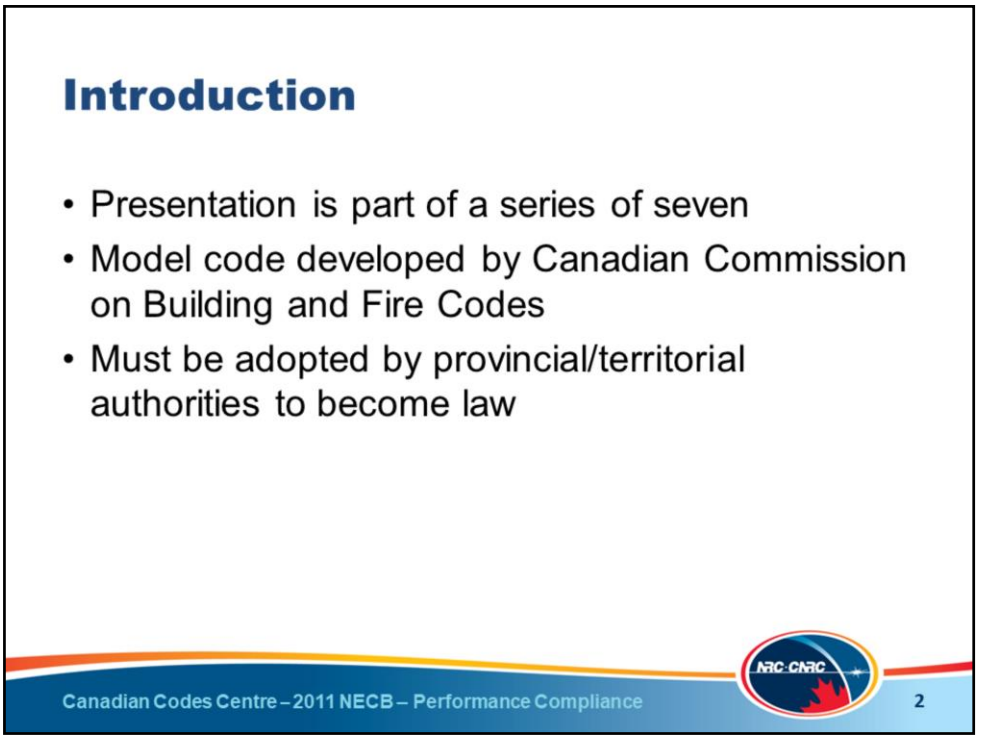
Welcome
My name is Elisabeth Girgis.

This presentation will focus on the building energy performance compliance part of the 2011 National Energy Code of Canada for Buildings (NECB) - Part 8.

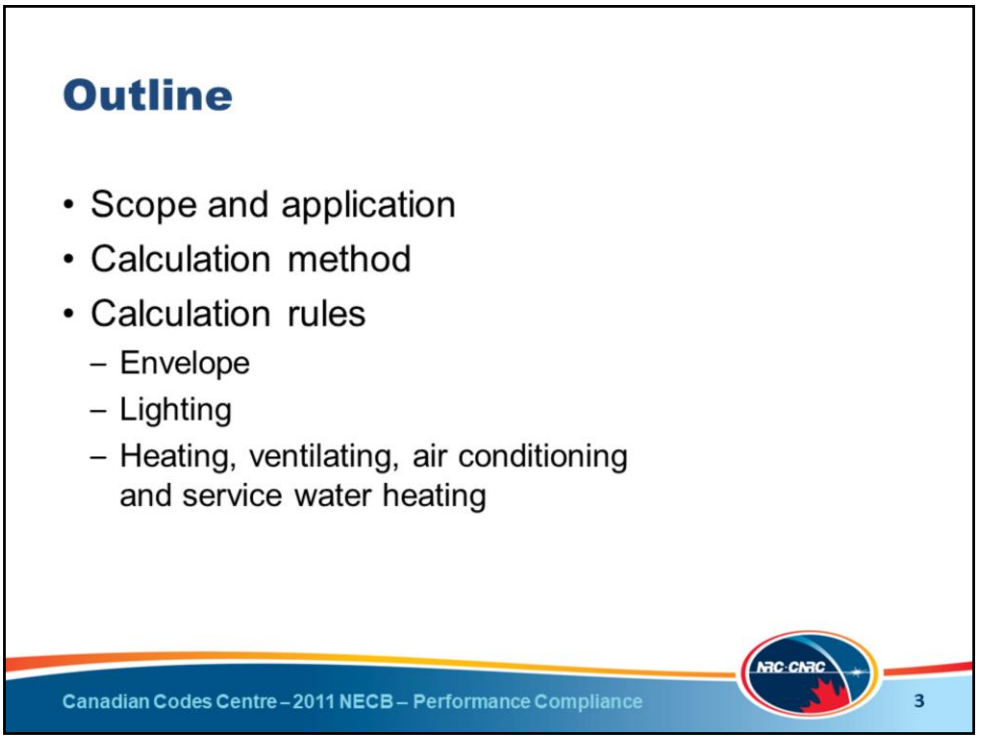


This presentation is part of a series of seven on the 2011 NECB.

It is important to note that this is a model code developed by the Canadian Commission on Building and Fire Codes (CCBFC) and must be adopted by provincial/territorial authorities to become law.

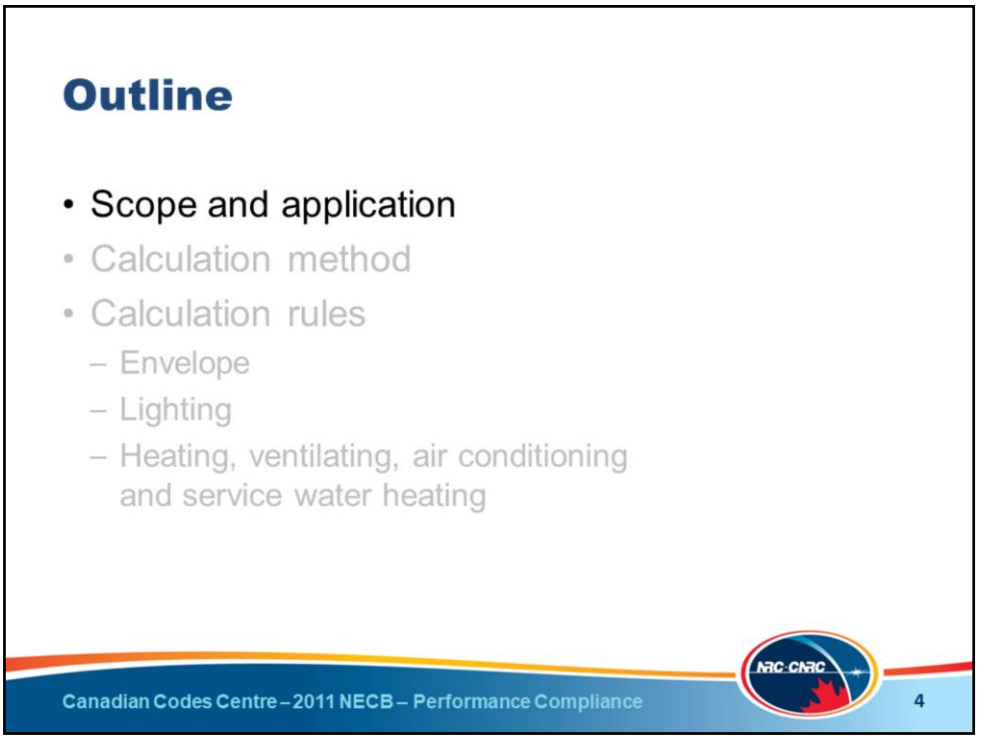
This may mean that code requirements enacted by legislation within your province or territory might differ from what is presented here.

