall be located below the command. If the status does not equal the command, a “Failure” text shall show up in red below the status line.

vii. Enabled equipment, such as a boiler, has its own onboard controls start/stop. Therefore, the status may not follow the command and shall not be alarmed. These devices have a separate “Alarm” field. The command for enabled equipment shall still be “S/S” such as “S/S Enabled”, or “S/S Disabled”.

viii. Object labels shall be on the left side (right justified) and data on the right (left justified).

ix. Valve and damper positions shall be shown in “%”. Other text indicating “Open” or “Closed” is not needed since it is assumed to be reading the open position. The exception is for 3-way valves. In this case, locate text identifying the main flow path after the “%” such as “Coil”, or “Chiller”.

x. Piping lines shall never cross unless there is no other option. If they must cross, one pipe is to show a break. Provide flow direction arrows and water flow animation.

e. Summary Screens

Multiple equipment, such as Fan Coils, VAV’s, Exhaust Fans, etc., shall be shown in a summary matrix. Each screen shall provide: zone location, temperature, set point (global/remote), discharge air temperature, valve position, fan command, fan status, dead band set point(s), CFM set points, CFM flow rate, etc. as is applicable for the equipment. Summary screen format and required display data shall be approved by the University Controls Department prior to screen development.

f. Alarms

I. Alarm conditions shall be shown in red and shall begin on the campus map with the entire building footprint. When navigating through the main screen, the entire equipment footprint and link shall be red, until you arrive at the final sub-screen. Critical alarms shall follow the same
alarm strategy with the exception that they shall flash red on/off at 2-times per second.

II. The University has an alarm matrix that shall be used to define alarm groups and routing.

III. Every alarm shall have an associated pop-up.

g. Offline Controller/Points

Either of these issues shall follow the same guidelines as “Alarms” with the exception that the color code shall be pink instead of red. In the event that a piece of equipment has both conditions occurring at the same time, the color code on the equipment link shall be red, but the graphic screen shall differentiate which point(s) are in alarm (red), and which point(s) are experiencing a failure condition (pink). If the entire controller is offline, then all associated point fields shall show pink.

h. Overrides

When a point has been manually overridden, both the data and associated text field shall change to orange and shall only show up on the bottom tier graphic.

i. Custom Graphic Elements

The University uses some modified graphic elements (.PNG files). All contractors shall use the University data base to keep graphics standard. All graphic elements (.BMP, .JPG, .PNG) files that are created and used on any graphic shall be stored in a folder on the University common drive. The contractor shall have rights to access this folder and no others.

j. Miscellaneous

I. All graphic displays shall be submitted to the University Controls Department for review and approval prior to commencing any programming.

II. All displays specified to be dynamic shall depict motion. Dynamic displays shall include rotating fan wheels and rotating pump impellers and water flow through pipes.

III. All set points which are identified as “adjustable” in the written control sequences shall be adjustable via the associated graphic displays (including dead band between heating and cooling room set point).

IV. All occupied mode and unoccupied mode room temperature set points shall have an adjustable dead band (adjustable from the associated graphic display).
V. All inputs and outputs shall be programmed with the capability to override the values via the associated graphic display (this requirement applies to all equipment, valves, dampers, fans, pumps, temperatures, etc.).

VI. The main graphic page shall have a link to the as-built control drawings, all commissioning documentation, schedules and operation and maintenance manuals.

3. BMS Integration
   a. Direct Protocol (Integrator Panel)
      I. The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers’ control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to chillers, boilers, variable frequency drives, power monitoring system, and medical gas.
      II. All data required by the application shall be mapped into the network controller and shall be transparent to the operator.
      III. Input and output points from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.
   b. BACnet Protocol Integration
      I. The neutral protocol used between systems shall be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135.
      II. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
      III. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

4. Input Devices
   a. All equipment shall be sized, selected, installed, setup, and calibrated as appropriate for the application and per the manufacturer’s specifications.
   b. Temperature Sensor General Requirements
I. Temperature sensors shall be resistance type, and shall be two wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD, or thermistor 10k-2 (10k ohms @ 25°C, -55 to 150°C).

II. Room sensors on exterior walls shall be mounted with adequately insulated bases, and insulation shall be stuffed inside the wall to block off internal wall air flows. Wall boxes shall be caulked around perimeter and conduit penetrations shall be sealed.

III. All fluid temperature monitoring shall be accomplished by using insertions sensors inside thermo wells. Wells shall be filled with thermo conducting compound.

IV. All HVAC air moving equipment shall have a duct discharge air temperature sensor installed. This includes but is not limited to: Air Handling Units, Roof Top Units, Make Up Air units, Fan Coils, Terminal Units, etc.

V. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:
   i. Chilled Water +/- 0.5°F.
   ii. Room Temp +/- 0.5°F.
   iii. Duct Temperature +/- 0.5°F.
   iv. All others +/- 0.75°F.

   c. Room Temperature Sensors
      I. Room sensors shall be constructed for either surface or wall box mounting.
      II. Room sensors shall have the following options when specified:
          i. Set point adjustment providing a minimum +/- 3 degree (adjustable) range.
          ii. A momentary override request push button for activation of after-hour operation with LED status.
          iii. Temperature and mode display.
d. Thermowells

I. When thermowells are required, the sensor and well shall be supplied as a complete assembly.

II. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

III. Thermo wells and sensors shall be mounted in a thread-o-let or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

IV. Thermo-wells and sensors shall be matched in size. They shall be sized such that the end of the well is located in the center of the pipe.

V. Thermo-wells shall be constructed of 316 stainless steel, if installed in the High Temperature Hot Water System (HTHWS). All other installations may be brass.

e. Outside Air Sensors

I. The University has divided its campus into zones which group buildings into similar OSA climates. Each zone has a NIST certified Vaisala OSA temperature sensor and %RH transmitter. The values from these devices are mapped across the BMS network to all buildings in their respective zones.

II. New buildings or new control installations in buildings that do not have a standalone OSA sensor shall have a new OSA and %RH sensor installed. After the new control system is brought online on the campus network, the existing climatic zone sensors shall be programmed as the primary sensor and the building’s standalone sensors shall be programmed as the backup in the event that the primary goes unreliable. In addition, the program shall be written to allow for manually selecting which sensor is used as the primary.

f. Duct Mount Sensors

I. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned to be easily accessible for repair or replacement.

II. 2. If the duct has exterior insulation, the sensor shall be provided with standoff spacers with insulating material firmly fitted around spacers.

III. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
IV. For outdoor duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

g. Averaging Sensors

I. For ductwork greater in any dimension than 48 inches, mixed air applications, or where air temperature stratification could exist, an averaging sensor shall be used.

II. The sensor shall have continuous averaging over the entire element; discrete points will not be accepted.

III. The sensor element shall be installed in a serpentine fashion with no less than 18” between each pass. The element shall span horizontally to within 8” from each coil edge.

IV. Capillary supports at the sides of the duct shall be provided to support the sensing string.

h. Humidity Sensors

I. The sensor shall be a solid-state type, relative humidity sensor. The sensor element shall resist surface contamination.

II. The humidity transmitter shall be equipped with non-interactive span and zero adjustment; a 2-wire isolated loop powered 4-20 mA, or 0-10VDC, and 0-100% linear proportional output.

III. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

IV. Transmitters shall be shipped factory pre-calibrated.

i. Pressure Transmitters

I. Pressure transmitters shall be constructed to withstand 100% over-range pressure without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

II. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Maintain accuracy up to 20 to 1 turndown ratio. Reference Accuracy: +0.2% of full span.

III. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings. Shut-off valves in the high and low sensing pick-up lines shall only be provided for water to allow the balancing Contractor and Owner a permanent, easy-to-use connection.
IV. A minimum NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

V. The exterior sensing tip for a building differential air pressure transmitter shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind. The outside air static probe must be a Static Outside Air Probe (S.O.A.P.) provided by Air Monitor Corporation. Location of pressure sensors shall be shown on control as-built drawings.

VI. Room pressure monitoring and/or control

i. Pressure monitoring and/or control below 0.10” shall be by thermal anemometer technology which senses air flow and correlates this to a pressure difference. Mechanical diaphragm, strain gauge, or similar means shall not be used.

ii. Pressure monitoring and/or control shall be a through the wall pressure sensor UL listed for 2-hour fire walls, bi-directional +/- 0.00001” accuracy. Display shall have audio & visual alarms along with keypad and LCD display for field adjustment of parameters. Monitor shall have dual alarm time delays for door closed and door open conditions. Furnish and install GE 1076 flush mount door switches on all associated doors. Monitor shall be a native node on BACnet control network. Sensors shall be TSI, Setra or equal upon approval.

j. Static Pressure Traverse Probe

Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.

k. BTU Monitoring Devices

I. Building BTU’s shall be monitored by the building’s gas supply source, if the building is not on the HTHW loop. The meter shall provide an output which can be read by the BMS. Mass flow shall be sent to the Bulb server where it will be converted to BTU’s and the data held in long term storage.

