1. This information provides guidelines for the design and construction of mechanical systems. These systems include heating, ventilating and air conditioning (HVAC), plumbing, steam, compressed air, natural gas distribution, and other mechanical systems.

2. Civil site utilities (water, sanitary, storm, irrigation) are covered in other parts of these standards or are available from the Facilities Management (FM) project representative. Design and construction shall comply with the City of Bellingham Development Guidelines and Improvement Standards Manual available at http://www.cob.org/cob/dgi.nsf.

3. The FM project representative will inform FM and other campus departments or groups affected by the work.

4. Variance from these guidelines requires approval from the FM project representative, FM, Public Safety Office, and Environmental Health and Safety Office.

5. Provide means and methods that ensure minimal disruption to adjacent building activities and operations and protect occupants from exposure to noise, dust, traffic, and other hazards.

6. Definitions:
   a. High pressure steam: Above 35 psig.
   b. High temperature water: Greater than 180°F.
   c. Hydronic: Prohibit the use of "hydronic" to describe mechanical piping systems. Instead use specific medium terminology such as "heating water," "chilled water," "steam," etc.
   d. Low pressure steam: 15 psig and below.
   e. Medium pressure steam: 16 psig to 35 psig.
   f. Readily accessible: Capable of being identified and reached quickly and safely for standard operation, repair, and inspection by one individual without requiring climbing, moving obstacles, dismantling, or using specialized equipment. A ladder and a lift are not considered specialized equipment.
   g. Reliable: Designed for an anticipated 30 to 40 year life span before requiring major repairs or replacements.
   h. Serviceable: Designed to provide manufacturer's recommended clearances for maintenance. Easy to maintain.
   i. Simple: Having few parts; not complex or complicated or involved; requiring minimal maintenance; readily understood or performed; easy to operate.
   j. Sustainable: "Sustainable design and construction or 'green building' is a holistic approach that minimizes environmental impact, reduces maintenance, and creates a more desirable workspace for the occupants." See http://www.ga.wa.gov/EAS/green/index.html.

7. Mechanical systems shall be simple, reliable, serviceable, and easy to operate and maintain while providing a comfortable environment for building occupants with minimum energy consumption.

8. Remodel projects affecting existing building mechanical systems shall be designed to allow full occupancy during construction without major building system shutdowns.

9. Require all abandoned mechanical systems be removed where feasible.

10. Whenever equipment is removed, demolish associated branch mechanical systems back to the main, and cap whenever feasible. Concealed or inaccessible services may be capped and abandoned in place.
11. Consider future flexibility and expansion in the design of major mechanical systems and infrastructure in coordination with the FM project representative.
   a. Provide space in the mechanical room for future equipment, e.g. chiller, air handler, pump, etc.
   b. Specify equipment to operate efficiently at partial load conditions.
   c. Size main duct and main piping runs, within control parameters, to accommodate future space usage modifications.
   d. Consider cross connection of chilled water systems between buildings through the campus tunnel system.
   e. Size variable air system fans to accommodate 100% of the connected capacity as well as the design load (with diversity).

12. Mechanical equipment:
   a. All mechanical equipment and components requiring periodic maintenance must be readily accessible.
   b. Require all equipment and materials to be new, the latest model, and of the best quality.
   c. Require all equipment and material to be installed in a good, workmanlike manner per manufacturer's recommendations or published instructions and following the best practices of the trade.
   d. Require a complete mechanical installation connecting to all equipment, including owner furnished equipment and materials.
   e. Per project require a single-source supplier and manufacturer for equipment and products to allow for ease of standardization, familiarity and maintenance. For remodels, match existing equipment and materials.
   f. Obtain approval from the FM project representative and Western Contract Administration for proprietary equipment selection.
   g. Require a proven local supplier for replacement parts and technical assistance.
   h. Locate mechanical equipment in mechanical rooms or conditioned penthouses. Avoid rooftop equipment.
   i. Make sure all equipment and components will fit allotted space. Provide clearances for servicing filters, tubes, etc. Indicate filter and tube pull areas for all equipment. Check door sizes in mechanical rooms to permit passage of equipment.
   j. Provide the lifting points and hatchways where maintenance requires lifting of heavy parts over 100 pounds (45 kg) in coordination with FM.
   k. Arrangement of large mechanical equipment shall allow access by cranes, forklifts, hoists, etc.
   l. Require housekeeping pads for all mechanical equipment at least 3" (75mm) larger than equipment dimensions and 4" (100mm) thick.

