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).
Laboratory[1] (general wet lab)	22°C	25°C or as required by lab processes.	As determined by laboratory manager.
Classroom[1]	22°C	25°C peak temperature	
Student Residences	22°C	25°C peak temperature	
Stairwells & Hallways	22°C	None – ventilation only	N/A
Assembly spaces[1]	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 climate[1]) 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 (DB)
20C + 2.9 = 22.9C (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.

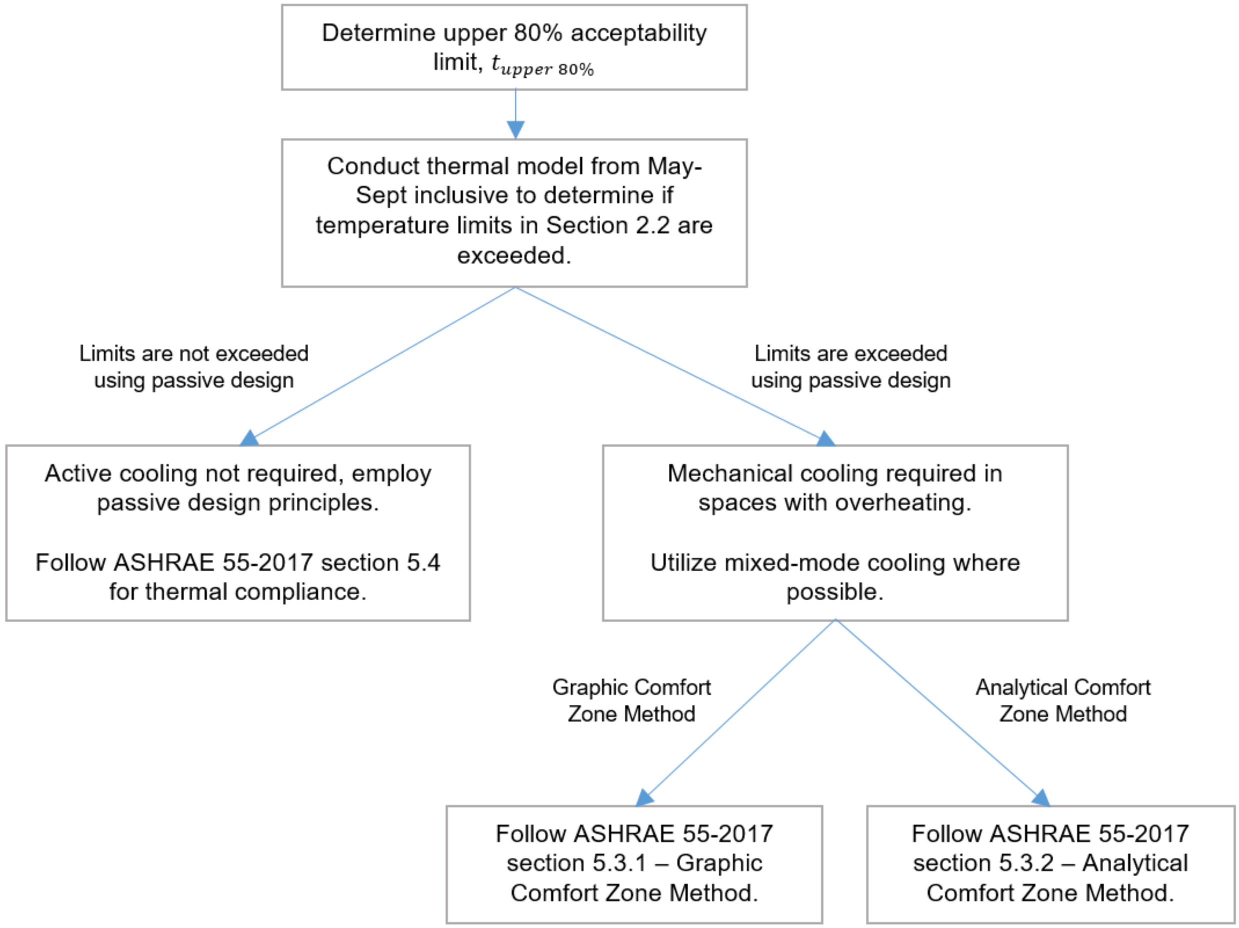
2.6 Process

.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 <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 "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)

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

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

Zone	**Space Type**	**Design Criteria / max design temperature**	**Occupied Hours (May-Sept)**	**Hours of exceedance (May-Sept)**	**% hours exceedance**