II. If the building heat is supplied by the campus HTHWS, the secondary side of the building heat exchanger shall be monitored. Flow shall be read by strap on ultrasonic flow sensors and a matched pair of strap on temperature sensors. All inputs shall go into a centralized BTU meter which performs all data calculations.
I. Refrigerant Leak Detectors

I. The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the BMS. The alarm relay contact shall also directly energize the exhaust fans.

II. The sensor(s) shall be mounted 18” above finished floor. The detector shall have an adjustable sensitivity range to allow for alarming at any refrigerant concentration from 100 PPM to 1,000 PPM. The sensor(s) shall be factory calibrated with the first stage alarm (non-audible alarm) calibrated at 600 PPM, the second stage alarm (non-audible alarm) calibrated at 800 PPM, and the third stage alarm (audible and visible alarms) calibrated at 1,000 PPM. The third stage alarm shall also enable the emergency ventilation system. Refrigerant leak monitor shall be furnished with optional remote audible/visible alarms (horn/strobe combination). Locate two horn/strobes at each chiller room exit (one inside and one outside of each exit door). Install each horn/strobe at approximately 7'-6" above finished floor. Remote audible/visible alarms shall be suitable for either indoor or outdoor installation.

III. The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.

m. Smoke Detector

Smoke detectors shall be furnished as specified elsewhere in Division 26, and for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

n. Current Sensing Switches

I. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

II. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads. Note: If VFDs are used, motor status shall come from VFD status output. The exception is when the VFD controls multiple loads as in fan walls. In that case CTs would be required for each load.
III. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

IV. Devices shall be split core to have the ability to be installed and removed on a conductor without disconnecting the conductor.

o. Air Filter Status

I. Differential pressure transducers shall be used to monitor air filter status.

II. A complete installation kit shall be provided, including: static pressure taps, tubing, fittings.

p. Air Pressure Safety Switches

I. Air pressure safety switches shall be of the manual reset type with DPDT contacts rated for 2 amps at 120VAC.

II. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service. Installed device locations shall be indicated on control as-built drawings.

q. Low Temperature Limit Switches

I. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

II. Mount on the discharge side of the first water or steam coil in the air stream.

III. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in strict accordance with manufacturers recommended installation procedures.

IV. The sensor element shall be installed in a serpentine fashion with no less than 18” between each pass. The element shall span horizontally to within 4” from each coil edge.

V. Capillary supports at the sides of the duct shall be provided to support the sensing string.

VI. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required, and wired in series, to provide full protection of the air stream.
Provide additional switches at a ratio of one linear foot of element per one square foot of duct opening or coil surface area.

5. Output Devices

a. All equipment shall be sized, selected, installed, setup, and calibrated as appropriate for the application and per the manufacturer’s specifications.

b. Actuators

I. Damper and valve actuators shall be electronic.

II. Electronic control actuators for all valves and dampers shall be modulating 4-20 mA or 0-10 VDC control signal, unless the application calls for a two position function. Two position functions with fail safe positions shall be achieved with actuators that are powered to drive and unpowered to spring return to the fail safe position. Three wire “floating control” actuators are powered to drive one direction, and reverse powered to drive in the other direction. They shall only be allowed for 2-position, non-fail safe applications. They shall never be used for modulating applications, except for the onboard integrated actuator on the VAV controller. Modulating actuators with fail safe positions shall do so via spring return.

III. All actuators shall have external adjustable stops (to limit the travel in either direction), and a gear release to allow manual positioning.

IV. Two-position or open/closed actuators shall accept 24 or 120 VAC power and be UL listed.

V. Modulating actuators shall accept 24 or 120 VAC or 24 VDC power, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA.

VI. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

c. Damper Actuators

I. Electronic damper actuators shall be mounted directly to the shaft.

II. Actuator sizing shall be based on actuator manufacturer’s recommendations in regards to face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required.
d. Valve Actuators

I. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

II. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

e. Control Relays

I. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

II. Mounting Bases shall be snap-mount.

III. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application. SPDT are not allowed. DPDT is the minimum number of contacts.

IV. Contacts shall be rated for 10 amps at 120VAC.

V. Relays shall have an integral indicator light.

f. Control Valves

I. All automatic control valves shall be fully proportional and provide near linear flow control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position as specified on the drawings. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the flow requirements, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule.

II. Chilled water control valves shall be modulating ball, globe, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer’s recommendations for the given application.
III. Ball or globe valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.

IV. Butterfly valves shall be acceptable for modulating only on condenser water supply to a chiller for head pressure control application, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, and a replaceable lining suitable for temperature of system. Valves for isolation service shall be the same size as the pipe. Valves in the closed position shall be bubble-tight.

6. Miscellaneous Devices

   a. All equipment shall be sized, selected, installed, setup, and calibrated as appropriate for the application and per the manufacturer’s specifications.

   b. Variable Frequency Drives shall be provided by the controls contractor. The following points shall be hard wired: start/stop, status, and speed, whereas kW and fault shall be networked.

   c. Local Control Panels

      I. All control panels shall be professionally constructed, incorporating the BMS manufacturer’s standard designs and layouts. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

      II. Low and line voltage wiring shall be separated. All wiring that comes into the panel, shall first go to the terminal strip, and then to the controller. All provided terminal strips and wiring shall be UL listed 300-volt service and provide adequate clearance for field wiring.

      III. All wiring shall be neatly installed in plastic trays or tie-wrapped.

      IV. Panels shall not be located directly underneath valves or other areas where they may be subject to water, heat, or steam damage. Panels shall be mounted with the top no higher than 7 feet above the floor with a minimum of 3 feet frontal clearance.

      V. Panels shall be mounted on, or adjacent to the equipment they serve, with the exception of Network Controllers. If a panel must be located away from the equipment it serves, contact the Controls Shop for location coordination. Network Controllers are to be located in data rooms. Contact the Controls Shop for any deviation from this directive.
VI. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers (transformers to have secondary protection via onboard circuit breaker).

VII. Surge suppression is required for all control panels and network controller.

VIII. All panels must have terminal strips with enough extra slots to allow for the 20% extra point count of the controllers.

d. Power Supplies

I. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

II. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

III. A power disconnect switch shall be provided next to the power supply.

e. Thermostats

Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All of these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer’s standard finish.

7. Spare Controller Capacity

All controllers (except application-specific controllers for fan coils, heat pumps, and VAV boxes) shall be furnished with a minimum of 20% spare points capacity to allow for addition of both analog and digital inputs and outputs. Expansion cards will not be accepted as a means of providing additional inputs and/or outputs to meet this requirement. Controller’s memory and/or CPU shall not be overloaded.

8. Energy Monitoring and Management

a. Provide the University Facilities Services Department a standard electrical monitoring system for each new building. The monitoring system shall use Veris Industries 8100 series KW power meters with current transformers matched to the actual load. The meters shall have the capability to interface with Johnson Controls or ALC BAS. Mount the meter in the main supply and return piping on the building loop.
b. Data output shall be:

- **kWh**, Consumption
- **kW**, Real Power
- **kVAR**, Reactive Power
- **kVA**, Apparent Power
- **Powerfactor**
- **Voltage, Line to Line**
- **Voltage, Line to Neutral**
- **Amps, Average Current**
- **kW, Real Power ØA**
- **kW, Real Power ØB**
- **kW, Real Power ØC**
- **Powerfactor ØA**

9. BMS Wiring

a. Bus communication cabling shall be selected to only have the minimum quantity of conductors required. Doubling of the conductors for the purpose of bringing the bus communication back from the device shall not be allowed in the same cable. All Johnson Controls Metasys bus cable (N2 and BACnet) shall be blue jacketed. ALC Arcnet and BACnet bus cables shall be green. All bus communication cable shall meet controls manufacturer requirements/standards. Paint all conduit covers blue for Metasys or green for ALC.

b. Each device that requires an IP address (such as a global controller, chiller, boiler, VFD, etc.,) shall have a dedicated network drop from the IT department’s managed switch. Single network drops that split to multiple devices via a hub or mini-switch shall not be allowed. Hubs or Mini-switches shall only be installed with written authorization from the Controls Department on a case by case basis but are generally not allowed.

c. Cables shall be continuous and without splices (except at field terminal panels). Cable jacketing shall extend into the cabinet. All network wiring shall comply with Division 27.

d. All low voltage wiring (whether plenum rated or not) shall be installed in raceways with the following conditions, clarifications, and exceptions:

   I. Fire alarm and security system wiring shall follow National Electrical Code guidelines.

   II. Low voltage wiring for data, communications, intercom, temperature controls, and energy management systems may be routed utilizing open cable trays above accessible ceilings.
III. Where open cable trays are utilized above accessible ceilings the following conditions apply.

   i. Low voltage wiring routed in open cable trays shall be plenum-rated (whether or not the ceiling space is utilized as a return air plenum).

   ii. Low voltage wiring concealed in walls, floors, and above inaccessible ceilings shall be routed in raceways or conduit.

   iii. Low voltage wiring routed between conduit stubs and cable trays shall be secured with appropriately spaced J-supports.

