

1.0 **GENERAL**

1.1 **Related UBC Guidelines & Documents**

- .1 Section 20 00 00 Mechanical (and all subsections)
- .2 Section 21 00 00 Fire Suppression (and all subsections)
- .3 Section 22 00 00 Plumbing (and all subsections)
- .4 Section 23 00 00 HVAC (and all subsections)
- .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.
- .5 This section of the Technical Guidelines is the parent of Division 21, 22 and 23. All requirements here, apply equally to those sections.

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 projects shall be subjected to UBC's design review process. Reviews will generally be conducted by representatives from UBC Facilities as well as other stakeholders. Requirements will vary depending on project. Consultants should work with UBC Project Managers to identify key steps.
- .2 All buildings shall utilize district energy
 - .1 This point and all sub-bullets for UBC Vancouver Only: All new and renewed buildings shall utilize district energy as the primary source of external heat opposed to boilers.
 - .1 When heatpump systems are utilized, district energy shall be used for supplemental heat.

- .2 Specifications and design details are to follow those described Section 33 61 00 District Hot Water Energy Distribution. Section 20, 22 and 23 of the UBC Technical Guidelines apply to secondary piping only. Refer to Section 33 for all information on primary side DES piping including installation and piping details.
- .3 Where the district hot water heating system is not yet available to tie into the building, space is to be allowed for the installation of a heat exchanger to provide heat transfer to the building heating system.
- .2 This point and all sub-bullets for UBC Okanagan Only: All new and renewed buildings shall utilize district energy as the primary source of heating and cooling
 - .1 Refer to Section 33 61 00 for all information on primary side DES piping including installation and piping details.
- .3 Wherever specialty systems are being installed (ex solar collectors), coordinate with UBC Facilities during the design stage to ensure that their service requirements can be met.
- .4 Designers shall implement redundant or partially redundant systems when practical. Many buildings may have specific requirements for N+1 redundancy. In less critical applications, such as teaching buildings provide core building infrastructure provide multiple pieces of equipment at 50% each. For example:
 - 2x District energy heat exchangers at 50% each
 - 2x Chillers at 50% each
 - Steam boilers per individual piece of equipment instead of one serving multiple
 - Air Handlers at 50% each

2.2 Access Requirements

- .1 Installing piping above ceilings, out of reach of any access panel shall be avoided. Installing valves such that they cannot be reached through an access panel is not acceptable.
- .2 Access panels shall be installed wherever required to access valves, equipment, sensors, etc.
- .3 Any equipment that requires regular access for maintenance shall not be located in a confined space.
- .4 Access to piping chases shall be granted
- .5 Consideration shall be given to accessing, servicing and replacing plumbing fixtures – particularly when they're mounted against tile.
- .6 All manufacturer recommended clearances and service requirements shall be met.
- .7 The designer shall include general notes pertaining to equipment access. If access is not adequate then projects will be responsible for granting adequate service access.
- .8 All rooftop equipment (including fans) shall be accessible for service without the use of ladders. Provide access platforms if required.

- .9 Designs shall consider any rigging requirements. For example, how rigging is to be installed to remove motors, chilled end bells, etc. Where needed, structural members shall be installed for this purpose.
- .10 Avoid placing equipment above communication rooms, freezer farms or other sensitive spaces where the floor will generally be consumed by large equipment which is hard to move. Consider floor mounted equipment in utilitarian spaces such as these as they are easy to access and service.
- .11 Where ladders exceed 16 feet in height or where there is a danger of a worker falling from the ladder to the ground level, roof or floor including an elevated access from a platform having less than 1.2 meters (48 inches) clearance between the ladder and any adjacent guardrail. The cage shall commence not more than 2.2 meters (7 ft.) above grade and continuing at least 90 centimeters (36 inches) above the top landing with openings to permit access by a worker to rest platforms or to the top landing.
- .12 Equipment (including exhaust fans) shall not be placed within 10' of the edge of a roof unless a 3'-6" high guardrail or parapet is in place.
 - .1 Note that TG 07 00 10 requires such full-height guardrails or parapets on all new buildings, so this should only be a common consideration on renovation projects.
- .13 Under no circumstances shall any utility piping extend under buildings as direct buried and in not readily accessible locations. Entire length of utility piping must be readily accessible after project completion. This includes steam, condensate, any gas piping, heating water, cooling water, domestic water, fire protection water, chilled water, and storm and sanitary drainage not related to the building.
- .14 No equipment with regularly scheduled maintenance (i.e. filter changes) shall be located above wood slat ceilings or other integrated ceiling systems (ceilings that feature proprietary panels, clips, etc.) Examples include:
 - .1 Although not preferred, a VAV box, reheat coil or similar may be located above a wood slat ceiling when necessary provided that access panels are provided.
 - .2 A horizontal fancoil or terminal heat pump shall be located in an open ceiling or above t-bar (preferred) or above drywall when absolutely necessary.
- .15 All regularly scheduled maintenance (i.e. filter changes) must be able to be done off a 12' ladder.
 - .1 Although not preferred, a VAV box, reheat coil or similar may be located higher than 12' provided that either:
 - .1 The space is accessible by a scissor lift. If scissor lifts are anticipated for maintenance then coordinate elevator capacity and ensure that a clear pathway to the work area is present without steps.
 - .2 Or there is space to setup a simple vertical scaffold on flat ground. Setting up scaffold above stairs or tiered seating is not acceptable access to mechanical equipment.

.2 If fancoils or terminal heatpumps serve spaces with high ceilings then they shall be located outside the space in a location where they can be accessed from a ladder and ducted to the space they supply.

2.3 Equipment Requirements

.1 All equipment shall have local support including proof of representation by the same local supplier for a minimum of three years.

.2 Motors

.1 Requirements for variable frequency drives (VFDs):

.1 Refer to TG 26 29 23 -2.0.2 for electrical requirements for VFDs

.2 Refer to TG 25 00 00 – 7.21 for BMS requirement for VFDs

.3 Provide bypass only on critical applications where deemed appropriate by the designer. Avoid bypasses unless they're required.

.2 All motors over 1hp shall be MG1 Part 31 Inverter Duty.

.3 All motors over 20hp shall have shaft grounding rings.

