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BASIC MECHANICAL MATERIALS AND METHODS

General

All mechanical rooms and spaces shall be adequately sized, lighted and arranged so that any and all repair and maintenance that may be necessary can be performed. Controls, mixing boxes, balance dampers, fire dampers, valves, filter banks, heat exchanger coils, pumps, belts, etc., shall be accessible for repair or replacement, and shall not be obstructed by any pipe, conduit, or other obstacle.

All gas appliances, air conditioning units, and HV units shall be de-rated for 7000 foot elevation. Engineer shall request verification of BTU and specific gravity content of supplied gas in order to specify altitude corrections.

All service and supply systems, including, but not limited to, steam, high temperature hot water, natural gas, domestic water, waste, and electrical, shall be sized for peak demand throughout the project and shall be sized as far back as the main meter or central distribution system. The adequacy of any central distribution system to carry all added peak loads shall be determined, and no loads shall be connected to any such system that is determined to be undersized.

The Design Professional shall clearly define the separation of responsibilities of electrical, mechanical, control, plumbing, or any other sub-contractor or sub-consultant involved in the project.

The Design Professional through his subconsultants shall be responsible for coordination of all systems including but not limited to: electrical systems, control systems, heating and cooling systems, plumbing systems, and any other mechanical systems as one included in the building design. This responsibility includes all mechanical subcontractors, Federal, State, and local agencies, and franchised service companies.

All designs, system tie-ins, system components, contractor and sub-contractor qualifications, and work shall comply with the requirements of federal, state, local and Northern Arizona University laws, codes, and standards as referenced in section 01060 of this manual.

The selection of all energy consuming systems and sub-systems shall conform to the requirements of Arizona Revised Statute #34-454, which requires that life cycle costs shall be calculated based on: owning, operating, and maintaining each system. The system with the lowest life-cycle costs shall be selected. Included are such costs as fuel, energy, labor, and replacement components determined on the basis of systematic evaluation and comparison of alternative building systems. The life cycle is the expected life of the system, or fifteen years, whichever is shorter.

The Design Professional shall construct a process and instrumentation diagram drawing depicting all pressure gauges, thermometers and flow meters required for the project. Included on this drawing shall be actual design flows pressures and temperatures for each and every system.

Gauges and thermometers shall be specified for all HVAC equipment.

No underground storage tanks of any type shall be specified without signed prior approval by the Manager of Planning and Design.

One set of "As Built" drawings and one set of O&M manuals shall be provided to the HVAC department.

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Quality Assurance

The selection of products or service companies shall be from those firms whose products or services have proven satisfactory in similar service for not less than three years. Repair or replacement parts, or required service, shall be readily available, and the supplier of products or services shall have a proven track record of response to complaints or problems during, and after, the warranty period.

All parts or products shall be of commercial or industrial quality, and shall be suitable for heavy duty use.

Installers and sub-contractors shall have at least three years experience in installation of similar equipment on similar projects. All sub-contractors shall have a proven track record of response to complaints or problems during and after the warranty period.

References/Regulatory Requirements

All work shall be subject to inspection by the following agencies as appropriate to the stage of construction:

State Fire Marshal's Office
Arizona Corporation Commission (Gas Line Installation)
State Risk Management Division
City of Flagstaff (for utilities installation that cross campus borders)
State Boiler Inspector (Boiler Installations)
NAU Risk Management Office
NAU Capital Assets and Services, Operations/Maintenance Inspectors
NAU Capital Assets and Services, Planning and Development
NAU Office of Regulatory Compliance

All work shall conform to the requirements of all Federal, State and local laws, including but not limited to Codes and Standards referenced in Section 01060 and Section 01065 of this Project Manual.

Design Parameters

The Design Professional shall evaluate the potential for overheating of building spaces. Particular attention shall be paid to areas which house computer or other electronic equipment. Evaluator shall consider all factors including but not limited to equipment, passive solar gain, and occupant loads. Where such potential exists, the value and cost effectiveness of cooling shall be analyzed.

Any ventilated space which houses water piping, vessels, or equipment, such as equipment rooms, shall be heated to a minimum of 40° F. When equipment rooms must be ventilated to provide boiler combustion air, the heat source shall be independent of the boiler.

All equipment, as appropriate, shall be derated for operation at 7,000 feet altitude. Derating of gas appliances and equipment shall be for the specific gravity and BTU as supplied by NAU. Other equipment requiring derating includes, but is not limited to, transformers, motors, fans and blowers, ducts, controls, atmospheric heat exchangers, and motor speed controls.

The use of any electrical source heating equipment, including heat pumps, heat tape, baseboard heat, and electric domestic hot water heaters, shall not be considered unless a minimum of 20 year life cycle

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cost analysis of all alternatives is performed. Electrical source heating equipment shall not be specified unless it is proven to be the most cost effective for the 20 year life cycle. The determination of energy costs must include both kwh and demand charges.