10. Equipment and Wiring Identification

   a. All instrument and output device wiring shall be labeled at every termination including both sides of interim splices within field terminal panels (splices out in the field are not acceptable).

   b. Labels are required for wire pairs, and not for individual wires. Labels shall be installed within two (2) inches of termination, or in the case of I/O devices around the wire jacket anywhere in the device wiring cavity within six (6) inches of termination.

   c. Labels shall be machine printed with indelible ink on heat shrinkable plastic tubing. In no case are self-adhesive labels accepted, unless machine printed and protected with clear heat shrinkable tubing.

   d. Label names shall reflect the BMS object name as displayed on the network (i.e. SF-S). The Controls Contractor to contact the University Controls Department for current nomenclature.

   e. Equipment, devices and sensors which are located above the ceiling shall be indicated by a label on the ceiling beneath the unit. For T-bar ceilings, locate label on metal cross supports. The equipment label must follow the nomenclature called out on the mechanical prints (example: TU-113, AHU-1, etc.).

   f. Panel Labeling:

      I. Each panel face shall have an engraved plastic tag bearing the panel number designated in the riser drawing along with the equipment name it controls.

      II. Each component shall be tagged on the panel back plate with a machine printed tag bearing the BMS object name, i.e. SF-C for the relay that commands on the supply fan. Controls contractor must Contact UNR Controls Department for current object name list.
g. Room sensors shall be labeled with the corresponding terminal unit or fan coil unit number and controller address. Labels shall be self-adhesive clear back with black lettering (1/8” high lettering on 1/4” high label). Label ceiling grid for location of all concealed equipment, VAV’s, duct static pressure sensor/probe etc.

11. Accessibility

All instruments shall be installed such that they are accessible for removal, repair, or recalibration in place. All instrument cabinet doors shall allow full one hundred twenty (120) degree opening without interference. Any installation deemed by the University to be inaccessible shall be corrected by the contractor at no extra cost to the University.

12. Penetrations

a. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

b. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

c. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

d. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

B. Product Standards and Manufacturers

1. Building Management Systems (BMS) DDC Control Modules

a. Approved manufacturers are: Automated Logic or Johnson Controls

I. Land Gate Router (LGR); Network Automation Engine (NAE)

II Multi-Equipment Control Module (M-Series); Field Equipment Controller (FEC)

III. Room Controllers (RC-Series); Network Thermostats (TEC)

IV. Multi-Equipment Control Expanders’ (ME/MX Series); Input / Output Modules (IOM); Expansion Modules (EXP)

V. Control Modules (ZN-Series); Network Sensors (NS), VAV Controller (VMA)

VI. Single Equipment Control Module (SE-Series); Field Equipment Controller (FEC)
b. The controls contractor shall warrant that all equipment supplied, and all work performed shall be free from defects in workmanship and materials for a period of one year from acceptance by the University. If any such products or workmanship should prove to be defective within the one year period, the contractor agrees either to correct by repair or by replacement with equivalent product or corrective workmanship, provided that such defects developed under normal and proper use. The equivalency determination rests with the University. Troubleshooting services shall be the responsibility of the contractor; preventative maintenance of the system is the responsibility of the Owner.

2. Input Devices

a. Approved manufacturers

I. Room Temperature Sensors
   i. Johnson Controls
   ii. BAPI
   iii. ACI
   iv. Equal upon approval

II. Thermowells & Duct Mount Sensors
   i. Johnson Controls
   ii. Mamac
   iii. BAPI
   iv. ACI
   v. Equal upon approval

III. Averaging Sensors
   i. Johnson Controls
   ii. Mamac
   iii. BAPI
   iv. Veris Industries
   v. Grey Stone
   vi. Minco ACI

IV. Humidity Sensors
   i. Veris
   ii. Mamac
   iii. ACI
   iv. Equal upon approval

V. Pressure Transmitters
   i. Veris
   ii. Equal upon approval
iii. Exterior Sensors shall be Veris, Setra or equal upon approval. Veris PX series shall be used for Air and PW series for wet application.

VI. Carbon Dioxide Sensors shall be silicon based NDIR single beam dual wave length technology

i. Vaisala
ii. Johnson Controls
iii. INTEC
iv. Equal upon approval

VII. Air Flow Monitoring

i. Ebtron
ii. Equal upon approval

VIII. Static Pressure Traverse Probe

i. Cleveland Controls
ii. Equal upon approval

IX. BTU Monitoring Devices

i. Sierra Instruments model series 640S gas mass flow meter (buildings not on the HTHW loop)

ii. Fluxus ADM 7407 by Flexim with either Modbus or BACnet communication options (if the building heat is supplied by the campus HTHWS)

iii. SITRANS FUE1010 by Siemens which comes in Modbus or N2 communication protocols (if the building heat is supplied by the campus HTHWS)

iv. Equivalent upon approval

X. Refrigerant Leak Detectors

i. Amseco Model CSHB-BG (with blue light lens)
ii. MSA Instruments
iii. Approved equal by Kele & Associates

XI. Current Sensing Switches

i. Veris Industries
ii. Functional Devices
iii. Equal upon approval
XII. Air Pressure Safety Switches
   i. Penn
   ii. Dwyer
   iii. Equal upon approval

XII. Water Flow Switches & Low Temperature Limit Switches
   i. Penn P74
   ii. Equal upon approval

XIII. Electrical Power Monitoring Devices
   i. Meters shall be Nexus series 1262.

3. Output Devices
   a. Approved manufacturers
      I. Actuators & Control Valves
         i. Belimo
         ii. Equal upon approval
      II. Control Relays
         i. Idec
         ii. Equal upon approval

4. Miscellaneous Devices
   a. Approved manufacturers
      I. Variable Frequency Drives
         i. ABB
         ii. Dan Foss

230910 – LABORATORY SYSTEMS - INSTRUMENTATION AND CONTROL FOR HVAC

A. System Design and Performance Requirements

1. All variable volume systems shall have an occupant sensor for each fume hood which will reduce the air flow to a minimum level when the hood is not in use.

2. For all variable volume systems, the fume hood shall have a local override control that will permit the operator to run the hood air volume to its maximum rate.
3. Variable air volume systems controllers must be integrated with the campus controls system, Automated Logic, or Johnson Metasys. The system shall provide BACnet interface capabilities.

4. Variable air volume systems shall have pressure independent airflow control valves suitable for up to 3” w.g. pressure drop.

5. Variable volume control system must react within 3 seconds to changes in airflow.

6. Fume hood average face velocities shall be a minimum of 80 fpm at the design sash position of 16” with no individual face velocity measurement less than 65 fpm. All hoods must be tested both in the factory and on-site in accordance with ASHRAE 110. Fume hood designs that demonstrate as installed containment with an average face velocity of less than 80 fpm, such as low flow constant volume hoods, can be considered with approval from Facilities Services and EH&S; however, average face velocities at the design sash position shall be at least 60 fpm. In addition to meeting the requirements of ASHRAE 110 as installed, hood field certification by EH&S is required before being turned over for service to the user.

7. All fume hoods shall have a flow indicator installed which has both an audible and visual alarm for low flows.

8. All fume hood exhaust ducting shall be made from 16 or 18 gauge 316 stainless steel with screwed slip joint connections sealed with an appropriate sealant such as polysulfide. Facilities Services will determine if welded ‘TIG’ joints are required based on the laboratory materials and use planned for the fume hoods. (Type 316L must be used if welded joints are specified.) Additionally, Facilities Services will review alternate duct materials such as galvanized steel if proposed.

9. Fume hood exhaust shall not pass through un-ducted areas. Exhaust ducts shall always be at a negative pressure with regard to ambient.

10. All exhaust fans shall be located outside of the building on the roof or in a dedicated penthouse mechanical room with its own independent ventilation. All motors shall be outside of the duct and be of spark-proof design.

11. Laboratories with fume hoods shall maintain a slightly negative air pressure with regards to non-laboratory areas. Biosafety level 3 & 4 laboratories require a minimum of -0.03 to -0.05 w.g. differential between the laboratory and adjacent areas.

12. The fume hood and ducting shall have materials with a flame spread rating of 25 or less, per NFPA method 255.

13. Fume hood exhausts shall extend above the building roof at least seven (7) feet to prevent personnel exposure and re-entrainment unless modeling demonstrates a higher point of discharge. Air dispersion modeling shall be done for new installations with two or more fume hoods.
14. Fume hood exhausts should be located at least fifty (50) feet away from any supply air intakes.

15. Exhaust discharge velocities shall be 3,000 fpm to prevent personnel exposure and re-entrainment unless modeling determines a different value is required. This requirement does not negate the need to perform air dispersion modeling. Mixed-flow exhaust fans shall be considered in addition to centrifugal type fans.