Please check with your local authority.

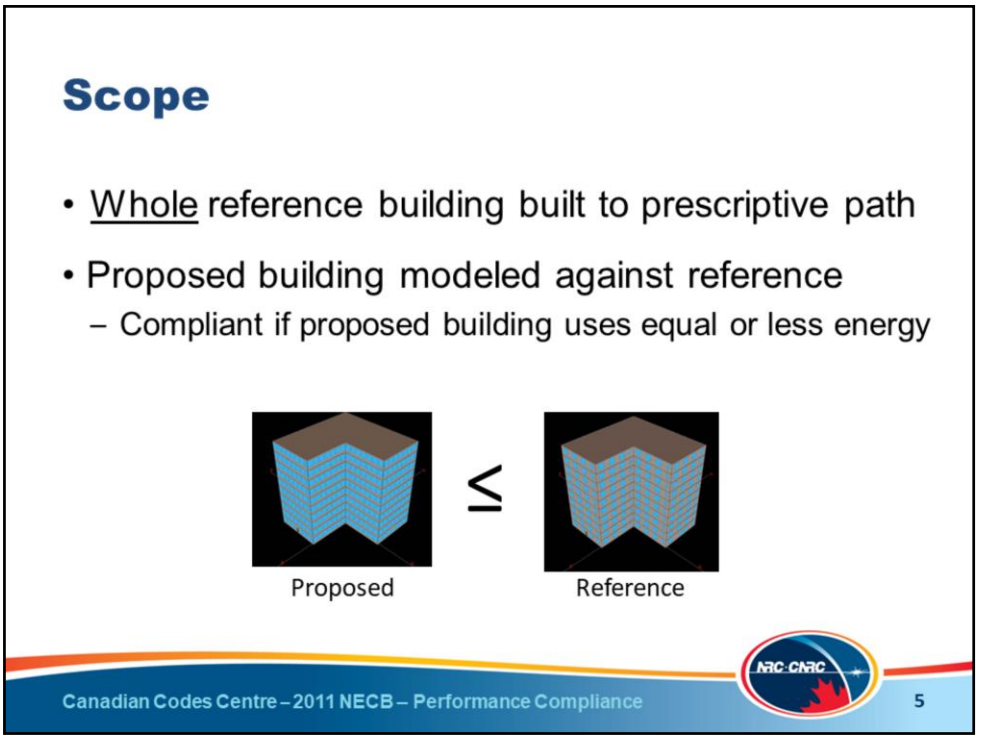


Part 8 provides an alternative to the prescriptive requirements and trade-off of other Parts. Compliance is demonstrated by showing that a building will not use more energy than it would if it were to comply with the prescriptive requirements.

This presentation will provide details on the scope and applications addressed by Part 8, as well as calculation methods and specific details on the building envelope; lighting; heating, ventilating and air-conditioning (HVAC) and service water heating modeling rules.



We'll start with the first topic, scope and application.



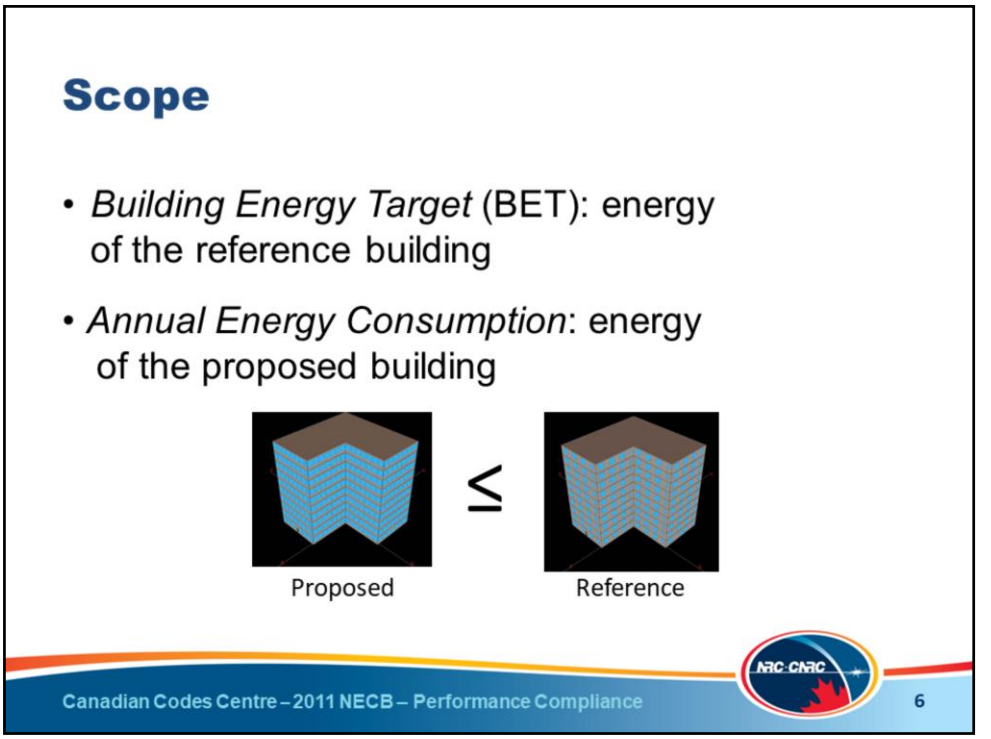
The performance path is a whole building approach.

Two buildings are simulated. One is a reference building built to the prescriptive path. The other is a proposed building that calculates the energy use of a modeled building that is consistent with the proposed building design and specifications.

Both simulations account for the effect on energy consumption of the building envelope, lighting, HVAC and service water heating systems. Where construction techniques or building components are used that are more energy efficient than those required in the prescriptive requirements, the extra performance over the prescriptive requirements can be credited, provided it can be quantified and is not dependent on occupant interaction. Conversely, if techniques are used that are less efficient, a penalty on performance would be modeled.

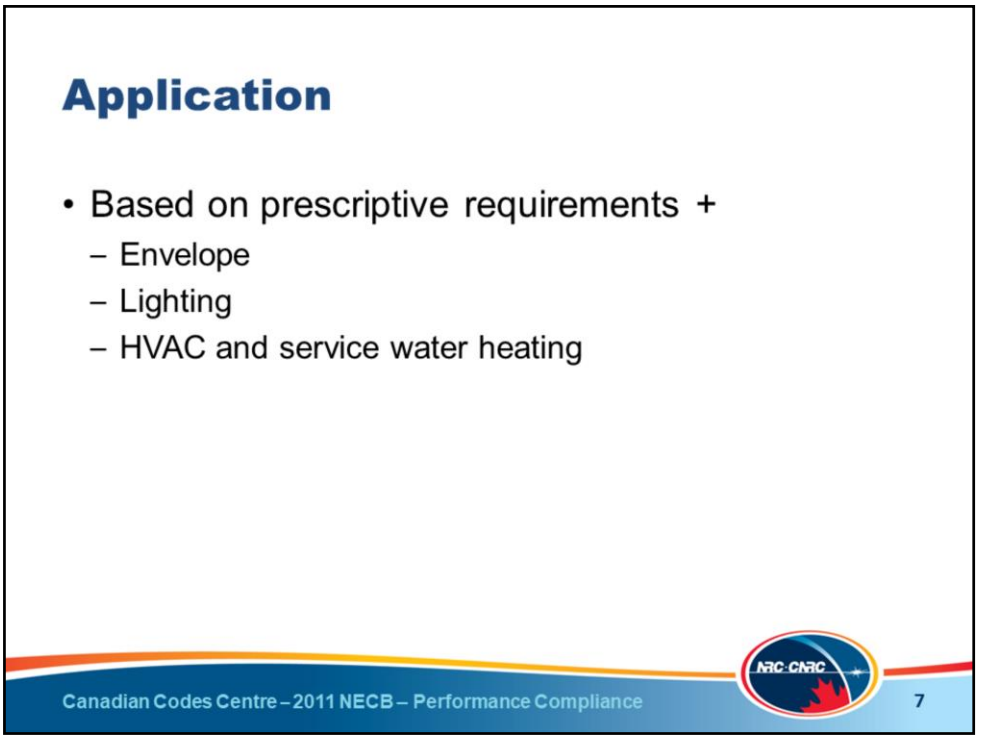
A design is compliant if the proposed building uses equal or less energy than the reference building.