.4 Requirements for electronically commutated motors (ECMs):

.1 Minimum BMS Connectivity

BMS Connectivity	Fractional HP ECMs (terminal units, small circulators, etc.)	ECMs > 1hp (air handlers, pumps, etc.)
Motor/drive enable (BO – input into drive from control device) (enables the drive to run, can be used to interlock for safety shut downs)	Required*	Required*
Motor/drive speed (AO – input into drive from control device) (this is a linear representation of the motor speed, 0-100% speed. “pressure or flow” control reset is not acceptable)	Required	Required
Motor/drive alarm (BI – output from drive into control device) (this is a dry contact that represents fault, as defined by the device manufacturer)		Required
Motor/drive status (BI – output from drive into control device) (represents drive is running)	** ***	Required ***
BACnet MS/TP master connection (slave connections are not acceptable) (modbus NOT acceptable) (Modbus to BACnet gateway NOT acceptable)		Preferred

* May be combined with the speed AO in some cases.

** Generally, a status is not required for fractional horsepower ECMs such as fancoils. However, DHW recirc pumps require status, even if they're fractional horsepower.

*** CTs are not recommended for status of an ECM. Due to the high turn down, ECM's which can read their max current draw may not be able to read their minimum current draw accurately. Ensure that a suitable CT or CS is used if you're relying on a 3rd party device for status.

- .2 It is not acceptable to use any pre-programmed functions built into ECM controllers (e.g. constant flow, constant pressure, proportional control, etc.) The primary reasons for this is that trouble shooting this controls approach and controlling access is very challenging at a campus wide level and if the controller is ever reset or replaced, it is very likely those settings also will be lost.
- .3 It is not acceptable to use pumps that require proprietary dongles or remote controls for setup. All settings must be available via local screen.
- .4 It is not acceptable to use integrated ECM sensors as primary control devices (such as differential pressure sensors built into ECM pumps). However, where possible, these sensors should be available through BACnet for monitoring and optimization.
- .5 ECMs 3hp or less must use 120/208V or 347/600V. It is preferred that ECMs larger than 3hp also use these voltages, however it is not a requirement at this time.

.3 Heat exchangers

- .1 This point and all sub-bullets for UBC Vancouver Only: All DES Heat Exchangers
 - .1 Primary side temperatures: 70C EWT, rated for 150C.
- .2 Brazed Plate Double Wall Heat Exchangers (for domestic hot water energy transfer stations)
 - .1 Rated for potable water service (NSF 372)
 - .2 Double wall design must include air vents and leak detection ports
 - .1 Leak detection via wetting anywhere over the entire exterior surface is not acceptable
 - .3 Plates shall be type 316L stainless steel and they shall be .4mm thick (minimum)
 - .4 Heat exchangers to be specified with removable insulation “blankets”

.4 Equipment such as boilers, chillers, variable speed drives, air handling units with integral control panels, or unitary HVAC equipment with integral controllers shall be capable of interfacing with UBC's Building Management System via BACnet protocol. All such equipment shall have IP set in the field (UBC to provide list of instance numbers). UBC is to be provided with all the tools to change the IP instance number in the future should it be required.

- .1 This does not preclude the fact that all central equipment (chillers, boilers, etc.) must have a hardwire BMS connection for enable, reset, alarm and status.
- .2 See section 25 05 00 – Building Management System (BMS) Design Guidelines.

.5 5th class plants as defined by the BC Boiler and Pressure Vessel act are not acceptable. This means that systems must be divided up to stay under BC Boiler and Pressure Vessel Act cutoffs for steam, refrigeration and hot water.

.6 Within the O&M Manual, provide an as-built equipment schedule prepared in spreadsheet format including:

- .1 Equipment type
- .2 Equipment Tag
- .3 Manufacturer
- .4 Model
- .5 Description
- .6 Location
- .7 Other information as may be pertinent
- .8 Detailed performance information (flows, capacity, etc) are not required in this table. This information can be looked up in the shop drawings as needed.

.7 Within the O&M, provide a filter schedule prepared in spreadsheet format including the below info for all equipment with filters

- .1 Tag
- .2 Equipment type
- .3 Location
- .4 Filter type
- .5 Filter size(s)
- .6 Filter quantity

2.4 Mechanical Room & Roof Requirements

- .1 Mechanical rooms shall, at a minimum have painted drywall c/w waterproof cove base sealed or integrated into the floor.
- .2 Where mechanical rooms are adjacent to occupied spaces provide special attention to the acoustic concerns; avoid placing critical spaces like offices next to mechanical rooms and consider the use of concrete or block walls which are resistant to moisture and have substantial sound deadening effect.
- .3 Mechanical rooms shall be accessible from the outdoors via double doors.
- .4 Mechanical rooms and roofs shall have keycard access. Coordinate with other disciplines during design phase as needed.
- .5 Floor shall have an elastic membrane coating when mechanical rooms are built over occupied spaces. Refer to TG 09 67 00 Fluid Applied Flooring for more information.
- .6 Designs shall minimize the mechanical equipment, which is installed exposed on rooftops, and ensure that all equipment installed on rooftops is suitable for outdoor installation:
 - .1 All buildings with a high density of rooftop mechanical equipment shall have fully enclosed mechanical penthouses to contain all air handlers, pumps, tanks, boilers, chillers, etc. and where practical exhaust fans and mixing box's.
 - .2 Exposed piping on rooftops should only include low point drains, high point air vents and manual isolation valves with valve stem extensions. Where additional piping accessories are required, a heated valve house shall be constructed. All pipes and electrical connections shall rise into this room and penetrate to the roof horizontally. All pumps, control valves, temperature sensors, strainers, etc. shall be installed in this room.