16. Fume hood discharge air shall not be recirculated.

17. Biological safety cabinets and clean benches are not a substitute for laboratory fume hoods.

18. The minimum air changes for laboratories are six (6) air changes per hour (ACH) for occupied conditions and four (4) ACH for unoccupied conditions. Supply air is 100% outside air. Variable volume (and constant volume) systems should be designed to have some capability for additional ventilation rates beyond the design level. Facilities Services and EH&S will work with the design team on what additional capacity is feasible for each zone. For a single lab which is served by a single, dedicated make-up air unit and the cooling load cfm exceeds the required exhaust cfm, a make-up air system with outside air and return air is acceptable provided however that the 6 ACH minimum cfm rate required must be outside air.

19. Fume hoods shall not have automatic sprinkler systems or fire detection devices installed in them, unless specifically required by the authority having jurisdiction.

20. Heat recovery systems for room and/or laboratory fume hood exhaust shall be considered and a life cycle cost analysis should be performed to determine if the heat recovery system has a payback of ten (10) years or less. Heat recovery for fume hood exhausts shall be 100% cross contamination free between two air stream.

21. Fume hoods shall be located away from opening windows, doors and high traffic areas.

22. The fume hood shall be designed to contain minor spills. A ¼ inch lip or recess shall be provided within the hood.

23. Time clocks shall not be used to control fume hood exhaust or sash height.

24. All hood lighting shall be of UL-listed fixtures and meet NFPA 70, be of fluorescent type and be replaceable from outside the hood.

25. Sashes shall be made of laminated or tempered safety glass.

26. Dampers, when used in exhaust systems, shall fail open.

27. Room ambient air velocities directly adjacent to fume hoods shall avoid strong air currents. Ambient air velocities shall be less than 35 fpm as measured directly in front of the fume hood.
28. Perchloric acid hoods shall meet the requirements of NFPA Chapter 8 and be reviewed by EH&S and Facilities Services during the design phase.

29. Fume hoods shall meet a noise criteria (NC) curve of NC 55 (DBA) for research labs and NC 40 for teaching labs; measured four (4) feet from the sash face.

30. Natural-gas, direct-fired make-up air units are not permitted for laboratory make-up (supply) air.

31. Used fume hood are not acceptable unless approved by EH&S.

230933 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

A. System Design and Performance Requirements

1. All motors over 1/2 horsepower shall be premium efficiency type. Motors shall be open drip-proof (ODP), or totally enclosed fan cooled (TEFC) in high heat or high humidity locations. Minimum motor efficiencies at full load shall be as follows:

<table>
<thead>
<tr>
<th>HP</th>
<th>Efficiency</th>
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<tbody>
<tr>
<td>1.0 HP</td>
<td>86%</td>
</tr>
<tr>
<td>5.0 HP</td>
<td>89.5%</td>
</tr>
<tr>
<td>10.0 HP</td>
<td>91%</td>
</tr>
<tr>
<td>50.0 HP</td>
<td>94.1%</td>
</tr>
<tr>
<td>100.0 HP</td>
<td>95.1%</td>
</tr>
</tbody>
</table>

2. Those motors that will be controlled by a frequency drive shall be inverter rated. Any motor that could possibly have a frequency drive installed at a future date shall be inverter rated.

3. Ceiling mounted fan coils shall have a power disconnect switch mounted ON the cabinet on the same side as the filter access door. In addition the motor and V-Belt shall be accessible from the same side of the unit.

232100 – HIGH TEMPERATURE HOT WATER PIPING SYSTEMS WITHIN BUILDINGS

A. System Design and Performance Requirements

1. All HTHW systems shall be engineered and tested in accordance with ANSI/ASME B31.1, Power Piping Code. A professional engineer registered in the state of Nevada shall take full responsibility for HTHW system design by affixing his stamp to the drawings and specifications.

2. All piping, components and heat exchangers shall be rated for hot water service with continuous duty at 400 deg. F at 400 psig. See HTHW Heat Exchanger Piping Diagram Drawing #232116-3.

3. Piping located inside buildings shall be ASTM A53B Schedule 40 seamless type S or electric resistance welded type E, schedule 40 or wall thickness as determined by
4. In no case shall piping be smaller than ¾” diameter (NPS)

5. Fittings shall be 300lb. ASTM A105 forged, socket weld for 2” and below. Above 2”, use butt-weld or 300# flanged carbon steel fittings meeting ASTM A234 WCB and ANSI B16.5. Gaskets shall be 316 stainless steel and graphite spiral wound by Flexitalic Type CG or approved equal.

6. Piping located inside a building shall be insulated with either fiberglass or calcium silicate. Calcium silicate shall be used at the direction of UNR anywhere there is the possibility of incidental contact due to maintenance activities or foot traffic. Jacketing shall be kraft-faced, fittings shall be pre-formed plastic, and the piping shall be labeled.

7. Expansion loops shall be used whenever feasible. If it is not feasible to use expansion loops, expansion joints may be used with authorization from FSD.

8. Isolation valves shall be rising stem gate with bolted bonnet, cast carbon steel body ASTM A216 WCB, 13% Cr stem and disc with satellite seat, ANSI Class 300 with raised face flanges, and high temperature graphite packing.

9. Control valves shall be globe type with cast carbon steel body ASTM A216 WCB, with stainless steel trim, ANSI Class 300 with raised face flanges, and high temperature graphite packing. Valves 2” and smaller shall be socket weld or flanged. Control valves shall seat tightly to class IV seat leakage sent leakage at a pressure equal to 110% of the design pressure of 400 psig and 400°. Actuators shall have a minimum 25% margin over valve seating torque. Provide a 1/3 and 2/3 modulating control valves on the high temperature hot water return side and a two-way shutoff valve on the supply side. Valves to close on temperature in excess of 210 degrees F on the low temperature supply side and be manually reset.

10. Thermometers shall be installed in threaded 316 stainless steel thermowells installed in ¾” 300 lb. carbon steel threadolets. Thermometers shall be 4-1/2” dial, bi-metal type.

11. Pressure gages shall be no smaller than 4-1/2 dial. Isolation valves shall be installed between the line and the gage, and gages shall be selected such that the operating pressure falls between 40 and 50 percent of the full scale. Gage stems shall be no smaller than ⅝”. Water filled gages are not acceptable.

12. Branch Piping: Taps shall be made using 300 lb. Forged carbon steel ASTM A105 Grade B, ANSI B16.11 socketlets. No direct welding or use of half or full couplings is allowed. All branches shall utilize forged fittings, unless code calculations are provided.

13. All piping shall be seismically restrained as required by IBC, latest edition.
14. Piping shall be flushed prior to hydrotest. Contractor shall provide all temporary measures to facilitate flushing and testing, and shall provide a flushing and testing plan to the engineer for approval prior to flush or testing.

B. **Product Standards and Manufacturers**

Only piping fittings, valves and materials manufactured in the USA or Canada are acceptable.

### 232120 - THERMAL ENERGY METERS

**A. System Design and Performance Requirements**

1. Provide a fully integrated thermal energy metering system to calculate BTU’s.
   
   a. Ultrasonic clamp-on transit-time flow measurement: temperature measurement with clamp-on or insert temperature sensors.
   
   b. System has an onboard memory to store energy trends
   
   c. Quantities of measurement: Instantaneous thermal energy output, totalized thermal energy, volume and mass flow, temperature Ts,Tr,Td, flow velocity, liquid’s sound speed, signal strength.

**B. Product Standards and Manufacturers**

1. Use Fluxus Btu Ultrasonic Meter

2. Approved manufacturer

   Flexim Americas Corp.
   250-v Executive Drive
   Edgewood, NY 11717
   1-888-852-7473
   www.flexim.com

### 233113 - UNDERGROUND HIGH TEMPERATURE HOT WATER (HTHW) PIPING

**A. System Design and Performance Requirements**

1. High temperature hot water (HTHW) is the primary heat source for a variety of heating functions throughout the University. HTHW is generated at the Central Heat Plant and distributed via a loop piping system which operates at 325-375°F. Design conditions for piping are 400 psig and 400F.
2. Pipe
   a. ASTM A-106 or A-53 type S (seamless) or Type E (electric resistance weld), Grade B, black carbon steel. Type F (furnace butt weld) is not acceptable.
   b. Pipe Wall Thickness:
      I. 2 inch and smaller: Schedule 80
      II. 2.5 inch through 10 inch: Schedule 80

3. Fittings
   b. Butt Weld (2.5 inch and larger): ANSI B16.9, ASTM A234 WPB, extra strong.
   c. Flanged (2.5 inch and larger): ANSI B16.5, ASTM A105 forged steel, 300 pound class, weld-neck flanges raised face.
   d. Unions (2 inch and smaller): ANSI B16.11 forged carbon steel, 800 # class, socket weld ends.
   e. All buried pipe fittings shall be butt welded for all sizes.