Part 8 contains the rules for calculating the energy use of the two buildings.



Because “reference” and “proposed” are two words used throughout this presentation it is worth repeating that the “reference” is a full building modeled to the prescriptive requirements. The energy of the reference building is defined as the building energy target in the Code.

The “proposed “is modeled as per the building plans and specifications. Its energy consumption is defined as the “Annual Energy Consumption”.



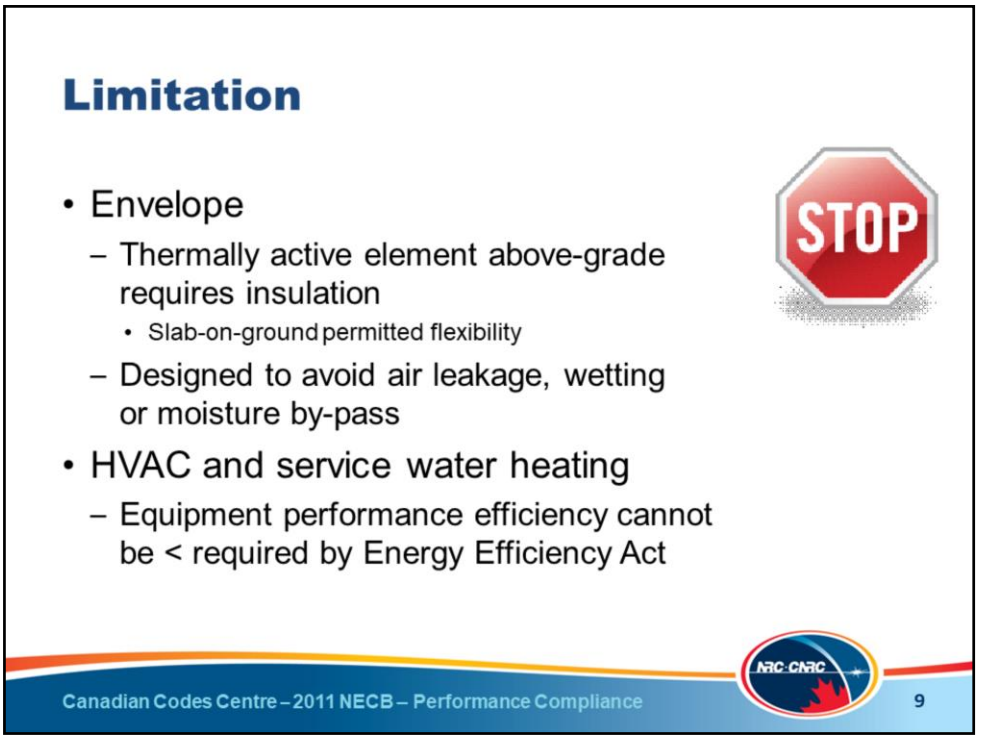
The elements considered in the performance compliance path are based on prescriptive requirements for the building envelope; lighting; HVAC; and service water heating (SWH) system (i.e. Parts 3, 4, 5 and 6 of the Code). Where a prescriptive requirement is present, Part 8 is written to refer back to the applicable prescriptive provisions. This approach provides flexibility in administering the document because changes to the prescriptive requirements from future code cycles will be incorporated in the compliance calculation without changing Part 8 text.

A plus is indicated in the first bullet to signal that more than the prescriptive requirements are considered. While assessing whole building energy use, some factors are not appropriate for inclusion as a requirement in a simplified prescriptive approach. However, when assessing whole building energy, they become important.

For example, consideration of the interaction between lighting and heat load changes in the HVAC system are too detailed for a simplified approach but they are appropriate in whole building modeling. The performance path therefore considers the prescriptive requirement plus other elements.

Part 8 does contain certain limitations.

- Sufficient information must be known on the building's occupancy, as it plays a significant role in the building's energy use.
- Additionally, sufficient information must be known about the components, materials and assemblies used in the proposed design. The level of detailed information required is the highest of all compliance paths. Although a compliance estimation could be conducted early in the initial design stage, detailed plans and specifications used for construction would typically be needed.

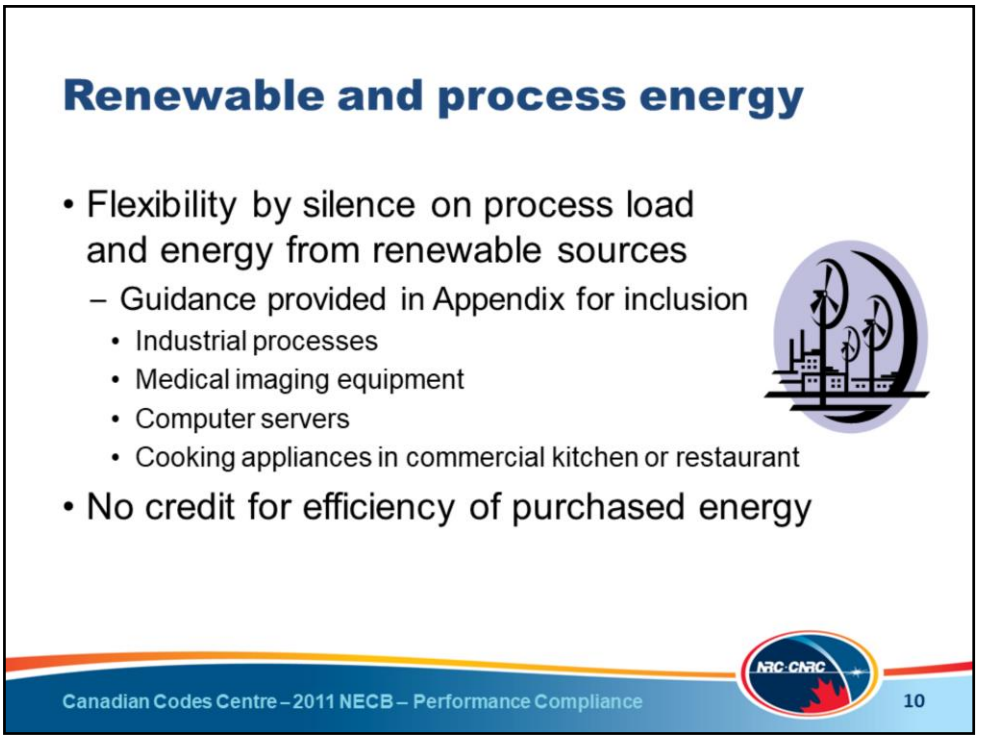


Physically, the limitations on the constructed building are:

- For the building envelope, thermally active above-ground opaque components of the building envelope with embedded radiant heating/cooling must meet the prescriptive requirements. Radiant floors slab-on-grade are not constrained by this limitation.
- The building envelope must also be designed to avoid reducing insulation material integrity due to air leakage, wetting or moisture by-pass.
- For HVAC and service water heating, the equipment performance efficiency cannot be less than that required by the Energy Efficiency Act (EEA).
- Lastly, there are no physical limitations for lighting or electrical power.