The Design Professional shall familiarize himself with special altitude and climatic conditions experienced in Flagstaff, and adapt his designs and specifications to suit.

Performance specifications shall not be used in lieu of designed systems unless specifically authorized by the Capital Assets Manager of Planning and Design or assigned Project Manager on an item-by-item basis.

Submittals

NOTE: Sequence of control diagrams shall be required to be submitted within 21 days of notice to proceed.

Provide Shop Drawings and product data prior to start of construction as applicable for the following:

Equipment room layouts, drawn to scale, showing all equipment, piping and accessories and clearances for operation and servicing.

All HVAC equipment including boilers, heat exchangers, pumps, tanks, valves, hangers, air handlers, filters, louvers and dampers, relief valves, strainers, traps and drip legs, etc.

All terminal equipment including volume control boxes, registers, grills, diffusers, etc.

Design curves and characteristics of fans, blowers and pumps.

Control diagrams and sequence of operations for all HVAC equipment.

HVAC and motor control wiring or pneumatic diagrams.

Plumbing fixture cuts, trim and fittings, rough-in dimensions and special supports.

Plumbing fixtures, equipment and specialties.

Piping materials, fittings, specialties.

Expansion loops, joints, guides, and anchors.

Foundations, supports, hangers and inserts.

Drains (roof/floor) carriers, cleanouts, downspout nozzles.

Insulation materials and finishes, duct and piping.

Mechanical identification.

Converters with saddles and relief valves.

Gauges and thermometers.

Flow fittings.

Utility sets with vibration isolation.

Dampers - back draft, volume, smoke, fire, combination smoke/fire.

Temperature control equipment, schematics and diagrams.

Panel boards, gauges and thermometers.

Fire protection system - hydraulic calcs.

Fire protection equipment and specialties (wet, dry and halon).

Wiring diagrams and motor control equipment. (Wiring diagrams must be project specific; manufacturer's standard diagrams will not be accepted).

Pressure testing procedure

All close-out submittals shall be indexed to the specifications, separated by dividers and bound in three ring binders.

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	Provide product extras as applicable from the following: Desktop computer, programming devices or applicable software Thermometers, each type. Two sets keys/wrenches for any covers. Spare belts for all fans. Spare thermostats. Chemical test kits as appropriate. One set of filters installed just prior to final balancing. One extra set of filters. One set of any proprietary trouble shooting or maintenance tools. Two copies any proprietary computer software for systems control, program back-up, troubleshooting or maintenance. 1 - 3 day start-up training as applicable (coordinated with Capital Assets & Services.) To be videotaped by the University. Valve tag index mounted under rigid clear protection in the mechanical room(s) and diagram submitted with the O & M manuals. Hard copies of all control codes and sequence of operations. Specialty tools specific to system operations Provide Manufacturer's certificates or test results for the following: Air balance reports. Heat exchangers. Boilers and chillers Chemical treatment products, application limits, test methods, and apparatus. Glycol mixing formula. Backflow preventers (per R18-4-232). Potable water system purification. Hydrostatic test on sprinkler system. Hydronics balancing. Field test make up air units and fans. Final inspection from Mechanical Engineer. Provide O & M manuals for the following: All HVAC equipment, indexed, referenced to the spec and bound in three ring binders to the HVAC shop. Three sets of all documents will be provided; 2 copies to the archives and 1 copy to the HVAC and Plumbing shop. Equipment directory, name plate data all units. Local supplier directory. Complete list of all motors indicating locations, horsepower, voltage, phase, and amperage draw of each motor. Provide written Warranty Certificates for the following: Entire scope of HVAC work - 2 years minimum. Any system or piece of equipment with a warranty which extends past two years.

*** END OF SECTION ***

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15060	<p>Pipes and Pipe Fittings</p> <p>All glycol charged piping systems shall be isolated from City water make-up using back flow device(s). Provide a mixing tank and pressurization pump for the addition of glycol mix to the system.</p> <p>Under no circumstances shall hazardous materials including, but not limited to, cement asbestos pipe, be used.</p> <p>All site piping fabrication, alteration and installation shall be conducted in a manner which complies with any environmental and OSHA requirements.</p> <p>Victaulic piping shall not be used in HVAC piping systems without prior approval of NAU Design Review (O&M Staff) Team</p>
15070	<p>Drains</p> <p>All drains, reliefs, and fire system test drains shall be piped to floor drains properly located by the Professional Consultant.</p> <p>All floor drains serving fire sprinkler systems shall be sufficient to accept full test flow.</p>
15100	<p>Valves</p> <p>The Design Professional shall specify supply valves of domestic quality i.e., Milwaukee Manufacturing or approved equivalent. All valves to be ball valves.</p> <p>Steam valves and steam pressure regulators shall be as manufactured by Fisher (TYPE 92B). Valves shall be carbon steel, forged or stainless steel ¼ turn ball valves, up to and including 2” pipe size. Valves for steam and condensate above 2” pipe size shall be high performance butterfly. Provide and secure brass identification tags to all valves. Incorporate in valve tag index.</p> <p>Install all valves for easy access generally without use of ladders.</p> <p>Heating valves shall fail to heat (normally open). Domestic steam valves shall fail closed.</p> <p>Unions shall be installed on the downstream side of all valves for access and repair of systems.</p> <p>All valves shall be accessible for repair and maintenance, generally without the necessity of using a ladder.</p>
15120	<p>Piping Specialties</p> <p>Dielectric materials must be used to eliminate dissimilar metal contact pipe to pipe, pipe to hanger, pipe to fittings, etc.</p> <p>Flange gaskets for steam, condensate, or HTHW service shall be spiral wound metallic, similar to Flexitallic.</p>