4. Valves
   a. General: Valves shall be socket welded for 1 1/2 inch and smaller piping, forged steel flanged or socket welded for 2” and larger. Flanged or butt welded for 2 1/2 inch and larger. Acceptable valve manufacturers are provided below; no substitutions unless approved by the Project Coordinator.
   b. Gate Valves
      I. Socket Weld (2 inch and smaller): ANSI B16.34, 800 pound class, forged steel, bolted bonnet, OS&Y, conventional port gate valve Walworth, Vogt, or Edwards.
      II. Flanged (2 inch and larger): ANSI B16.34, 300 pound class, A216 WCB cast steel body, bolted bonnet, OS&Y, stainless steel trim; Walworth, Crane or Stockham.
      III. Butt weld (2.5 inch or larger): ANSI B16.34, 300 pound class, A216 WCB cast steel body, bolted bonnet, OS&Y, stainless steel trim, Walworth, Crane or Stockham.
c. Globe Valves

   I. Socket Weld (2 inch and smaller): ANSI B16.34 800 pound class, forged steel body, stainless steel seat ring and plug, bolted bonnet, rising steam; Walworth, Vogt, or Edwards.

   II. Flanged (2.5 inch and larger): ANSI B16.34 300 pound class, A216 WCB cast steel body, OS&Y, stainless steel trim, Walworth, Crane or Stockham.

d. Rotary Valves

   I. 300 pound class, carbon steel, flanged, Adams or Keystone Vanessa. stainless steel seats.

5. Piping Specialties

   a. Gaskets: Non-asbestos containing ring gaskets, flexitallic type “cg” grafoil/304ss or equal, suitable for the fluids and temperatures encountered.

   b. Bolting: ASTM A193, Grade B7, for bolts and studs, and ASTM A194, Grade 2H for nuts.

   c. Sleeves: Sleeves for foundation wall penetrations shall be fabricated of one-eighth inch (1/8”) thick steel, with two inch (2”) wide collar welded in place, and the assembly hot-dip galvanized.

   d. Wall Penetration Seals: High temperature elastomeric link type mechanical seals compressed with corrosion protected bolts and compression plates; Thunderline High Temperature Link Seal, no substitution; or fiberglass rope stuffed packing box if pipe or casing surface temperature exceeds 375 degrees F.

   e. Expansion Joints (where permitted, expansion loops are preferred and shall be used wherever possible):

      I. Expansion joints shall be slip tube type as designed for the specific location. They shall be 300 # rating, flanged, and shall conform to the Standards of the Expansion Joint Manufacturer's Association.

      II. Slip-tube type shall have external and internal high performance guides rated for 500°F and designed for packing under pressure; Yarway or Hyspan.

      III. Slip-tube shall be single or double type with center take off taps as required for the given service.
f. **Air Vents (for high points):** ¾ inch, 300# steel gate valve is required at all high points and be located in accessible manholes. Discharge of air vents in vaults shall be routed to the floor with ¾ inch diameter steel pipe; use socket weld fittings. Install pipe nipple with threaded cap in outlet of valve.

g. **Strainers:** Y-type with cast or forged steel body. Cast steel 300# rated flanged ends or forged steel 300# socket weld ends; 1/8 inch mesh monel strainer elements, socket weld ends for 2 inch and smaller piping.

h. **Pipe Hangers and Supports:** Pipe hangers and supports shall be designed and located per the requirements of B31.1 and the recommendations of the powder insulation or prefabricated conduit system vendor.

i. **Pressure gauges:** 4.5 inch dial, bourdon tube, 0 to 500 psig, Ashcroft or equal. Include 300# forged steel needle isolation valve.

j. **Insulation:**

   I. In manholes, pipe 2.5 inch diameter and greater shall be insulated with ASTM C533, type I, calcium silicate; 2.5 to 6 inch diameter - 3 inches thick insulation, 8 to 12 inch diameter - 4 inches thick. Less than 2.5 inch diameter -1 inch thick.

   II. In manholes, tunnels, and exterior installations: pipe and fitting insulation shall be covered with 0.016 inch smooth aluminum jackets with integral moisture barrier. Stainless steel band on 12 inch center shall hold the insulation to the pipe.

   III. Valves and equipment shall be insulated with removable shop fabricated fiberglass padding rated for 500°F, with thin wire mesh lining, and covered with 18 ounce high temperature fiberglass cloth with Velcro straps.

6. **Manholes**

   a. All structures shall be of reinforced concrete. Main line junctions and service connections shall be in vaults, which require two openings.

   b. Prefabricated or field constructed manholes, where allowed, shall be provided with walls, floors, and roofs not less than 8 inches thick and reinforced with steel bars. Floors shall drain to sump hole.

   c. Concrete shall be 4,000 psi minimum compressive strength after twenty eight (28) days, synthetic fiber, for both prefabricated and field constructed manholes. Air entrained admixture, 5 to 7% entrainment for all concrete exposed to effects of weather or freezing conditions.

   d. Waterproofing shall be provided. Membrane waterproofing is preferred.
e. Steel ladders shall be provided.

f. Covers and openings shall be vehicular traffic rated (H-20).

7. Steel Pipe and Powder Insulation System

a. The powder insulation system shall provide for minimizing heat loss, corrosion protection, and unrestricted thermal movement between anchors.

b. Powder insulation shall be Gilsulate 500 XR. Thickness of the insulation shall be defined by the Engineer and shown on the Contract Drawings.

c. Expansion Loops and L-Bends: In addition to the powder insulation thickness, bends shall be preinsulated with ASTM C547, Class 1, mineral fiber to allow for thermal expansion of the piping. The mineral fiber thickness at bends should be approximately 200% of the calculated thermal growth.

d. Pipe Supports: Anchors shall be located outside vaults, typically at five feet from the vault wall. Anchors shall not transmit thrust loads to the manhole wall unless the manhole wall has been specifically designed for these thrust loads. Expansion loops shall use guides and vertical supports as required.

8. Buried Conduit Systems

a. Coated Steel Conduit Casing: Conduit casing shall be manufacturer’s standard drainable, ventable, and pressure testable system with an annular air space. Steel outer casing systems shall be epoxy coated. Perma Pipe Multi-Therm 500 or equal.

b. Conduit End Seals: Conduit end seals shall be fixed type where there is no thermal pipe expansion through the end seal and shall be slip type where there is thermal pipe expansion through the end seal. One-half inch (1/2”) threaded pipe ports at top and bottom of each end seal shall be provided for draining, venting, and pressure testing of conduit casings.

c. Insulation: ASTM C533, Type I, Calcium silicate, mineral fiber, or C552 cellular glass shall be used on the steel pipe within the casing.

d. Expansion Loops and L-Bends:

   I. ANSI B31.1 factory fabricated, with weld testing per design. Casing, couplings, insulation, and piping shall be identical to those used for straight runs and designed to ensure complete drainage. Fabricated materials shall be shipped to the job site in maximum feasible size sections to minimize number of fielded joints.

   II. Loop casings shall be sized to contain pipe movement without crushing the insulation or causing other damage. Eccentric reducers and increasers or welding collars designed to serve the same purpose shall be used to allow free drainage through the loop.
III. Pipe supports shall be slotted to permit unrestricted lateral movement of piping and shall be otherwise identical to pipe supports specified for straight runs.

e. Pipe Supports: Anchors shall be located outside vaults away from manhole wall. Inside vaults, vent and drain holes shall be provided at the top and bottom of casing closure plates.

9. Trenching, Backfilling, and Compacting

a. Trenching: The University may limit the amount of trench to be opened at any time.

b. Bedding:

   I. Pre-insulated conduit systems: Ditch bedding shall be accurately graded with a minimum of six inches (6") of sand. Sand shall pass a ¼ inch screen with not more than fifteen percent (15%) passing a No.200 sieve. Sand shall be backfilled to a minimum of six inches (6") above the pipe casing. Bedding shall be laid to firmly support the piping along its entire length.

   II. Steel pipe and powder insulation system: The steel pipes shall be top hung or bottom supported to allow a bedding of powder insulation underneath (in accordance with manufacturer’s specifications). The powder insulation shall be placed to the minimum thickness shown on the contract drawings. The insulation shall be installed and compacted (per manufacturer specifications) to firmly support the piping along its entire length.

c. Backfilling: Backfilling of trenches shall progress as rapidly as construction, testing, and acceptance of work permits.

d. Damage Repair: Utilities, wall, piping, and other improvements damaged during the course of work shall be repaired to their original condition or replaced by the contractor.

e. Excess Material: Excess material and debris shall be removed and disposed of, at an approved disposal site, within one week after final approval of installation.

10. Piping Installation

a. General

   I. Piping and pipe systems shall be fabricated, assembled, welded; installed, and tested in accordance with ANSI B31.1
II. Piping shall be cut accurately to field measurements and worked into place without springing or forcing, except where cold springing is specified. Piping shall not be buried, concealed, or insulated until it has been inspected, tested, and approved in accordance with FIELD QUALITY CONTROL (below).