For those familiar with the performance path in the 1997 Model National Energy Code of Canada for Buildings (MNECB), these physical limitations are comparable to the old mandatory requirements. This list is shorter and provides significantly greater flexibility on how the energy performance is achieved. For example, piping insulation would not be needed to meet the NECB's energy use efficiency objective. The reference building would be modeled with piping insulation as per the prescriptive requirements and the proposed building would not.

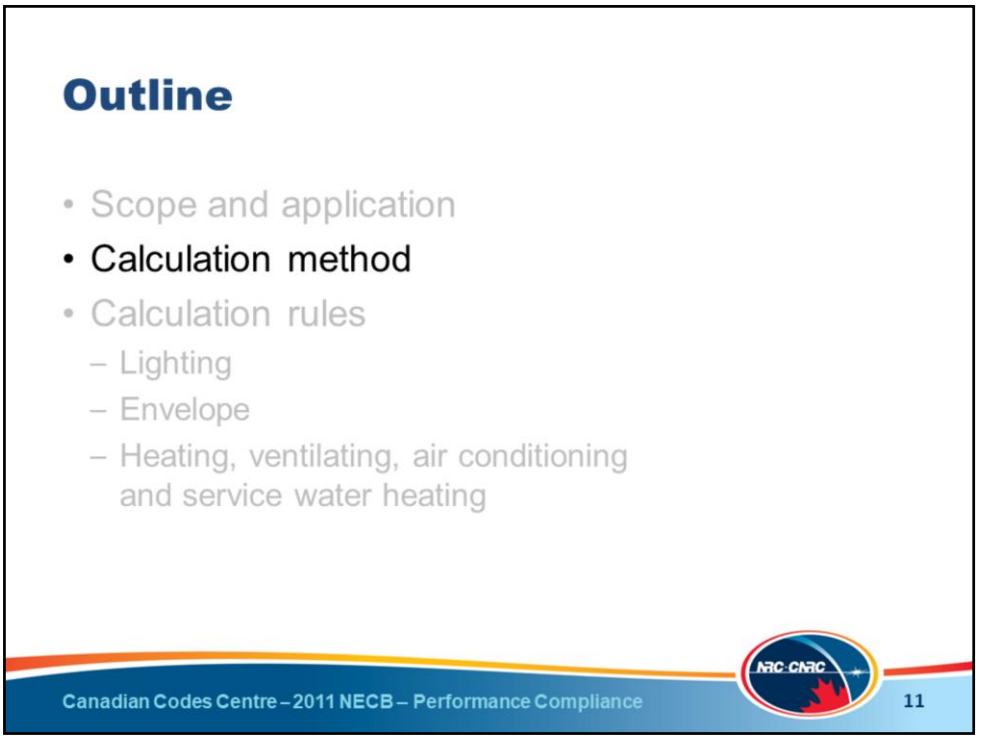
It is important to remember that where there are requirements in the National Building and Plumbing Codes for piping insulation that address an objective other than energy use, those requirements would still need to be met.



The prescriptive and trade-off paths are generally silent on process loads and renewable energy. Of all paths the performance path provides the greatest degree of flexibility and is the path likely to be chosen to obtain credit for their use. The large degree of different technologies involved and the lack of national consensus on their treatment is the reason for exclusion of their detailed treatment. However, by being silent, the NECB opens the door to consideration, by the building authorities, for a project that wants to have a credit applied when incorporating them.

An Appendix note is provided to clarify that the default internal loads in Part 8 represent common electrical equipment directly operated by the occupants for the building type. The note also lists some common commercial and industrial operations and process loads that are not included in the default loads. Some of these are listed on the slide. The Appendix recommends that reasonable professional judgment should be applied in evaluating whether or not these less common internal loads are correctly represented in the default values.

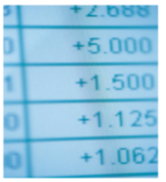
No credit is given for efficiency of purchased energy. It is modeled as an electric boiler with an efficiency of 100% for heating and as an electric chiller with a coefficient of performance of 1.0 for cooling.



When simulating a building's energy consumption, many factors can be considered. The calculation methods included in Part 8 do not address all of the factors affecting estimation of the energy consumed, but rather focus on the most significant elements. These calculation methods will now be discussed.

Calculation method

- Factors that calculation must account for
- Certain calculation steps that must be performed
  - e.g. verifying that heating load will be met
- In certain cases, the data that must be used



The Part 8 calculation method sub-section provides:

- the detail level the calculation must account for
- certain calculation steps that must be performed – such as verifying that the heating load will be met, and
- in certain cases, the data that must be used.

Required detail

- Hourly time step during one year
- 10 years of climatic data
- Account for
  - Effect of thermal mass
  - Space temperature
  - Heat transfer
    - Internal loads
    - Transfer of radiant and convective heat from lighting
  - Solar absorptance of opaque building assemblies
- Envelope assembly covering < 5% total assembly area need not be modeled separately

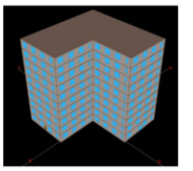
The energy calculations must be detailed. They must:

- be performed for one year using time intervals no greater than one hour
- use climatic data files based on 10 years of average measured data at the nearest weather station, and
- account for the elements on the slide.

A simplification is permitted in that an envelope assembly covering less than 5% of the total area of that assembly need not be modelled separately, provided its area is included in an adjacent assembly having a similar U-value and the same orientation.

Reference identical to proposed building

- Floor area of conditioned space
- Building or space use
- Thermal blocks
- Shape and exterior dimensions
- Orientation
- Default schedules and loads due to number of occupants



General criteria that must be accounted for, and match the specification of the proposed design for both simulations, are shown on the slide.

User-dependant variables

- Defaults for user-dependant variables set equal in proposed and reference
  - Schedules
    - Building or space type
    - 24 hours, 7 days a week
  - Occupant density (m^2/occupant)
  - Service water heating loads (W/person)
  - Receptacle loads (W/m^2)

When a variable is required for compliance calculation purposes, but is not in the prescriptive path, it can be set to a default, assumed, or treated the same, in both the reference and proposed building.