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15130	<p>Gauges</p> <p>Pressure gauges shall normally read at 60% of total gauge pressure capability. Pressure gauges shall be required on all inlet and outlet lines of the following:</p> <ul style="list-style-type: none">BoilersConvertersPumpsPneumatic ControlsMain steam supply lineStatic pressure gauges on all static controlled fans <p>Thermometers shall be provided on all of the following:</p> <ul style="list-style-type: none">Air Handlers (mixed air, hot deck, cold deck)BoilersConvertersCooling equipment, chillersHeat recovery systems
15140	<p>Supports and Anchors</p> <p>Drawings shall be detailed to show location and method of support for pipe anchors, thrust blocks, guides, expansion compensators, arresters, etc. Details shall be such that the contractor has no question of how the work is to be accomplished.</p>
15150	<p>Meters</p> <p>Specify totalizing meters for all steam, High Temperature Hot Water, chilled water, domestic water, electric power, (including demand) and gas systems to the facility.</p> <p>All specified gas meters shall be temperature and pressure compensating</p> <p>Design Professional shall specify sewage flow meters.</p>
15160	<p>Pumps</p> <p>All pump motors located remote from the master control center shall have a local disconnect that may be locked out.</p> <p>Dual system back-up pumps shall be specified in the base bid and installed on all new building and water heating and cooling systems. All heating, cooling, and domestic hot water circulation pumps shall have back-up. Automatic switch over in case of failure is to be required on heating water pumps.</p> <p>Provide housekeeping pads for all base mounted pumps. After completion of alignment and testing grout pumps to pads with non-shrink grout.</p>

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	Ball isolation valves shall be installed so that the pump can be isolated for repair. No butterfly valves shall be used on pipe under 4" in size.
15170	Motors All motors shall be high efficiency and sizing shall be compensated for altitude. (7,000 ft) All motor drives shall be ABB or approved equivalent.
15190	Mechanical Identification Provide and secure brass identification tags to all valves feeding mechanical equipment. Incorporate in valve tag index. Identify all piping within equipment rooms.
15240	Mechanical Sound, Vibration Isolation All rotating machinery is required to have vibration isolation at the following locations: Machinery to floor, machinery to ducts, and machinery to pipe connections.. The exception to this will occur where machinery is rigidly fastened to a concrete housekeeping pad. In this case the machine shall be grouted to the pad with non-shrink grout.
15250	MECHANICAL INSULATION
15260	Piping Insulation Insulate all elbows, valves, expansion joints, etc. All pipe insulation shall meet the following specifications: 2" and smaller -- 1" thick fiberglass 2-1/2" - 7" -- 1-1/2" thick fiberglass 8" and larger -- 2" thick fiberglass
15290	Ductwork Insulation Design Professional shall specify insulation all ductwork running through non-conditioned areas.

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15400 PLUMBING

All cleanouts, meters, controllers, valves, etc. in any green belt area must be installed in boxes with removable lids. All boxes shall be flush to surface at grade.

Backflow preventers and testing by certified authority per R18-4-232. Preventer shall be installed as close as practicable to the service connection.

Domestic water systems shall be zoned with shut-off capability for stacked rooms.

Provide isolation valves for each floor and for every bathroom. **All isolation valves shall be ball valves.**

15410 Plumbing Piping

Domestic water lines shall be a minimum of Type L copper. Waste and vent piping shall be cast iron.

Plumbing lines shall not be located in outside walls, unheated attics, basements, or other unconditioned areas without specific written approval from Capital Assets and Services.

15430 Roof and Floor Drains

Roof drains shall be provided with heat tape for use during the winter. Complete provision shall be designed into the system for removal of the water from the site, not just the roof.

Floor drains and sinks shall be precisely located on drawings. The location shall be such as to minimize length of drain pipes laying on the floor.

All floor drains shall be supplied with trap primers.

15440 Plumbing Fixtures

All fixtures shall be ADA compliant per the requirements of Division 1 of the Specifications.