III. Materials and equipment shall be protected from the weather during construction.

IV. Pipe runs underground between vaults shall be welded. Flanged and threaded joints shall not be buried.

V. Gaskets, packing, and thread compounds shall be suitable for the service. Joint compound shall be applied to male threads only.

VI. Arrangement of all piping shall be shown on the drawings. During installation, care shall be taken to avoid interference with other piping, conduit, and equipment. Lines shall be trapped only where shown on the drawings.

VII. Reducing fittings shall be used for changes in pipe sizes. Bushings shall not be used.

VIII. In horizontal lines two inches (2”) and larger, reducing fittings of the eccentric type shall be used to maintain the tops of the lines in the same plane.

IX. Pipe shall be adequately supported and anchored so that strain from weight and thermal movement of piping is not imposed on piping, equipment, or structures.

b. Cleaning

I. Each section of pipe, fittings, and valves shall be thoroughly cleaned free of all foreign matter before erection. Interior of piping shall be cleaned thoroughly as described in Article 3.7 (below) before final connections are made.

II. Open ends of mains shall be plugged or capped during shutdown periods. Lines shall not be left open at any place where foreign matter might accidentally enter pipe.

c. Pipe Expansion: Expansion of pipes shall be accommodated by expansion loops, L-bends, Z-bends in buried locations, or by slip type expansion joints in manholes, tunnels and buildings. Expansion joints shall be set to ensure proper function and movement during system operation.
d. Connections: Locations of capped or plugged outlets for future connections shall be shown on the drawings. Weldolets or welding fittings shall be used for tapping existing system.

e. Line Drainage: HTHW lines shall be pitched to allow for drainage to the low point. Buried lines shall be pitched to accommodate the worst case of elevations and must be recorded on the as-built drawings.

f. Welding

I. Responsibilities of contractor for electric fusion welding:

- Contractor shall be responsible for the quality of all welding.
- Contractor shall be capable of performing all welding operations required for construction of the high temperature hot water distribution system.
- Contractor shall determine the suitability of welding procedures used to ensure that welds meet the requirements specified herein.

II. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done after flame cutting, surfaces shall be ground and thoroughly cleaned of scale and oxidation just prior to welding. Beveling shall conform to ANSI standards.

III. Butt welds: All butt welds shall be open root, multi-pass welds, 6010 or 6011 root with 7018 filler caps (SMAW welding process).

IV. Electrodes shall be stored in a dry, warm area and kept free of moisture during fabrication operations. Electrodes that have lost part of their coatings shall be discarded.

V. Welds shall be inspected in accordance with ANSI B31.1 requirements. The University will radiograph 5 to 10% of the welds.

VI. If any welds are found to be defective, the contractor is responsible for full 100% radiograph testing of all the welds. Repair of defective welds by adding weld material over the defect, or by peening shall not be permitted. Welders responsible for defective welds shall be re-qualified before performing more welding on the job.

VII. All finished weld joints shall be painted with high temperature black paint.
g. Anchor Blocks:

I. Anchor Blocks: Concrete anchor blocks shall be provided for pipe anchorage not less than five feet (5') from building or manhole walls (except where metal anchor at the vault wall is shown on the contract drawings). Anchor blocks shall be cast against undisturbed earth using concrete that conforms to ASTM C-94 and has a minimum compressive strength of 4,000 psi at twenty eight (28) days.

II. Fabricated Structural Anchors: Fabricated structural anchors shall be provided if necessary in vaults, tunnels, and mechanical rooms as described in the contract drawings.

h. Wall Penetrations: Galvanized steel sleeves shall be provided for penetrations in concrete walls six inches (6") or less in thickness and masonry walls. Existing concrete walls thicker than six inches (6") shall be core drilled or equipped with galvanized steel sleeves. High temperature elastomeric link type seals shall be acceptable for use in all locations where the pipe temperature is 375 degrees F or less.

i. Insulation and Jackets:

I. Insulation shall be continuous through pipe hangers with calcium silicate inserts to prevent crushing of insulation.

II. Valves and equipment in manholes and buildings shall be insulated and covered with removable jackets. Insulation shall stop short of bolts/studs at flanges to allow their removal without damage of permanent insulation.

III. No exposed insulation will be permitted. Metal end caps that match the insulation jackets shall be used to cover the ends of insulation runs.

11. Valve Installation

a. Valves shall be installed in accordance with ANSI B31.1 and ASME Section VIII.

b. Valves shall be installed as shown on the drawings and as required for proper functioning of the system.

c. Valve handwheels shall be installed in locations accessible from floor level, preferably with vertical stems, for operation and repair.

d. All flange bolts shall be lubricated with a high temperature bolt lubricant approved by the project coordinator. Flanged bolt torquing shall be in an incremental staggered pattern to assure even compression of the gasket.
12. Piping Special Ties Installation (Hangers and Supports)
   a. Hangers shall be sized to allow for continuous pipe insulation through the hangers. Hangers shall not be permitted to touch pipe.
   b. Expansion bolts shall be acceptable for use in wall or ceiling construction.

13. Powder Insulation System Installation
   a. Installation of system to be done in strict accordance with the manufacturer’s specifications and design/installation manual. The contractor shall utilize the services of the manufacturer or manufacturer’s agent to oversee and approve the installation of the system at no additional cost to the University.

14. Buried Conduit Installation - Conduit Field Joints
   a. Conduit sections shall be joined after leak testing of carrier pipe. Conduit joining materials provided or specified by the system manufacturer shall be used.
   b. Pipe shall be insulated and casing joined to provide field joint equal to factory fabricated section on conduit system. Connections to existing conduit systems of a different manufacturer or type shall be made only in manholes or buildings and never in buried locations.
   c. Conduit End Seals: Conduit end seals in manholes or tunnels shall be provided with goose neck vents on the top and drain valves on the bottom. In buildings, conduit end seals shall be provided with threaded brass plugs.

15. Field Quality Control
   a. General: The project coordinator or his representative will conduct field inspections and shall witness all field tests specified in this section. The contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. The contractor shall produce evidence, when required by the project coordinator, that any item of work has been constructed properly in accordance with the contract drawings and specifications.
   b. Field Tests
      I. General: All anchor blocks and restraints shall be complete prior to testing. Concrete supports shall be fully cured.
      II. Piping Hydrostatic Pressure Tests:
         • Test pressure gauges for a specific test shall have dials indicating not less than one and one half (1-1/2) times nor more than two (2) times the test pressure.
III. Cleaning: After pressure and hydrostatic testing, the pipe system shall be flushed with a water/chemical solution such as San Joaquin Chemicals, Inc. Sansolv 6103 or equal. The procedure, cleaning solutions, and disposal shall be approved by the project coordinator.

IV. Operational Tests: After completion of the work, the system shall be operated for not less than six (6) hours at operational temperatures and pressure to demonstrate satisfactory function. The movement of each expansion joint shall be checked, and each valve shall be operated in both cold and hot conditions.

B. Product Standards and Manufacturers

1. All materials shall be certified new from factory. Pipe, and fittings shall be built in the USA or Canada to ANSI/ASME standards. Piping components made in other countries shall not be used unless specifically approved in advance by the Project Coordinator. Valves shall be made in the USA or Canada unless otherwise approved by the Project Coordinator.

2. Welder Qualifications: Welder(s) shall be qualified in accordance with ASME Boiler & Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Welders shall be thoroughly familiar with ANSI B31.1 requirements.

3. The Contractor shall furnish to the Project Coordinator all applicable welding procedures, individual welder certifications and procedure qualification records. All documentation shall be signed and dated by the appropriate contractor personnel.

4. Delivery and Storage

   a. Contractor shall be responsible for inspecting materials delivered to site for damage.

   b. Materials shall be stored on-site in enclosures or under protective coverings. Materials shall not be stored directly on ground.

   c. Insulation, expansion joints, joint materials, fittings, valves, and gaskets shall be stored under cover out of direct sunlight.
5. Handling
   a. Pipe, conduit sections, fittings, valves and other accessories shall be
      handled in such a manner as to ensure delivery to the trench in sound,
      undamaged condition.
   b. Special care shall be taken to avoid injury to coatings and linings on pipe
      and fittings. Damaged coatings and linings shall be repaired by the Contractor to
      the satisfaction of the Project Coordinator.

232500 – WATER TREATMENT

A. System Design and Performance Requirements

1. All new hydronic water piping shall be initially cleaned before start-up of any
   equipment with San Joaquin Chemicals, Inc. Sanasolv 6103 or equal.

2. Water treatment specialists shall be San Joaquin Chemicals, Inc. Concord CA,
   Chemtex, Reno Nevada, or Skasol, Reno, Nevada. All new water treatment chemicals
   shall be approved by the University of Nevada, Reno HVAC Maintenance Department
   prior to its introduction to the system.