Some of these variables are user-dependant. Part 8 compliance calculation rules treat these the same in both the proposed and the reference buildings. By applying the same assumption, they are neutral. Specifically, user-dependant variables that are set equal in proposed and reference comprise:

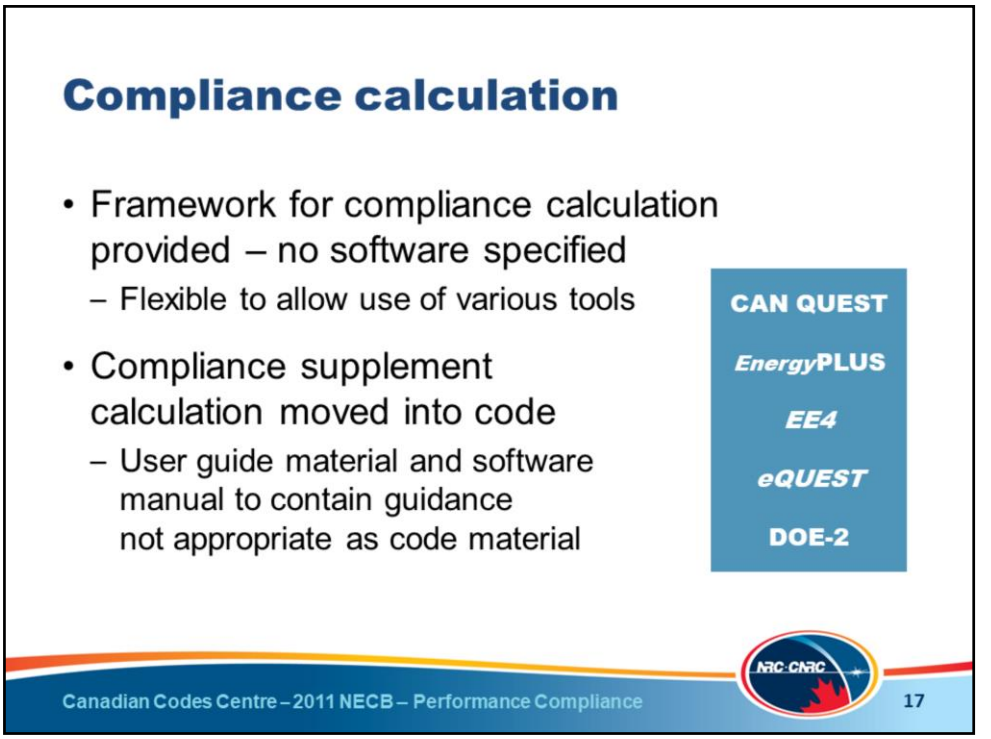
- schedules
- occupant density
- service water heating loads, and
- receptacle loads.

Semi-heated building

- Reference building internal temperature set to 18°C
  - Heating equipment capacity to no more than proposed building's peak heating load plus 5%
- Proposed building internal temperature as per design

For the purposes of the Code, a semi-heated building is considered to be a building heated to less than 18°C. These buildings are often warehouses.

For a semi-heated building, the reference building internal temperature is set to 18˚C and the proposed building is modeled with an internal temperature as per the design. There is an overall requirement that the heating equipment in the proposed building is not oversized to provide more than the proposed building's peak heating load plus 5%.



Given the number of calculation steps that need to be performed, the calculation method of choice for Part 8 will most often be a computer program, rather than pencil and paper or use of a spreadsheet.

To avoid hindering innovation in software development, and because the Canadian Codes Centre and the CCBFC do not maintain or accredit software programs for determining Code conformance, Part 8 is silent on which software program to use. Many different programs could be used, and NRCan is developing CanQuest, a software specifically designed to support the NECB.

Part 8 does require that if a software program is used, it must be evaluated against ASHRAE 140 or a similar software test method.

The 1997 MNECB compliance supplement contained requirements for software inappropriate for the Codes. Examples included software interface criteria or detailed calculation steps so specific that the number of tools that could be used for compliance demonstration was limited. That type of information was not incorporated into the 2011 NECB.

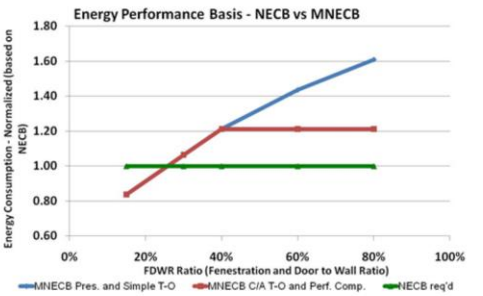
Outline

- Scope and application
- Calculation method
- Calculation rules
  - Envelope
  - Lighting
  - Heating, ventilating, air conditioning and service water heating

Specific calculation rules for the main prescriptive topics will now be discussed, starting with the building envelope.

Envelope – change in prescriptive criteria

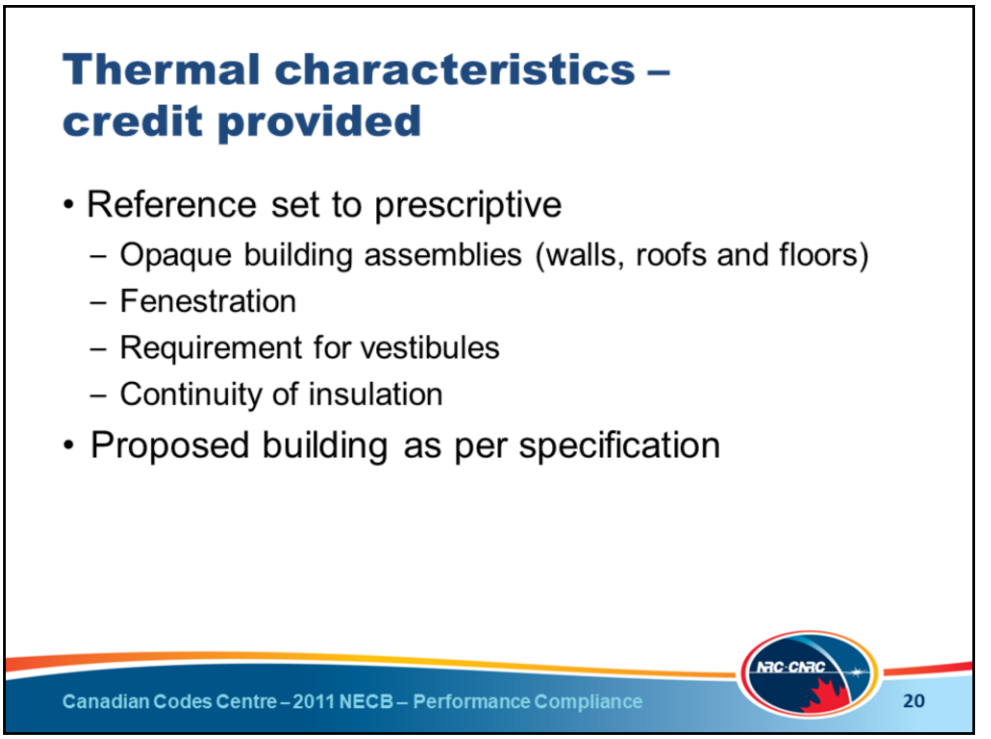
- Removed
  - Exemptions based on assembly type
  - Differentiation based on fuel type or region
  - 167% increase of thermal transmittance limitation
- Replaced
  - FWR with FDWR (% window to % window and doors)
  - Prescriptive based on climatic region



Relative to the 1997 MNECB, several significant changes have been introduced into the NECB 2011. Exemptions based on assembly type, and differentiation based on fuel type and administrative region have been removed. Specific to the performance path, the previous MNECB limitation on thermal transmittance increase to no more that 167% over the prescriptive requirement has also been removed.