Plumbing fixtures shall be **low flow** meeting the standards identified in Arizona State Governor's Executive Order 91-3. Toilets: 1.6 gallons per flush, urinals: one gallon per flush, lavatory faucets: spring loaded for auto-closing or self-closing after .25 gallons, Kitchen faucets: 2.5 gallons per minute, showerheads: 2.5 gallons per minute. Shower heads shall be Chatham model 10-2S; #2120 MN as manufactured by Niagra Products (1-800-831-8383); "Osage Showerhead" as manufactured by Whole Energy and Hardware (1-800-544-2986); or equal. Showerheads shall tamper resistant.

The DP shall specify plumbing fixtures as manufactured by the following (or approved equal): American Standard, Chicago, Elger.

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No substitutions shall be allowed for the following valves, as the NAU plumbing shop has standardized the campus in order to stock the required parts:

Flush valves: Sloan

Shower / Laboratory / Kitchen: Delta, single handle, ADA compliant, pressure & temperature balanced.

Custodial and Laboratory: Chicago, with vacuum breaker.

Handicapped shower units shall require pressure and temperature balancing type single-handed shower valve assembly with screwdriver stops, wand type shower head on flexible hose attached to arm on shower walls. Internal grab bars and seat shall be included in the assembly.

Prefabricated fiberglass shower enclosures shall be utilized which have full height walls, grout backed shower floors, and integral braces for rigidity.

Custodian closets are to be provided with floor service sinks. If fire sprinkler system test valves drain into these, they must accept the full flow of the test.

15450	Plumbing Equipment
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Water Softeners

Softener tanks and systems shall be specified to be fabricated with fiberglass, PVC, steel or similarly durable lining guaranteed for a minimum of five years service.

Water softeners shall be Water King Water Softeners.

Water softener control valves shall be equipped with "service" and "regeneration" lights.

Resin used: R.B.C., Purolite C100X10, Rohm & Haas I.R. 122/IR-132 Dow Hor/Hgr-W2, Ionac C-250/C299, Durolite C20 x 10 C255 X !.

Design Professional shall specify a mineral loss guarantee of a minimum of three years.

15460	Chemical Treatment - Pot Feed
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Chemical treatment pot feed shall be provided on all closed loop systems.

All water treatment chemicals shall be approved; no hazardous materials shall be used.

15480	Gas Piping
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Professional Consultant shall cross reference gas piping requirements within this section with those in section 02685 and the NAU Gas Distribution Line Instructional Guidelines.

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15500

HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

Distribution Systems

The University has steam or High Temperature Hot Water (HTHW) available in tunnels or direct burial in most areas of campus. Natural gas is also widely available. Electric power is available at 12470 volts. HVAC designs shall utilize these utilities. Any design not utilizing steam or HTHW must be justified using 15 year life cycle cost methods. All projects must utilize the 12,470 volt electrical system unless specifically authorized by FD to connect to the 2300 volt system.

Isolation valves and unions shall be supplied for all HVAC equipment.

HVAC Design Delta T shall be -20 to +90.

All air handling fans and blowers shall be operated at less than maximum RPM's to deliver design air pressures, flows and velocities, to minimize vibration and noise problems and to allow for air balancing without fan or blower over-speed. All fans, motors, blowers and their attachments must be derated for altitude.

All air handling units with outside air shall be equipped with freeze stats with manual reset, outside air dampers and low-limit controls. All heating water valves shall fail to heating position.

15510 Hydronic Piping

Dielectric materials must be used to eliminate dissimilar metal contact pipe to pipe, pipe to hanger, pipe to fittings, etc.

Flange gaskets for steam, condensate, or HTHW service shall be spiral wound metallic, similar to Flexitallic.

Glycol charged piping systems shall not receive make-up from city water. Provide a mixing tank and pressurization pump for make-up supplies. Victaulic piping shall not be used in HVAC piping.

15520 Steam and Steam Condensate Piping

All steam and condensate piping shall have adequate expansion joints or loops and such joints or loops shall compensate for expansion of the supply piping that it is connected to.

Drip legs shall be installed sufficient to ensure dry steam supplies, and to prevent water hammer.

Steam pressure may not be used to raise condensate through any heat exchanger, or in any area where steam hammer noise will be objectionable.

The use of thermostatic or orifice type traps is discouraged.

All condensate piping shall be schedule 80 black iron.