3. Cooling tower water treatment must include the following
   a. Controller to be an Aquatrac Multiflex M5T or M10T with Trackster
      software.
   b. Chemical pump shall be Walchem EZ Series digital chemical pumps.
   c. Make up and blow down low meters shall be Seamtrics WMP water
      meters.
   d. Blow down valves shall be TAC duradrive Electro-mechanical ball valves.
   e. Double wall containment tanks for chemicals and biocides.
   f. Chemical pot-feeders, bypass type, capable of being fitted with bag filters.

4. See detail drawings for standard design details
   a. Corrosion Test Coupon Rack (Drawing # 232100-1)
   b. Injection Quill Detail (Drawing # 232100-2)
233300 - DUCTS

A. System Design and Performance Requirements

1. All new round ducting shall be spiral. All fittings shall be long radius unless otherwise approved.

2. Fiberglass duct is prohibited.

234100 – FILTERS

A. System Design and Performance Requirements

1. General Air Handler Applications

   a. Pre- Filters: Standard efficiency pleated, media filters with average dust spun efficiency of 30 percent to 35 percent (MERV 8) when tested in accordance with ASHRAE 52.2-1999. Flanders 30/30 U/L class 2, 0.10” initial resistance at 300 FPM velocity.

   b. Final Filters: High efficiency pleated media filters with average dust spun efficiency of 80 percent to 85 percent (MERV 13) when tested in accordance with ASHRAE 52.2 – 1999, Flanders U/L class 2, 0.30” initial resistance at 300 fpm velocity.

2. Standard Filter Sizes: The following filter sizes are acceptable to use at the University Nevada Reno Campus. Sizes other than those noted below will not be accepted without prior approval from the Facilities Services Department.

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3. Furnish and install filter gauges as part of the DDC system. Assembly shall include an adjustable pressure transmitter with a 4-20 MA output signal for DDC interface.
B. Product Standards and Manufacturers

Manufacturer: Dwyer (No Substitutions)

235200- HEATING HOT WATER BOILERS

A. System Design and Performance Requirements

1. Hot water boilers shall be designed to provide 180 degrees F boiler water. Boilers shall be designed and constructed in accordance with ASME Boiler & Pressure Vessel Code Section IV and designed for 250 degrees F and 160 psig.

2. Boilers for critical use and/or emergency response facilities shall be dual fuel (natural gas and fuel oil) unless a variance is obtained or an alternate approach is approved by FSD. The secondary fuel (fuel oil) storage shall be for 24 hours maximum load and shall utilize in a double wall day tank located in the boiler room of 660 gallons or less per NFPA 30, of an exterior fiberglass or steel double wall storage tank either above-ground of buried type. All exterior tanks to have full instrumentation including interstitial monitoring and alarms and level reporting and alarm. Dual fuel boilers shall be equipped with electronic spark ignition for firing on fuel oil. Boiler flues for dual fuel boilers shall include a barometric damper at each boiler outlet.

3. Boiler types include steel vertical tubeless, scotch marine, fire box, fire tube and cast iron sectional. Selection shall be based on boiler horsepower requirements, available floor space and efficiencies. Boilers under 30 boiler horsepower can be cast iron sectional. Flex tube boilers are not permitted. A minimum of 5 square feet of heating surface per horsepower is required.

4. Burners shall be designed for a minimum 6:1 turndown.

5. The waterside pressure loss through the boilers at rated load shall not exceed 4psi.

6. The boiler shall have a factory installed insulation with metal jacket. Minimum of 2” thick fiberglass or mineral wool insulation. Jacket to be 18 gauge, painted steel with heat resistant primer and finish coats.

7. Provide ASME safety valve(s).

8. Each boiler shall be equipped with a combination feeder and low water cut-off. Low water cut-off shall be float type with manual reset.

9. Each boiler shall be equipped with a manual reset type high temperature limit control.

10. Modular, gas-fired boilers for non-critical facilities up to 1,000,000 BTU/h are non-condensing type, copper fin tube, 85% minimum thermal efficiency. Units shall be forced draft with modulating burners.
11. The specifications for projects including a boiler shall require that the contractor apply for and obtain all required boiler inspections and operating permits (as required by the Nevada Industrial Relations Division, Occupational Safety and Health Enforcement Section, the contractor shall obtain an installation application prior to beginning any work and shall apply for a final inspection as required to obtain the boiler operating permit). Reference NRS 455C.

12. All new gas burners on boilers will have an IRI (Industrial Risk Insurers) approved gas train.

**235700 –HEAT EXCHANGERS**

**A. System Design and Performance Requirements**

1. For free cooling systems, a plate and frame heat exchanger shall be specified. Heat exchanger shall be sized for a 2 degree F approach, 304 stainless steel plates and nitrile, EPDM or BUNA N gaskets. Flanged connections to be 150# ANSI raised faced flanges. Frames shall be epoxy painted carbon steel. Frame bolting to be stainless steel with carbon steel nuts. Provide in line conical stainless steel strainer.

2. High temperature heat exchangers shall be shell and tube type: U-tube design, 2-pass with removable bundle, similar to Bell and Gossett HTWU. Refer to High Temperature Heat Exchanger Standard Detail in the Appendix for piping arrangement.

3. The high temperature side shall be the tube side with a 400 psig/400 deg. F rating, and the shell side shall have a 150 psig rating.

4. Provide a ¾ inch HX bypass with orifice plate where required by Facilities Services to provide a minimum bypass flow. Provide a flanged Y-strainer on HTHW supply side with ¾ inch drain valve.

5. All connections to be steel flanges using spiral wound, 300# gaskets, 316 ss/graphite. All flanges and valves to be 300# rating; cast steel valves 2 inches diameter and above and Class 800 forged steel less than 2 inch. All joints to be welded, no threaded joints except for instrumentation connections.

6. Exchangers shall be selected with a 0.0005 fouling factor.

7. Materials shall be steel shell, tube sheet, baffles, and tie rods, with 90/10 cupronickel tubes, 0.035 inches minimum tube thickness.

8. Provide ASME Code vessel complete with U-1 form.

9. Provide pressure relief on the shell side.

10. Specify a ‘Selco Seal’ steel trap heat exchanger head.
236400 –WATER CHILLERS

A. System Design and Performance Requirements

1. Chillers shall comply and be tested in accordance with ARI 550/590. Pressure vessels to be in accordance with ASME B&PV Code Section VIII. Units shall be factory assembled including evaporator, condenser, compressor, lubrication system, refrigerant charge and controls/wiring. Chillers shall be UL listed.

2. The Engineer of Record shall analyze and recommend screw type water chillers or centrifugal chillers based on an energy analysis and IPLV (Integrated Part Load Value). Chillers over 300 tons rating to be centrifugal. Screw type chillers to be dual compressors with independent refrigeration circuits.

3. Condenser and evaporator tubs to be 0.035 inch wall thickness, copper. Condensers shall be cleanable, thru-tube types. 150 psig working pressure. Water boxes shall be removable. Tube side fluid velocity shall be 5 to 7 feet per second at full load.

4. Hermetic and semi-hermetic chiller drives shall have a five (5) year drive warranty that also includes refrigerant replacement in the event of drive failure and/or leakage. Open drives shall have squirrel cages, open drip-proof motors, induction type. All chillers to be factory tested to ARI standards.

5. The chiller shall have a graphic control panel with a standalone microprocessor to control the chiller. The display shall include the following:
   a. Chiller liquid leaving temperature
   b. Chiller liquid entering temperature
   c. Condenser liquid entering temperature
   d. Condenser liquid leaving temperature
   e. Percent full load amps
   f. Operating Hours
   g. Input kW
   h. Evaporator pressure
   i. Condenser pressure
   j. Oil Sump Temperature
   k. Oil pressure

6. Chiller shall be able to run from 100% to 10% of full load. The controls shall have BacNet capability to interface with the campus controls system: Automated Logic or Johnson Metasys.

7. Controls shall include an external unit stop pushbutton with indicating lights, oil safety switch, high and low pressure switches, water temperature controller, freeze protection thermostats, lock-out timer, compressor lead/lag switch, manual pump down switch and unloaders. The chiller shall also have local chilled water supply and return temperature gauges.
8. Screw chillers shall have independent refrigeration circuits and isolation valves.

9. Compressor drives shall be VFD drives.

10. Chillers shall be located in refrigeration machinery rooms per the Uniform Mechanical Code and a refrigeration monitoring system and evacuation system shall be provided.

236500 –COOLING TOWERS

A. System Design and Performance Requirements

1. Comply with ASCE 7 for seismic supports of equipment (Seismic design requirements for factory assembled cooling towers).

2. Cooling towers to be designed and constructed in accordance with the Cooling Tower Institute and CTI 201.

3. Cooling towers to be either cross flow or counter flow design, 2-cell, induced flow type designed for outdoor use, 304 stainless steel construction with PVC fill and mist eliminators. Low noise axial fan with V-belt drive. Towers systems to include conductivity controller and blow down valve. Where exposed to freezing conditions, cold water basin to have electric basin heaters.