13. Access to mechanical distribution systems:
   a. Provide isolation valves at each branch from the main, each wing, each floor, and at each individual piece of equipment to facilitate both routine maintenance and future remodel and expansion without a major building shutdown.
   b. Provide access panels in floors, walls, ceilings (except lay-in tile type) and ducts to readily access VAV boxes, valves, balancing dampers, fire dampers, coils, filters, etc.
   c. Coordinate access panel sizing and location between the mechanical engineer, architect, structural engineer and electrical engineer. Show locations and sizes on mechanical drawings and reflected ceiling plans.

14. Mechanical system labeling and identification:
   a. Require clearly visible nameplate data on all mechanical equipment.
   b. Require labels for each valve, fire damper, control device and balancing device.
   c. Require 2" (50mm) high black letters with system name on each major piece of mechanical equipment.
d. Require all mechanical room piping to be painted and/or labeled in accordance with ANSI 13.1 standards and the following schedule:

<table>
<thead>
<tr>
<th>Service</th>
<th>Additional Identification</th>
<th>Label Colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam 0-15 psi (0-100kPa)</td>
<td>Aluminum jacket with two black bands every 10’ (3m)</td>
<td>GRAY BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Steam greater than 15 psi</td>
<td>Aluminum jacket high heat</td>
<td>GRAY BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>(100 kPa)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam with aluminum jacket</td>
<td>Blue stainless steel bands</td>
<td></td>
</tr>
<tr>
<td>Condensate</td>
<td>ORANGE BKDG/BLACK LETTERS</td>
<td></td>
</tr>
<tr>
<td>Heating water supply</td>
<td></td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Heating water return</td>
<td>Green/White Green/White</td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Chilled water supply</td>
<td></td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Chilled water return</td>
<td></td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Cold water (domestic)</td>
<td></td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Hot water (domestic)</td>
<td></td>
<td>GREEN BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Natural gas</td>
<td></td>
<td>YELLOW BKGD/BLACK LETTERS</td>
</tr>
<tr>
<td>Compressed air</td>
<td></td>
<td>BLUE BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Fire service (wet)</td>
<td></td>
<td>RED BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Fire standpipe (dry)</td>
<td></td>
<td>RED BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Fire system (wet/dry)</td>
<td></td>
<td>RED BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>Waste, soil, vent and rain</td>
<td></td>
<td>BLACK BKGD/WHITE LETTERS</td>
</tr>
<tr>
<td>leader</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control air</td>
<td></td>
<td>PURPLE BKGD/WHITE LETTERS</td>
</tr>
</tbody>
</table>

e. Require labeling for mechanical piping and ductwork above the ceiling or in non-mechanical areas, with markers spaced every 25’ (7.6m). Label to correspond with service.

f. Require visible indication marking the location above a dropped ceiling of each valve, fire damper, control device, balancing device or maintenance access point for each piece of mechanical equipment. Label to correspond with service color with permanent adhesive color coded dot, ⅜” diameter minimum. Secure dot to nearest suspension ‘T’ in lieu of tile.


a. Submittal requirements:
i. Work plan: Obtain approval of alternatives to be analyzed from the FM project representative at the pre-design phase.

ii. ELCCA report: Submit preliminary report for review prior to “design development” phase.

iii. Design: Obtain approval for the selected alternative from the FM project representative prior to beginning preparation of working drawings.

b. Obtain utility operational rates for steam, natural gas, water, sewer and electricity from the FM project representative and the university utilities manager.

c. FM will make the systems selection based on the ELCCA alternatives provided. The simpler system with the lowest maintenance costs will be a major consideration.

d. Sustainable design principles shall be considered for all mechanical systems.

e. Investigate and include local utility energy and water saving incentives.

