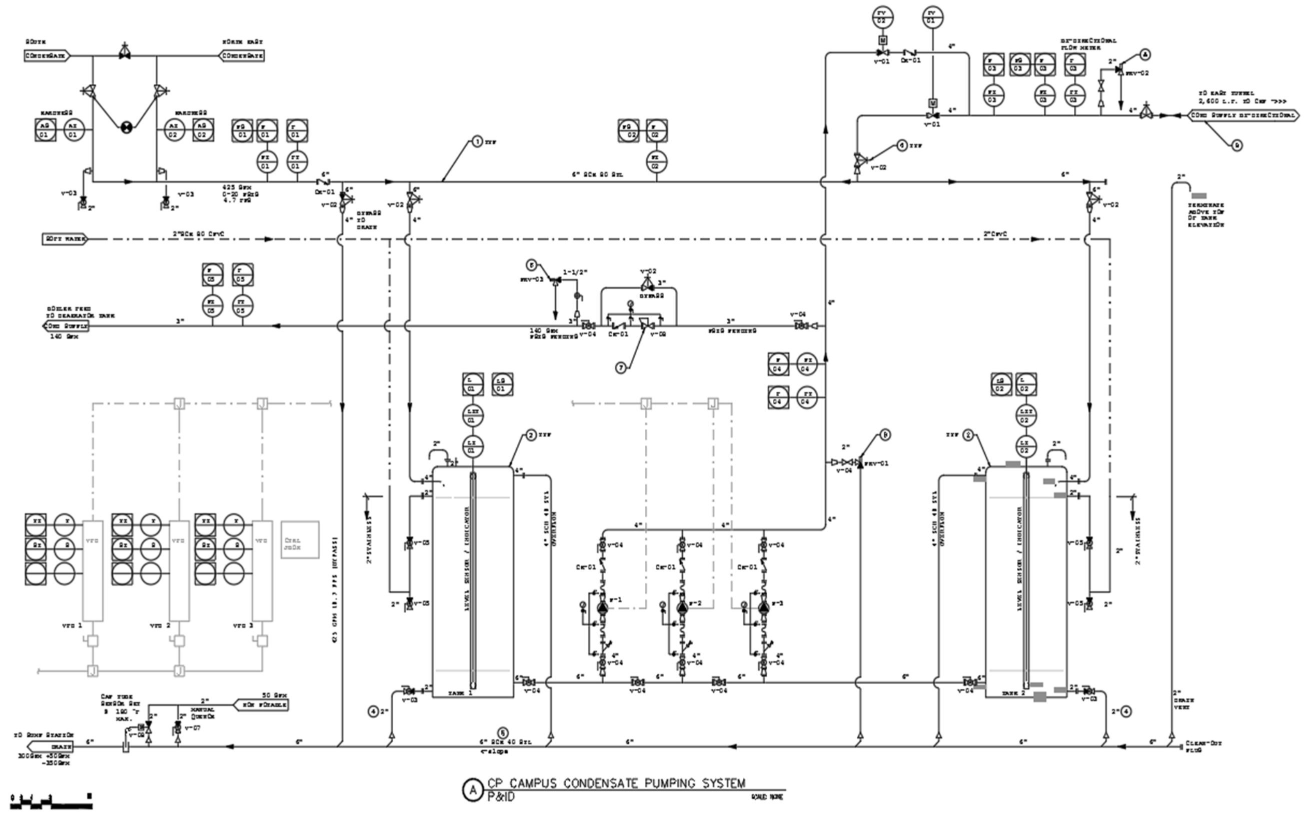
Arizona State University

Facilities Development and Management Engineering Design Guidelines



Contents

Introduction

The following guidelines are to be incorporated into the planning, design, construction and maintenance of Arizona State University's (ASU) facilities. As building science and technology continues to develop, these documents will be periodically updated to reflect the latest requirements. Design Professionals shall visit this site regularly to confirm they are utilizing the latest edition for the Engineering Design Guidelines.

This guideline intends reference to and coordination with other ASU Guidelines and in general the "FORWARD" and subsequent "SECTIONS" of the Facilities Development and Management (FDM) "Project Guidelines". Consult those documents for considerations not conveyed herein.

Purpose

The engineering design guidelines have been established to address the most common project elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good engineering practice and specific program needs. Omission of reference in these guidelines does not relieve responsibility for compliance with these requirements.

Consultants are encouraged to use professional judgment and ingenuity. The provisions of these guidelines are not intended to prohibit the use of alternative systems, methods or components. The consultant is ultimately responsible for the final design and its performance. Due diligence shall be performed to ensure the design is equivalent or superior to the prescribed elements of the guideline. As required, the consultant shall propose modifications to the guidelines to meet specific project goals, conditions and requirements through ASU's formal variance process.

SECTION 1

Engineering Design

Prudent engineering principles shall be followed, emphasizing efficiency, flexibility, maintainability, safety and reliability in an economic and environmentally responsibile manner. Systematic analysis of life-cycle costs shall be performed to provide a basis for comparison amongst available options. Such factors to consider include energy, operation, maintenance, repair and replacement costs, including escalation and residual value among others.