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	<p>Brass, copper and bronze fittings and/or valves shall not be permitted. Valves 2” and smaller shall be carbon steel, quarter turn ball valves. Valves larger than 2” shall be high performance butterfly, bubble tight shutoff, and bi-directional if the piping can or will be pressurized from two directions.</p> <p>Flange gaskets shall be spiral wound, Flexitallic or equivalent.</p>
15530	<p>Refrigerant Piping</p> <p>All refrigerant piping shall comply with manufacturers recommendations concerning size, rise, insulation, etc. to ensure that oil migration does not occur. Refrigeration isolation valves shall be included at each refrigerant section ie. compressor, condenser, evaporator; so that the charge does not have to be removed for repair and maintenance.</p>
15540	<p>HVAC Pumps</p> <p>All heating hot water and domestic hot water circulating pumps shall have back-up, and shall have automatic change-over on HHW pumps, and shall be specified for other pumps. All critical area chilled water pumps shall be similarly backed-up, and provided with automatic change over.</p> <p>All pumps will be selected for minimum maintenance, such as in-line circulators where appropriate. All coupled pumps shall be aligned after installation, and alignment documentation shall be provided.</p> <p>All pumps shall have in-line strainers installed.</p> <p>All pumps shall automatically restart after a power outage.</p> <p>All HVAC equipment shall be connected to a Hand/Off/Auto starter, no momentary starters shall be used.</p> <p>All pumps shall be Bell & Gossett</p> <p>All pump motors located remote from the master control center shall have a local disconnect that may be locked out.</p> <p>Dual system back-up pumps shall be specified in the base bid and installed on all new building and water heating and cooling systems. All heating, cooling, and domestic hot water circulation pumps shall have back-up. Automatic switch over in case of failure is to be required on heating water pumps.</p> <p>Provide housekeeping pads for all base mounted pumps. After completion of alignment and testing grout pumps to pads with non-shrink grout.</p> <p>Ball isolation valves shall be installed so that the pump can be isolated for repair. No butterfly valves shall be used on pipe under 4” in size. All motors shall be high efficiency and sizing shall be compensated for altitude.</p>

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HEAT GENERATION

Mechanical rooms, computer rooms, and other areas in which heat can build up shall be ventilated. Mechanical rooms with fresh air in-take shall have a heater installed in them independent of the boilers so as to prevent freezing.

15555

Boilers

All boilers shall be commercial/industrial quality. Boiler manufacturer requires prior approval by NAU Capital Assets and Services Gas/HVAC department. Submit proposed manufacturers before finalizing specifications. All boiler installations shall allow for a three foot clear working area around all sides of the boiler, including the top.

Boilers shall be modified as necessary for operation at 7000 ft. elevation. Boiler/burner shall be stamped for design performance at 7000 ft. elevation.

15570

Boiler Accessories

All safeties shall be non-lockout, unless codes require otherwise.

15580

Feedwater Equipment

15620

Fuel Fired Heaters

15630

Solar Energy Devices

Solar energy options shall be considered on all facilities. Justification shall be provided if solar options are not specified in the final design on structures comprising over 6000 s.f.

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REFRIGERATION

Mechanical air conditioning systems shall be utilized *only* when specifically authorized by NAU in writing. Life cycle costing shall be utilized to determine the most appropriate type.

Summertime cooling systems shall have economizer cycles with 100% outside air capability. Enthalpy controls shall be provided on all systems that run continuously. Indirect evaporative cooling shall be considered as an additional capacity system.

When A/C systems are proposed to run year round for critical areas, refrigerant receivers and suction line accumulators shall be used. All "critical area" A/C systems shall be redundant or a parts inventory shall be included in close-out submittal requirements to cover emergency repairs. This inventory shall include any and all controls motors or equipment required to make the system operational in an emergency.

Crank case heaters shall be installed on all compressors.

All outdoor compressor units shall be located under permanent covers.

Provide all necessary valves and equipment to permit freon recovery/recycle.

15670 Condensing Units

All air cooled condensers shall have low ambient temperature controls, and head pressure sensing or equivalent controls. Variable speed for the primary condenser fan is preferred.

15680 Water Chillers

Air Conditioning/Chillers

The selection of the type of air conditioning to be used shall be based on a 15-year life cycle cost analysis of all viable alternatives. This analysis shall include all expenses including equipment purchase and anticipated replacement costs, maintenance, refrigerant handling, replacement, and disposal costs, and anticipated costs of energy. Where applicable, the efficiency of equipment shall be calculated, and used in the life cycle cost analysis, for all expected load ranges. Electrical rates used in life cycle cost analysis shall be actual demand and consumption costs, not "average" costs.

All central air conditioning systems shall have air-side economizers with enthalpy controls. Wet side economizers shall be evaluated using life cycle cost analysis.

The suitability of using evaporative cooling, whether alone or in addition to a mechanical or indirect evaporative system, shall be evaluated. For wet wall installations, face and bypass dampers must be used for temperature control. Wet wall pump cycling shall not be an option for temperature control. Bypass dampers shall be sized to allow full air flow around the wet wall.

