1.0 GENERAL

1.1 Related UBC Guidelines & Documents

.1 Section 23 00 00 HVAC (and all subsections)
.2 Section 20 00 00 Mechanical - General Requirements
.3 Section 01 91 00 Commissioning Requirements
.4 Section 25 05 00 Building Management Systems (BMS) Design Guidelines
.5 All other Tech Guidelines as may be applicable to a given project.

1.2 Related Documents External to UBC

.1 BC Plumbing Code and all references contained there within
.2 BC Building Code and all references contained there within
.3 Work Safe BC Occupational Health and Safety Regulation

1.3 Description

.1 The Guidelines apply to all work completed within buildings on both UBC Vancouver and UBC Okanagan campuses unless stated otherwise.
.2 In instances where conflicts are found between these guidelines and provincial regulations or codes, please notify UBC Mechanical Engineer.
.3 These guidelines are intended to be read by designers and their content integrated into construction drawings and specifications. Construction documents are not to reference the technical guidelines directly.
.4 It is the requirement of the mechanical designer to coordinate these requirements with other disciplines.

2.0 MATERIAL AND DESIGN REQUIREMENTS

These are requirements specific to UBC that may not exist in code or other jurisdictions. Any deviation from these guidelines requires a variance be granted.

2.1 Design Requirements

.1 Designs shall incorporate strategies for maximizing the delta-t of heating water across the building's mechanical systems. The maximum acceptable supply water temperature to the building heating system shall be 46°C with a preference for lower temperatures whenever possible. Return water temperature on a design day should be 35°C. For UBC Vancouver, refer to section 33 61 00 for maximum supply and return water temperatures to the district energy system on the primary side of the HEX. Select heat exchangers and system designs that can meet these requirements. Design strategies that may be employed to achieve the low return water temperature requirements include:
    .1 Selecting heating coils for large delta-t or using switchover coils.
    .2 Cascading perimeter heat in series with heating coils.
    .3 Heating water temperature reset.

.2 Controls design and specification shall comply with TG Section 25 05 00 – Building Management Systems Design Guidelines

.3 Any system that utilizes large central air handlers to serve multiple zones shall include re-heat coils for all zones.
  .1 VAV box's shall have re-heat coils
  .2 Zones within displacement ventilation systems shall have re-heat coils

.4 All perimeter air terminal units shall have heating coils (or re-heat coils)

.5 Freezer farms, rooms that are specifically designated to hold multiple freezers have special design requirements.
  .1 Freezer farms shall have dedicated cooling equipment (such as fancoils or water to air heatpumps), it's not acceptable to have freezer farms drive the supply air temperature of large air systems (which would then require excessive re-heat in other zones).
  .2 Due to the amount of equipment located in freezer farms, accessing equipment above the ceiling can be challenging. Special care needs to be employed to ensure reliable equipment access.
  .3 Ensure that freezer farms are designed for future capacity. At the engineer's discretion, it may be reasonable to assume that all available floor space is filled with freezers comparable to the units being installed at the time of design.
  .4 Depending on the quantity and nature of the equipment, consider installing parallel cooling equipment.
  .5 If the room cannot be sufficiently cooled (to prevent equipment trip) by jamming the door open then make sure that the ac equipment (and all associated central infrastructure) is on emergency power.
  .6 Freezers associated with research should be on emergency power
  .7 Floor mounted cooling units should be considered for these spaces for the ease of service access. Alternatively, consider high wall fancoils (see discussion in bullet below about cooling for IT and electrical rooms).

.6 Window mounted air conditioners and exhaust fans are not acceptable.

.7 Open ceilings generally make maintenance easier than drywall or t-bar. Work with the architect to install open ceilings in spaces such as communication closets, freezer farms, back of house prep areas, hallways, research labs.
  .1 Many of UBC's clientele (especially in the Science departments) prefer utility and flexibility over aesthetics. Consider the wide use of open ceilings when it has service or future flexibility benefits.

.8 All mechanical equipment that is related to temperature control, equipment that that requires scheduling, or any item that requires remote monitoring shall be connected to BMS.

.9 This point and all sub-bullets for UBC Vancouver Only: Refer to Section 20 00 30 Indoor Thermal Environment (UBC Vancouver) and I-B-53 Energy Policy for Classrooms for thermal design criteria. Some key points are:

.1 2.5% summer design condition for cooling systems at UBC shall be 31°C DB/ 23°C WB based on projected 2050s climate. See 20 00 30 for more info on how this was determined.
.2 Many spaces including learning spaces shall be designed for indoor temperatures of 25°C.
.3 Where possible use natural ventilation and passive principles to cool offices and transient spaces.
.4 Refer to the following for detailed design guidance:
.1 Climate Ready Requirements for UBC Buildings
.2 TG Section 20 00 30 – Indoor Thermal Environment
.3 I-B-53 Energy Policy for Classrooms.

.10 UBC's Climate Action Plan (CAP) has set a target of 100% reduction in GHG emissions below 2007 levels by 2050. In support of this plan, natural gas shall not be used as the primary heating source in new and replacement air handling and space heating equipment, including but not limited to rooftop units, unit heaters, space heaters, etc.
.1 At UBC Okanagan, gas heating is acceptable for backup heating where critical spaces require redundancy. Reach out to UBCO Campus Operation for details.
.2 At UBC Vancouver, gas is not acceptable, even for backup.