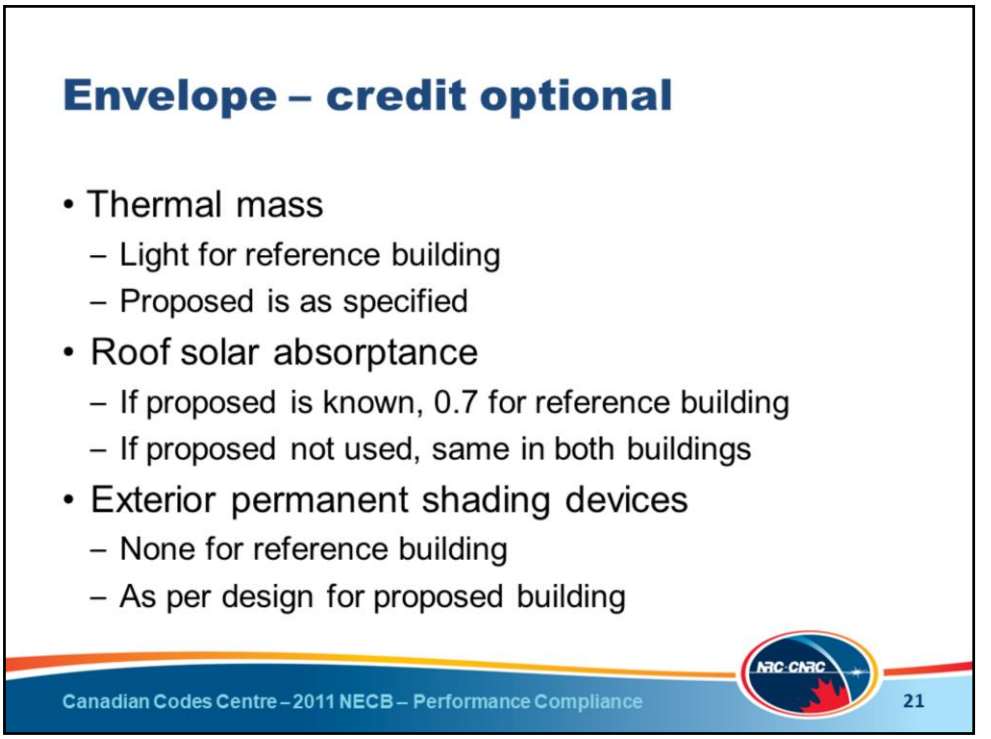
These criteria have been replaced with requirements setting the envelope properties to the same as the prescriptive requirements and introduction of a maximum fenestration and door to wall ratio (FDWR) for the reference that does not change depending on your proposed design, but varies with the building site's climatic conditions.

In combination with the changes to be discussed for the HVAC system reference building , this modification introduced a consistent level of performance for the reference building. In the graph shown on this slide the NECB is represented by the green horizontal line showing a consistent performance. It does not vary based on the FDWR, as was the case with the MNECB prescriptive and performance paths, which are shown in blue and red.



The thermal characteristics of opaque building assemblies (walls, roofs and floors), fenestration, requirements for vestibules and continuity of insulation are modeled as per the prescriptive requirements.

A credit or penalty is obtained depending on whether or not the proposed building specifications are better or worse than the simple prescriptive requirements.



Building envelope criteria not covered in the prescriptive path, for which credit can be obtained in Part 8, are thermal mass, roof solar absorptance and exterior permanent shading devices.

- Thermal mass is assumed to be identical to that of lightweight construction for the reference building. The proposed building may use the default values or the specified thermal mass, if it is known.

- Roof solar absorptance shall be the same in both, unless the proposed value is known. This rule allows credit for technologies such as albedo roofs.

- The reference building is assumed not to have any permanent exterior shading devices. The proposed design can include them, as per their specifications, and could thereby obtain a credit for reduced solar heat gain.

Envelope – no credit

- Whole building air leakage: 0.25 L/(s•m2) – same in both
- Exterior shading by tree or other structure – same in both

Criteria that are important to consider in modeling, and for which no credit can be obtained, are air leakage and shading by exterior structures.

For the reference and proposed cases, air leakage is set at 0.25 L/(s•m^2) of total gross above-grade wall and roof areas. A joint task group is currently investigating air barriers and, should more detailed prescriptive requirements be incorporated in the next code edition, these will be reflected in the performance path.

Exterior shading by other buildings or trees are to be treated the same in the proposed and reference buildings.

Outline

- Scope and application
- Calculation method
- Calculation rules
  - Envelope
  - Lighting
  - Heating, ventilating, air conditioning and service water heating

Specific calculation rules for lighting will now be discussed.

Lighting – credit provided

- Interior, site and exterior lighting power density
  - Reference building as per prescriptive requirement
  - Proposed building as specified
- Occupant sensors
  - 10% credit
- Daylighting
  - Use trade-off if none in software used

The Part 8 building types and space functions have been coordinated to align with those in the Part 4 lighting prescriptive categories.

Credit can be obtained for performance above the prescriptive requirements for interior, site and exterior lighting. Provision of better controls for the prescriptive requirements also allows for a credit to be applied. Similarly, lighting above the prescriptive lighting power densities will result in a penalty for the proposed building.

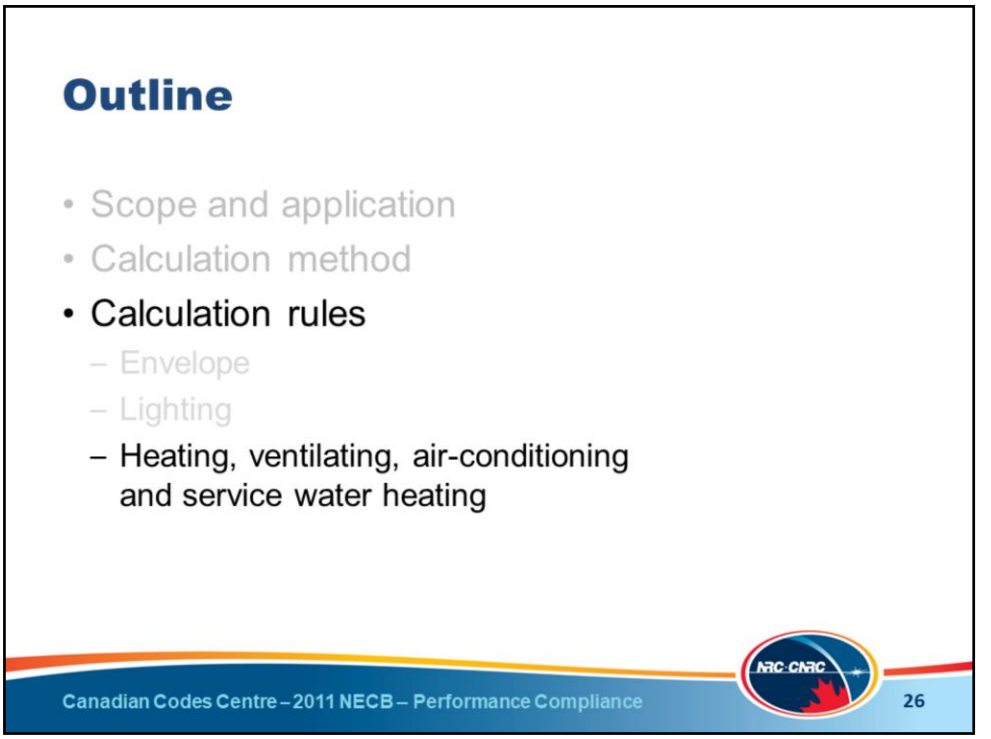
A 10% credit on the installed interior lighting power is provided when occupant sensors are included in the design of the proposed building.

If used, daylighting measures are also credited. The calculation, if not in the software program used, needs to be determined using the Part 4 trade-off methodology.