Whenever practical, as determined by a life cycle cost analysis, the central chilled water system shall be used as the source of chilled water. If central chilled water is used, the design shall conform to the delta T and delta P requirements of that system. **Only 2 way valves shall be used in systems utilizing central**

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	<p>chilled water. This system utilizes variable speed pumping to maintain 15# differential pressure in the distribution piping. Building distribution and terminal equipment shall be designed to utilize this differential pressure for building flow without the addition of booster pumps. Building and equipment design delta T shall be 14 degrees F. at a supply temperature of < 42° F. during the summer cooling months.</p>
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Towers used for water cooled condensing or for indirect evaporative cooling shall be protected from freeze damage. Whenever condenser water is pumped through a coil located in a tower, redundant pumping with automatic start of the alternate pump is required. These systems shall be remotely alarmed upon loss of flow through the coil. It is preferred that sumps drain to storage rather than to waste for freeze protection.

All systems shall be equipped with chemical feed systems as specified by the University's chemical treatment consultant. Tower sump and evaporative cooling sumps shall have TDS controlled blowdown; continuous blowdown is not acceptable.

15710	Cooling Towers
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Towers used for water cooled condensing or for indirect evaporative cooling shall be protected from freeze damage. Whenever condenser water is pumped through a coil located in a tower redundant pumping with automatic start of the alternate pump is required. These systems shall be remotely alarmed upon loss of flow through the coil. It is preferred that sumps drain to storage rather than to waste for freeze protection.

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15750	HEAT TRANSFER
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Isolation valves and unions shall be required on all heating units. **All Isolation valves shall be ball valves.**

15755	HEAT EXCHANGERS
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Heating coils to temper outside air shall be glycol systems, and shall be closed loop, with no City make-up water connection. A mixing tank and pressurization pump shall be provided.

Glycol inside of a building to be a 40/60 mix

Glycol outside of a building to be a 50/50 mix

All glycol used on the university shall be propylene glycol

Back-up for heating and domestic hot water exchangers shall be specified.

All heat exchangers shall be provided with isolation valves and unions for maintenance purposes.

All heat exchangers used for space heating purposes shall have controls that fail to the heating mode.

All heating coils that may be exposed to outside air shall be protected by a low temperature control, located downstream of the coil, which will open the supply valve upon failure to maintain the minimum temperature set point. Further, any fan or blower that moves air across such a coil shall shut down upon failure to maintain a minimum temperature, which should have a lower set point than the supply coil low limit. Outside air dampers shall be closed and a hot water valve shall be opened.

15780	Packaged Air Conditioners
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15845	Energy Recovery Units
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Heat recovery shall be specified on all major exhaust systems.

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15850	AIR HANDLING
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All air handling fans and blowers shall be operated at less than the maximum revolution per minute to deliver design air pressures, lows, and velocities, to minimize vibration and noise problems, and to allow for air balancing without fan or blower over-speed. All fans, motors, blowers, and their attachments must be derated for NAU's 7,000 ft elevation.

The contractor shall notify DP in writing along with shop drawing submittals, potential for, or deviation from, design intent.

Ventilation standards shall be a minimum of 20 cubic feet per minute per occupant.

Only low pressure, low velocity (2000 FPM max, 2" WG max) air distribution shall be installed. Noise level volumes of air movement and equipment shall be designed and installed as compatible for intended functions within building spaces. The Design Professional will be held responsible for maintaining acceptable sound levels in all systems.

15855	Air Handling Units with Coils
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All air handling units with outside air shall be equipped with freeze stats with manual reset, outside air dampers and low-limit controls. All heating water valves shall fail to heating position. All outside air dampers shall fail closed.

15860	Centrifugal Fans
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In-line fans/blowers shall have adequate access panels for service and maintenance. Grease fittings shall be extended for easy access without the need for equipment shutdown.

15870	Power Ventilators
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Toilets, shower rooms, laundries, and kitchens shall be individually power exhausted and not tied into any other building exhaust or ventilating systems. Heat recovery shall be specified.

15880	Fume Hoods
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General

Utilize one fan of the industrial unitary type (preassembled package unit) for each fume hood. Manifold systems can be considered as an option for high density lab fume hood applications. Prior approval for design required. Energy recovery will be required when manifold systems are installed.

Fume hood fan and motor sheaves will be the continuously adjustable type.

Fume hoods will be provided with air flow indicators of the pilot tube-type and alarmed.

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The users and maintenance staff should know when a chemical fume hood is not functioning. Remote alarms, where specified, shall be through a dry contact and wired to the nearest mechanical space and terminated on a terminal block for future connection to an enunciation panel.

A pre-heat mechanism shall be incorporated into the HVAC system design where 100% outside air is utilized.

The system should be energy efficient within the design criteria.

Fume hoods with built-in exhaust fans are not allowed. When relocating or remodeling fan enclosed fume hoods, they must be removed and replaced.

All exhaust fans and fume hood fans will be arranged in a cluster fashion and enclosed within an appropriate structure on the roof of the building. The structure will be furnished with supply air and will be vibration isolated from the main building structure by appropriate methods.