.11 Preferred approaches to cooling of electrical, IT, elevator machine rooms or similar utility spaces are below.
.1 Preferred cooling strategies (from preferred to least desirable are):
.1 No HVAC if loads are small enough
.2 Exhaust fan and transfer air if loads are small enough
.3 Chilled water fancoils
.4 Terminal heatpumps
.5 VRF or split cooling
.2 When loads are moderate, a cost-effective and maintenance supported approach to installing fancoils is to install ductless high wall fancoils (HWFC).
.1 These are most commonly seen on VRF systems but are available by several manufacturers with chilled water.
.2 The electrical TG's specifically ask designers to leave space above the doors for the installation of HWFCs. This is an ideal location because:
.1 If it is possible to open the door then it is possible to erect a ladder at this location.
.2 It is unlikely that there will be equipment below this location and therefore drips are less of a concern.
.3 Electrical is unlikely to clutter this space with riser conduits.
.3 Coordinate electrical rooms to not have ceilings whenever possible. Install the HWFC at high level so that the condensate drain can be run by gravity. Drop to the floor below if necessary. Avoid condensate whenever possible.\

.12 *Demand controlled ventilation requirements*
.1 *For spaces larger than 20m2 - provide occupancy sensor(s) that adequately detect motion of entire space.*

.2 *When motion has not been detected for a minimum of 15 minutes, the system goes into standby mode. Refer to section 25 05 00 for specifications on sensors and sequences. Unoccupied nighttime setbacks in laboratories are required per Section 23 38 00.*
.3 *For UBCO only - for spaces with a design occupancy larger than 50 people, provide CO2 sensors*
.4 *Additional requirements may apply as dictated by external codes and standards such as LEED.*

.13 All spaces with critical humidity requirements such as galleries or sensitive research spaces shall be specified with Vaisala HMT-120/130 sensors c/w display screen. Refer to the BMS TG 25 05 00 for more information.

2.2 Testing and Commissioning Requirements

.1 Any project which is modifying the central building system or installing new central infrastructure that will affect multiple spaces shall hire a Commissioning Authority (CxP). Refer to section 01 91 00 for more information. Some examples where this would apply are:
.1 Chiller replacement
.2 Boiler replacement where the piping has significant modifications
.3 Installation of manifolded fumehood exhaust system
.4 Full floor renovations
.5 Any project with a moderate mechanical scope or controls scope. If unsure, ask UBC Building Operations Mechanical Engineer

3.0 <u>LESSONS LEARNED & COMMON MISSES ON UBC PROJECTS</u>

Items in this section are not specific requirements of UBC but are code or industry best practices which have been missed on past jobs. These items should be considered in mechanical designs at UBC. However, if they’re not applicable then a variance is not required.

.1 Displacement ventilation systems are not suitable in many office environments where they may blow under desks or be affected by moving furniture. Displacement ventilation systems also provide limited options for modifications (i.e. increasing/decreasing supply air temp) if comfort requirements aren’t being met.

.2 Condensation from cooling coils is a common source of leaks. Please make sure that designs include these best practices:
.1 Condensate pans for all cooling coils
.2 Condensate pans for all heat recovery coils including glycol run around loops and chilled water exhaust coils
.3 Appropriately designed p-traps for negatively or positively pressurized plenums
.4 Adequate ceiling space for p-trap drops and sloped condensate lines
.5 Only use condensate pumps where absolutely necessary. Drain by gravity whenever possible.

.3 Elevator machine room drip pans under fancoils. Please be aware that the TSBC Elevator inspector expects that drain pans are installed under fancoils if they are installed in the elevator machinery room.

  .1 If possible, provide cooling with an exhaust fan or locate the cooling device outside the room and duct in.

  .2 If installing a fancoil in the room (for example high wall fancoil above the door) please coordinate a drain pan that does not encumber maintenance access.

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

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2.0 MATERIAL AND DESIGN REQUIREMENTS

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2.1 Design Requirements

.1 Glycol use in air handlers:
  - .1 This point and all sub-bullets for UBC Okanagan Only: All air handlers that are exposed to outdoor air (including mixed air units) are to use 30% uninhibited propylene glycol. Supplied glycol is to meet requirements of 23 25 00.
  - .2 This point and all sub-bullets for UBC Vancouver Only: All air handlers that are used for 100% outdoor air shall have glycol coils.
    - .1 Glycol loops shall be separated from the main building hydronic loop by heat exchangers.
    - .2 If the air handler has heat recovery (heat wheel, plate to plate or tempeff), is fully controlled by BMS and has a freeze stat directly wired to disable the fan VFD and has a pumped coil then glycol may be omitted at the designer’s discretion.

.2 Provide shutoff valves on the supply and return of all equipment. Use of balancing valves for isolation is not acceptable.

.3 Triple duty valves are not acceptable. Install, instead a balancing valve (or other flow measuring device), isolation valve and a check valve.

2.2 Equipment Requirements

.1 Pumps
- .1 All critical pumps shall be installed in duty/standby configuration. Lead/lag is not acceptable unless installing a triplex pump set lead/lag/standby.
  - .1 Critical pumps include most heating/cooling pumps and any pump with a possible freeze protection application as well as all other pumps of notable size or as identified by the consultant.
- .2 All pumps shall be displayed on BMS graphics showing the command and the feedback status. If a pump fails to run, an alarm shall be displayed on the front page of the graphics.

.2 Fluid Coolers and Cooling Towers
- .1 Closed loop fluid coolers are preferred to cooling towers. Where sizing pushes a project towards an open loop cooling tower, submit a variance application.
- .2 Cooling towers/fluid coolers over 8 ft high shall have service platforms with permanent ladders.
- .3 Multi-cell cooling towers with separate sumps shall have equalizing line of sufficient size to maintain water level in all sumps.
  - .1 Provide external equalizing lines c/w isolation valves. Do not provide internal equalizing flume as these are challenging to close off to drain and clean individual basins.
- .4 Provide a multifunction controller for chemical treatment complete with:
  - .1 Conductivity based bleed
  - .2 Makeup scale and corrosion inhibitor
  - .3 Dual biocide feed based on calendar clock
- .5 Cooling towers/fluid coolers over 100T shall have BACnet connected BTU meters installed on the inlet/outlet which log instantaneous power (kW) and cumulative energy (kWh)
- .6 All closed loop fluid coolers or dry coolers that are not drained/winterized in the winter shall run a glycol mixture.
  - .1 In buildings that incorporate the fluid coolers into the heating water loop as part of a heat recovery setup, the fluid cooler shall be separate from the main loop with a heat exchanger.

.3 Chillers
- .1 Specify minimum five year warranty.
- .2 Where chillers with brazed plate heat exchangers are used, provide parallel strainers selected for full flow c/w isolation valves so that each strainer can be cleaned independently. Strainers shall meet chiller manufacturer requirements (typically 60 mesh). Provide pressure gauges piped across the strainers for measuring pressure drop (one set of gauges for both strainers is okay).
- .3 Barreled chillers where the shell and tube hex can be opened at both ends are preferred to modular chillers

.4 Brazed plate heat exchangers are not to be installed on piping systems connected to an open loop cooling tower.

.5 Modular chillers or heat pumps must be installed with isolation valves on condenser and chilled water heat exchangers.

.6 Chillers over 40T shall be provided with a BACnet connected power meter (electricity) which logs instantaneous power (kW) and cumulative energy (kWh).

.7 Installed chillers must have a Prime Mover Nameplate kW Rating, as defined by the BC Safety Authority Directive D-BP-2013-02, of less than 200 kW. Units over 200 kW nameplate rating fall under continuous supervision status plant operation and require a variance from the Technical Guidelines to be specified and installed.

.8 Chillers connected to open loop cooling towers shall be specified with marine water box's on the condenser. These attachments make it easier to clean and test the tubes as the condenser can be accessed without disconnecting the adjoining piping.

.1 Note that this is anticipated most frequently on retrofits to existing buildings as new buildings typically have closed loop systems and this is indicated by TG 23 21 00 - 2.2.2

.9 Air source chillers / heatpumps shall be fed with glycol. This glycol loop shall typically be separated from the main hydronic loops with a heat exchanger.

.1 Replacement air source chillers in scenarios that don't already have glycol are exempt from this requirement. However, even in these replacement situations, glycol is still desired – please coordinate with UBC Facilities to discuss options.

.4 Boilers or chillers with aluminum heat exchangers are not acceptable because they do not align with UBC's water treatment procedures.

.5 Expansion tanks shall be installed on all hydronic systems.

.1 Specify expansion tanks with the "bladder monitor" feature where available. This is offered by several major manufacturers and provides a pressure gauge and a bladder leak indicator which changes colour from white to red when a leak occurs.

.2 All expansion tanks shall have an isolation valve from the system. Between the isolation valve and the expansion tank there shall be a drain valve.

.1 This is necessary to accommodate maintenance of expansion tanks which requires to first isolate, then drain the expansion tank before proceeding with maintenance such as checking the bladder pre-charge.

.6 Avoid oversizing chillers/heatpumps and select equipment with enough stages that compressor cycling is minimized.

.1 Chillers/heatpumps shall operate with an average cycle time of greater than double the minimum cycling time recommended for the unit by the manufacturer. Average cycling time shall be calculated per equipment stage as the annual operating hours divided by the number of annual starts.

.7 Heat tracing is to be monitored by the BMS. Dedicated heat trace controller must include hardwired alarm contact to BMS or bacnet communication interface for monitoring. CT based alarm for BMS is not acceptable as it is considered unreliable for self-regulating heat trace.

2.3 Construction and Material Requirements

.1 Acceptable piping systems (this section is a work in progress, please email andrew.porritt@ubc.ca to request updates – most industry standard, non-proprietary systems will be accepted)
  .1 Heating Water
    .1 Black iron (all manufacturers with local support and proven track record)
      .1 Grooved for 3” and above
      .2 Threaded for 2” and below (with regular use of unions)
      .3 Welded with flanges
    .2 Type K Copper (solder, grooved or flanged)
    .3 Uponor (up to 3”)
      .1 Not acceptable within 20’ of district energy heat exchangers
      .2 BMS to Close the DES primary side valve and throw a latching high temperature alarm if the water temperature leaving the DES heat exchanger exceeds setpoint by more than 10C. This high temperature alarm should be considered a critical alarm due to the damage that overheating water can do to plastic pipe. There must be substantial labelling (on BMS graphics and on site) stating the max temperature and implications of higher temps.
      .3 There must be substantial labelling (on BMS graphics and on site) stating the max temperature and implications of higher temps
  .2 Cooling Water
    .1 Black iron (all manufacturers with local support and proven track record)
      .1 Grooved for 3” and above
      .2 Threaded for 2” and below (with regular use of unions)
      .3 Welded with flanges
    .2 Type K Copper (solder, grooved or flanged)
    .3 Uponor (up to 3”)
  .3 Condenser Water
    .1 Black iron (all manufacturers with local support and proven track record)
      .1 Grooved for 3” and above
      .2 Threaded for 2” and below (with regular use of unions)
      .3 Welded with flanges
    .2 Type K Copper (solder, grooved or flanged)
    .3 Uponor (up to 3”)

.2 Insulation Requirements
  .1 Chilled water and condenser water piping shall have continuous vapour barrier.
  .2 All piping 3” and over shall have h-block supports at the hangers.
  .3 Indoor piping
    .1 Insulation shall have paper wrap (even in existing mech rooms which have canvas)
    .2 Pre-formed PVC elbows
  .4 Outdoor piping
    .1 Insulation shall have continuous pvc wrap which is UV stable and sealed to prevent water ingress into the insulation.
    .2 Pre-formed, PVC elbows
  .5 Chilled and condenser water pump bodies shall be insulated with pre-formed foam (preferred) or closed cell adhesive foam.
  .6 Thickness and additional specifications by consulting engineer.

.7 Heat exchangers, valves 3" and over and other special fittings shall have removable insulation blankets.

.8 Plastic pipe shall have the same insulation requirements as metal pipe except that additional supports shall be used when required by code.

.1 Trays shall always be used when the pipe is flexible.

.3 Provide valve handle extensions on all chilled and condenser water valves where they penetrate piping insulation.

.4 Wafer style valves are not acceptable. All valves shall be capable of end of line isolation.

.5 Provide pressure test plugs (Petes Plugs or Winters Test Plugs) at all locations that a pressure gauge is installed and on both sides of all differential pressure sensors. The reason for this is that pressure gauges are notoriously inaccurate and this can be used to validate them and also to commissioned differential pressure sensors.

.6 Where filters are required, the housings must either have:

.1 Twist off shells (ex. typical hydronic sidestream filter with ¾" connections)

.2 Swing-bolt lids (ex. large specialty water system filters, central side stream filters with 2" connections)

.1 Band-clamp closures are not acceptable.

.7 Glycol system requirements

.1 Glycol feeders shall be provided with a low-level alarm. Connected to BMS where practical (eg new build), audible where not.

.2 Provide a receptacle near the glycol feeder

.3 Provide a hose bib protected by a backflow preventer near the glycol feeder

.4 All auto air vents and pressure relief valves on glycol systems should be piped back to the feeder

.1 Where not practical to pipe back to the feeder, use manual air vents

2.4 Testing and Commissioning Requirements

.1 This point and all sub-bullets for UBC Vancouver Only: UBC Building Official shall be invited to witness all tests that are required by code or the tech guidelines.

.2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure.

.1 Maintain test pressure without loss for 48hr.

.3 For renovation projects, all new lines shall be flushed and pressure tested prior to connecting to the base building system.

.4 This bullet and all sub bullets shall apply to UBC Vancouver Only: Projects that do work on building hydronic systems shall be responsible for chemical treatment. The mechanical engineer is responsible for specifying the water treatment protocol and which chemicals are required. The contractor is responsible to hire a specialized water treatment company to supervise and direct, at a minimum the below:

.1 New Buildings
  - .1 Flush and clean each loop including circulating a cleaning/dispersant chemical for 24 hours or as recommended by the chemical cleaning company. Provide a report of completed flushing by the chemical treatment company indicating that the water has been tested to confirm that the cleaning chemicals have been removed from the system.
  - .2 Supply and install appropriate chemicals as determined by the engineer and the water treatment company - chemical scale and corrosion inhibitor (closed loops) or algaecides (open loops)
  - .3 Provide final test report after all treatment and flushing indicating that the system is clean and at normal levels.

.2 Existing buildings
  - .1 At project outset, take a sample water quality reading. Use this sample to identify any existing deficiencies in water quality. If water quality is sub-par, provide the Project Manager with a proposed plan to remediate. UBC may, at their discretion choose to proceed with this work.
  - .2 If required (as determined by the engineer and water treatment company), flush and clean each loop including circulating a cleaning/dispersant chemical for 24 hours or as recommended by the chemical cleaning company. Provide a report of completed flushing by the chemical treatment company indicating that the water has been tested to confirm that the cleaning chemicals have been removed from the system.
  - .3 At project completion, supply and install appropriate chemicals as determined by the engineer and the water treatment company - chemical scale and corrosion inhibitor (closed loops) or algaecides (open loops)
  - .4 Provide final test report after all treatment and flushing indicating that the system is clean and has achieved, at a minimum levels equal to the project outset testing.

.3 Each analysis shall include at a minimum:
  - .1 Total suspended solids
  - .2 Total suspended iron
  - .3 Total hardness
  - .4 Total dissolved solids
  - .5 Magnetite
  - .6 pH
  - .7 Conductivity

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

.1 Section 23 00 00 HVAC (and all subsections)
.2 Section 20 00 00 Mechanical - General Requirements
.3 All other Tech Guidelines as may be applicable to a given project.

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2.0 MATERIAL AND DESIGN REQUIREMENTS

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2.1 Design Requirements

.1 All condensate receivers shall have an overflow, piped to drain through a condensate cooler/quench tank.

.2 All condensate receivers and quench tanks shall be vented outside the building.

.3 Autoclaves
  .1 Preference is for autoclaves that have unitary electric steam generators with automatic blow down to quench tanks.
  .2 Central steam boilers shall only be considered in buildings with a very high density of equipment that requires process steam.

.4 This point and all sub-bullets for UBC Vancouver Only: Humidification shall only be provided where it has research impacts; for example some labs such as animal care have specific humidity requirements or areas that house art or rare books.
  .1 In general, humidification shall not be provided for occupant comfort because Vancouver's mild climate does not justify the added cost, complexity and energy.

.5 Ultrasonic and spray/adiabatic humidifiers are not acceptable because of the risk of bacteria growth / airstream contamination and because of the maintenance requirements of the upstream filtering and deionizing equipment.
  .1 If there is a strong desire to pursue this technology and a large carbon impact (lab AHU>10,000CFM) then UBC Facilities is open to discussing the use of this technology and whether they are able to support it. A variance would be required.

2.2 Construction and Material Requirements

.1 Acceptable piping systems
  .1 Steam (treated with amines)
    .1 Schedule 80 Carbon Steel
    .2 Schedule 40 Carbon Steel
  .2 Condensate Return (treated with amines)
    .1 Schedule 80 Carbon Steel
  .3 Steam (untreated)
    .1 304 Stainless steel
  .4 Condensate Return (untreated)
    .1 304 Stainless steel

.2 Insulation
  .1 In mech rooms or other exposed installs
    .1 Insulation shall have canvas jackets
  .2 In ceiling spaces and other concealed indoor locations
    .1 Insulation shall have paper wrap (even in existing mech rooms which have canvas)
    .2 Pre-formed PVC elbows

.3 No brass or bronze valves shall be used on steam systems.

.4 All steam systems shall include provisions for “double block and bleed” isolation. UBC Staff are unable to work on steam systems unless a double block and bleed isolation is in place.

.5 Unions shall be provided at regular spacing throughout steam systems so that any piece of equipment or valve can be replaced without having to substantially dismantle the system.

2.3 Testing and Commissioning Requirements

.1 This point and all sub-bullets for UBC Vancouver Only: This UBC Building Official shall be invited to witness all tests that are required by code or the tech guidelines.

.2 Hydraulically test steam and hydronic piping systems at 1-1/2 times system operating pressure.
  .1 Maintain test pressure without loss for 48hr.

3.0 LESSONS LEARNED & COMMON MISSES ON UBC PROJECTS

Items in this section are not specific requirements of UBC but are code or industry best practices which have been missed on past jobs. These items should be considered in mechanical designs at UBC. However, if they're not applicable then a variance is not required.

.1 Where central steam boilers are installed for process loads, the steam is typically treated with neutralizing amine chemicals to prevent damage to the condensate return lines. However, the use of amines may be un-acceptable in live steam humidification systems. In some cases using chemically treated steam may be unacceptable for sterilizing processes as well. Please consider steam chemical treatment requirements in your design and as a result, consider separate systems for humidification and for process loads. Steam system designs need to indicate which boilers should be treated with amines.

.2 This bullet and all sub-bullets for UBC-V only: Humidifier selections need to consider the water quality at UBC Vancouver. UBC-V has observed a high failure rate of stand-alone humidifiers.

- .1 UBC water measures an average of ~50micro-siemens/cm (water is from Metro Vancouver so presumably this is typical for the region).
- .2 Consult manufacturer specifications for acceptable water conductivity ranges.
- .3 Electrode humidifiers are not acceptable at UBC-V as they typically require minimum water conductivity of 300 micro-siemens/cm so UBC-V water is too pure for them to operate properly.
- .4 Some resistive humidifiers use water level probes which rely on conductivity and may not work with Vancouver water.

.3 Permits for boilers and pressure vessels:

- .1 Per the BC Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation – all steam boilers over 20kW (including steam generators integral to autoclaves) require a TSBC installation permit and need to comply with the requirements of CSA-B51.
- .2 Per the BC Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation - most pressure vessels do not require a TSBC Installation Permit however they are regulated equipment and they do require a TSBC Operating Permit. While they will not be subject to the installation inspection process that comes with a TSBC Installation Permit, they will be subject to annual inspections that come with a TSBC Operating Permit.
- .3 Refer to UBC Document, CPG-03 – Regulatory Requirements of Boilers, Pressure Vessels and Refrigeration Systems for more info.

.4 Per CSA-B51, pressure relief valves off all regulated equipment (this includes steam boilers and pressure vessels) must discharge in a safe location. This is commonly interpreted by TSBC (and supported by UBC) as meaning:

- .1 Relief valves off steam generators larger than 20kW shall be:
  - .1 Preferred - piped to the outdoors (all new builds should provide a pipe for this purpose)
  - .2 Or, if not practical to go to the outdoors, they may relieve in the room if a mechanism to collapse the steam is provided prior to discharging to drain (this is not necessarily a straight forward option) and the approach used is acceptable to the TSBC Safety Officer
- .2 Relief valves off pressure vessels (ex. Autoclaves, autoclave jackets) may be either:
  - .1 Piped to the outdoors
  - .2 Relieve inside the room if it is safe to do so in the opinion of the Engineer of Record and the TSBC Safety Officer
    - .1 No risk of scalding room occupants
    - .2 Noise level of discharging PRV is not dangerous

.3 Potential steam charge doesn’t have any contaminants dangerous to human health

.5 Per ASME CSD-1 (which is referenced in CSA-B51), all steam boilers (including steam generators integral to autoclaves) require an emergency shutoff button near the main exit door.

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

.1 Section 23 00 00 HVAC (and all subsections)
.2 Section 23 38 00 Fume hood and Lab Exhaust
.3 Section 20 00 00 Mechanical - General Requirements
.4 All other Tech Guidelines as may be applicable to a given project.

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2.0 MATERIAL AND DESIGN REQUIREMENTS

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2.1 Design Requirements

.1 Underground HVAC Ducts are not acceptable.

.2 For all heating/cooling coils, ensure that access is provided to replace the coils without necessity to dismantle adjacent equipment or building components.

.3 Variable pitch fans are not acceptable.

.4 Fan Array Requirements:
 .1 All fan arrays shall have back draft dampers associated with each fan. Such that if any one fan fails, the others can continue to run without short circuiting through the failed fan (this includes air handlers where parallel fans are used).
 .2 BMS shall receive status on each individual fan within a fan array and this shall be displayed on the graphics.

.3 Preference is that BMS has direct control over each fan in the array (enable, status, speed, alarm, BACnet). If this is not possible, the controller must connect to BMS with enable, status, speed, alarm and BACnet.

.5 VAV Diffusers are not acceptable at UBC. Small VAV's are similar in cost and a better fit for the institutional environment.
.1 This technology is, in our opinion not suitable for integration into large VAV air-handling systems. It hinders and limits system operation because they do not integrate well with BMS systems and they do not have reheat coils.

.6 Provide heat trace & insulation on all exterior drain pipes including but not limited to:
.1 Cooling tower overflow drains
.2 Condensate drains (including air handling unit p-traps and heat recovery unit p-traps). The purpose of this is to ensure that equipment can drain during cold weather and to mitigate the risk of damage from a burst coil.

2.2 Construction and Material Requirements

.1 Filters
.1 Air filters provided for use in primary air handling equipment must adhere to the following nominal trade sizes:
.1 24" x 24" x 2"
.2 12" x 24" x 2"
.2 This bullet and all sub-bullets apply to UBC Vancouver only: Filters in primary air handling equipment for standard academic buildings shall filter to MERV 13.
.1 Filters in special applications such as lab buildings shall have MERV ratings as determined by the consulting engineer.
.3 This bullet and all sub-bullets apply to UBC Okanagan only: Filters in primary air handling equipment shall filter to MERV 15
.1 Use micropleat filters with a frame depth of 12" (300mm)
.2 Filters shall not support microbial growth
.3 Filter frames shall be ABS construction with header complete with neoprene gasket seal to prevent any air bypass and allow filters to be incinerable.
.4 Air systems shall be designed to handle a final pressure drop across filters of at least 375Pa WC (1.5"WC) at a flow rate of 2.5m/s (500ft/min)
.5 Confirm with UBCO Operations that equipment is compatible with standard UBCO filter supply and operation.

.2 Flex connectors shall be supplied on the inlet and outlet of all ducted fan equipment (fancoils, fans, air handlers, etc.)

.3 Flex connectors shall not be used to connect ducts of different size/shape

.4 Direct drive fans are preferred.

.5 When belt drives are required, the following applies:
.1 Multiple belts must be matched sets
.2 Cast iron or steel sheaves secured to shafts with removable keys shall be used

.3 Adjustable pitch sheaves are commonly supplied on fans and while useful for balancing, they shall not be left in place at project completion as they lead to increased belt ware. It is suggested that consultants include in their spec that the balancer should be responsible for changing the sheaves.

.4 For motors 7.5 kW and over sheave with split tapered bushing and keyway having fixed pitch.

2.3 Testing and Commissioning Requirements

.1 Mechanical Designer is responsible for specifying cleaning requirements and ensuring that the HVAC system is turned over clean of construction dust/debris and ready for use.

.1 Projects modifying existing ducts systems shall clean all existing ductwork within their project boundaries.

.2 Filter access demonstration.

.1 During the project demonstration UBC Facilities reserves the right to ask the contractor to demonstrate the removal and replacement of 5% or Q=5 (which ever is greater) filters at the UBC Facilities representatives choosing.

.2 If the filters are not reasonably accessible, the contractor shall make modifications and demonstrate to UBC Facilities at which time UBC Facilities may ask for a further 5% or Q=5 to be demonstrated.

3.0 LESSONS LEARNED & COMMON MISSES ON UBC PROJECTS

Items in this section are not specific requirements of UBC but are code or industry best practices which have been missed on past jobs. These items should be considered in mechanical designs at UBC. However, if they're not applicable then a variance is not required.

.1 Avoid putting air moving equipment such as fancoils above classrooms as they lead to acoustic issues.

.2 It is common that acoustic return air boots are not installed or are incorrectly installed (line of sight to the fan section is not completely obscured). Please see that this item is addressed during design and construction.

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

.1 Section 23 00 00 HVAC (and all subsections)
.2 Section 20 00 00 Mechanical - General Requirements
.3 All other Tech Guidelines as may be applicable to a given project.

1.2 Related Documents External to UBC

.1 BC Plumbing Code and all references contained there within
.2 BC Building Code and all references contained there within
.3 Work Safe BC Occupational Health and Safety Regulation

1.3 Description

.1 The Guidelines apply to all work completed within buildings on both UBC Vancouver and UBC Okanagan campuses unless stated otherwise. In instances where conflicts are found between these guidelines and provincial regulations or codes, please notify UBC Mechanical Engineer.
.2 These guidelines are intended to be read by designers and their content integrated into construction drawings and specifications. Construction documents are not to reference the technical guidelines directly.
.3 It is the requirement of the mechanical designer to coordinate these requirements with other disciplines.

2.0 MATERIAL AND DESIGN REQUIREMENTS

These are requirements specific to UBC that may not exist in code or other jurisdictions. Any deviation from these guidelines requires a variance be granted.

2.1 Design Requirements

.1 All exhaust ductwork for Class 3 exhaust or greater (as defined by Ashrae 62.1) shall be negative while within the building. Class 3 exhaust may be positive in mech rooms. Class 4 exhaust may be positive in mech rooms provided that exhaust fans are in their own separate mech room. Please review The Fumehood Mechanical Room and Rooftop Access Policy I-B-06 and ensure that all designs comply with this policy – some pitfalls are:
  .1 UBC uses leak detector on the flex connections and ductwork on the positive side of the fan to check for air leaks.
  .2 Special attention must be paid to drains on fumehood exhaust fans. Many fans have these drains on the positive side of the fans. Where this is the case, these drains are a source of contaminated air leakage that must be addressed to comply with UBC's roof access policy. Caution that there are many pitfalls with using p-traps as maintaining a positive seal is challenging – trap primers typically have air gaps built in which can themselves become a source of leakage. Please reach out to UBC Facilities if you would like to discuss this item.

.2 On all manifolded fumehood exhaust systems, provide pressure relief doors (implosion doors) on the pressure exterior ductwork. Mechanical engineer to size the door to ensure that duct pressure cannot exceed duct pressure rating in any foreseeable operating circumstance (ie all upstream dampers closed or in min position with fan running).

.3 See Section 11 53 13 Fume Hoods, for design and face velocity requirements for fume hoods.

.4 Radio isotope cabinets to be on separate fans, not connected to other systems or other RI cabinets.

.5 Fumehood numbering/labelling requirements:
- .1 Attached to the fumehood
  - .1 Fumehood equipment tag (FH-ROOM-INDEX#) (see TG 20 00 08)
  - .2 Associated exhaust fan
    - .1 If installing a new system then the exhaust fan tag should indicate the location of it. However, if connecting to a fan where the tag does not indicate the location then add this information (ex FEF-05 (Roof)).
- .2 Attached to the exhaust fan
  - .1 Exhaust fan tag (FEF-FLOOR-INDEX#) (see TG 20 00 08)
  - .2 List of associated fumehoods
    - .1 These lamacoids made end up being quite large for manifolded systems, be sure to allow for this. Use multiple lamacoids if required.
  - .3 Associated disconnect (VFD, starter, or breaker)
- .3 Attached to the VFD
  - .1 VFD tag (VFD-FLOOR-INDEX#) (see TG 20 00 08)
  - .2 Associated exhaust fan
  - .3 Associated disconnect

.6 Decision to install scrubbers for percloric acid or similar uses shall be reviewed with UBC Risk Management Services during the design phase.

.7 Where fume hood exhaust stacks are used their design shall comply to WSBC and ANSI Z9.5.
- .1 Manifolded exhaust systems are often preferred and are acceptable as described by WSBC.

.8 In new buildings, stacks shall be grouped together to provide an aesthetic appearance when viewed from street level.

.9 When installing manifolded fumehood exhaust systems with heat recovery coils:
- .1 Filters shall be provided upstream of the coils.
- .2 Means shall be provided to service the filters or coils without shutting down the fumehood exhaust system. Options for this include:
  - .1 Large by-pass sections complete with dampers (which may be motorized or have manual handles)
  - .2 Installing a coil for each fan, downstream of the isolation damper.

.10 For lab exhaust systems all devices directly related to the lab need to be on the same BMS controller so that there isn't a lag in response times. For example if a fumehood sash height sensor isn't on the same controller as the exhaust fan (or pressure independent exhaust valve) then there can be a lag in response time and the hood can go into alarm before the fan speed ramps up.

.11 Provide minimum of 8 air changes per hour (ACH) for all wet laboratories during occupied hours and, where possible, an unoccupied nighttime setback to 4 ACH. Laboratories designed with 4 ACH unoccupied nighttime setback must have adequate motion detection to override nighttime setback conditions when occupied, as well as adequate VAV supply and exhaust control. Alternate proposals to be reviewed with UBC Facilities and approved by UBC Safety and Risk Services.

.12 All constant volume, bypass type fumehoods must run 24/7 including new installs and renovations of existing as per UBC Safety and Risk Services. This policy is in place to protect against possible improper use of the hood such as storing chemicals or running an experiment within a closed hood that is turned off.

- .1 This approach simplifies the HVAC system as the supply and general exhaust does not need to account for changes in the hood operation.
- .2 If there is a lab renovation where the hood previously had a on/off switch, then the project shall modify fumehoods that are within scope to run 24/7 including the associated room HVAC pressure controls sequence if necessary.
- .3 In many cases there is no energy penalty to this approach as spaces with a low density of fumehoods are unlikely to dictate the room air change rate.
- .4 See TG 11 53 13 for possible other scope on existing hoods.

.13 Makerspaces, workshops, electronics laboratories with soldering and other similar spaces shall be appropriately ventilated to manage airborn contaminants. Air within these spaces shall be considered, at a minimum, Class 2 as defined by ASHRAE 62 and shall not be suitable for recriculation to most other spaces.