Systems shall be flexible and designed to accommodate future expansion and renovation. Equipment encorporating VFD's shall be sized such that day-one operation, plus any designed future capacity, shall not exceed 60 hertz. The systems shall be effectively zoned and shall incorporate provisions for continued operation to perform maintenance or in the event of a failure.

System layouts shall be fundamental with necessary clearances to allow for ease of operation and maintenance. Space planning shall allow for the removal and replacement of equipment and components, including major equipment, without disturbing permanent walls or disrupting service to other systems.

Equipment and components shall be selected, and systems engineered, to provide reliable performance that is accurate and repeatable at full and part load conditions and under all operating modes. Experimental, unproven or proprietary equipment or systems are not allowed unless documented proof of historical capability is provided and accepted by ASU. Systems and components shall be selected to maximize the utilization of competitive standard elements.

Projects that accomodate highly technical or critical facilities will include considerations for equipment redundancy, backup operation modes commensurate with the hazard, potential loss of use impacts and excessive cost implications .

SECTION 2

Documentation

A Basis of Design (BoD) document shall be prepared by the consultant to establish the understanding of the program, and identify methodologies and systems to achieve programmatic goals. The BoD will serve as an oversight tool for the University and shall be updated and submitted at each project phase. A final BoD shall be submitted as part of project closeout and shall be aligned with the implemented design. At a minimum, the following information shall be provided:

A. Assumptions

   1. Any that will drive the direction of the design.

B. Calculations:

   1. Load calculations shall be provided to and reviewed by FDM at each phase of the design starting with the Schematic Design phase. Acceptable forms are summarized reports that cover aspects of peak cooling, heating, dehumidification and humidification when applicable. Occupancy, equipment loads, plug loads, lighting loads are to be documented.

   2. Energy Modeling (when required by LEED or requested by ASU); Energy modeling results shall be provided to and reviewed by FDM at each phase of the design starting with the Schematic Design phase. Acceptable forms are summarized reports of critical considerations and comparitive energy results in the early phases and estimated versus ASHRAE baseline in the final construction phase. Additional reports may be required contractually to support LEED requirements. eQuest models are preferred.

   3. Piping and Plumbing calculations that cover Water Supply demands, Fuel Gas demands, Waste and Vent sizing are to be included within each submittal of the BoD. WSFU summary with calculations to be included within the plans.

   4. Ventilation calculations in accordance with ANSI/ASHRAE 62.1, documented within the plans.

   5. Campus Chilled Water network analysis when applicable.

   6. Campus Steam and Condensate network analysis when applicable.

C. Applicable codes, standards, laws and ordinances

D. Indoor design conditions for each space (dry bulb, relative humidity and control ranges)

E. Outdoor design conditions (see Design Criteria section)

F. Indoor air quality (IAQ) requirements and assumptions, i.e. use of the space, filtration, location of intakes coordinated with contaminanate sources, assumptions regarding recirculation of air, etc.

G. Ventilation rates, air change rates, outdoor air and exhaust air requirements, including abatement.

H. Pressure relationship between adjacent spaces

I. Lighting and equipment loads

J. Occupant density, activity, and heat rejection

K. Building envelope construction and infiltration

L. Diversity and sizing criteria

M. Equipment scheduling assumptions and heat rejection

N. Narrative describing each individual system

O. Equipment and distribution sizing criteria, operating conditions and materials

P. Redundancy and reserve capacity

Q. Operation and control strategies

R. Controls and Sequence of Operations; to be included with all projects, within the plans, starting at SD/DD phases, and updated at each sucessive review.

S. Wind study (if required)

Sufficient information shall be included in the construction documents not only to permit and construct the project, but to also facilitate system maintenance and troubleshooting. Plans shall clearly identify and callout all equipment, valves and system instrumentation (i.e. differential pressure sensors, duct detectors, etc.). Equipment and valve numbering shall be coordinated with Facilities Development and Management (FDM). Plans shall identify all clearance spaces and access paths, pipe and duct sizes, pressure class/material transitions, slopes and elevations.

Flow and control diagrams, riser diagrams, single line diagrams, one line diagrams and similar shall be prepared, updated or maintained, as part of the contract documents for every project, tenant improvement, renovation and / or new construction. They shall identify all equipment and instrumentation required for system operation. Accompanying points lists and sequence of operations shall also be submitted on the drawings. Special emphasis of this documentation is mandatory for highly technical applications, Laboratory and / or Research type buildings. Uniformity of instrumentation symbols and identification shall be based on ANSI/ISA-5.1.

Room airflow balances and space pressurizations shall be clearly identified on plans, diagrams or in schedules.

Schedules shall be prepared as part of the contract documents and shall include pertainent information required for procurement and analysis of the equipment selections. Specifically, air handler schedules shall include the following information at a minimum:

A. Entering outside air dry bulb and wet bulb temperature

B. Return air dry bulb and wet bulb temperature

C. Mixed air dry bulb and wet bulb temperature

D. Leaving air dry bulb and wet bulb temperature for each coil

E. Minimum outside air percentage

   a. Interpreted as the quantitiy of outside air required, no less.