Testing for air flow and noise levels will be completed by an independent testing contractor/consultant under separate contract with the University. Copies of any test from the manufacturer and the air flow and noise level tests will be supplied to the University.

Acoustics

Maximum allowable noise within laboratories shall be:

- o For hood operating with a sash face velocity greater than 100 feet per minute, excluding perchloric hoods: a maximum decibel level of 72 dba.
- o For perchoric hoods: decibel levels which are within the standards for the industry with the two following considerations:
 - An appropriately specified and adequately designed fume hood system.
 - An installation by the general contractor per the direction delineated in the contract documents.

Fume hoods, excluding perchloric hoods, will be tested in accordance with the ASHRAE 110 test at the manufacturing facility and in accordance with the most recent SAMA test after the building HVAC system is balanced.

Testing for air flow and noise levels will be completed by an independent testing contractor/consultant under a separate contract with the University. Copies of the tests from the manufacturer and for the air flow and noise levels will be supplied to the University.

Flow Rates

Fume hood fans will be selected for the specified velocity with the sash in a fully open position.

Fume hood systems will be selected for the specified velocity of 100 feet per minute with the sash in a fully open position, with the exception for hoods requiring a greater face velocity. For hoods requiring a greater face velocity, fume hood systems will also be selected to provide the required face velocity with the sash in the fully open position.

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For research buildings with multiple laboratory levels, the following criteria will be utilized to provide for additional supply and exhaust air capacity for the addition of fume hoods in the future:

"Supply and exhaust air capacity will be provided for the addition of future fume hoods within the new building, equal to the quantity of supply and exhaust air provided to the building level containing the most fume hoods."

The laboratories will have a minimum of 8 air changes per hour; air shall be 100% exhausted.

Auxiliary air for fume hoods is limited to a maximum of 70% of the required fume hood flow rate.

A minimum duct velocity of 1600 feet per minute will be provided through ductwork up to the exhaust fan for hoods requiring a face velocity of 100 feet per minute.

The exit velocity from ductwork located on the building roof will be a minimum of 3,500 feet per minute directed straight up from exhaust duct. The minimum exhaust duct height shall meet the most recent OSHA criteria or 7 feet, whichever is most stringent.

Ductwork

Fume hood ductwork will be constructed of:

- o Spiral duct, with flanged connections.
- o 26 gauge, stainless steel, type 316
- o Joints will be constructed with a process equal to the Thermofit Wrap-around Duct Bands manufactured by Raychem.

90° bends and offsets in ductwork will be kept to an absolute minimum. When they are required, they will be designed with long radius sweeps to avoid turbulence in the duct.

Fume hood exhaust systems are to be designed without any inside surface protrusions especially at joint connections that can catch condensation of fume hood vapors. University approved connections are available upon request. Crimped couplings are not acceptable.

15890	Ductwork Accessories
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Filters shall be 2" thick, pleated, 300 FPM maximum velocity, mean efficiency of 36% according to ASHRAE 52-68.

The Design Professional will call out in the specification and show locations on the drawings for all dampers, fire dampers, extractors and other controls.

*** * * END OF SECTION * * ***

DIVISION 15 – MECHANICAL & PLUMBING

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15950 CONTROLS

All controls shall be specified to be industrial/commercial grade.

Indoor space temperatures shall be maintained at a maximum of 72° F. in a heating mode, as measured 4' above the floor and 2' from the exterior wall shielded from the sun and artificial heat sources.

Indoor space temperatures shall be maintained at a minimum of 78° F. in a cooling mode as measured 4' above the floor and 2' from any exterior walls.

15955 Building Systems Control

Heating systems shall be zoned to differentiate between north, south, east and west exposures, internal areas, locations of large glass areas with independent controls for each zone, and shall include outside air and zone temperature reset, and solar gain compensation

DDC

All DDC controls shall be native BAC net. The preferred control is Alerton. Controls contractor to provide one work station with computer, hard drive, keyboard, monitor, and mouse in a locked cabinet.

System requirements are listed below:

Processor:	2 GHZ Intel Pentium
Memory:	512 MB SDRAM Memory
Cache:	512 KB
Hard Drive:	80 GB UDMA
Removable Disk:	1.44 MB 3.5" Floppy Drive
Video Card:	8 Meg AGP Video Card
CD_ROM Drive:	CDRW 52x32x52x Max. Variable
Operating System:	Microsoft Windows XP Professional
Keyboard/Mouse:	Quite-Key Keyboard/Microsoft Intellimouse (PS2/2v)
Monitor:	17" SVGA, Minimum LCD Flat Screen Monitor
Modem:	56K Modem

There will be temperature sensors for outside air, return air, mixed air on each air handler or variable box. The building shall be hooked to a front end computer provided by NAU in the HVAC department.