16. Require all mechanical control systems to be connected to Western’s Building Administration and Control (BAC) System.

a. Require simple HVAC control systems. Simple systems are easier to operate, more reliable and ultimately less expensive to maintain and operate.

b. Siemens Building Technologies Inc. is Western’s proprietary direct digital control system manufacturer, supplier, programmer and installer.

c. Coordinate all mechanical control system one-line diagrams and sequences of operation with the Siemens representative.

d. Require all mechanical controls system components to be compatible with Siemens.

e. The consultant will design the control scope of work and the sequences of operation in close coordination with Siemens, FM project representative and FM. FM will negotiate the Siemens estimates and allowances.

f. Provide a cost estimate from the Siemens representative for all phases of design. The final cost estimate will be the basis for the controls “Allowance” in the specifications in the final contract bid package.

g. Require the mechanical control system contractor to facilitate complete and accurate HVAC testing and balancing.

17. Mechanical design submittals:

a. Mechanical basis of design narrative (provide at the “schematic design” phase):
   i. Provide a presentation of facts sufficiently complete to describe all proposed mechanical systems. General parameters and computations supporting system selection are required.

b. Mechanical drawings:
   i. Avoid overly congested drawings.
   ii. Demolition plans should be separate and distinct from new work plans for large projects.
   iii. Plumbing plans should be separate and distinct from HVAC plans for large projects.
   iv. The orientation of mechanical drawings shall match the architectural plans. Column line designations shall be consistent with the architectural plans. Provide north arrows on all building and site plans.
   v. Provide legends to identify all symbols and abbreviations used on mechanical, plumbing, fire protection and control drawings.
   vi. Avoid vague and ambiguous references between sheets. Provide key plans, match lines and references to continuations on othersheets.
   vii. Provide a unique number or mark (Western’s equipment ID) for each piece of equipment and terminal device. For work in existing facilities, coordinate next number or mark available with FM Energy Management Center for each proposed equipment or device type. Intent is to have consecutive numbering within the central EMCS system with no overlaps. Western’s equipment ID is provided by FM Energy Management Center.
   viii. Provide mechanical equipment schedules as required, including coordinated electrical information.
   ix. Mechanical rooms should be drawn to no less than a scale of $\frac{1}{4}'' = 1'-0''$. 
x. Ductwork with width greater than \( \frac{3}{8}'' \) on full-size drawings shall be represented by double lines.
xi. Show all mechanical components as readily accessible.
pii. Show all zone isolation valves on floor plans.
ixii. Show all air and water flow measuring devices.
ixv. Clearly indicate pipe and duct sizes on plans.
ixv. Clearly show air and water flow quantities and temperatures in balance for each mechanical system.
ixvi. Include water quantities and pressure heads in pump schedules.
ixvii. Include air quantities and pressure heads in fan schedules.

Mechanical calculations: Provide at each design submittal phase.

i. Provide final calculations, bound and indexed and stamped by a licensed professional engineer with final construction documents.
ii. Heating and cooling load calculations, including a psychrometric diagram for all cooling systems.
iii. Sizing calculations for fans, pumps, terminal air devices, coils, control valves, dampers, meters, louvers, etc.
iv. Pressure drop calculations for mechanical ductwork.
v. Pressure drop calculations for mechanical piping.
vi. Pipe stress analysis for all medium and high pressure steam (>15 psig) and high temperature hot water (>180°F) heating systems. Note: Comply with ASME/ANSI B31.1 Power Piping Code.
vii. Pipe stress analysis for all low pressure steam, condensate and hot water piping systems where the diameter exceeds 3" and/or length exceeds 100 LF without a change in direction. Note: Comply with ASME/ANSI B31.9 Building Services Piping Code.
viii. Size condensate return pumps for a minimum of 60 psig backpressure. Verify with FM project representative and university utilities manager.
ix. Equipment selections for all major equipment from three manufacturers.
x. Sizing calculations for unusual equipment items.
xi. Catalog cuts of the equipment and devices used as the basis for design.