F. Day one airflow quantity and designed airflow quantity

G. Coil velocity at day one and designed airflow quantity

H. Apparatus pressure drops at day one and designed airflow quantity

I. Fan data; cfm, total pressure, brake horsepower, electrical voltage and phase.

J. Filter data; pre-filter rating and thickness, final filter rating and thickness, e.g. Merv 13- 12" thick.

K. Abatement data (if applicable).

SECTION 3

Sustainability

Environmentally responsible design shall be approached in a systematic and integrated effort to ensure the sustainability initiatives of the University are surpassed. The appropriateness of the available solutions, and the economic and environmental benefit of their implementation, shall be evaluated for each project. It is the expectation that the minimum requirements set by codes, standards and ASU's Sustainability Guidelines will be exceeded in a fiscally responsible and proven manner.

SECTION 4

Campus Utilities and Existing Conditions

Campus utilities shall be used whenever possible for any new construction or expansion projects. Systems operation and design criteria at each campus shall be verified with FDM. It is the responsibility of the consultant to perform due diligence to verify existing conditions and the availability of all campus utilities and building systems. This includes capacity studies and modeling / analysis to ensure adequate capacity is available and the additional loads will not adversely affect other buildings or the reliable operation of existing distribution systems.

Modification to existing HVAC systems will require verification of current status and operation of related components. The project shall include "pre-reads" of systems such as exhaust, make-up air, chilled water, hot water and others, in an effort to validate capacity exists. Test results are to be reviewed with ASU prior to proceding with the project. Deficiencies, when applicable, require the project PM to identify the appropriate corrective means.

New buildings and projects including substantial renovation of mechanical systems shall include in their scope the hydraulic separation of buildings via heat exchanger(s) from the campus chilled water system(s).

The routing and connection to existing campus utilities shall be coordinated with FDM. New tunnels shall be as wide as possible with a minimum walking clearance of 3'-0" wide x 7'-0" high. Refer to Tunnels and Vaults section that follows. Connections to existing utilities shall not impede walking clearances and shall have isolation means at an accessible location.

All building service entrance utilities shall be metered in accordance with the utility company, ASU FDM and ASU Energy Information System (EIS) requirements. Sub-metering building utilities is encouraged to provide measurable data to evaluate individual system performance and plan for future energy programs.

SECTION 5

Equipment Rooms

The location and size of equipment rooms shall allow for ease of maintenance, removal and replacement of equipment and components. Equipment rooms that house major equipment shall be directly connected to the outdoors and the outdoor path shall be accessible. The consultant shall allocate space for system expansion and addition.

Equipment shall be located on concrete equipment pads. Sufficient pad height shall be provided to allow for equipment appurtenances to be installed without the need to notch or penetrate the floor.

Equipment rooms shall have convenience outlets.

Floor drains and floor sinks shall be provided in equipment rooms to allow for continuous applications and intermittent maintenance without impeding paths of travel or cause damage to the floor. Provide exposed, non-mechanical type trap primers at these locations and other locations where subject to evaporation. The intended minimum trap and tail piece size of the floor drain or floor sink shall be no less than 3". Multiple floor drains and sinks are preffered for projects with large equipment rooms supporting multiple components.

The use of “sure seal” type devices in lieu of a trap primer shall not be specified in new projects. Short term solutions to trap seal odors due to loss of seal shall be reviewed with FACMAN.

Equipment rooms housing HVAC equipment shall have at least one water supply. A ¾” outlet with male hose bib connection and antisiphon protection when applicable.

It is preferred that vibration producing components, such as rotating equipment, boilers, etc., and large/heavy equipment and storage tanks be located on grade whenever possible.

Equipment rooms connected to Tunnels are to include a solid door to isolate air flow communication between each.

SECTION 6

Tunnels and Vaults

The location and size of mechanical tunnel and vaults shall be determined by the design consultant with respect to the utilities being served. Steam system distribution requires consideration for low point condensate control at regular intervals typically 150 feet apart. See primary heating systems for expansion joints.

Tunnel(s) and Vault(s) are to have ample interior room with head clearance for equipment service and maintenance.

Tunnel(s) and Vault(s) shall include natural ventilation to minimize humidity and encourage natural drying.

Any new tunnel or vault shall include a means to accomodate utility piping leakage and or surface and subsurface rain water infiltration. The means for removal, e.g. dry well / sump pump etc., shall be coordinated with FDM.

Tunnel and Vault access shall include considerations to install and remove the largest section of pipe, valve or equipment.

Tunnel and Vault design to include considerations for piping expansion, contraction and the forces involved in anchorage of piping and components. Preference to expansion loops and “L-bends” shall be given over other means, as space constraints dictate. Bellows joints are preferred over slide joints.

Materials used within the vault should be selected for longevity, adequately coated or selected for corrosion resistance. Hot dipped galvanized steel preffered. Designed to avoid metal resting in potential water laden areas.

Pipe joints within Tunnels and Vaults are to be welded for campus chilled water, steam and steam condensate. Flanged joints are prefferable and should be minimized to the extent possible.

Entry and exit points are expected to be protected from public access. Emergency "breaker bar" exit doors may be necessary in certain scenarios and require analysis by the design professional for emergency situations.

Tunnels and Vaults directly connected to building interiors are to have a solid door to prohibit air flow into the building.