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Contractor shall be required to furnish all applicable software and graphics necessary to maintain the system.

A back-up software controls program for the building shall be provided by the controls contractor to the HVAC department. The controls contractor shall provide service or warranty work within 24 hours of notification by NAU, excluding weekends and holidays.

15960	Energy Management and Conservation Systems
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Systems shall be instrumented sufficiently so that the energy efficient operation can be trend monitored (i.e., magnahelic differential pressure gauges across the filters, across the barometric dampers, etc. and temperature transmitters).

The systems shall be designed to provide the maximum energy conservation evaluated on a five-year payback basis.

The system shall be user programmable.

15970	Control Systems
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Factory set (pre-programmed) modules shall not be acceptable. Proportional authority percentage (re-set) shall be field adjustable.

Sequence of operations and control diagrams and shop drawings require sign off approval by Capital Assets and Services HVAC department.

Pneumatic Control Systems

All control panels, consoles, etc., shall have a minimum of 3' clearance to the front.

Gauges shall be installed on all controller inlet and outlet ports.

Control air tubing shall be copper when located in close proximity to any heat source. Plastic tubing shall be laid in troughs or installed in conduit. Unsupported tubing shall not be installed.

When plant air is used, a back-up air compressor must be installed.

All pneumatic systems shall have an air dryer installed on the main air supply and shall be equipped with an in-line outlet oil filter.

Sequence of operations and control diagrams and shop drawings require sign-off approval by Capital Assets and Services HVAC Department.

* * * END OF SECTION * * *

DIVISION 15 – MECHANICAL & PLUMBING

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15990

TESTING, ADJUSTING AND BALANCING

The air distribution system shall be tested and balanced by an independent firm licensed, bonded and certified to perform such work in the state of Arizona.

The firm's services shall be paid for and the firm shall be selected by the OWNER. Under no circumstances shall the balance contractor be a sub-contractor to the General Contractor or to the Mechanical Contractor.

The air flows shall be set within 3% of the design requirements. The Design Professional shall specify all the necessary dampers, extractors, controls and sheaves required to meet these balance conditions. **The final air balance will be conducted after all systems are in place and operational and have been accepted.**

Final balance report shall include copies of pump and fan curves.

All systems start-up, testing, balancing, Final Operations & Maintenance Manuals and training shall be completed on or before, and is a requirement of, final completion.

15991 Equipment Testing, Adjusting & Balancing

Equipment shall be adjusted so that indoor ambient conditions to be maintained during the winter are 72° F. minimum measured 4' above the floor and 2' from the exterior wall shielded from sun and artificial heat sources. Indoor ambient conditions to be maintained during the summer are 78° F. maximum measured 4' above the floor and 2' from the exterior wall shielded from sun and artificial heat sources.

15992 Piping Systems Testing, Adjusting & Balancing

Each system (steam, water, condensate) shall be flushed, checked for leaks, corrosion inhibitors added where applicable, disinfected for domestic water and otherwise made ready for acceptance. Notice of such tests will be given to Capital Assets and Services and Coconino County Health Department.

Design Professional shall specify testing on all backflow preventers. Testing shall be performed by a certified tester and results shall be submitted in writing to Capital Assets and Services.

Domestic water supply systems shall be charged with a sterilization solution conforming to Federal Specification 0-8-441, Grade D (chlorine).

Solution shall remain in system (8) Hours. System shall then be flushed and test results provided to the PM or CM.

All pressure tests shall be performed using a certified gauge which has been approved for use by the HVAC Manager.

Pressure testing needs to be conducted on the new system only. The new system needs to be isolated from the existing system during the pressure testing.

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	Pressure testing procedure is to test the new system at 1.5 times the operating pressure for a period of two hours. A testing procedure needs to be submitted to the HVAC Manager and approved prior to any testing.
15993	<p>Air Systems Testing, Adjusting & Balancing</p> <p>The Design Professional shall ensure that final mechanical system noise levels are compatible with intended functions within the building spaces.</p> <p>All air distribution systems shall be balanced in the heating mode.</p> <p>The testing agency shall provide verification that systems operate at 50% to 75% of capacity as designed.</p> <p>Two copies of the air system testing, adjustment, and balancing report shall be provided to NAU one copy to the HVAC department and one to be archived.</p>
15994	<p>Demonstration</p> <p>Maintenance training sessions shall be required to be provided on all systems. All sessions shall be scheduled through Capital Assets and Services. Sessions shall be videotaped by the University.</p> <p>All required close-out diagrams, sequence of operations and O/M manuals shall be on-site and available at the time of the scheduled training sessions.</p> <p>All training shall be completed in such a manner so as to assure proper end-user competency.</p> <p>Training shall include both on-site, in-building efforts and remote site training at Control Contractor's facility.</p>

*** * * END OF SECTION * * ***