- .3 The designer may determine how to execute this concept including putting it on the side of an elevator overrun, as a freestanding structure, built into custom air handling equipment or other concepts that maintain the same design intent.
- .4 In situations where a "valve house" is not deemed necessary, insulated heating and cooling pipes shall not penetrate rooftops vertically with just a sleeve installed. A proper "dog house" shall be installed. This "dog house" shall have an overhang.
 - .1 Isolation valves may be installed under the overhang of the "dog house" provided that they have valve stem extensions so that the insulation is only minimally compromised.
- .5 Small diameter pipes such as refrigerant pipes and gas pipes may penetrate the roof through a gooseneck provided that the gooseneck is counter flashed into the roof and that the gooseneck is sealed to prevent insects, rodents and birds from entering the building through these penetrations.
 - .1 Where applicable consideration must be given to oil return and/or airlocks forming in goosenecks.
- .6 Plumbing vents flashed into the roof with a spun aluminum cap that overlaps the roof penetration or similar flashing are acceptable.
- .7 Exposed duct runs shall be minimized. Where they are used, structural steel supports integrated into the roof are required, the ductwork shall be insulated and clad with appropriate waterproof cladding (plated sheet metal shall not be exposed) and ductwork layout shall not impede access to equipment. Use of numerous ships ladders to go over ductwork does not constitute reasonable access.
- .8 See link here for 2018 memo which includes more details on this item:
https://www.technicalguidelines.ubc.ca/Division_20/Ref_materials/Roof_Memo_Apr2018.pdf

2.5 Construction Requirements

- .1 Where pipes penetrate through floor slabs they must be sleeved with a pipe that protrudes a minimum of 2" (50 mm) proud of the floor or a small housekeeping pad installed to prevent flooding to the floor below.
 - .1 Where riser clamps are used, an appropriate detail must be used such that the riser clamps do not sit on the sleeves.
- .2 All exposed materials prone to rusting (equipment supports, cut ends of unistrut, fasteners, exposed pipe sleeves, etc.). Shall be coated with rust inhibiting paint.
- .3 Insulation on piping or equipment shall be installed such that all factory or field installed labels remain visible.
 - .1 All piping shall have computer generated labels. Preference is to stack the lettering and display the full word description of the piping (i.e. "Domestic Hot Water", not "DHW" or "District Hot Water", not "DHW" or "Domestic Cold Water", not "DCW")
 - .2 All pipes that are accessible must be labelled every 10m and where they enter and leave rooms.
- .4 Pipe all equipment drains to floor drains.
 - .1 See plumbing fixture section for additional requirements.

- .5 All base mounted equipment shall sit on housekeeping pads, minimum 2" high and 4" wider than the equipment.
- .6 Cleaning
 - .1 Refer to 01 77 00 for further information
 - .2 Specify cleaning of interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.
 - .3 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.
 - .4 Specify new filters at turn-over, clean switch gear and VSD serving mechanical equipment inside and out.
 - .5 Specify removal of construction debris from the mechanical/electrical rooms.
- .7 No mechanical equipment or services shall reside in or pass through an electrical room or communications room unless they directly serve that room.

2.6 Demolition Requirements

- .1 Decommissioned equipment shall be demolished and disposed of in accordance with applicable codes and standards. No equipment shall be abandoned.
- .2 Where pressure vessels are decommissioned or abandoned, the contractor shall supply UBC Facilities with a photo of all labels on the equipment including the TSBC (previously BCSA) registration decal. The contractor shall also drill a hole in the equipment prior to disposal and shall confirm in writing to UBC Facilities that this has been done. This is so that we can cancel the operating permit for this equipment and stop paying the annual fees associated with it.
- .3 Decommissioned piping and ducts located within mechanical rooms shall be demolished and cut back to the edge of the mechanical space, capped and clearly tagged. No piping shall be abandoned within mechanical rooms.
- .4 Decommissioned piping may be abandoned outside of mechanical rooms to the designer's judgement. Pipes which are likely to be obtrusive to future use of the space or maintenance should be demolished. Abandoned pipes are to be clearly labelled as such – at least once per room and more regularly as required.
- .5 All dead legs shall be capped and disconnected as close as possible to the active pipe. Valves shall not be considered acceptable isolation from a dead leg. The dead leg piping/equipment shall be demolished as per the requirements above.

2.7 Water Feature Requirements

- .1 All ponds shall utilize standard building components that maintenance crews are familiar with servicing. Avoid the use of specialty pond manufacturers for components such as pumps.

.2 All ponds shall be controlled by a standard BMS Controller by one of UBC's approved providers. A graphic shall be constructed for the pond that is remotely accessible through UBC's BMS system.

2.8 Miscellaneous Requirements

- .1 Provide one set of special tools including computer hardware and software required to service equipment as recommended by manufacturers and in accordance with Section 01 77 00 Closeout Procedures.
- .2 Connections into existing systems to be made at time approved by owner. Request written approval of time when connections can be made.

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 All pipe penetrations through fire rated walls must have appropriate firestop listing
 - .1 If the pipe is subject to movement (thermal expansion, vibration, etc.) then the listing must accommodate the pipe movement
 - .2 If the piping has the potential to condense on the outside then the listing must make accommodations to maintain the insulation and vapour barrier

END OF SECTION

1.0 GENERAL

1.1 *Related UBC Guidelines*

- .1 *Division 01, Section 01 91 00 Monitoring Based Commissioning*
- .2 *Division 25, Section 25 05 00 Building Management Systems*
- .3 *Division 26, Section 26 27 13 Metering*

1.2 *Coordination Requirements*

- .1 *Coordinate with UBCO Facilities.*
- .2 *Coordinate with UBCO Energy Team.*
- .3 *Obtain details of space requirements, access, location and provision of associated services such as electrical, BMS, telecommunications wiring from UBC Building Operations – Technical Services.*

2.0 MATERIALS AND DESIGN REQUIREMENTS

- .1 *The project shall bear all costs associated with installation of meters.*
- .2 *Site-level meters: All site meters shall be supplied by the project.*
- .3 *All UBC owned and non UBC owned buildings and all irrigation systems constructed on UBC property shall have meters installed on all services, for example:*
 - 1. *Water*
 - 2. *District Energy System (DES)*
 - 3. *Gas*
 - 4. *Electricity*
- .4 *Main building water, gas, district energy, and electrical meters shall be compatible for remote monitoring and be wired to the building BMS for monitoring. The Division 25 contractor shall be responsible to install all pathways and wiring for remote monitoring of these meters.*
- .5 *Standard of acceptance of mechanical meters shall be as follows:*
 - 1. *Water: Badger M2000 utilizing pulse output configured at 0.1m³ per pulse.*
 - .1 *For core campus buildings the design requirements are shown in standard drawing 1140-UT-07A-WaterMeterStdMag. See also Division 26 16 00 Section 2.4*
 - .2 *If the manufacturer and designer confirm that a strainer is not required upstream of a meter, a spool piece with a 1.5"-2" port, isolation valve and hose bib shall be installed in place of the strainer.*
 - 2. *Gas: Fortis Provided meter complete with pulse hand-off module.*
 - .1 *The project is responsible for providing any required protection, such as installing a lockable enclosure and/or bollards as per UBCO Facilities Management approval.*
 - 3. *District Energy: Refer to Division 25 05 00, section 4.9 and Monitoring Based Commissioning 01 92 00.*
 - 4. *Electrical Meters: Refer to Division 25 05 00, section 4.6 and Division 26 16 00.*

