ENGINEERS & GEOSCIENTISTS
BRITISH COLUMBIA

PRACTICE ADVISORY

CLIMATE CHANGE CONSIDERATIONS FOR BUILDING ENCLOSURE ENGINEERS

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This practice advisory has been issued for registrants of Engineers and Geoscientists BC (engineering professionals) who provide building enclosure engineering services for new building projects, building renovation projects, building rehabilitation projects, and building renewal projects in British Columbia (BC). It provides guidance on considering and addressing the implications due to climate change in design and decision-making processes for the selection of building enclosure assemblies and integration detailing, and discusses the roles and responsibilities of professionals involved in these projects.

This advisory was created to provide building enclosure engineers (BEEs) with practice-specific guidance on climate change considerations. In particular, this advisory focuses on the mitigation of embodied and operational greenhouse gas (GHG) emissions related to building enclosure components, as well as the adaptation of building enclosures for changing climatic conditions.

Specific considerations include:

- use of embodied GHG emission assessments to inform designs;
- evaluation of the impact the building enclosure has on operational GHG emissions;
- evaluation and quantification of durability over the service life of building enclosure components;
- impact of the projected increase of exterior temperatures on building enclosure performance, including the potential for overheating;
- potential changes in environmental loading on building enclosures, including increased intensities of rain, wind, and wildfire smoke; and
- potential changes in environmental loading on at-grade and below-grade enclosure systems due to sea-level rise and/or pluvial flooding.

Note that although building enclosure consulting is a shared area of practice between architects and engineering professionals, the guidance in this advisory applies solely to engineering professionals registered with Engineers and Geoscientists BC.

BACKGROUND

Understanding of climate change is continually evolving. Accordingly, regulations, as well as expectations and obligations of professional practice, are regularly reviewed and revised to reflect current studies of the effects of climate change on buildings, and of buildings' effects on climate change. However, it can take several years for new information and guidance for design considerations related to climate change to be integrated into national or provincial building codes and regulations, and then to be adopted and enforced at the municipal level.

The speed of these changes does not match the critical nature and global importance of climate change considerations that should be adopted in building designs. Therefore, this practice advisory is intended to provide guidance on climate change considerations related to building enclosure engineering services, based on best practices and the state of knowledge in the profession as of the publication date.

Engineering professionals have a professional responsibility to uphold the principles outlined in the Engineers and Geoscientists BC Code of Ethics, including protection of public safety and the environment. As such, engineering professionals must use a documented approach to identify, assess, and mitigate risks that may impact public safety or the environment when providing professional services.

One of the risk factors that must be considered is climate change implications, including both how climate change affects buildings and how buildings affect climate change. Engineering professionals have a responsibility to notify their clients of current and future climate-related risks, recommend reasonable adaptations to lessen the impact of climate-related risks, and inform their clients of potential impacts should a client refuse to implement the recommended adaptations. Engineering professionals are themselves responsible for being aware of and meeting the intent of any climate change requirements imposed by a client or an authority having jurisdiction.

This advisory was created in response to the publication of two Engineers and Geoscientists BC documents: the What We Heard Report and the Climate Change Action Plan (Engineers and Geoscientists BC 2020a and 2021). The Report summarizes the feedback obtained from registrants on the development of the Climate Change Action Plan. The Plan itself provides a framework for how Engineers and Geoscientists BC can support its registrants in their professional practice, allowing the organization to respond to climate change issues proactively rather than reactively.

In general, respondents asked for sector-specific guidance and practical examples describing what the requirement to "consider climate change" means for engineering professionals in daily practice. Respondents also sought guidance on how to motivate clients to allocate resources for climate-focused design services, and how to propose measures for proactively addressing climate change that are not currently addressed in building codes or code-referenced standards.

In response to this feedback, this advisory was created to provide BEEs with practice-specific guidance on climate change considerations and solutions. It also complements guidance provided in the *Professional Practice Guidelines – Sustainability* (Engineers and Geoscientists BC 2016).