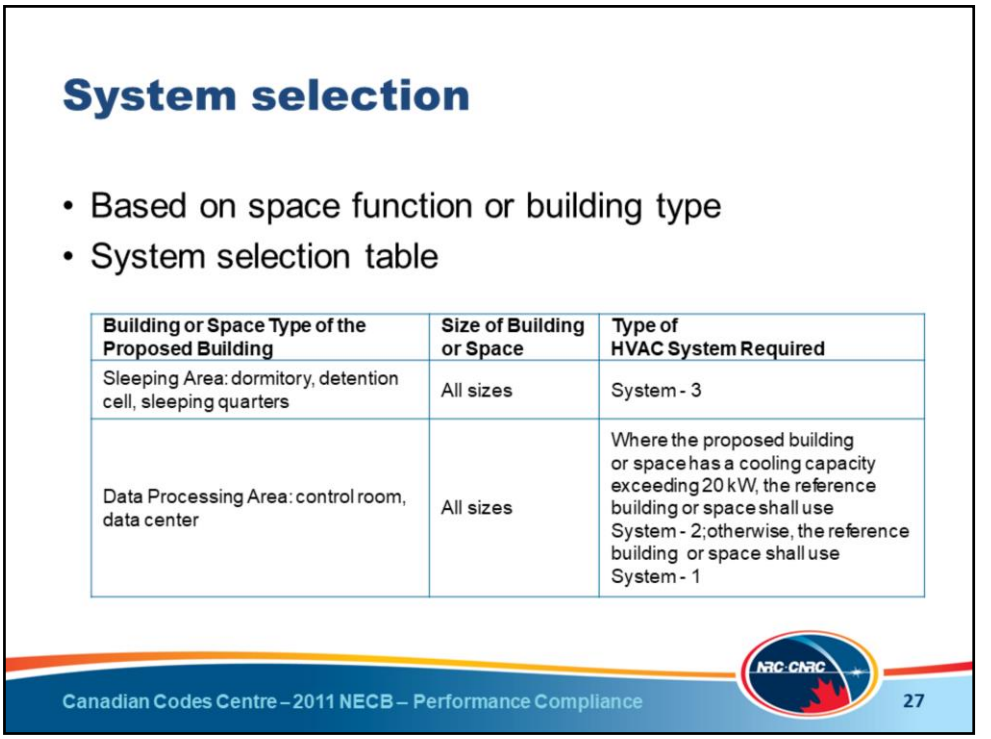
Lighting – no credit

- Lighting density in dwelling units not mandated in Part 4
  - 5 W/m^2 increased allowance for dwelling units

Since the prescriptive requirements do not contain lighting power densities for dwelling units, they are treated the same in the proposed and reference building. The allowance has increased to 5 W/m^2, compared to the MNECB modeling rules.



Specific calculation rules for the HVAC and service water heating systems will now be discussed.

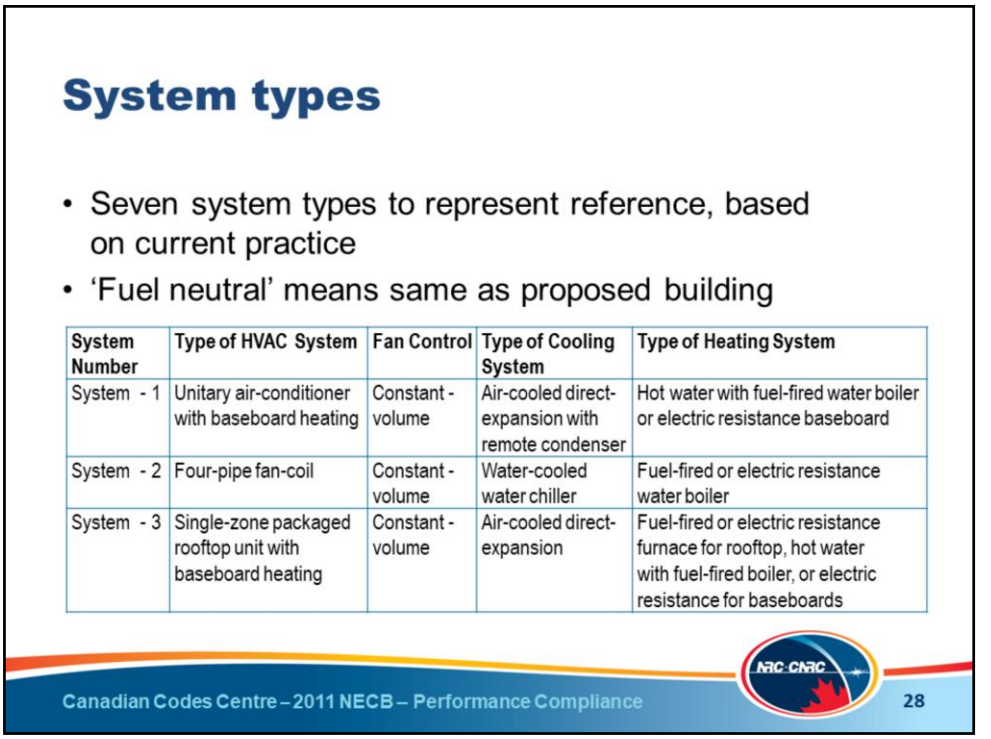


Similar to the significant change in the building envelope reference , the HVAC and service water heating references have also changed. The NECB sets the HVAC and service water heating system to the most typical type used for the various buildings or space type. The building type or space function have been coordinated with the Part 4 lighting groupings. Shown here is an excerpt from the system selection table. First, the building type is found, and then the HVAC system type is selected.

This approach provides two key advantages over the previous compliance calculation approach.

First, more consistency by building type is provided in the reference energy consumption. This increased consistency moves the NECB closer towards establishing a quantitative energy target for future code cycles and aligns the code with its objective of energy used by the building.

The second advantage is that the energy consumption of an innovative HVAC system design is compared to that of a typical HVAC system. It is not compared to a system which, although it may be more similar to the proposed design, would be unrealistic or unrepresentative for the building type. The unrepresentative reference could force a much higher level of performance than a similar building using a standard design, and could hinder innovation.



Seven system types are available to represent the reference building. These system types are based on current practice.

An excerpt from the table is shown here. The type of HVAC system, fan control method and types of cooling and heating systems are provided. The last two columns indicate the heating and cooling type. They are fuel neutral in that the same fuel is used in the proposed and reference building.

Ventilation – credit provided

- Heat recovery credit above Part 5 requirement
  - Central exhaust > 150 kW, above 50% efficiency
  - Any in dwelling units with self-contained ventilation in climatic zones 4, 5 and 6
- Ventilation
  - Reference constant volume, except general area type > 2 storeys
- Cooling with outside air above Part 5 requirements

Credits can be obtained for heat recovery performance above the prescriptive requirements. For systems > 150 kW, credit is obtained for efficiency above 50%. For dwelling units with self-contained mechanical ventilation, credit is provided for any heat recovery ventilation in climatic zones 4, 5 and 6 (i.e. the warmest in Canada, where they are exempt). In other zones, credit is provided for use above the Part 5 50% requirement . Similarly, if the proposed building does not provide heat recovery when required in the prescriptive path, an energy penalty would be generated.

The reference building is set at constant volume for all building types, except the general area category above 2 storeys for which variable speed ventilation is the reference. This reference allows credit for the use of variable air volume systems.

Cooling with outside air above Part 5 requirements would also enable a credit.