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

- .1 Section 26 16 00 – Metering
- .2 Section 33 10 00 – Water Utilities
- .3 Section 33 51 00 – Natural Gas Distribution
- .4 Section 33 61 00 – District Hot Water Energy Distribution

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

1.3 Description

- .1 These guidelines apply to all work completed within UBC owned buildings at UBC Vancouver – this includes core academic buildings, student housing, athletics.
 - 1. [For metering requirements for non-UBC owned buildings, coordinate with UBC Energy and Water Services](#)
- .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.
- .5 This section of the Technical Guidelines is the parent of Division 21, 22 and 23. All requirements here, apply equally to those sections.

2.0 MATERIALS AND DESIGN REQUIREMENTS

- .1 The project shall bear all costs associated with installation of meters.
- .2 All site-level meters, unless otherwise specified, shall be supplied by the project, from local distributors as per spec in this document. Coordinate with UBC Energy and Water Services for approval.
- .3 All UBC owned and non UBC owned buildings and all irrigation systems constructed on UBC property shall have meters installed on all services, for example:
 - 1. Water
 - 2. District Energy System (DES)
 - 3. Gas
 - 4. Electricity
- .4 Main building water and gas meters shall be compatible with remote monitoring and wired directly to the building automation system. The Division 26 contractor shall be responsible to install all pathways and wiring for remote monitoring of these meters. Refer to Section 26 16 00 and standard drawing E4-6 for wiring methods.
- .5 Deleted.

- .6 DES meters shall be network connected for remote monitoring only. The Division 20 contractor shall provide all necessary communication equipment to ensure effective remote monitoring is achieved. [Refer to Section 33 61 00 0 5.3.1 and 5.3.5](#) and standard drawings E4-6c.
- .7 All UBC buildings shall have the following services metered:
 - 1. Water: All buildings
 - 2. Gas: All buildings
 - 3. Electricity: All buildings
 - 4. District Energy: All buildings
- .8 Standard of acceptance of mechanical meters shall be as follows:
 - 1. [Water: Badger M5000](#)
 - 2. [Gas: Dresser D800](#)
 - 3. [District Energy: Kamstrup Multical 603 with BACnet module](#)
- .9 Electrical Meters
 - 1. Refer to Division 26.

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

1.0 GENERAL

1.1 Coordination Requirements

- .1 UBC Facilities
- .2 University's Project Manager
- .3 UBC Energy and Water Services.

1.2 Description

- .1 Salvage of existing mechanical equipment or controls components on renovation or retrofit projects.

2.0 MATERIAL AND DESIGN REQUIREMENTS

- .1 The Mechanical Consultant shall prepare a list of those items that are potentially reusable by the Owner. Submit the list to the University's Project Manager before demolition commences.

- .2 The list will be reviewed with the UBC Operations Department, revised to reflect the University's needs and returned to the Consultant before demolition.

- .3 The Consultant shall list, in the specifications, all items that are to be salvaged.

- .4 The following wording shall be included in the specifications:

- .1 The following items shall be carefully removed and handed over to the Owner.
- .2 The Sub-Contractor shall inventory all items identifying their source, the location, date of removal and stating the Company's name.

- .5 Items for Disposal

- .1 Remove all redundant material not required by the owner from the Campus and dispose of legally outside of UBC Property.

END OF SECTION

1.0 GENERAL

1.1 Related UBC Guidelines

- .1 Standard Piping Signage Designation
- .2 ANSI 13.1 Scheme for Identification of Piping Systems.

1.2 Coordination Requirements

- .1 Coordinate with UBC Facilities
- .2 Coordinate with other design disciplines.
- .3 Refer to the University's standard designators for systems and components.

1.3 Description

- .1 Identification of mechanical systems and components in all University buildings, facilities and tunnels.
- .2 The identification system is composed primarily of nameplates, labels, tags and stenciled lettering.

2.0 MATERIAL AND DESIGN REQUIREMENTS

2.1 Identification Logic

- .1 Identify each system and system component according to the nomenclature used on the drawings and specifications. Identification to be consistent throughout the project.
- .2 When identifying systems and components in existing buildings, the new items shall be numbered sequentially with existing systems. Where possible include the zone or building area serviced by each system.
- .3 In new buildings (or full scale renewals), all mechanical equipment shall be tagged with a two or three letter equipment description, followed by the floor number (of the physical location of the equipment), followed by the indexed number. Examples:
 - .1 AHU-B2-03 is the third air handler located on level B2
 - .2 FC-04-16 is the sixteenth fancoil on level four
- .4 Special tagging requirements exist for fumehoods, associated fans and starters. [See TG 23 38 00.](#)
- .5 In existing buildings, equipment tagging shall be consistent with existing tagging in the building. Tags shall not be re-used.

2.2 General

- .1 Submit list of system and component labels to be Consultant for review prior to engraving.

2.3 Labels (Identification)

- .1 Provide lamicoid plastic labels with black face and white centre, 100 mm x 35 mm x 2.5 mm thickness for the following applications:
 - .1 Gauges and Panels engrave with 6 mm high lettering. Note for electrical switch gear, coordinate with Division 16.
 - .2 Systems engrave with 25 mm high lettering.

- .3 Fume Hoods engrave with 10 mm high lettering.
- .4 Apply labels to the following systems within the Mechanical Rooms and Penthouse:
 - .1 Water.
 - .2 Natural Gas.
 - .3 Steam.
 - .4 Fire Protection.
 - .5 Condensate.
 - .6 Compressed Air.
 - .7 One label to be affixed to the system and a second applied to the associated switch gear.
- .5 Gauges and Panels.

.2 All fume hood systems shall be identified with lamicoid labels. Identical labels are to be affixed to each fume hood and associated fan and motor starter (note that three labels are required for each system). The wording which will identify the specific fume hood and associated fan will be supplied by the owner.

.3 Limacoid labels shall be mechanically fastened to the identified system and components in a conspicuous location.