4. Cooling tower basin shall be equipment with a basin cleaning system consisting of PVC piping and nozzles. A filtration system rated for 10% of condenser water system flow shall be provided with a pump that discharges to the basin cleaning system. Flame spread of all materials used shall be 25 or less.

5. The cooling tower, where required, shall have an OSHA-compliant handrail around the top and/or side where access is necessary and a cage ladder to all platforms.

6. Cooling Tower Water Treatment: Provide a chemical treatment system with tanks, pumps, piping and controls. EPA approved dual biocides for microbiological control. The following criteria must be met: 1) Biological control of both bulk water and under deposit bacteria. The program components must be EPA registered as a biocide and be known to be effective against Legionella. Our maximum counts for open systems are 10,000 cells/ml or less for total aerobic; 50 cells/ml or less for anaerobic in the bulk water; and no Legionella. 2) Scale Control - This is normally accomplished with a combination of polymers & phosphonates. The LSI's should be calculated at various cycles and the program limitations identified. The highest skin temperatures are used in this calculation. 3) Corrosion Control - This is normally accomplished with a combination of the water's naturally scaling tendencies (hardness + alkalinity) and then modified as necessary using phosphates, zinc, molybdenum, etc for mild steel. Azoles are used for copper corrosion control. Our acceptable corrosion rates are 1.0 mils/yr or less for mild steel and 02 mils/yr or less for copper. Provide for storage tanks, positive displacement metering pumps and piping for two alternating biocides and two corrosion inhibitors on cooling tower condenser water circuit.
7. Testing: Biweekly testing and written reports by the vendor for a period of one year from building occupancy, at no cost to the University, of condenser water with the following testing and data: conductivity, M alkalinity, pH, iron, copper, chlorides and microbiological counts (anaerobic and aerobic species and identification of species). Also, install steel, copper and galvanized steel (or 304ss) coupons in a 4- position coupon rack. Examine, weigh and replace coupons every ninety days. Also, the vendor must have a plan and demonstrate passivation of the cooling tower surfaces over a 90 day break-in period, if galvanized. At the end of one year of continuous services the vendor shall perform a borescope inspection of the chiller condenser bundle with photographs showing tube surfaces.

8. Corrosion Coupon Racks – All cooling towers shall have a four-position corrosion coupon rack, Betz-Dearborn # 2013971 PVC pipe and furnished with a flow meter, Dwyer Visi-Float VFC-142, 1-10 GPM range.

See Drawing Other Applications:
Drawing # 232100-1  Corrosion Test Coupon Rack
Drawing # 232100-2  Injection Quill Detail

237339 – MAKE UP AIR UNITS

A. System Design and Performance Requirements

Make-up air units shall be indirect gas-fired units with stainless steel heat exchanger. Modulating or staged burners required. UL and Factory Mutual listed. Air filters to meet MERV 8 or better.

237400- AIR HANDLERS

A. System Design and Performance Requirements

1. Roof top air handlers shall be built in accordance with AMCA and ARI standards and shall be factory assembled and tested. The exterior casing shall be 22 gauge steel or better with 2” thick acoustic panels. Unit shall have a C-channel steel base and 14 gauge floor plate. Unit shall have fully gasketed access doors same thickness as walls. Minimum door dimensions are 24” x 72”. Finish shall be epoxy prime coat and acrylic finish. Centrifugal fans shall be steel or aluminum. Minimum bearing life to be AFBMA L-10 200,000 Hours.

2. Hot water and chiller water coils to be rated for 250 psig, 0.20” minimum wall and 5/8 inch tube diameter. Minimum 10 fins per inch copper coils with aluminum fins. Cooling coil racks to be 304 stainless steel. Chilled water coils to have minimum 12 degrees delta T. face velocity not to exceed 500 fpm. Provide compartment in unit for coil valving, accessible from outside the units via access doors.
3. Unit shall have disposable pre-filters, 4 inch thick, meeting MERV 6. Final filters to be MERV 13 or better. Strion electro-static filters shall be evaluated for large units. Provide sound attenuators in unit.

237433 – ROOFTOP AND GROUND MOUNTED PACKAGED HEATING/COOLING UNITS

A. System Design and Performance Requirements

1. Unless specifically approved by the University, all rooftop and ground mounted packaged heating and cooling units shall be supplied with an outside air economizer section to provide free cooling complete with exhaust air to prevent over pressurizing the space. Dampers shall be full modulation with minimum position set to provide 100% or required ventilation air.

2. Heating sections shall be indirect natural gas fired with an electronic ignition system.

3. Cooling sections shall utilize either R-22 or R-410A refrigerant and use hermetic scroll compressors. Low ambient controls including but not limited to crankcase heaters, head pressure controls, low pressure cut-outs and manual reset high pressure cut-outs shall be included. Each refrigerant circuit shall include a thermostatic expansion valve (TXV) with removable power element.

238100 – HVAC EQUIPMENT: SPOT COOLING APPLICATIONS

A. System Design and Performance Requirements

For high density cooling applications, such as computer/server rooms or other sensitive electronic equipment, that requires constant 24/7 cooling: the product allowed is Liebert precision air conditioning systems. For controls, a field supplied 3 or 4 wire connection, (24 VDC) is required between the evaporator and condenser. Control wiring must not allow a voltage drop in the line of more than 1 volt (16 gauge minimum for 75 feet). On a small system, the wall box is connected to the system's microprocessor board using a four wire system. Wiring to be Belden shielded cable, 20-22 AWG up to 1,000 feet. The shield should be grounded at the evaporator unit.

238100 – UNITARY AIR CONDITIONERS

Window or wall mounted air conditioners are not acceptable. Where space cooling is needed and the building primary system cannot be sued, split DX cooling systems with a remote condenser shall be used.
HVAC COMMISSIONING

1. **Hot water, glycol, chilled water, and condenser water piping systems:** work includes installation inspections and checks; pressure tests and documentation; expansion tanks; confirmation of flow balancing completion; seismic restraints installation certification.

2. **Duct and air-handling systems:** work includes installation inspections and checks; confirmation of flow balancing completion; leak testing as applicable; seismic restraints installation certification.

3. **Chillers:** work includes installation inspections and checks; seismic restraints installation certification; checkout and startup by manufacturer’s representative; documented performance measurements including capacity, evaporator and condenser flows, motor amperage, controls operation, and sound levels.

4. **Cooling towers:** work includes installation inspection and checks; seismic restraints installation certification; chemical treatment; checkout and startup by manufacturer’s representative in conjunction with chiller; documented performance measurements including sound, capacity, motor amperage, pan heater operation, sweeper system operation, makeup water, overflow, and capacity controls.

5. **Closed-circuit heat rejecters or Evaporative Condenser:** work includes installation inspection and checks; seismic restraints installation certification; chemical treatment; checkout and startup by manufacturer’s representative in conjunction with chiller; documented performance measurements including sound, capacity, motor amperage, pan heater operation, sweeper system operation, makeup water, overflow, and capacity controls.

6. **Refrigeration compressor/condensing unit:** work includes installation inspection and checks; seismic restraints installation certification; checkout and startup by manufacturer’s representative as specified; documented performance measurements including capacity, evaporator and condenser pressures, motor current draw, and controls operation.

7. **Boilers:** work includes installation inspection and checks; seismic restraints installation certification; boil out and chemical treatment; checkout and startup by manufacturer’s representative as specified; documented performance measurements including combustion efficiency, capacity test, burner and controls operation.

8. **Pumps:** work includes documented checks on alignment, rotation, motor current draw, flows and pressures.

9. **Supply, Return, Relief and Exhaust Fans:** work includes checks on installation; seismic restraints; dampers and other accessories; rotation, sound levels, motor current draw, and airflows and pressures.

10. **Air Handling Units (both packaged and built-up):** work includes installation inspections and checks; seismic restraints installation certification; checkout and startup
11. **Air Terminal Devices:** work includes installation inspection and checks; for VAV units, flow adjustments and calibration coordinated with controls and air balancing; controls operation including flow modulation, reheat, controls responses.

12. **Fan-coil Units:** work includes installation inspections and checks; performance and controls checks.

13. **Water-source Heat Pumps:** work includes installation inspections and checks; documented seismic installation certification; performance and controls checks.

14. **Controls Air Compressor:** work includes installation inspections and checks; documented seismic installation certification; operational checks.

15. **Direct Digital Control System:** work includes inspections and checks of installation and operation of all devices; complete operation of all controls sequences, in coordination with commissioning of all controlled systems.

16. **Variable Frequency Drives/Motor controls:** work includes inspections and checks of installation and operation of all devices; complete operation of all controls sequences, in coordination with commissioning of all controlled systems.

End of Division 23

HEATING, VENTILATING AND AIR CONDITIONING