SECTION 7

HVAC Heating Ventilation Air Conditioning

A. Reference

1. Applicable Codes, Laws and Ordinances
2. ACGIH Industrial Ventilation – A Manual of Recommended Practice
3. AIHA Z9 Series Standards
4. ANSI
5. ASU Project Guidelines
6. ASHRAE e.g. 15, 52.2, 55, 62.1, 90.1-2, 160, 170, 188 etc.
7. ASME
8. FM
9. Guide for the Care and Use of Laboratory Animals
10. NIH
11. NFPA
12. OSHA
13. SMACNA
14. UL

B. Design Criteria

1. Indoor Design Conditions

a. Environmental conditions for human occupancy comfort are based on the sustainability principle of adaptive comfort. To achieve thermal comfort of this principle, design considerations shall factor in personal activity, humidity levels, air distribution, etc. without sacrificing the energy savings potential of this principle.

b. Special programs whose environmental conditions are dependent on processes or equipment requirements are exempt from this principle and their requirements shall be individually reviewed.

c. In the absence of any critical program needs, temperature conditions for human comfort shall be as follows:

Condition	**Design Setpoint**	**Upper/Lower Range**
Heating	70°F	68°F
Cooling	78°F	80°F

d. Note that this is the common operating setpoint and differs from actual equipment size. The equipment selected to support the design set point is expected to support some level of flexibility in operation to meet a heating set point of 74° F and a cooling set point of 72˚ F. This is understood to be capability not actual operation, as both cannot occur simultaneously.

2. Outdoor Design Conditions

Outdoor design conditions shall be based on local climatic data tabulated from the ASHRAE Handbook - Fundamentals (current edition) unless a more appropriate and recognized source for local climatic data is proposed by the consultant and accepted by ASU. Outdoor design conditions shall include a 30-year projection based upon the most recent 20-year changes in climatic conditions.

a. Critical Program

- Heating design criteria shall be based on the 99.6% column dry bulb temperature. Humidification when applicable shall use 6.5 Grains as the minimum humidity ratio. (Tempe, AZ and vicinity).
- Sensible load cooling design criteria shall be based on the 0.4% column dry bulb temperature with its mean coincident wet bulb temperature.
- Monsoon conditions shall be considered when determining outside air, infiltration and dehumidification loads. Preference to 95 / 77 deg. F dry bulb / wet bulb, 120 Grains and enthalpy of 40.6 Btu/lb dry air shall apply. (Tempe, AZ and vicinity).

b. Non-Critical Program (Comfort Only)

- Heating design criteria shall be based on the 99% column dry bulb temperature.
- Sensible load cooling design criteria shall be based on the 2% column dry bulb temperature with its mean coincident wet bulb temperature. Monsoon conditions shall be considered when determining outside air, infiltration and dehumidification loads. Preference to 94 / 74 deg. F dry bulb / wet bulb, 100 Grains and enthalpy of 38.5 Btu/lb dry air shall apply. (Tempe, AZ and vicinity).

3. Ventilation and Make-Up Air

a. Unless a more current version is required, the design of ventilation systems to provide indoor air quality acceptable for human occupancy shall follow ASHRAE Standard 62.1 – 2019 (or the most currently adopted) Ventilation for Acceptable Indoor Air Quality.

b. Special programs subject to contamination by odors, toxic, noxious or flammable/explosive/radioactive particles, vapors or gases, etc., or that require cleanroom type functions, shall be addressed on an individual basis.

c. Refer to ASU Laboratory Guidelines for best practices involving further definition regarding the variety of considerations within the special programs (critical program) categorization.

d. Refer to ASU EH&S Laboratory Standard & Design Guide Lab Ventilation, Section 1.0, 5.0 and 7.0 also cover considerations in the Ventilation and Make-Up Air category.

e. Use and application of ASHRAE Classification of Laboratory Ventilation Design Levels is preferred when designing or modifying Laboratories. Refer to the appendix, Table 3 for design and operation considerations.

f. Air Changes pertaining to Laboratory applications are primarily founded within EH&S Guidelines. These may differ depending on special or critical program requirements, occupancy determination and hazard level. Any level of hazardous material use related to Lab determination requires single pass (once through) ventilation. Further evaluation is required to justify single pass ventilation in Laboratories deemed non-hazardous by EH&S. For example, an electron microscope application may be designated non-hazardous, but also use Nitrogen as a purge gas in quantities that require special program considerations. A speech or hearing lab may be located in an office environment. These shall be addressed on an individual basis with the owner, EH&S and FACMAN. For determination of ventilation needs, refer to the Laboratory Ventilation Design Levels from ASHRAE.

g. Laboratory environments that may want to use less than 6 ACH are to be reviewed with

ASU EHS, Fire, FDM and obtain final approval by ASU's AHJ by way of the variance review/approval procedure. Some spaces may require more than 6 ACH.

h. Outdoor air intakes shall be located so as to not induce contaminants or entrain rain and shall be secure from public access. Measurement, access and balancing of outdoor air shall be addressed when locating the intakes.

i. Any project that results in changes to any existing space, must include ventilation calculations and the recommended adjustment to the ventilation air at the AHU level for test, adjust and balance purposes. These are to be documented in the plans. Large AHU systems with complex control strategies should be carefully reviewed in conjunction with the project. Existing equipment shall "pre-read" the equipment and systems in preparation for required adjustments as may be necessary.

4. Pressurization

a. The building pressure relationship relative to ambient shall minimize infiltration year-round.

b. Room pressure relationships to adjacent spaces shall be from the cleanest spaces to least clean spaces. Depending on the application of the program, multiple step pressurization may be required. Where this is required, cascading type air locks shall be used for non-containment applications to prevent contamination of the room; sinks, bubbles or dual-compartment air locks shall be used for containment applications to prevent contamination of both the room and adjacent spaces.

c. Rooms that utilize active or passive chilled beam technologies, sensitive to condensation that may communicate with the outdoors should include provisions for vestibules in an effort to mitigate excess humidity migration into the space.

d. For critical program applications where room pressure differentials need to be sustained, the preferred method is through the use of a fixed volumetric offset between the supply and exhaust airflows. Room pressure monitors and alarms shall confirm room pressurization, applicable to increased safety levels such as LVDL-3 and above, refer to the section above "Ventilation and Make-up Air" paragraph 3, part e.

e. Generally, laboratories typically require holding to a slight negative pressure with respect to adjacencies. Variation on this generality must be reviewed on an individual basis. Certain Labs may not fall within this category when considered non-hazardous only.

f. Generally, laboratories may obtain transfer air directly from an egress corridor. Not all design scenarios may follow this convention and shall be confirmed by the design professional given the program, hazard and related considerations.

5. Zoning

a. Mechanical systems shall have an adequate number of zones, fundamentally laid out to perform each intended function, provide flexibility for future renovations, expansions and maintenance and incorporate energy saving strategies. Program spaces requiring 24/7 conditioning, or processes requiring different operating conditions (temperature, humidity and filtration), shall be provided with dedicated and independent HVAC systems and/or loops.

b. Common use spaces such as multiple offices along a common wall orientation shall have no more than three offices on a single zone. Building floor plates shall be zoned horizontally unless approved otherwise.

6. Roof mounted mechanical equipment and ductwork Structural Considerations

a. Mechanical systems exposed to the environment shall be evaluated for wind loading as to up-lift, downward and overturning forces. The structural design shall include plans and calculations evaluating and recommending retaining / supporting elements.

Consideration for ductwork expansion and contraction shall be included. When and where applicable seismic considerations are to be resolved. Parameters for forces shall use local accepted design values and physical configuration conditions (terrain), e.g. City of Tempe for Tempe Campus.

b. Vibration analysis shall be considered for all rotating equipment that is roof mounted on buildings known to be or designed to be vibration sensitive. The Structural Engineer shall provide selection of recommended isolation.

Section 8

Systems

A. General

When central utilities are not available, preferred alternative systems are those that are reliable, efficient and with fewer, larger and less complex components. Refer to the ASU Technical Guidelines for equipment requirements.

B. Primary Cooling

Campus chilled water shall be used whenever available. When not possible, a life-cycle cost analysis shall be performed on available options to provide a basis for comparative analysis.

Considerations when using campus chilled water:

1. New buildings and projects including substantial renovation of mechanical systems shall include in their scope the hydraulic separation of buildings from campus chiller water systems via heat exchanger(s) “HEX”. Critical programs are to include redundancy with a 2/3rd and 2/3rd size confirguration unless determined otherwise to be full capacity each.
2. New buildings and projects including substantial renovation of mechanical systems shall include in their scope a chilled water filtration product equivalent to a high efficiency coalescing air separator combination dirt separator with timed blow down. The size and selection shall consider full flow to the building with capacity for future expansion. A full size bypass shall be provided to service the filter, without impact to normal building operation. The filter shall be located on the campus side of the supply prior to the heat exchanger(s). Critical programs may apply one filter per heat exchanger. Consulting FDM for appropriate means and preffered products.
3. A bypass around the building pumps for emergency situations.
4. Critical programs shall consider portable chilled water supply connections as a supplemental means of backup.
5. A temperature control strategy to allow for supply water temperature reset and elevate campus return water temperatures under part load.
6. A building differential pressure reset strategy to operate the pump(s) at the lowest speed possible while maintaining temperature setpoints.
7. Pump lead, lag/standby with a runtime equalizing control strategy.
8. Consult FDM and the chemical company under contract to ASU for pipe pretreatment requirements.
9. Campus chilled water pressure and temperatures may vary throughout the campus and

throught the year. Connection locations are to be verified for ample capacity and differential pressure. Chilled Water temperatuers may vary pending location and time of year, ranging from 42 deg. F to 48 deg. F. Coordinate verification with ASU PM and Facman as required.

C. Primary Heating Systems

Campus steam shall be used whenever available. When not possible, a life-cycle cost analysis shall be performed on available options to provide a basis for comparative analysis.

Considerations when using campus steam:

1. A steam to hot water converter shall be used.
2. Steam coils shall not be used for HVAC heating applications.
3. Mount the converter at an elevation sufficient to allow for condensate drainage and with a vacuum breaker to eliminate stall and potential failures.
4. Use union/flanged spool pieces on the water side to allow for head removal and clear space for tube pull.
5. ~~Parallel float and thermostatic steam traps should be considered, each sized for 100% at critical locations for of the full design load. Normally a single F&T steam trap with manual valve bypass otherwise.~~
6. A pressure reducing station with a manually regulated bypass shall be used upstream of the control valve.
7. Depending on the size of the system, 1/3 – 2/3 valve control may be required.
8. The pressure reduction should provide the lowest possible steam pressure at the heat exchanger.
9. A manually regulated bypass shall be used around the control valve(s).
10. Unless otherwise required, the supply water temperature shall not exceed 140°F and a temperature reset control strategy should be implemented.
11. A building differential pressure reset strategy should be considered to operate the pump(s) at the lowest speed possible while maintaining temperature setpoints.
12. Pump, lead, lag/standby with a runtime equalizing control strategy shall be used.
13. Condensate shall be collected and returned back to the central plant. High pressure condensate shall be flashed and reused on a low pressure steam system / preheating system before being returned to the plant if feasible and economically viable.
14. Pressure-powered condensate pumps are preferred over electric motor driven pumps. Discharge pressure to the campus network shall be adjustable up to the motive pressure available.
15. All steam vents shall discharge to a safe location outdoors and at a location so as to not damage building components.
16. Design efforts must include analysis of the existing campus condensate return system to ensure adequate capacity is available and the additional loads will not adversely affect other buildings or the reliable operation of existing systems.
17. Due to campus steam quality, a moisture separator shall be applied prior to steam pressure control stations and steam measurement flow stations.
18. Steam to hot water converters shall include a vacuum breaker.
19. Modulating steam equipment and equipment steam traps must discharge to atmospheric

pressure or account for backpressure. Preference shall be given to systems that receive hot steam converter condensate at atmospheric pressure and pump back to steam condensate return.

20. Pipe expansion control preference is to use expansion loops and or "L-bends. When space does not permit their application, preference for bellows type expansion joints will apply.
21. The use of grooved joints in heating water and steam systems is to be avoided.
22. Campus steam and condensate piping shall be Schedule 80 pipe, welded joints unless impractical to do so. Flanged joints shall be preferred otherwise.
23. "Sparge tube" design method shall be applied to pressurized condensate return piping from condensate control traps.

Future Heating System, Campus LTHW (currently anticipated to be 140°F), Low Temperature Heating Water System

1. Tempe Campus projects involving new construction or utility redistribution shall consider the substitution or conversion from steam utilization to Low Temperature Heating Water.
2. The programming phase of new construction will include considerations for use of centralized, or distributed generation of LTHW.
3. Development of the infrastructure, where not currently avaiable, will be included in the schematic design planning phase.
4. New or replaced AHU with pre-heat, heat, or reheat coils shall be sized and selected to accomodate the future use of LTHW (140°F).

D. Humidification Systems

Campus steam shall be used whenever available. When not possible, a life-cycle cost analysis shall be performed on available options to provide a basis for comparative analysis.

When using campus steam:

1. Campus steam shall be used to generate humidification steam when required, when steam is available.
2. A steam-to-steam (STS) generator shall be used.
3. Direct injection of central plant steam into the airstream shall not be used for humidification applications.
4. Condensate on the central plant side of the STS generator shall be collected and returned back to the central plant. Any high pressure condensate shall be flashed and reused on a low pressure steam system before being returned to the plant if feasible and economically viable.
5. Condensate blow-down on the humidification side of the STS generator shall be drained to waste through a drain cooler.
6. All steam vents shall discharge to a safe location outdoors and at a location so as to not damage building components.
7. Care in selection of water supply to the steam generator shall consider water quality of low chloride content and , when applicable, laboratory water Type III and greater (>4 Ω-cm).

E. Air Handling Systems

1. Air systems shall have the capability to provide 100% outdoor air to incorporate energy saving strategies, pre-occupancy startup and/or space purge functions. Control measures shall be incorporated to maintain proper building pressurization at all concentrations of outdoor air and to reset static pressure to operate the fan(s) at the lowest speed possible.

2. Dedicated outdoor air configurations, when applicable are preferred.

3. Outdoor air shall be measured and controlled to maintain the minimum required ventilation rates in the breathing zone whenever the zones served are occupied. Systems supplying 100% outdoor air are exempt, and do not require DCV demand controled ventilation.

4. A separate outside air damper, appropriately sized, with flow measurement is preferred to address un-occupied area outdoor airflow rates "Ra". Demand based control is the preferred method to reset the minimum ventilation rate for systems serving multiple zones. Single zone systems or spaces with well-defined occupancy schedules may consider other methods of resetting the outdoor air flow rate. Increasing outdoor air requirements beyond the minimum requirement in the breathing zone is not desirable from an energy standpoint unless this can be accomplished passively or when used in conjunction with strategies that decrease overall energy consumption.

5. DCV Demand based control may utilize CO_2 detection within preferably the common return ducting when such systems benefit economically due to scale or size.

6. Alternative methods to traditional overhead VAV space conditioning and ventilation systems are encouraged. Proven concepts for energy recovery and reduction shall be investigated and proposed. The reduction of use, or the complete elimination of reheat systems, shall be considered.

7. Ductwork shall be directly connected to the air handler and exterior outdoor and relief openings, supply duct/plenums and return duct/plenums. Equipment rooms and penthouses shall not be used as plenum spaces.

8. When new equipment and ductwork is installed, the distance between the roof surface and the underside of the equipment shall be at minimum 18 inches to allow for roof repair.

9. HVAC coils shall avoid back to back configurations to allow for cleaning purposes. This includes space between other elements such as filter racks, dampers, fans, etc.

10. Vestibules are to be considered when Chilled Beam equipment may be affected by intermittent outdoor influences.

11. Air filter selection and arrangement shall consider a minimum preference to MERV 13. Various arrangements with pre-filters, high efficiency filters and others dependent on the project, are to be reviewed with ASU FDM for approval.

12. When considering large AHU’s with multiple filters stages, provide separate racks for MERV 8 filters and MERV 13, 14, etc. Filter racks are to be designed to operate against maximum VFD frequency plus 0.5” w.g. Filter cabinets must have doors that swing more than 90 degrees when open for service access. Avoid removable panels for filter access.

13. Refer to the filter list within ASU Project Guidelines for standard filter size preferences. Odd or rare filter sizes are to be avoided.

14. Coordinate new or replaced equipment tag and identification with FACMAN department. Equipment numbers and convention will be provided to the installer.

F. Exhaust

1. The primary function of exhaust systems is to provide a safe and healthy environment through containment and removal of contaminates. Proven energy conservation and/or recovery strategies shall be evaluated for each project, but shall not sacrifice the health and safety of building occupants or the public.

2. Exhaust and vents shall discharge directly, or first through air cleaning devices, in a safe manner to an exterior location. Minimum separation distances from the discharge shall be maintained in accordance with applicable codes and standards. Additional considerations shall be given to prevailing winds and airflow patterns around the building and building elements.

3. Laboratory exhaust systems, refer to the most recent release of ASU FDM Project Guidelines.

4. For preferred duct materials, refer to the most recent release of ASU FDM Project Guidelines.

G. Air Distribution Sizing Guidelines

Cross reference FDM Project Guidelines 23 31 00 - HVAC Ducts and Casings for further considerations, not otherwise addressed herein.

1. Low Pressure Duct Sizing (Pressure class 2" WG and less)

   A. Supply:

   - Maximum Pressure Drop: 0.1"/100ft
   - Maximum Velocity: 1,600 fpm

   B. Return/General Exhaust:

   - Maximum Pressure Drop: 0.08"/100ft
   - Maximum Velocity: 1,600 fpm

2. High Pressure Duct Sizing (Greater than pressure class 2" WG)

   A. Supply:

   Maximum Pressure Drop: 0.15"/100ft

   Maximum Velocity: 2,000 fpm

Chilled and Heating Hot Water Pipe Sizing Guidelines

1. Preference shall be given to ANSI/ASHRAE/IES Standard 90.1 , most recent addition, Table "Piping System Design Maximum Flow Rate in GPM" for various pipe sizes 2-1/2" to 24". Assume operating hours per year as >4,400.

2. District Cooling Pressure and Temperatures may vary throughout the campus and throughout the year. Connection locations are to be verified for ample capacity and differential pressure. Chilled Water temperatures may vary pending location and time of year, ranging from 42 deg. F to 48 deg. F.

Section 9

Plumbing

Cross reference FDM Project Guidelines Division 22 - Plumbing for further considerations, not otherwise addressed herein.

A. Reference

1. Applicable Codes, Laws and Ordinances
2. ADA
3. ANSI
4. ASU Project Guidelines
5. ASPE
6. CISPI
7. FM
8. Guide for the Care and Use of Laboratory Animals
9. NIH
10. NFPA
11. OSHA
12. UL
13. ASHRAE Std 188 Legionella Guideline

B. Design Criteria

General

Fixture unit quantities shall be assigned in accordance with applicable plumbing codes. Recognized methods to reduce the performance impacts of high-efficiency fixture loads on traditional sanitary waste pipe sizing methods shall be evaluated. This does not apply to non-potable water systems, storm drains or special waste.

Storm drain sizing to be determined based on 3 inches per hour rain fall. Typical for Tempe, AZ and vacinity.

C. Water Conversation

Strategies to conserve water use shall be considered for every project. Reuse and collection systems shall be evaluated for each new construction, addition or major renovation project. Reduction in water use shall be pursued through the use of waterless (subject to owner approval) or low flow fixtures, hot water recirculation systems and other water saving technologies.

The use of potable water for once through equipment cooling is prohibited.

Cooling towers shall consider and apply strategies that minimize water waste. Products that remove solids via high efficiency coalescing dirt separators are to be used. Re-use of blow down water shall be considered where practical to do so.

Low flow fixtures such as floor moutend urinals require a higher gpf gallons per flush, an exception to allow 1.0 gpm vs Leed required 0.12 gpf is permissible.

D. Systems

The design of building supply and distribution systems shall provide a volume of water at the required flows, pressures and temperatures to ensure safe, efficient and code compliant operation during periods of peak demand. Piping shall be sized at a velocity not exceeding six feet per second (fps) for cold and hot water and four fps for hot water return.

Existing building system modifications that add demand are to be analyzed and include a WSFU water supply fixture unit assessment and calculation (for the entire building). Updated riser diagrams shall be included (for the entire building).

The design and engineering of all water systems shall incorporate best practices for control of Legionella, including consideration of temperature, circulation, dead legs, etc.

When central utilities are not available, preferred alternative systems are those that are reliable, efficient and with fewer components. Refer to the ASU Technical Guidelines for equipment requirements.

Water quality is to be considered when selecting equipment that may be affected by the high chloride content of the current untreated local water supply.

E. Domestic Hot Water

Campus domestic hot water shall be evaluated for capacity, pressure and recircution and used whenever determined to be available. The next preference is the use of campus steam to produce domestic hot water at the building level. When neither is possible, a life-cycle cost analysis shall be performed on available options to provide a basis for comparative analysis.

Double-wall heat exchangers shall be used for domestic hot water applications.

F. Potable Water

Separate water systems into potable and non-potable with the required reduced pressure backflow preventers. Landscape irrigation shall be provided with a dedicated water meter separate from the building meter. Non-potable makeup water to equipment and systems shall be individually metered and totalized at ASU BAS for maintenance and troubleshooting purposes. Provide a bypass around meters.

Consider tempering requirements for outdoor eyewash/safety shower installations, including anti-scald valves where needed.

All backflow protection will comply with the local ordinance of the municipality in which the campus is located. Pipe relief from the backflow preventer indirectly to a drain of sufficient size to evacuate maximum flow discharge.

Bypasses around backflow devices are prohibited. Where interruption of service shall be avoided, separately valved backflow preventers may be installed in parallel. All domestic water services to buildings shall have two backflow devices in parallel.

Connections to the local water supply grid shall include provsions to filter the potable supply at the building prior to serving any equipment such as booster pumps, water softeners and further split to non-potable useage. Selection of filter to be reviewed and approved with ASU FDM.

Water pressure loss calculations with current or updated WSFU water supply fixture units, are to be provided for new and renovation / tenant improvement projects, on the plans. Complete riser diagrams are to be included within the plans.

G. Hazardous Evaluations

When it is necessary to have multiple piping connections to tanks, equipment or systems, the potential for cross-contamination shall be evaluated. The evaluation should consider the potential motive force for contamination and the severity of the consequences from cross-contamination.

The motive force for cross-contamination can come from pipe line pressure, static head, siphonage, sudden depressurization, or molecular diffusion (migration of fluids under static conditions). The greater the motive force, the greater the potential for cross-contamination.

The consequences of cross-contamination may include hazards to employee health, product contamination and/or equipment damage.

H. Common Utilities for Laboratory Facilities.

For general laboratory use, allocate 1 scfm per outlet for compressed air and nitrogen, 5 cfh per outlet for natural gas, and 0.5 scfm per inlet for vacuum, plus the flow required for individual equipment. Apply reasonable diversity factors to the system sizing based on the number of inlets/outlets.

I. Laboratory Waste.

In new buildings, do not connect sanitary and laboratory waste piping systems to each other inside the building. Collect waste lines independently at the site sanitary sewer. Consult ASU PM regarding collection and neutralization of laboratory waste before connection to the sanitary system.

The design of all hazardous waste systems must be reviewed and approved by both ASU FDM and EHS early in the design process.

Radioactive waste shall be independently collected and disposed of per the Office of Radiation Safety program.

SECTION 10

LCCA Section

Life Cycle Cost Assessment is encouraged early in the design to identify design alternatives that may support best value through least cost to ASU, over the life expectancy of the project. The detailed paramenters used in the analysis shall be reviewed with the owner and agreed upon prior to evaluation. Rates of return, cost of electricity (kW, kWh), cost of steam and chilled water , water and others are to be reviewed. Modeling of systems for anticipated energy use and recovery may apply. (Refer to Section 2, B, 2). Systems selected should follow the recommendations in these guidelines for simplicity, reliablity, maintainability, future support availability and similar. (Refer to Section 1, Engineering Design).

Index Section

Abbreviations

BAS = building automation system
Critical Program = highly technical or critical facilities , research, laboratories, health care, hazardous applications and similar.
CO2 = carbon dioxide as it relates to human emissions and ventilation
DCV = demand controlled ventilation
EH&S = ASU Department, environmental, health and safety , may include Fire Department
FDM = facilities development and management department
GPM = gallons per minute
HEX = heat exchanger, typically plate and frame, fixed or expandable
LEED = leadership in energy and environmental design
LTHW = Low Temperature Hot Water
LVDL = Laboratory Ventilation Design Levels (see ASHRAE TC 9.10)
MERV = filters, minimum efficiency reporting value
PM = ASU Project Manager
Ra = pertaining to ventilation, Chapter 4 IMC or ASHRAE 62.1, flow rate for area
STS = steam to steam
WG = water gage (or column)
WSFU = water supply fixture unit

Revisions Cycle

This guideline is a living document, typically maintained on a yearly basis, updated and released at the beginning of each year.

Revisions are by consensus agreement, internal to ASU, as approved at the Director Level and above.

Input and coordination of changes are by the "SME" subject matter experts, employeed by ASU.

External input and future changes are received by the SME and a running record of suggested changes are maintained with in the "Guidelines Repository" (Google Doc's, visible to all internal staff via request). Not all suggestions may be included per revision cycle. Suggestion for improvement are to be sent to the attention of the Guidelines Steering committee and or subject matter experts (SME's).

At the time of this release, ASU staff responsible for the up-keep, revisions, and future changes may be contacted by:

James H. Brown, PE, CEM, Leed AP via James.H.Brown@ASU.EDU
Anthony Gasca, PE via Anthony.Gasca.1@ASU.EDU

Revisions this Cycle

Changes for this release are indicated with a vertical line to the right of each change.