2.4 Labels for Perchloric Fume Hoods

- .1 Provide limacoid plastic labels with "fire red" face and white centre 135 mm x 65 mm x 2.5 mm thickness to act as a warning to Fume Hood users.
- .2 For label layout refer to Standard Detail in Division 20. This label is in addition to that required above.
- .3 Perchloric fume hood labels shall be secured to the upper front panel adjacent to the static pressure gauge.

2.5 Color Coded Dots

- .1 Color Coded Dots
 - .1 Provide self-adhesive color-coded dots 13 mm in diameter.
 - .2 Dots shall be Avery TR808 or an alternate approved by the Owner. Colors shall be yellow, black, red and green.
- .2 Doors and ceiling panels providing access to devices mounted in concealed locations shall be identified by color coded dots.
- .3 Color coding shall be to the following schedule:

.1	Mechanical equipment and cleaning access	Yellow.
.2	Control equipment, dampers, valves and sensors	Black.
.3	Fire, smoke and sprinkler equipment	Red.
.4	Pipe mounted equipment other than above	Green.
- .4 Where access is through a suspend T-Bar ceiling affix dot to exposed T-Bar frame closest to the concealed equipment.

2.6 Valve Tags

- .1 Tags shall be 40 mm diameter brass with 10 mm stamped alpha-numeric coding filled with black paint.

- .2 Tags shall be complete with non-ferrous chain or "S" hooks.
- .3 Tags shall be as supplied by W.H. Brady or an alternate approved by the Owner.
- .4 Consecutively number all valves and controllers installed by Division 15 on a system basis using tags. Coordinate between the various mechanical trades to prevent duplication.
- .5 Identification coding is to start with a utility description followed by a maximum of three numerals:
 - .1 Water WXXX
 - .2 Natural Gas GXXX
 - .3 Steam SXXX
 - .4 Fire Protection FPXXX
 - .5 Condensate CXXX
 - .6 Compressed Air
- .6 The first tag number in each series will be supplied by the Owner.
- .7 For installations in existing buildings the valve and controller numbers shall be numerically sequential with the existing series.
- .8 Provide six identification flow diagrams for each system incorporating the tag schedule stating the designation number, the service function and location of tagged items and normal operating position of valves. Flow diagram shall be on maximum size 11" x 17" sheets having a 3/4" border on the left side to permit insertion into a ring binder.
- .9 Mount one copy of the flow diagram in a glazed frame.
- .10 Provide copies of flow diagram for the Operating and Maintenance Manuals.

2.7 Stenciled Letters

- .1 Black stenciled letters and numbers 25 mm high, to sign painting standards.
- .2 Black stenciled direction arrows shall be 175 mm long by 56 mm wide.
- .3 Duct Work and Access Panels: Use the system designators stated on the drawing and specification.
- .4 Duct Identification and Direction Arrows shall be located on all duct runs in Mechanical Rooms and Penthouses.
 - .1 Maximum distance between markings shall be 8 meters.
 - .2 Where ducts pass through walls or partitions identify ducts on both sides of the section.
 - .3 Beside each access panel.
- .5 Perchloric Fume Exhaust
 - .1 Identify each duct "Danger-Perchloric" using 50 mm high black letters in the following locations as described above in "Duct Identification and Direction Arrows":
 - .1 Adjacent to all major changes in direction.
 - .2 At least once in each room. Where duct is concealed in a chase, shaft, gallery or other confined space, identify at points of entry and leaving and at each.
 - .3 At access openings.

.6 Access Panels

.1 Panels shall be identified according to the following schedule of functions:

<u>Access Function</u>	<u>Symbol</u>
Cleaning and Service	C.A.
Controls including Sensors	C.
Dampers – Back draft, Balance and Control	D.
Fire Dampers	F.D.
Smoke Dampers	S.D.

.7 Preference is for full words when labelling pipes or ductwork opposed to abbreviated versions. This is because abbreviations can often be misinterpreted. Some examples that have caused confusion in the past are:

- .1 CWS could be condenser water or chilled.
- .2 CHWS could be change over water supply or chilled water supply.
- .3 DHW could be domestic hot water or district heating water.

2.8 Manufacturer's Nameplates

- .1 Each piece of equipment shall have an original factory installed metal nameplate with raised or recessed characters.
- .2 The nameplate shall fully describe the component as to manufacturer, size, model, serial number, voltage, cycle, phase, power, pressures, volume, etc.
- .3 Locate nameplates so that they are easy to read. Do not insulate or paint over.
- .4 Provide standoffs where nameplates cannot be located on cool surfaces.
- .5 Ensure that regulatory registration plates are also attached to equipment - Pressure Vessel Rating, Underwriter's Laboratory Approval, CSA Approval, etc.
- .6 For all pressure vessels, order with two identification plates (each with the CRN) - one on either side of the pressure vessel so we're not at risk of the identification plate facing into the wall. Most manufacturers can accommodate this request when it is made at the time of ordering.

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

1.0 GENERAL

1.1 Related UBC Guidelines

- .1 Building Operations Energy Management Policy

1.2 Coordination Requirements

- .1 Coordinate UBC Okanagan Campus Operations and Risk Management (CORM) – Facilities Management and Energy Team.

1.3 Description

- .1 Guidance for the design and operation of HVAC systems in order to provide a suitable thermal environment for sedentary work (e.g. in office, classroom, library, laboratory).
- .2 The basis for design and operation are the applicable ASHRAE standards, however guidance is required for interpreting them in the context of UBC Okanagan campus.

2.0 MATERIALS AND DESIGN REQUIREMENTS

2.1 Applicable Codes, Standards and Guidelines

- .1 Referenced standards refer to the same edition referenced by the BC Building Code.
- .2 ASHRAE 55 Thermal Environmental Conditions for Human Occupancy.

The purpose of this standard is to specify the combinations of indoor thermal environmental factors and personal factors that will produce thermal environmental conditions acceptable to a majority of occupants within the space.

- .3 ASHRAE 10 Interaction Affecting the Achievement of Acceptable Indoor Environments.