Radiant systems – credit provided

- In-floor, in-ceiling or in-wall radiant systems modeled with 2˚C difference in temperature set-point (e.g. heating to 21°C versus 19°C)

In-floor, in-ceiling or in-wall radiant heating and/or cooling system are modeled with a 2˚C difference in temperature setting between proposed and reference buildings, thereby providing a credit in the proposed building. This means the reference building would be modelled at 21˚C versus 19˚C for the proposed building.

Equipment operation – credit optional

- Oversizing addressed
  - Reference heating equipment not oversized by > 30%
  - Reference cooling equipment not oversized by > 10%
- Part load performance characteristics
  - Reference defaults provided
  - Proposed as specified can be used

Part 8 addresses equipment oversizing in more detail than the prescriptive requirements. Reference building heating equipment shall not be oversized by more than 30% of the capacity required. Reference building cooling equipment shall not be oversized by more than 10%. The proposed equipment is modeled as specified.

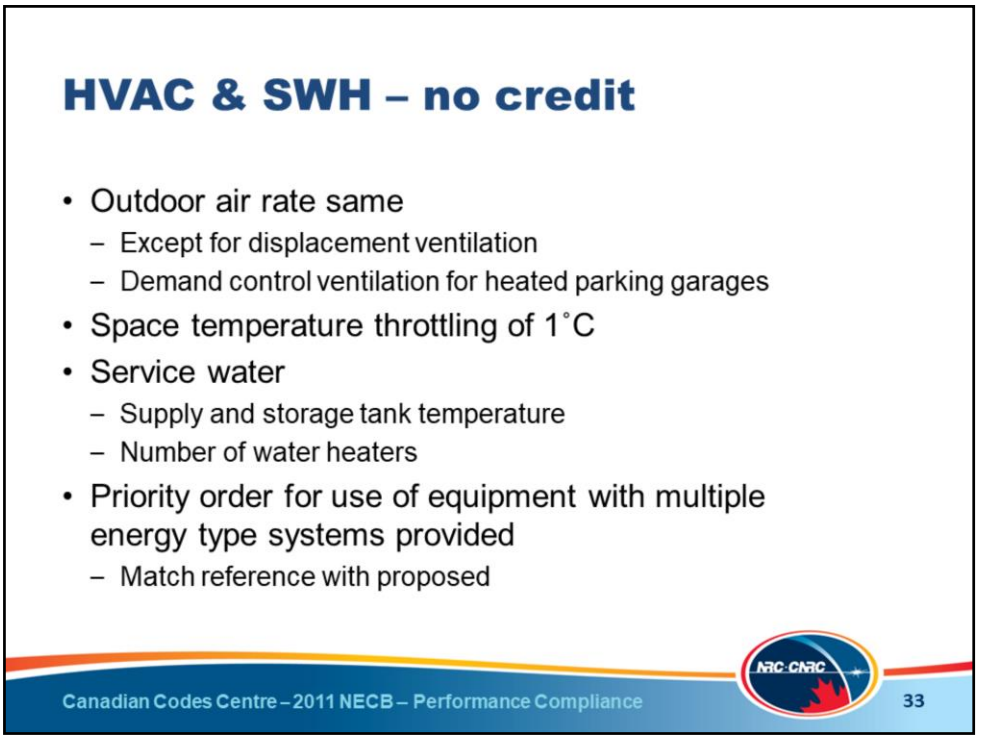
Additionally, default part-load performance curves are provided for heating, cooling and ventilating equipment. The reference building will use these defaults and the proposed building can either use these or use the specified equipment's part-load performance.

Other – credit optional

- Heating system
  - Constant speed pumping
  - Hot water supply temperature reset
- Cooling system
  - For hydronic, number of chillers based on plant size
  - For direct expansion, number of stages based on size
  - For cooling tower, number of cells based on size
  - Temperature drops
- Fan part load performance characteristics

Here are other items for which Part 8 provides a reference.

The proposed building may obtain a credit or penalty depending on whether the design is better or worse than the reference building.



In addition to the user-dependant criteria discussed earlier under scope, other factors specific to HVAC and SWH are treated the same in the proposed and reference building.

They remain neutral and include the following:

- The outdoor air rate must be the same in the proposed and reference buildings. The implication for outdoor air is that the ASHRAE 62 breathing area method calculation can be used, as well as other methods accepted by the authority having jurisdiction.

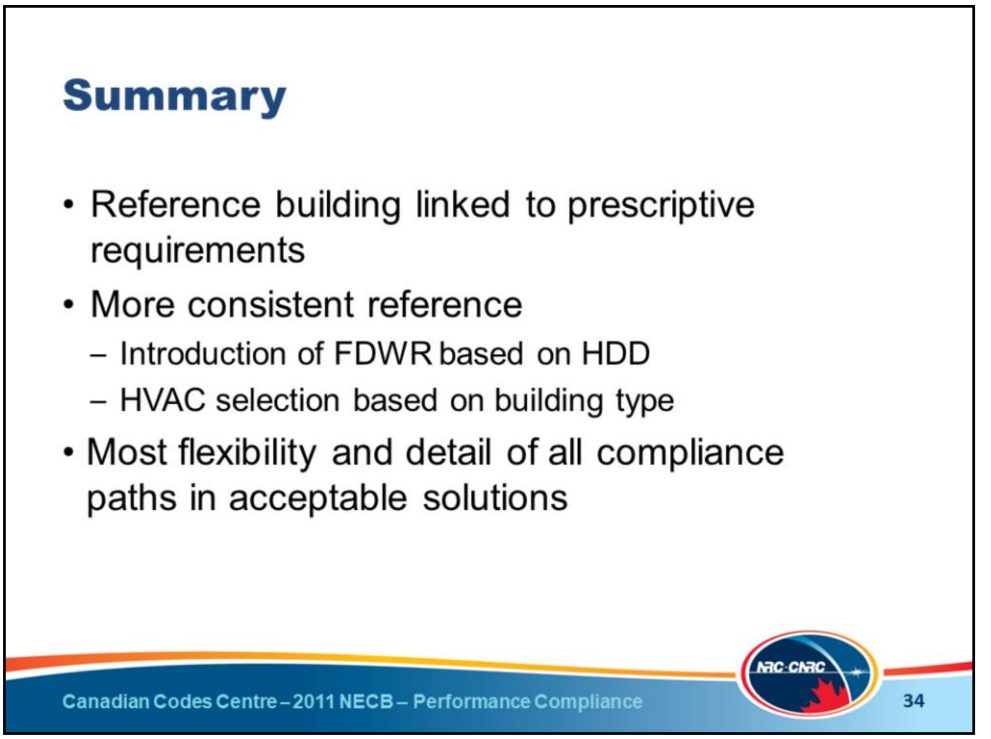
  This approach also acknowledges that local conditions may exist that necessitate the use of outdoor air rates differing significantly from values typically used.

  Except for heated parking garages, demand control ventilation strategies are not included in the reference building.

- Space temperature throttling of 1˚C must be used.

- For SWH, the supply temperature defaults for service water must be the same in the proposed and reference buildings. As well, the same number of water heaters must be modeled.

- Priority order for use of equipment with multiple energy type systems is provided to ensure consistency in the comparison.



In summary, the reference building is linked to the prescriptive requirements. The NECB Part 8 provides a more consistent reference with the introduction of:

- the fenestration and door to wall ratio, based on heating degree-day, and
- HVAC selection, based on building type.

It is also the most flexible and detailed of all compliance paths in the acceptable solutions.

This concludes the presentation on Part 8, the building energy performance compliance part of the NECB.