Mechanical cost estimates: Provide at each design submittal phase.

i. Provide a separate cost estimate for the mechanical control systems from the Siemens representative.
ii. Include the Siemen's cost estimate in the “Allowance” section of the specification in the final bid package.

18. Mechanical system commissioning:

a. Require the following acceptable test results to be provided for approval at substantial completion phase and prior to final acceptance by the FM project representative:
   i. Operational tests to demonstrate and verify the HVAC control systems are operating as designed.
   ii. HVAC testing and balancing reports to demonstrate all air and water quantities are within 10% of design.

b. See complete requirements in DIVISION 23 “Testing, Adjusting, and Balancing” and “Mechanical Control Systems” standards.

19. Mechanical operations and maintenance submittals: Require for approval at the substantial completion phase.

a. Require complete Operations and Maintenance Manuals for all mechanical systems and equipment.
   i. Provide a minimum of four hard copies and one complete copy electronically in .pdf format.
   ii. Include permits, tests, inspections, final balancing report, and operating certificates.

b. Require a screw and post binder for posting in the main building mechanical room.
i. Provide on individual sheets encased in clear laminate and bound together in the binder.
ii. Include complete as-built equipment schedules, flow diagrams for (both air and water), control drawings with set-points and sequences of operation.

20. Record Drawings:
   a. As-built information shall be provided to design consultants for inclusion in electronic archive record drawings.
   b. Contractor’s field red-line drawing set shall remain in legible, good condition. Red line set shall be stored in building at designated location at close-out of the project.

21. Heating systems (see “DIVISION 23 Steam and Heating” standard for detailed requirements):
   a. High pressure steam from the campus Steam Plant is the preferred heating source on campus for major mechanical equipment. 100 psig is maintained at the Steam Plant. Actual pressure at buildings remote from the Steam Plant may differ significantly depending upon distance and usage. Obtain written verification of lowest anticipated pressure at building entrance from university utilities manager prior to sizing equipment.
   b. Require all new facilities to be connected to the high pressure steam distribution system located in tunnels and utilidors throughout the campus. Note: The tunnel system also distributes compressed air campus communication lines, and high voltage electrical service.
   c. Provide isolation valves in high pressure steam system to allow back feeding under emergency conditions or for extended steam system maintenance. Valves shall be pressure rated butterfly with laminated stainless steel seat and seal and cast steel body for longevity and reliability. Manufacturer shall be Zwick to match other upgraded existing valves – no exceptions.
   d. Require all high pressure steam and pumped condensate return piping to be located in readily accessible tunnels or utilidors.
   e. Avoid direct buried steam and condensate piping.
   f. Require all steam condensate to be returned to the campus Steam Plant.
   g. Prohibit natural gas as a heating source without prior written approval from the FM project representative and the University utilities manager.
   h. Use of electricity may be considered for backup and emergency service during annual steam maintenance shut-down and for emergencies. Obtain prior written approval from the FM project representative and the University utilities manager.
   i. Require all building heating systems to be closed circuit hot water circulating systems.
   j. Require a steam pressure reducing station with two pressure reducing valves sized at \( \frac{1}{3} \)– \( \frac{2}{3} \) capacity.
   k. Require only one steam converter sized at 100% with no redundancy.
   l. Require 100% redundant heating water pumps.
   m. Require all boilers, and unfired pressure vessels to have an ASME stamp and be certified by the state boiler inspector prior to final acceptance. Require all steam fired pressure vessels and expansion tanks to be National Board registered.
   n. Heating water distribution system:
      i. Prefer a reverse return system whenever possible.
      ii. Require up-feed piping from floor below to floor level terminals.
      iii. Require all terminal equipment piping be designed to eliminate air at high points.
      iv. Require all terminals to be readily accessible for maintenance and operation with minimal disturbance to building occupants.
      v. Require readily accessible automatic air vents at all high points in the distribution piping system. Tube the high point air vents to the nearest floor drain.
      vi. Require chemical pot feeders with filters.

22. Mechanical cooling systems (see “DIVISION 23 Refrigeration Systems” standard for detailed requirements):
   a. As a general practice, mechanical cooling will not be provided in general use buildings, except
libraries and large classrooms and auditoriums. Mechanical cooling may be provided for process loads requiring year round control of temperature and humidity, such as animal vivariums, temperature sensitive equipment or research procedures, high-density computer rooms, rare books, archives, art galleries, etc.

b. If mechanical cooling is required, obtain final approval from the Director of FM at the programming phase of the project. Clearly indicate spaces approved for mechanical cooling in the “Mechanical Basis of Design.”

c. When mechanical cooling is approved, prefer chilled water from a central shared water cooled chiller plant as the cooling medium (if available).

d. Prefer Marley induced draft cooling tower.

e. For process cooling of small spaces requiring year round cooling:
   i. Require chilled water fan coil unit connected to building chiller when building chiller plant will operate year round,
   ii. When building chiller plant is not available:
      1. Minimize direct expansion packaged or split system (dx) units.
      2. Require all units to be accessible and maintainable without disrupting classroom or other occupant operations. Mount units in a corridor rather than in an occupied space.

g. Require blind flanges for future cross connection to other building chilled water systems if the building is connected to the campus tunnel system.

23. Freeze protection:
   a. Prohibit heat tape for freeze protection on new construction. Use heat tape only where required and approved by FM.
   b. Prohibit glycol for freeze protection except as indicated for process load condenser water loop and where approved by FM.
   c. Require distribution pumps to be connected to emergency power.

24. Ventilation:
   a. All ventilating systems shall be capable of supplying 100% outside air to meet cooling and ventilation requirements.
   b. The minimum ventilation rate for general use buildings shall be designed to ASHRE standards. Historically, WWU FM has designed for up to 6 air changes per hour without mechanical cooling. This includes perimeter rooms with operable windows.
   c. The minimum ventilation rate for laboratories shall be 10 air changes per hour.
   d. For areas with high ceilings, the ceiling height to calculate air changes shall be 10’ or actual ceiling height, whichever is less.
   e. Mechanical and electrical rooms shall be ventilated for temperature control. Provide 10 air changes per hour minimum. Do not use mechanical rooms as a supply or relief/exhaust air plenum.
   f. Provide ducted supply and return air systems. Plenumized supply and return air distribution systems are not allowed in new construction. Plenums in renovations require approval of Facilities Maintenance.


26. Indoor air quality:
   a. Require all air intakes for systems greater than 10,000 cfm, or as required by LEED, to have air flow measuring devices to measure minimum outside air quantities.
   b. Locate outside air intakes as far away as possible from streets, service roads, exhaust vents, generator exhausts, relief vents, sanitary vents, loading docks, and other sources of
contamination.
c. Locate rooftop air intakes a minimum of 25’ from roof exhaust, relief, or sanitary sewer vents. Locate wall air intakes a minimum of 10’ above grade.
d. Provide rain or storm proof louvers with screens at exterior wall intakes and exhausts. Design to minimize penetration of wind driven rain or snow.
   i. Design air intake louvers for a maximum 400’ per minute free area velocity. Face area of triangular louvers shall not include areas less than 3 blades high.
   ii. All exterior louvers shall be coordinated by the architect and mechanical engineer.
e. Slope drainable louvers to a low point and pipe to a roof drain or an approved floor drain with air gap. See “DIVISION 22 Plumbing Systems” section for drain requirements.
f. Prohibit drains in low point of air intakes.

27. Compressed air:
a. Require all new compressed air piping to be connected to the central distribution system in tunnels and utilidors. Prohibit stand-alone building air compressors.
b. Connecting piping between the tunnel and the building shall be located in readily accessible tunnels or utilidors.
c. The campus compressor is located in the Steam Plant and provides filtered, 100 psig, 35°F dew point air to the tunnel distribution piping. Actual pressure at buildings remote from the Steam Plant may differ significantly, depending upon distance and usage. Obtain written verification of lowest anticipated pressure at building entrance from university utilities manager prior to sizing compressed air system.
d. Provide a “Deltec” oil filter at each building entrance.

End