This guideline raises awareness of interactions affecting the achievement of acceptable indoor environments

- .4 ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality

Natural ventilation design guidance (Section 5)

2.2 Principles

- .1 Passive design: designers shall adopt passive design approaches that use the building architecture to improve indoor thermal comfort and minimize energy use and equipment sizing.
- .2 Adaptive thermal comfort: where occupants are free to adapt their clothing to the indoor temperature, mechanical cooling is not necessary. Where design conditions in such spaces have been shown to need mechanical cooling, submissions for variance are to be made as part of the initial design philosophy submission.
- .3 Humidity control: Okanagan's temperature climate, with moderate temperatures and low humidity levels year round, allows the humidity in a space to be uncontrolled and the space still be considered comfortable, unless there is a particular reason for humidity control e.g. rare book storage, laboratory operations.

- .4 Adaptation: Where possible space for future cooling coils shall be provided to mitigate risk of increased cooling degree days. Provide thermal comfort modelling in support of design.
- .5 Thermal modeling simulation shall be used to verify mechanical cooling requirements.
- .6 Mechanical cooling shall be provided where process or code requirements dictate e.g. high heat loads in laboratories, IT server rooms, control rooms, AV rooms, electrical rooms, etc.
- .7 Large classrooms (>50 students) may require 100% fresh air supply for air quality and/or provision of mechanical cooling, due to high heat load.

2.3 Selection of Ventilation Strategy

- .1 Select a ventilation strategy which is most suitable for the building design. Passive or natural ventilation should be used wherever appropriate. For buildings where passive ventilation is unable to meet either the thermal comfort requirements given in this guideline or the program requirements of the building, a mixed-mode ventilation strategy should be considered that uses a combination of natural ventilation and mechanical HVAC where necessary.
- .2 Refer to CIBSE – Natural Ventilation in Non-Domestic Building – Chapter 2 “Selecting a natural ventilation concept” as a source of reference.

2.4 Design of Naturally Conditioned Space (i.e. no mechanical cooling)

- .1 Naturally conditioned space shall be designed to satisfy the following criteria through passive design practices and shall be verified using thermal modeling simulation:
 - .1 Internal Temperature (T_i) $\geq 24^\circ\text{C}$ shall not exceed 150 occupied hours.
 - .2 Internal Temperature (T_i) $\geq 27^\circ\text{C}$ shall not exceed 50 occupied hours.
 - .3 Internal Temperature (T_i) $\geq 30^\circ\text{C}$ shall not exceed 20 occupied hours.
- .2 Where operable windows are provided sensors shall interlock to space heating and cooling. See ASHRAE Handbook Fundamentals, Natural Ventilation and Infiltration, Chapter 22.

2.5 Design of Active Systems

- .1 Active systems shall be designed to achieve the following minimum conditions during occupied hours:
 - .1 Heating systems shall be designed to maintain an indoor temperature of 21°C for an external temperature of -20°C (BC Building Code 1% value for January).
 - .2 Cooling systems shall be designed to maintain an indoor temperature of 25°C for an external temperature of $38^\circ\text{C DB and } 24^\circ\text{C WB}$.

2.6 Operation of Active Systems

- .1 Space Heating Systems: Set point $21^\circ\text{C} \pm 1^\circ\text{C}$
- .2 Space Cooling Systems: Set point $25^\circ\text{C} \pm 1^\circ\text{C}$
- .3 Night Time Setback conditions:
 - .1 Buildings will be maintained between 15°C to 17°C during winter, depending on building recovery time.

- .2 No ventilation, unless nighttime cooling control strategy is required.
- .3 Pre-conditioning time of 1 hour prior to occupancy, depending on building recovery time.
- .4 Research laboratories that require continuous ventilation: During unoccupied conditions reduced ventilation and temperature conditions are expected.

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

1.0 GENERAL

1.1 Related UBC Guidelines & Documents

- .1 UBC Facilities Energy and Operations Policy I-B-53.
- .2 Section 23 00 00 HVAC (and all subsections)
- .3 BC Building Code and all references contained there within

1.2 Related Documents External to UBC

- .1 ASHRAE 55-2017: Thermal Environmental Conditions for Human Occupancy
- .2 ASHRAE 10-2011: Interaction Affecting the Achievement of Acceptable Indoor Environments
- .3 ASHRAE 62.1-2013: Ventilation for Acceptable Indoor Air Quality
- .4 BC Building Code and all references contained there within

1.3 Coordination Requirements

- .1 Coordinate with UBC Sustainability and Engineering and UBC Facilities.

1.4 Description

- .1 The Guidelines apply to all work completed within buildings on the UBC Vancouver campus 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.

1.5 Purpose

- .1 This document is meant to provide guidance for the design of HVAC systems in new buildings and major renovations in order to provide a suitable thermal environment for the activities typical of UBC office, classroom, and laboratory spaces.
- .2 The basis for design and operation are the applicable ASHRAE standards. This standard clarifies how to interpret and apply these standards for the UBC Vancouver campus.

2.0 MATERIALS 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 Principles

- .1 Passive design:
 - .1 Designers shall adopt passive design approaches that use building architecture to improve indoor thermal comfort, minimize equipment sizing and run-time, and attempt to eliminate the requirement for active space conditioning and ventilation. Design

approaches such as the use of trees and architectural features for shading are recommended, as well as selection of glazing with a low solar heat gain coefficient for large window areas and operable windows.

.2 Passive cooling:

- .1 A passive cooling strategy is the preferred design approach where possible. Buildings with passive cooling shall be designed such that spaces served shall not overheat, as defined in ASHRAE 55-2017 and Section 2.3 of this guideline.
- .2 Operable windows shall be provided. Sensors shall interlock with space conditioning to prevent the mechanical system fighting the natural ventilation. See ASHRAE Handbook Fundamentals, Natural Ventilation and Infiltration, Chapter 22.
- .3 For buildings where passive cooling strategies are unable to meet either the thermal comfort requirements given in this guideline or the program requirements of the building, a mixed-mode ventilation strategy should be considered that uses a combination of natural ventilation and mechanical HVAC where necessary.

.3 Mixed-Mode Ventilation:

- .1 Designers are encouraged to use natural ventilation when available through passive design measures. When it is impracticable for the building to use natural ventilation (during cold winter months, for example), the building should have a ventilation system capable of supplying sufficient ventilation air to the building. In this case, passive cooling principles would be used as a first stage of cooling, and mechanical cooling would activate as a second stage. Designers are encouraged to use demand control ventilation strategies to reduce heating of outdoor air.

.4 Mechanical cooling:

- .1 Mechanical cooling shall only be used when spaces cannot comply with Section 2.3 using passive design principles. When it is required, mechanical cooling shall serve only the zones which will overheat.