PROFESSIONAL PRACTICE

OVERVIEW

Climate change considerations generally fall into one of two areas of focus for BEEs:

- Mitigation: the reduction of GHG emissions of buildings
- Adaptation: the ability of buildings to withstand current and future climate impacts, and provide a safe, functional space for the occupants

Climate change mitigation relates to the reduction of GHG emissions via both embodied emissions and operational emissions. Embodied emissions are GHG emissions resulting from extraction, manufacturing, material transportation, construction, maintenance, renewal or retrofit, deconstruction or demolition, and recycling of the building enclosure components and materials over the life cycle of the building. Operational emissions are GHG emissions resulting from the operation of the active building systems. Building enclosure systems can have a significant impact on the energy demand of the building, and using an energy-efficient enclosure assembly can result in reduced overall operational GHG emissions.

Climate change adaptation relates to the ability of a building's design to address the impacts of changes to the climate, while not necessarily addressing the issue of minimizing current and future climate loading.

The overall resilience of a building depends on the combined effects of mitigation and adaptation strategies, to both reduce embodied and operational emissions and increase a building's ability to withstand and respond to current and future climate shocks and stresses.

Mitigation and adaptation measures will vary from project to project depending on regulatory requirements and/or the client's resiliency objectives. Mitigation and adaptation strategies are typically targeted and measured in relation to a baseline, such as minimum code requirements, or to a benchmark set by an incentive program. In some cases, resiliency objectives and targets will be clearly set by the client or legislation; however, in other cases, the BEE should propose that resiliency objectives be included in the project scope, and then work with the client and other professionals to determine appropriate targets.

Formal building envelope commissioning (BECx) measures can be undertaken, to ensure project requirements for both mitigative and adaptive measures are being met. For more information on commissioning requirements, refer to the following standards and guidelines:

- ASHRAE Guideline 0-2019 – The Commissioning Process
- ASTM E2813-12, Standard Practice for Building Enclosure Commissioning
- National Institute of Building Science (NIBS) Guideline 3-2012, Building Enclosure Commissioning Process BECx
- CSA Z5000-18, Building Commissioning for Energy Using Systems
- CSA Z5001:20 Existing Building Commissioning for Energy Using Systems

ROLES AND RESPONSIBILITIES

The typical services and associated roles and responsibilities provided by a BEE are described in the *Professional Practice Guidelines – Building Enclosure Engineering Services* (Engineers and Geoscientists BC 2020b) (referred to here as the *Building Enclosure Engineering Guidelines*).

Although some of the climate change-related considerations discussed below can be incorporated into the typical services provided by a BEE, several would be considered part of the categories called “Other Building Enclosure Services for Construction Projects” or “Other Services,” as described in the *Building Enclosure Engineering Guidelines*, Sections 3.4 and 3.5, respectively. The BEE should discuss these other services with the client when establishing the BEE’s scope of work.

Building enclosure consulting is a shared area of practice between architects and engineering professionals. *Bulletin 34: Building Envelope Services – Appropriate Professional Practice* (AIBC and Engineers and Geoscientists BC 2011) defines the roles and responsibilities of the different professionals for different types of building enclosure projects. As the role of the BEE differs for each project type, so too does the BEE’s ability to influence the design considerations impacted by climate change.

The guidance in this advisory assumes the BEE has been engaged to provide a variety of other services (as defined in the *Building Enclosure Engineering Guidelines*); has been granted approval by the client, the architect, and, if applicable, other professionals to implement climate change mitigation and adaptation strategies; and is either responsible for reviewing and providing input on the building enclosure design provided by an architect (for new construction or renovation) or is ultimately responsible for the building enclosure design (for an existing building renewal or repair).

However, it is recognized that the BEE may not be engaged to provide climate change-related services, or may not have sole responsibility for the building enclosure design. In these situations, where appropriate, the BEE should use the guidance provided in this advisory to educate the client and fellow design team members and encourage them to include measures to address climate change in their designs and decision making.

BEEs are reminded that they should only take on professional activities or work for which they have adequate education, training, and experience.

MITIGATION

For the mitigation of embodied and operational GHG emissions, the BEE should consider:

- implementing passive measures, to reduce energy use during building operations;
- selecting materials and assemblies where the expected service life of one component does not affect the future replacement of others, to avoid unnecessary removal of layers;
- utilizing life-cycle assessment (LCA) strategies, to inform selection of building enclosure systems; and
- conducting a cost analysis (e.g., net present value) of building ownership, to evaluate the benefits and costs of implementing mitigation measures.

Depending on the type of project, the BEE will have either direct control or indirect influence on these measures. In either case, the BEE should discuss the benefits of implementing mitigation measures with the client and the design team.

It should be noted that mitigation strategies such as fuel switching, demand reduction (e.g., as affected by the building form), implementing energy-efficient measures (e.g., heat recovery), and integration of renewable energy systems are the responsibility of other registrants and are outside the scope of this advisory. However, the BEE can provide input with respect to these elements, as needed. For example, renewable energy systems, such as rooftop photovoltaic panels, need to be integrated into the enclosure assemblies. Similarly, to accommodate future building adaptation, the enclosure assemblies may need to be proactively equipped with integration points (e.g., roof conduit penetrations incorporated into the surrounding enclosure system).

PASSIVE MEASURES

The first priority of a BEE with respect to mitigating climate change should be to encourage and adopt passive measures that reduce operating GHG emissions. Reduction in operating GHG emissions can result from a host of passive measures, including:

- using energy-efficient enclosure assemblies;
- reducing thermal bridging at building enclosure interface details;
- improving building air tightness;
- optimizing building form and solar shading; and
- optimizing glazing systems (e.g., window-to-wall ratio, solar heat gain coefficient, orientations).

To evaluate and quantify the impact that these operating GHG emission reduction measures will have, a whole building energy model is typically required. A whole building energy model, as well as whole building air tightness testing, are required for projects pursuing *BC Building Code* compliance via the *BC Energy Step Code*. Although providing a whole building energy model is outside of their typical scope of services, BEEs are often involved in the modelling process to provide input on the building enclosure arrangements and assemblies. For more information, refer to the *Professional Practice Guidelines – Whole Building Energy Modelling Services* (Engineers and Geoscientists BC 2018).

The second priority of the BEE with respect to mitigation via passive design elements should be to select appropriate materials both in the initial construction of a building and over its service life. While meeting the project performance objectives, the BEE should consider selecting building enclosure assemblies, components, and materials that have lower embodied GHG emissions. Resources for data on embodied emission of various building enclosure materials can be found in the References and Resources section below.

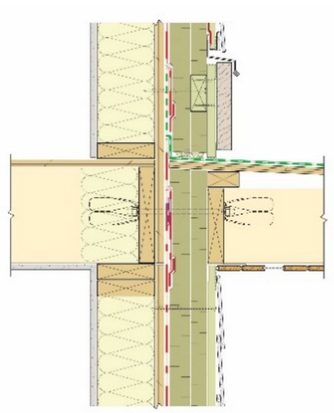
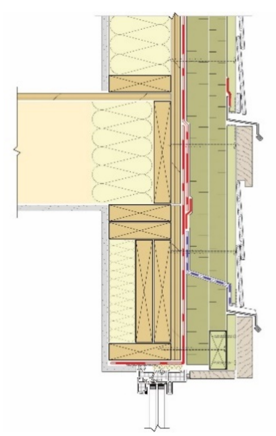
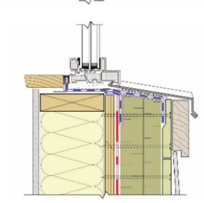
EXPECTED SERVICE LIFE

As per the *Building Enclosure Engineering Guidelines*, BEEs are responsible for considering the expected service lives of building enclosure components, including the layering of enclosure components, so that maintenance and renewal of components (layers) with shorter service lives do not necessitate removing layers with longer service lives. BEEs should consider providing enclosure details that easily facilitate future replacement work for building enclosure components, to help minimize additional embodied energy/emissions resulting from removal and renewal of layers to provide access to concealed layers. For technical guidance, refer to the standard titled CSA S478-19, Durability in Buildings.

Example details and considerations for light wood frame residential buildings are shown in Table 1 below. The principles presented in this table can be extrapolated to other building types and occupancies.

When selecting building enclosure components and materials, the BEE should consider how temperature (e.g., more frequent freeze-thaw cycles) and exposure (e.g., more concentrated rain and wind loading) will affect the lifespan of the materials, as they may not perform in the future as they have historically. See the Adaptation section below for more information.

Table 1: Conceptual Details That Consider Component Replacement

DETAIL DESCRIPTION	DETAIL DRAWING	NOTES
• Base of wall flashing with flashing breaks to facilitate roof/balcony membrane renewal		• As the lifespan of the balcony membrane is expected to be less than the wall, the base of wall detail facilitates a balcony membrane renewal without having to remove the cladding. • The trim board can be easily removed without disturbing the base of wall flashing. • The trim board could also be replaced with a two-component flashing.
• Cladding to window interface that has removable trim/flashings to allow for window renewal	 	• To facilitate the replacement of a window prior to cladding replacement (specifically for flanged windows), the perimeter flashings and trim could be designed to be removed easily without disrupting the surrounding cladding. • In the adjacent images, the head trim and sill flashing/trim can be disassembled for window removal.

NOTE: Images provided by RDH Building Science Inc.

LIFE CYCLE ASSESSMENTS

To better understand the embodied energy/emissions for the whole-project, BEEs should encourage their clients to conduct a life-cycle assessment (LCA) at the outset of the project and assist with the assessment, as appropriate.

To better understand the impacts of designs and material selections, the LCA should consider the cradle-to-cradle (i.e., resource extraction, product manufacturing, transportation, construction, maintenance, retrofit or replacement, demolition and disposal, and recycling) embodied emissions. BEEs should also consider the predicted replacement cycles when selecting building enclosure assemblies, components, and materials.

Figure 1: Phases of Life Cycle Assessment

NOTE: Copyright BC Housing; reprinted with permission (BC Housing 2021a).

For example, a durable roof system that is predicted to only need one replacement over the building's 60-year life span may be preferable over a lower-durability roof system that may need to be replaced multiple times over the building's life span.

References and tools for conducting LCAs include, but are not limited to, the following:

- City of Vancouver Green Buildings Policy for Rezoning, Path B, Item 6.2, which provides direction on the LCA process, including information on the relevant ISO standards (City of Vancouver 2018)
- LEED v4.1 – Materials and Resources – Building Life-Cycle Impact Reduction (USGBC 2021)
- Estimator tools such as the following:
  - Impact Estimator for Buildings (Athena Sustainable Materials Institute 2021)
  - OneClick LCA software (OneClick LCA 2021)
  - Tally LCA application (Tally 2021)
  - Embodied Carbon in Construction Calculator (EC3) (Building Transparency 2020)

COST OF BUILDING OWNERSHIP

Conducting a cost analysis would not typically fall within the scope of work or expertise of a BEE, but BEEs should consider suggesting this be done for the long-term benefit of the client and the environment. Where appropriate, BEEs may make themselves available to provide input on the renewal of enclosure systems or help determine the operating and replacement costs of other building components, in consultation with other engineering professionals for other building systems (e.g., mechanical or electrical systems).

Using more durable and energy-efficient building enclosure systems (that can be informed by the climate change mitigation measures discussed above) may lead to higher upfront costs to building ownership. However, this does not necessarily mean the overall cost of the building will be higher. While the cost of professional services may be redistributed to the beginning of the project, the overall cost of the building enclosure system may be lower, because it is well designed, coordinated, and efficient, with fewer wasted materials. See the standard titled CSA S478:19, Durability in Buildings for criteria and requirements for the design of durable buildings and building elements.

The costs of inaction with respect to climate change mitigation measures may not be easy to consider at the design stage or during the purchase of a new building. However, inaction can ultimately result in increased future costs related to higher building operating energy/emissions resulting from poorer-performing enclosure systems, more frequent replacement of less-durable building enclosure components, and, potentially, loss of use (for example, if a building is unoccupiable due to lack of thermal comfort or indoor air quality).

Having the full picture of the cost of building ownership can help inform and motivate design decisions related to more durable and energy-efficient building enclosure assemblies, details, components, and materials. If the cost of ownership of a building is presented to the owner at the time of design as a net present value (NPV) that includes both the operation costs and the future replacement costs of building enclosure components, at estimated future timelines and with estimated future inflation rates, the owner should be able to tangibly evaluate the benefit of a more durable and energy-efficient building enclosure design over the entire service life of the building. A comprehensive NPV cost of building ownership analysis would consider the building operational energy/emissions costs in combination with costs of the building systems renewals over the service life of a building.

A depreciation report is a form of cost analysis that is regularly used by strata corporations and other building owners to help estimate building component replacement timeframes and costs. Maintenance and renewal plans have similar scopes. While these are typically done for existing buildings, a depreciation report or maintenance and renewal plan could be done as part of the NPV analysis for a new construction project.

ADAPTATION

Climate change is expected to increase overall temperatures globally and cause more frequent heat waves, increase the likelihood of wildfires that degrade air quality, and cause more intense and frequent storm events that increase the likelihood of flooding.

These environmental stresses result in both direct and indirect effects on building enclosure systems, such as the following:

- Increased temperatures and more frequent heatwaves, resulting in:
  - direct effects on thermal comfort and the health of building occupants; and
  - indirect effects on the frequency of power outages, due to higher demand on the energy grid and contributions to regional problems related to overheating (e.g., heat island increases).
- More frequent wildfires, resulting in:
  - direct effects on combustible enclosures, indoor air quality, and the health of building occupants; and
  - indirect effects on the frequency of power outages caused by transmission line damage.
- More intense and frequent precipitation events, resulting in:
  - direct effects on wind, rain, hail, and snow loads; and
  - indirect effects on the frequency of power outages and pluvial flooding.
- Sea level rise, resulting in:
  - direct effects on the surface water and groundwater building enclosure loads.

Several strategies to address these effects and create adaptive and resilient building enclosure components are discussed in the following subsections.

As discussed in the Mitigation section above, depending on the type of project, the BEE will have either direct control or indirect influence on adaptation measures. In either case, the BEE should consider and discuss the benefits of implementing adaptation measures with the client and the design team.

Finally, adaptation and mitigation measures are not mutually exclusive; many adaptation measures have trickle-down mitigation effects. For example, the same adaptation detail intended to minimize the amount of cold air entering a space through the structure or assembly will likely work in the opposite direction as well, minimizing the amount of heat loss through the structure or assembly, thereby decreasing the amount of energy required to heat the space and decreasing the resulting GHG emissions.

THERMAL COMFORT

Thermal comfort requires a holistic and coordinated design effort by the professionals responsible for the architectural form, the mechanical/electrical systems, and the building enclosure assemblies. BEEs are expected to provide input on environmental separation.

A building energy model is necessary to evaluate and quantify thermal comfort during the design stages of a project, and is outside the typical scope of services for a BEE, except to provide input on the building enclosure assemblies. For more information, refer to the *Professional Practice Guidelines – Whole Building Energy Modelling Services* (Engineers and Geoscientists BC 2018).

Thermal comfort pertains to an occupant's satisfaction with the indoor thermal environment. However, with increased ambient temperatures during the summer months and significant likelihood of further increases due to extreme heat events, health and life safety risks should also be considered, to mitigate potential adverse health implications resulting from prolonged exposure to extreme heat.

There are three main considerations that a BEE should have regarding thermal comfort and potential health and life safety issues associated with prolonged extreme heat exposure:

- overheating;
- thermal bridging; and
- passive survivability.

Overheating

Overheating occurs as a result of the accumulation of heat within a building. Excessive interior temperatures within an occupied space can negatively impact the health and safety of the occupants. With projected increases in external temperatures, and in the frequency and severity of extreme heat events, BEEs should implement design strategies that maintain occupant comfort as well as mitigate health and life safety risks.

Further, given the projected changes in climate, BEEs should consider not only current climatic conditions, but also future projected conditions, to reduce associated overheating risks over the lifecycle of the building. BEEs should review future climate projections, such as those published in the Pacific Climate Impacts Consortium (PCIC) online data portal (PCIC 2021), and consider using the data to design building enclosures that can withstand increased temperatures beyond those that are required by the *BC Building Code*. See the References and Resources section below for more information.

Aspects of building design with the potential to negatively affect the interior thermal environment, which can exacerbate overheating risks, include:

- high window to wall ratio;
- lack of appropriate passive shading measures (either fixed or operable);
- building form and orientation;
- thermal bridging;
- inadequate passive or active ventilation;
- lack of active cooling; and
- inappropriate solar heat gain coefficient values for windows.

Ideally, solar heat gain is optimized to achieve passive gains in the heating season, while being controlled through shading in the cooling season. To help control solar heat gain in the cooling season, shading can be provided by the architectural form, the building enclosure details, or the building enclosure system.

While some strategies may cause thermal bridging issues if they are not appropriately detailed, the following strategies may improve the performance of the building enclosure as it relates to the indoor thermal environment:

- Implementing permanent exterior shading elements, such as canopies, fins, balconies, eyebrows, brise-soleils, and exterior blinds, to reduce the interior solar heat gain and frequency of overheating
- Optimizing the window-to-wall ratio and solar heat gain coefficients for glazing
- Locating the fenestration within the depth of a wall or the head flashing details, to optimize the shading from the enclosure details themselves
- Providing for future additions of exterior shading elements within the enclosure details by either allowing for the enclosure system to be easily disassembled, or by including structure to accommodate future installation of shading elements, such as brise-soleils or fins (thermal bridging must be considered)
- Including operable windows, where appropriate, to allow for passive ventilation
- Optimizing selection of exterior colours and surface finishes to account for heat gain
- Applying coatings (e.g., low-E, electrochromic) to insulated glass units (IGUs) within the fenestration system, or allowing for easy replacement of IGUs when advanced shading technology is more prolific

Thermal Bridging

Heat flow (loss or gain) through building enclosure details (i.e., thermal bridging) has a direct impact on interior thermal comfort, as it can lead to faster changes in interior ambient temperatures as well as significant variations in interior surface temperatures. The effects of thermal bridging within building enclosure systems are determined by several factors, including:

- the alignment of the thermal barrier layers in relation to the fenestration IGU; and
- how highly conductive components, such as concrete or steel structural components, are connected, and where they are located within an enclosure.

BEEs are commonly involved in analyzing thermal bridging impacts (using resources such as the *Building Envelope Thermal Bridging Guide* [BC Housing 2021b] or 2D/3D heat flow modelling) on interior surface temperatures, in order to review condensation resistance potential. However, reviewing overall thermal comfort for building enclosure details is currently less common. Nevertheless, where appropriate, BEEs should discuss potential improvements of details for increased thermal comfort with their client and design team.

Passive Survivability

With the changing climate and more extreme weather events or higher loads on the power grid during heatwaves, an indirect effect of climate change will be more frequent power outages that impact mechanical and electrical systems. Power outages will require the building enclosure systems to perform passively to help maintain interior thermal comfort for longer periods of time.

The thermal comfort considerations discussed above also double as measures to provide passive survivability of a building during a prolonged power outage. BEEs should discuss the performance expectations with the client and the design team, considering both normal building operations and passive survivability during power outages.

INDOOR AIR QUALITY

The quality of indoor air within a building is primarily determined by the mechanical and passive ventilation strategies. Mechanical ventilation primarily relies on the active air handling and filtration systems, as well as the building enclosure air barrier system and compartmentalization, to isolate the exchange of indoor and outdoor air to the active mechanical system. Therefore, the air barrier system plays an important role in the overall effectiveness of the mechanical system and can have a direct impact on the indoor air quality.

Drought and extreme weather events have led to more wildfires in BC in the past few years, and this trend is predicted to continue with climate change. The reduction in indoor air quality during wildfire events will have a considerable impact on the health of occupants. BEEs should work with the architect and consider implementing improvements to the air barrier system to not only reduce the operating GHG emissions of the building, as discussed above, but also to provide environmental separation to help enhance the indoor air quality during wildfire events.

Improvements to the air barrier system could include:

- using fully adhered air barrier materials, such as self-adhered or liquid applied air barrier products, depending on the base structure;
- testing the overall performance of the air barrier (whole building air barrier testing), as well as providing quality assurance testing of typical or complex air barrier system details during construction (see the CSA and ASTM test standards listed in the References and Resources section), to help confirm efficacy; and/or
- assisting the general contractor in the development of their quality control plan for the air barrier system.

Under normal operating conditions, the indoor air quality, like thermal comfort, can be moderated by the use of passive ventilation from operable windows.

ENCLOSURE COMBUSTIBILITY

In a wildfire-prone region, the architectural form of a building, the building maintenance, and the selection of building enclosure components and materials can greatly impact a building's resistance to combustion from a nearby wildfire.

Specifically, architectural forms that allow for the collection of organic debris (i.e., fuel) at horizontal or vertical surfaces with complex details (e.g., roof dormers, unguarded roof gutters, parapets, eyebrows, windowsills) can increase the risk of ignition from wildfire embers, while regular building maintenance to remove organic debris at architectural details or surrounding the building footprint can decrease the risk.

Although the architectural form and efficacy of building maintenance is typically beyond a BEE's direct influence, the selection of building enclosure materials that resist wildfire combustion may be within a BEE's scope of influence. Where appropriate, BEEs may also provide input to the owner's building maintenance manual.

With the increasing frequency and severity of wildfires in BC, where appropriate and when retained, BEEs should work with the architect to help specify combustion-resistant materials for enclosure systems in areas prone to wildfires, particularly for surfaces that have the highest likelihood of interacting with embers from a nearby wildfire (e.g., roofs, decks, balconies).

Consideration should be given to specifying class A flammability rated materials, as determined by the standard titled CAN/ULC-S107, Methods of Fire Tests of Roof Coverings, for the roofing (e.g., metal roofing, asphalt shingles, some SBS membranes, concrete pavers) and fiber cement cladding, masonry veneer cladding, fire-rated metal cladding, or other combustible-resistant cladding material for wall systems.

For more information, refer to the *Home Development Guide* (FireSmart 2021) and the *National Guide for Wildland-Urban Interface Fires* (NRC 2021).

WIND AND PRECIPITATION

With the changing climate, more concentrated precipitation events and increased wind speeds caused by increased temperatures can be expected. As these environmental loads directly affect building enclosure systems, BEEs should consider utilizing future climate files, such as those published by the PCIC, for guidance on determining appropriate loading conditions, and should encourage the design team to do the same.

With greater amounts of precipitation anticipated in shorter periods of time, the potential accumulation of precipitation on horizontal enclosure systems should be assessed as part of the adaptation measures. BEEs should coordinate the roof systems, drains, overflow drains, and door curb heights with other members of the design team.

Intensified precipitation can also lead to more frequent flooding (e.g., pluvial, snowmelt). BEEs should consider this higher likelihood of flooding when selecting below-grade and at-grade enclosure systems. Considerations for these systems may include:

- selecting waterproofing rather than damp-proofing materials and systems;
- extending waterproofing above the expected flood-related water heights;
- providing appropriate details at penetrations below the expected flood-related water heights; and
- encouraging the professionals responsible for the drainage strategy at the perimeter of the building to allow for unrestricted flow of surface water to the perimeter drainage system.

The predicted increased wind speeds will lead to higher structural loads on fenestration systems and other building enclosure components. For more information, see the report titled Climate-Resilient Buildings and Core Public Infrastructure (Government of Canada 2021) and the PCIC data portal (PCIC 2021).

Increased wind speeds will also impact the driving rain wind pressures that are used to determine the water penetration resistance pressures for fenestration systems. BEEs, along with the structural engineer of record, should discuss any additional capacity, anchorage, or water penetration requirements for building enclosure components with the supporting registered professionals responsible for those designs.

SEA LEVEL RISE

Climate change is expected to impact low-lying coastal regions of BC in two ways:

- Sea level rise of 1 m by the year 2100; see *Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Sea Dike Guidelines* (BC MOE 2011)
- Increased coastal flooding from storm activity and/or tsunamis

Design teams and building owners should consider how these two situations will impact new and existing buildings during their service life. For more information, refer to the following documents:

- *Guidelines – Flood Plain Standards and Requirements* (City of Vancouver 2014)
- Sea Level Rise Adaptation Primer (BC MOE 2013)
- *Flood Hazard Area Land Use Management Guidelines* (BC MOE 2018)

While BEEs are not responsible for major design considerations such as building location, elevation, and architectural form, BEEs may be responsible for the below-grade and at-grade waterproofing systems and should consider the implications of the expected sea-level rise when selecting below-grade and at-grade waterproofing systems. As such, BEEs should be aware of any resources and expectations that the authority having jurisdiction has published related to design to adapt to sea-level rise. The considerations BEEs should make related to sea-level rise are the same as for precipitation, mentioned above.

REFERENCES AND RESOURCES

REFERENCES

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CODES AND STANDARDS

ASHRAE Guideline 0-2019 – The Commissioning Process.

ASTM E783, Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

ASTM E1186, Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

ASTM E2813-12, Standard Practice for Building Enclosure Commissioning.

CAN/ULC-S107, Methods of Fire Tests of Roof Coverings.

CSA S478-19, Durability in Buildings.

CSA Z5000-18, Building Commissioning for Energy Using Systems.

CSA Z5001:20, Existing Building Commissioning for Energy Using Systems.

National Institute of Building Science (NIBS) Guideline 3-2012, Building Enclosure Commissioning Process BECx.

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