.14 3D Printers are a source of airborne contaminants. Spaces that house 3D printers shall be designed with the below considerations in mind:

- .1 Designers shall be familiar with the document "Approaches to Safe 3D Printing: A Guide for Makerspace Users, Schools, Libraries and Small Businesses" as published by the US National Institute of Occupational Safety and Health (NIOSH) especially 4.4 - Engineering Controls.
- .2 Mechanical Engineers shall utilize a combination of local exhaust, ventilated enclosures, air change rate and filtration as recommended by the NIOSH article above.
- .3 The air in spaces that contain more than two PLA 3D printers shall be considered Class 2 as defined by ASHRAE 62 and shall not be suitable for recirculation to other spaces
- .4 The air in spaces that contain any number of resin or ABS 3D printers shall be considered, at a minimum Class 2 as defined by ASHRAE 62 and shall not be suitable for recirculation to most other spaces

2.2 Construction and Material Requirements

.1 Fumehood exhaust material requirements - All fumehood exhaust shall be constructed of welded stainless steel as a minimum. Mechanical Engineer to determine if a more resistant material is required such as CPVC. Lesser materials such as galvanized steel aren't acceptable even if the exhaust is non-corrosive because it's impossible to forecast future uses of fumehoods.

  .1 Whatever resistant material is deemed necessary, this standard must be carried through all connected equipment including fans and pressure independent air control valves.

.2 Flex connections on inlet and outlet of fumehood exhaust fans shall be installed:

  .1 Between two round ducts of the same diameter which are completely in line with each other and which are ~1" apart.

  .2 Out of a single piece of flexible material (rubber or other material suitable for the contaminated exhaust stream) which overlaps the ducts on each side by 1" minimum and overlaps onto itself by 3" minimum.

  .3 The flexible material shall be glued to itself to create continuous loop around the duct.

  .4 The flexible connector shall be connected to the ductwork with two stainless steel worm-drive duct clamps on each side of the flex connector.

.3 Sound attenuators and internally line ductwork are not acceptable on fumehood exhaust ductwork.

.4 Provide hasps on all fumehoods so that the fumehoods can be locked shut for servicing the exhaust air system.

2.3 Testing and Commissioning Requirements

.1 Refer to section 11 53 13 - Fumehoods

3.0 LESSONS LEARNED & COMMON MISSES ON UBC PROJECTS

Items in this section are not specific requirements of UBC but are code or industry best practices which have been missed on past jobs. These items should be considered in mechanical designs at UBC. However, if they're not applicable then a variance is not required.

.1 When manifolding multiple fumehoods into a single exhaust system, ensure that the requirements of ANSI Z9.5 are met for system reliability (typically multiple fans) and flow regulating devices (pressure independent air valves).

  .1 All manifolded exhaust systems need to run 24/7 as per ANSI Z9.5. Minimum airflow volumes for closed vav hoods shall be per ANSI Z9.5 (3.3.2).

.2 WSBC regulations do not currently allow low flow fumehoods. Face velocities must be between 80-120fpm

  .1 WSBC regulations do not currently allow fumehood occupancy sensors to reduce face velocity (when the area in front of the hood is vacant). However, a hood occupancy sensor may be used to prompt the researchers to close the sash.

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

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.2 Section 20 00 00 Mechanical - General Requirements
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2.0 MATERIAL AND DESIGN REQUIREMENTS

These are requirements specific to UBC that may not exist in code or other jurisdictions. Any deviation from these guidelines requires a variance be granted.

2.1 Design Requirements

.1 CSA B52 describes signage requirements for machinery rooms. At UBC these signage requirements shall be extended to all mechanical rooms with central chillers. In addition to the information required by CSA B52, the signage shall include the following: "For assistance contact UBC Building Operations Service Centre: 604-822-2173".

.2 Refrigerant leak detector requirements are:
  .1 Visual and audible alarm inside the mechanical room and outside each door.
  .2 Refrigerant PPM display outside the mechanical room.
  .3 Signage on the door(s) indicating the equipment type, refrigerant type and quantity per TSBC Reqs.
  .4 Manual override button for the exhaust fan.
  .5 BMS to monitor the refrigerant detector alarm as well as the fan status.

2.2 Equipment Requirements

.1 See section 23 21 00 – Hydronic Systems for building level chiller requirements

.2 Use of domestic water cooled condensing units (i.e. once through cooling) is not permitted. This includes HVAC equipment as well as specialty lab equipment, cold rooms, ice makers and other similar devices.

.3 When VRF systems are used, the expectation is that they will generally have a standalone control system. Provide a manufacturer supported bacnet gateway and integrate into the Building Automation System for monitoring and alarms.

  .1 If VRF systems are providing cooling to a critical space then provide a temperature sensor connected to the BMS for alarms only.

.4 VRF systems are not acceptable as a building wide solution for new buildings.

2.3 Construction and Material Requirements

.1 Brazed joints are required for all field installed refrigeration joints. Compression couplings aren't acceptable.

.2 All exterior refrigerant piping insulation shall have aluminum hard covers to protect the insulation from UV and birds.

3.0 LESSONS LEARNED & COMMON MISSES ON UBC PROJECTS

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.1 Unitary refrigerant equipment such as terminal heatpumps, split systems and especially VRF systems often have higher maintenance cost and lower reliability compared to chilled water systems. These systems should only be used for targeted cooling or special applications such as retrofitting cooling on a relatively small scale.

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