.5 Process Cooling:

- .1 Mechanical cooling shall be provided where process or code requirements dictate.

.6 Ventilation

- .1 Select a ventilation strategy which is most suitable for the building design. Passive or natural ventilation should be used wherever appropriate, using buoyancy of warm air, building orientation, etc. to ventilate the building.
- .2 Refer to CIBSE – Natural Ventilation in Non-Domestic Building – Chapter 2 “Selecting a natural ventilation concept” as a source of reference.

.7 Adaptation:

- .1 Designers shall design with climate change adaptation in mind. Heating coils shall be selected such that they can be used as changeover coils in the future. Where this is not possible, space for future cooling coils shall be provided.
- .2 Refer to [Climate Ready Requirements for UBC Buildings](#) for information on potential climate adaptation strategies for new buildings.

.8 Humidity control:

- .1 Vancouver's temperate climate, with mild temperatures and moderate humidity levels year round, allows the humidity in a space to be uncontrolled and the space still be considered comfortable. Unless there is a specific reason for humidity control (animal care, etc), it shall not be provided.

.9 Modeling:

.1 simulation shall be used to verify the need for mechanical cooling. Thermal modeling shall be conducted using the 2050s (2041-2070) weather files for YVR. Future shifted weather file can be obtained from the PCIC website (<https://www.pacificclimate.org/data/weather-files>). Note that this weather file should be used for summertime thermal comfort modeling only from May to September inclusive. This weather file is not be used for energy simulations.

2.2 Design Criteria

.1 The following table summarizes the heating and cooling design requirements for new construction and major renovation projects at UBC:

Space Type	Heating Design Temp	Cooling Design Temp or Standard	Allowed Exceedance
Office	22°C	ASHRAE 55-2017 section 5.4 if passively cooled 25°C peak temperature if mechanically cooled	3% occupied hours of exceedance (between May-Sept inclusive).
Laboratory¹ (general wet lab)	22°C	25°C or as required by lab processes.	As determined by laboratory manager.
Classroom¹	22°C	25°C peak temperature	
Student Residences	22°C	25°C peak temperature	
Stairwells & Hallways	22°C	None – ventilation only	N/A
Assembly spaces¹	22°C	25°C peak temperature	
Transient spaces	22°C	ASHRAE 55-2017 section 5.4 if passively cooled 25°C peak temperature if mechanically cooled	3% occupied hours of exceedance (between May-Sept inclusive).

¹ Note that these spaces are expected to utilize mechanical cooling, as they cannot rely on natural ventilation to maintain the 25°C temperature limit. Additionally, adaptive thermal comfort principles do not apply to these spaces as users typically don't have the ability to adjust clothing levels, open windows, get up for breaks when needed, etc.

2.3 Design Criteria of Passively Cooled Spaces

.1 Spaces that are passively cooled shall be designed such that they comply with the table in section 2.2 when modeled from May to September inclusive.

.2 Thermal comfort modeling shall be conducted using the 2050s weather file for YVR obtained from the PCIC website (<https://www.pacificclimate.org/data/weather-files>). Models shall simulate indoor thermal conditions for the months of May to September inclusive.

- .3 Where mechanical cooling is required to meet compliance as per sentence 2.3.1, for all space types other than classrooms, designers shall apply for a design variance (see Appendix A) to the UBC Energy & Operations Steering Committee indicating:
 - .1 which criteria were failed when attempting to use passive cooling,
 - .2 which zones shall be served by mechanical cooling, and
 - .3 which passive design features are being employed and why they can't meet the thermal comfort requirements of the zone.

2.4 Design Criteria of Mechanically Cooled Spaces

- .1 Systems shall be designed such that spaces served by mechanical cooling meet ASHRAE 55-2017, Section 5.3. Graphic Comfort Zone Method or Analytical Comfort Zone Method defined in 5.3.1 or 5.3.2 are acceptable for determining overheating in mechanically cooled zones.
- .2 Active cooling systems, where required, shall be sized to prevent overheating (see section 2.2 for thermal comfort criteria) based on 31°C DB / 23°C WB (the expected 2.5% summer design condition in the 2050s climate¹) and an indoor temperature of 25°C.
 - .1 2050s design condition is determined by: (BCBC 2018 2.5% July condition) + (2050s median change for YVR2) for both dry bulb and wet bulb. This works out to:
$$28C + 3.0 = 31.0C \text{ (DB)}$$
$$20C + 2.9 = 22.9C \text{ (WB)}$$

2.5 Design Criteria of Heating Systems

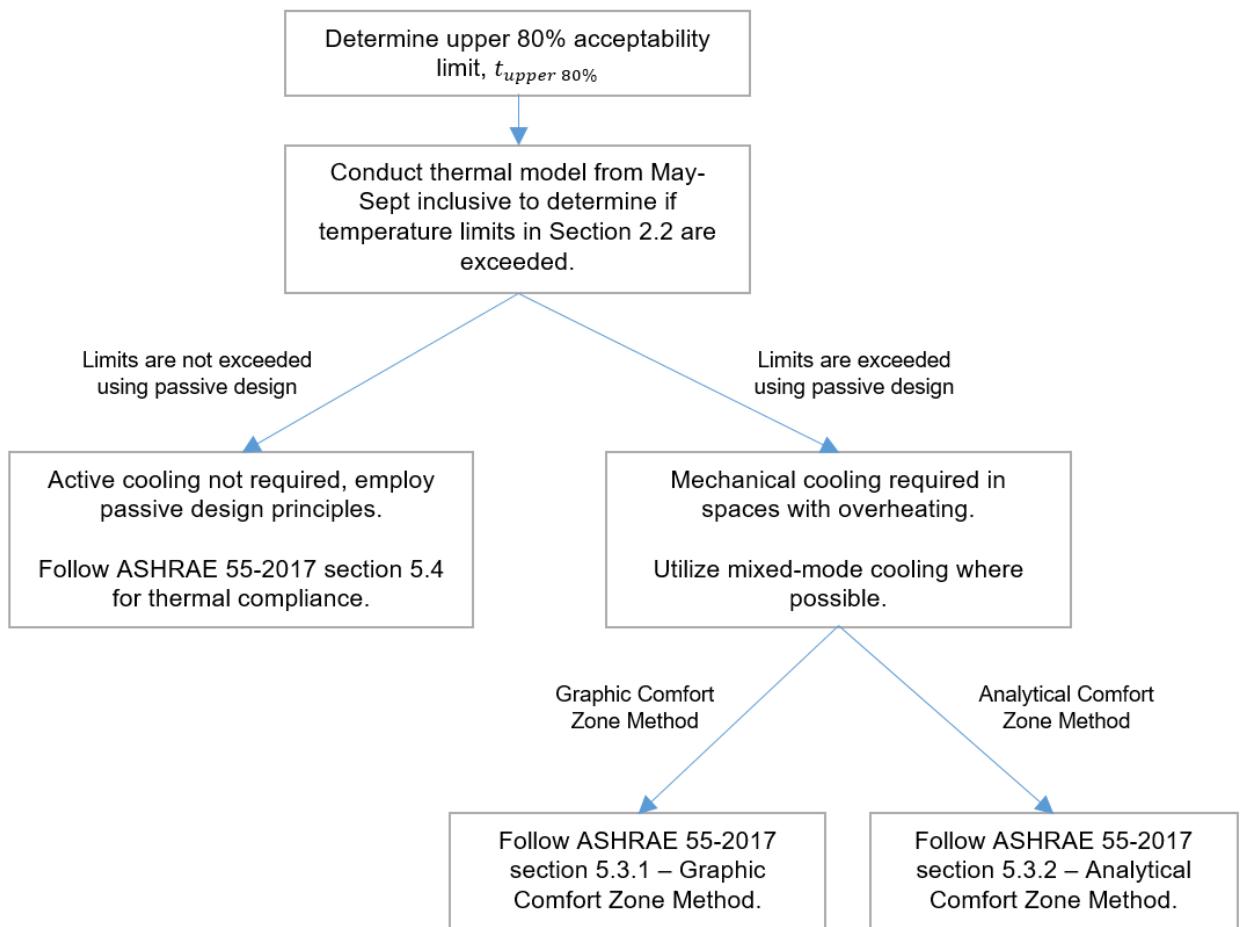
- .1 Heating systems shall be sized to maintain indoor temperature at 22°C when the outdoor temperature is equal to the BC Building Code January 1% design temperature.

2.6 Process

- .1 The adaptive model of thermal comfort has found that building occupants perceive thermal comfort inside buildings as it relates to the current and recent historical outdoor air temperatures. People tend to acclimatize to outdoor temperature conditions with recent outdoor thermal experiences being more influential in a person's perception of how hot or cold a space is.
- .2 For this reason, UBC has adopted the ASHRAE 55 approach for passive cooling designs to identify a daily maximum comfort temperature using a running mean approach where recent daily mean temperatures are weighted more heavily in the calculation. The 2050s model hourly dry bulb temperature is available on UBC's SkySpark platform and shall be used for this calculation.

Obtain the 2050s weather file (per section 2.1.9 above); and the prevailing mean outdoor temperature $\overline{t_{mda(out)}}$, and upper 80% acceptability limit $t_{upper\ 80\%}$ (calculated as per ASHRAE 55-2017) through UBC's SkySpark platform following the instructions here: <https://energy.ubc.ca/energy-and-water-data/skyspark/>

- .3 The process to determine whether a space overheats is given below. Mathematical definitions of variables discussed are included in section 2.7.



- .1 Determine daily running mean outdoor temperature ($\overline{t_{mda(out)}}$).
Using the 2050s weather file, designers shall determine the daily running mean outdoor temperature ($\overline{t_{mda(out)}}$) between May and September inclusive. The preferred method for determining $\overline{t_{mda(out)}}$ is given in ASHRAE 55-2017 Appendix J (note, this is *not* simply an average of the previous days' temperatures, but adds weight to recent days' temperatures).
- .2 Determine daily 80% upper acceptability limit ($t_{upper\ 80\%}$) for each day.
From the daily running mean temperature, designers shall determine the upper 80% acceptability limit for each day, using the formula given in ASHRAE 55-2017 section 5.4.2.2.
- .3 Determine whether overheating is an issue with your passively cooled space with reference to section 2.2. If a passive design will lead to overheating as per Section 2.2, mechanical cooling will be required.

2.7 Definitions:

.1 Upper 80% acceptability limit (°C)

$$t_{upper\ 80\%} = 0.31 \times \overline{t_{mda(out)}} + 21.3$$

.2 Prevailing mean outdoor air temperature

$$\overline{t_{mda(out)}}$$

(refer to ASHRAE 55-2017 Appendix J for calculation method)

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 “Passive design” or “passive cooling” does not mean simply omitting mechanical cooling from the project. Passive design is a holistic approach to building design, using building architecture and orientation to minimize heat gain in the summer, and using the buoyancy of warm air and strategically located building openings to catch wind to naturally force ventilation air through the building.
- .2 Some recent buildings that have not undertaken thermal comfort modeling and have simply omitted mechanical cooling in office spaces have had significant thermal comfort challenges in recent summers. Design teams should use the results of the thermal comfort model to inform design decisions early in project design stages.
- .3 Leaving room for cooling coils (per section 2.1.7) also means leaving sufficient space to install the coil. I.e. providing clearance in front of the AHU to add the coil. In terms of clearance requirements, a future cooling coil should be treated the same as an actual coil.

*** END OF SECTION ***

APPENDIX A – VARIANCE REQUEST

Variance Request Process

All permanent Variance requests shall be submitted to the UBC Energy & Operations Steering Committee in which the change is to take place. Requests should be submitted early in the building design stages to give the design team sufficient time to update the design.

The Steering Committee will consider multiple criteria when reviewing a variance request, including (but not limited to) effects on energy consumption; impacts on building systems such as electrical or plumbing systems; whether any additional equipment can reasonably be maintained; and impacts on UBC's overall goals of operational excellence. After a request has been reviewed, a written response will be provided to the design team.

VARIANCE REQUEST FORM

Please fill out as many fields as possible in the form below, and email to the building's Project Manager who will forward on to the UBC Energy & Operations Steering Committee.

Request Date: _____

Requestor Contact Information

Name: _____

Phone: _____

Email: _____

Variance Information

Building: _____

Passive measures employed in building design:
(attach additional sheets if required)

Proposed solution to achieve thermal comfort:
(attach additional sheets if required)

Please indicate below the zones where the thermal comfort criteria are not met, and the degree of exceedance: