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Proposed Change 1859

Code Reference(s):	**NECB20 Div.B 5.1.1.2. (first printing)** **NECB20 Div.B 13.5. (first printing)**
Subject:	Alteration of Existing Buildings
Title:	Alteration of HVAC Systems
Description:	This proposed change adds requirements that define the application of NECB Part 5 to HVAC systems subjected to alteration.
Related Proposed Change(s):	PCF 1864

This change could potentially affect the following topic areas:

- ☐ Division A
- ☐ Division C
- ☐ Building operations
- ☐ Small Buildings
- ☐ Fire Protection
- ☐ Accessibility
- ☐ Building Envelope
- ☑ Heating, Ventilating and Air Conditioning
- ☑ Division B
- ☑ Design and Construction
- ☐ Housing
- ☑ Large Buildings
- ☐ Occupant safety in use
- ☐ Structural Requirements
- ☑ Energy Efficiency
- ☐ Plumbing
- ☐ Construction and Demolition Sites

General information

See the summary for subject Alteration of Existing Buildings.

Problem

Heating, ventilating and air-conditioning (HVAC) systems in existing buildings can remain unaltered for the life of the system, which can be many decades in some instances. Older buildings that were built to meet the requirements of past editions of the Codes tend to consume more energy than their more modern counterparts.

The alteration of the existing building also provides a good opportunity to gradually upgrade the HVAC system and any ancillary components to meet current Code requirements. However, since renovation works in existing buildings are typically more

costly than when building new constructions, the requirements of NECB Part 5 applicable to these upgrades must be adapted to maintain an acceptable level of cost-effectiveness.

Justification

HVAC systems comprise different components and subsystems that are integrated and interconnected to operate as a whole. Furthermore, the design requirements for a component, subsystem or an entire HVAC system can have a cascading impact on others. NECB Part 5 reflects that complexity by providing requirements that target each component and subsystem that can also have a cascading impact. The application of these requirements to systems in existing buildings must be carefully measured to ensure a reasonable cost-effectiveness.

Consequently, Part 5 requirements have been considered for full application to

- new standalone installations or additions within existing buildings, as these can be easily designed to different requirements than the rest of the building's HVAC systems, and
- the entire scope of any alteration works.

The rest of the existing HVAC systems subject to alteration (i.e., those parts that are not affected by the initial scope of the alteration) are generally exempt because of the high cost of the related and cascading effects between components and systems that can be incurred. A few common upgrades generally considered to be cost-effective by the industry are still required.

However, when the proposed alteration work involves a significant change to the characteristics of a system (represented by a significant change in the thermal capacity of a system or in the layout of an air or water distribution system), it is deemed cost-effective in the long term for these systems to comply with all Part 5 requirements.

The threshold to determine what constitutes a "significant change" was set at 60%, as works of this magnitude generally and naturally have a significant cascading impact on existing systems, subsystems and associated systems, which require additional extensive modifications to maintain interoperability. Expanding these works to subject the entire HVAC system to the Part 5 requirements is considered cost-effective in these conditions.

PROPOSED CHANGE

[5.1.1.2.] 5.1.1.2. Application

[1] 1) Except as permitted in Sentence~~s~~ (2) ~~and (3),~~ and except for systems and equipment used exclusively for the control of smoke in the event of a fire, this Part applies to heating, ventilating and air-conditioning systems and equipment.

[2] 2) A heating, ventilating or air-conditioning system or part thereof may be exempted from some or all of the requirements in this Part where it can be shown that the nature of the *occupancy* or the type of heating, ventilating or air-conditioning equipment used makes it impractical to apply these requirements. (See Note A-5.1.1.2.(2).)

~~**[3] 3)** This Part does not apply to the existing components of systems that are extended to serve *additions*.~~

[13.5.] -- Heating, Ventilating and Air-conditioning Systems

[13.5.1.] -- General

[13.5.1.1.] --- Scope

[1] --) This Section is concerned with HVAC systems covered in Part 5.

[13.5.1.2.] --- Application

[1] --) This Section applies to existing HVAC systems subjected to *alteration* and new HVAC systems installed in *existing buildings*.

[13.5.2.] -- Compliance

[13.5.2.1.] --- Requirements

[1] --) Except for repair and maintenance, and except as provided in Sentences (2) and (3), HVAC equipment and systems shall comply with Part 5.

[2] --) Existing HVAC equipment and systems, and replacement components, shall comply with the requirements of Part 5, adjusted as follows:

[a] --) where leakage testing of air distribution systems is performed in compliance with Subsection 5.2.2., the entire air distribution system subjected to *alteration* shall be tested for leakage in accordance with Article 5.2.2.4., and

[b] --) where Subsection 5.2.3. applies, fan systems need only comply with

[i] --) for variable-air-volume systems, Sentences 5.2.3.3.(2) and (3), and

[ii] --) Article 5.2.3.4., and

[c] --) only replacement air-handling units need comply with Article 5.2.2.7., except where impractical because of structural or construction constraints.

[3] --) Parts of the HVAC system that are not subjected to *alteration* need not comply with Part 5, where

[a] --) the added thermal load does not exceed 60% of the peak design load supplied by the existing HVAC system, and

[b] --) the length of added and replacement ductwork or piping does not

exceed 60% of the length of ductwork or piping in the existing distribution system.

(See Note A-13.5.2.1.(3).)

Note A-13.5.2.1.(3) Criteria for Upgrading Existing HVAC Systems.

The alteration of existing HVAC systems presents an opportunity to reduce the energy use of these systems by upgrading them to meet the requirements of the current edition of the Code. The obligation to upgrade an HVAC system is triggered when at least one of two criteria is met as a result of the alteration.

The first criterion, as set out in Clause 13.5.2.1.(3)(a), applies where a significant thermal load is added to the system, for example, to a boiler plant. This criterion may be evaluated by comparing the peak thermal loads served by the system before and after its alteration.

The second criterion, as set out in Clause 13.5.2.1.(3)(b), applies where a significant length of ductwork or piping is added to or replaced in the distribution system. This criterion may be evaluated using measurements on plans that are representative of the existing installation.

Impact analysis

The impact analysis guidelines for the alteration of existing buildings require that the proposed changes be evaluated for several building vintages. The key metric of interest in the impact analysis is the marginal difference between the current market practice and the proposed changes.

Since the prescriptive requirements for the alteration of existing buildings are triggered only when alterations are performed, the metric to evaluate the impact of these requirements is defined as the comparison between the new prescriptive requirements and what would normally be done in the absence of such (i.e., current market practice).

For this analysis, four vintages of unaltered buildings were selected:

- Pre-1980
- 1980–2010
- NECB 2011
- NECB 2015

Current market practice is defined as complying with NECB 2017, and the proposed code is considered to be the NECB 2020.

To calculate the marginal energy increment, a model representing the vintage was created (see https://github.com/NREL/openstudio-standards/tree/master/lib/openstudio-standards/standards/necb). The HVAC systems were then updated in the model to comply with the NECB 2017 requirements and the thermal energy use intensity (TEUI) calculated. The same process was followed for the

NECB 2020 requirements. The marginal energy increment is the difference between these two TEUIs. This process was repeated for all the vintages for 16 archetypes in 32 locations across Canada (and later collated by region).

The primary driver of energy savings is the increased equipment efficiency from the NECB 2017 to the NECB 2020; few other differences exist (e.g., duct insulation), and their impact is negligible because they are not modeled or are narrow in scope (e.g., conditions applying to variable-air-volume systems only). The archetypes examined in this study use a range of HVAC systems. Table 1 presents the heating and cooling equipment used and their efficiencies as modeled in NECB 2017 (i.e., current practice) and in NECB 2020 (i.e., proposed code); fuel savings for each type of equipment is also estimated (i.e., how much less fuel is required).

NOTE:

- Table 1 only highlights relevant equipment efficiencies; the efficiencies related to auxiliary equipment (e.g., energy recovery ventilators, fans, pumps) were assumed to be constant and are not shown.
- Efficiencies are based on individual equipment capacities, and the values in Table 1 are representative of the class of equipment in the archetypes.

Table 1. Differences in HVAC Equipment Efficiency by Archetype

Type of Conditioning Equipment		Applicable Archetypes	Approx. NECB 2017 Efficiency Requirement	Approx. NECB 2020 Efficiency Requirement	Approx. Simple Fuel Savings, %
Heating	Furnace, gas-fired	All, excluding medium and large offices	92.4%	95%	2.7
	Boiler, gas-fired	All	83%–85%	90%	5.6–7.8
Cooling	Packaged terminal air conditioner (PTAC)	Apartments and hotels	Varies by capacity; generally, from COP 3.23 to COP 3.29 in climate zone 4		~1.8
	Unitary air conditioner; capacity < 19 kW	All, excluding medium and large offices	SEER 14	SEER 15	6.7
	Unitary air conditioner; 19 kW ≤ capacity ≤ 223 kW		No change in requirements		0
	Chiller	Medium and large offices	Varies by capacity; COP 5.7	Varies by capacity; COP 6.0	5
		Hospitals, hotels	Varies by capacity; 4.50	Varies by capacity; 4.51	0.2
	Cooling tower	Medium and large offices, hospitals, and hotels	No change in requirements for direct-contact cooling towers		0

Summary results from the simulations are presented by region in Figures 1 (TEUI reduction) and 2 (percentage reduction); positive values indicate energy savings.

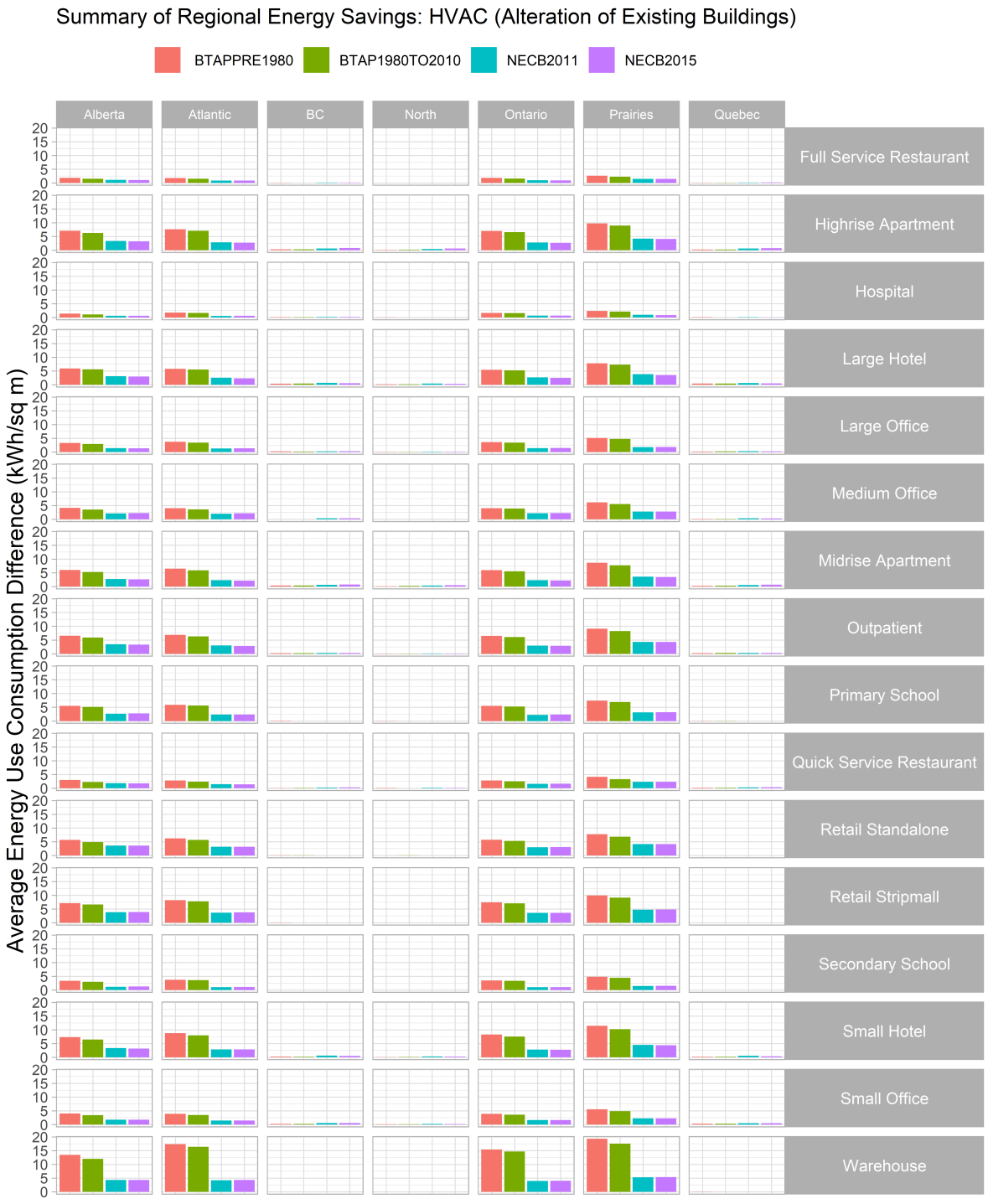

Figure 1. Marginal energy use intensity increment for various building archetypes and vintages in regions across Canada

Figure 2. Marginal percentage energy use intensity increment for various building archetypes and vintages in regions across Canada

Energy savings in British Columbia (BC), the North and Quebec are limited and are entirely attributed to cooling equipment because the archetypes assume electrical heating for those locations and there are no changes in electrical heating efficiencies (~100%). The cooling savings are minor because

- package terminal air conditioners are only used in dwelling spaces (apartments and hotels), the increased efficiency results in minor fuel savings (1.8%), and there is less energy reduction because total energy consumption is limited by the small capacities of the units;
- unitary air conditioning efficiencies have largely remained unchanged, except for smaller capacity systems (< 19 kW) that are used in archetypes with smaller energy consumption;
- Large capacity chillers (with 5% fuel savings) are limited to medium and large offices, and chillers with lower capacities have a negligible increase in efficiency (in hospitals and hotels);
- Cooling energy generally constitutes a small portion of the overall consumption

for most buildings in Canada.

Conversely, energy savings for archetypes in Alberta, Atlantic Canada, Ontario and the Prairies are around 2% or higher, as shown in Figure 2. This is the result of increased energy efficiencies of the gas-fired heating equipment in addition to the cooling energy savings previously discussed. Heating energy savings are higher because

- heating constitutes a much larger portion of the overall energy consumption of buildings in Canada, therefore, increased energy efficiencies of these equipment have a larger impact, and
- gas-fired boilers had an appreciable increase in efficiency and are modeled in all archetypes.

Over time, the HVAC energy consumption of buildings decreases as newer equipment efficiencies are required. Figure 3 presents the average HVAC (including ERVs, fans and pumps) energy consumption of each archetype by vintage, indicating a decreasing trend over time. Note that to provide more neutral datum to demonstrate the trend of HVAC performance, a 1.5 L/(s×m^2) at 75 Pa air leakage rate (as specified in Article 8.4.3.3. of Division B of the NECB 2020) was assumed for each archetype, regardless of vintage. Although this assumed air leakage rate provides a lower estimate of HVAC energy consumption in older vintages (i.e., energy consumption should be higher in older vintages), it provides a more conservative trend in declining energy consumption over time. Similarly, the differences in high-rise and midrise ventilation requirements between the NECB 2020 (ASHRAE 62.1-2016, "Ventilation and Acceptable Indoor Air Quality") and older vintages (ASHRAE 62-2001, "Ventilation for Acceptable Indoor Air Quality") were neutralized as well to demonstrate the performance of the HVAC independent of the differences in the ventilation loads of the dwelling spaces.

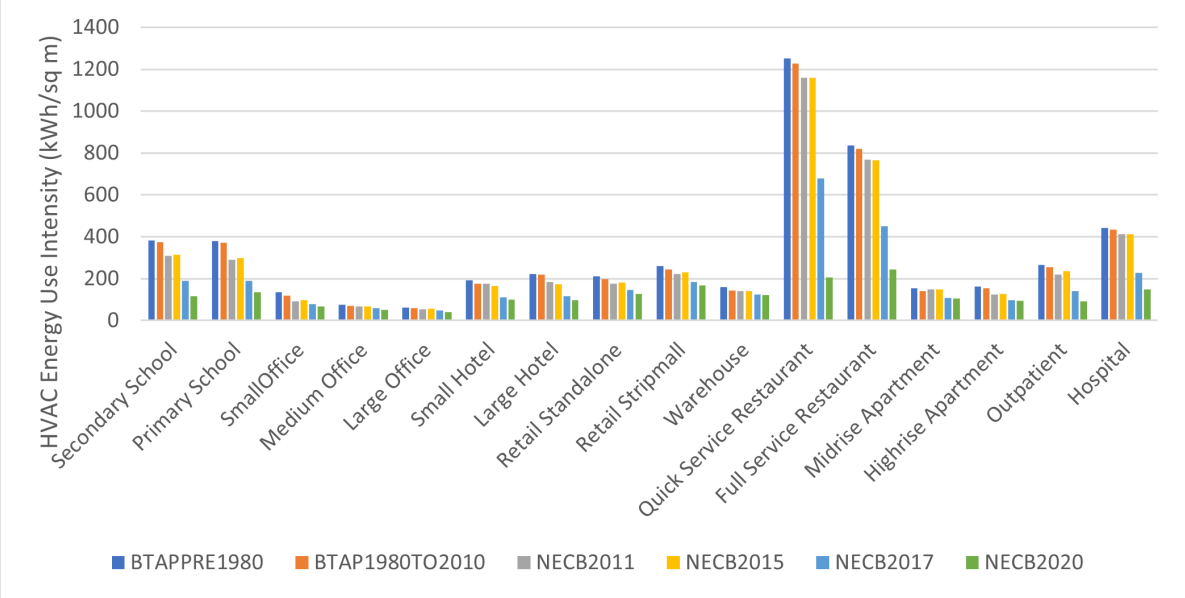

Figure 3. HVAC energy use intensity for various Canadian archetypes and vintages

Enforcement implications

The requirements for the alteration of HVAC systems in existing buildings could be enforced by the same means and resources involved in the enforcement of the prescriptive requirements of Part 5 of the NECB.

Who is affected

Designers, specification writers, manufacturers, contractors, building owners and building officials.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[5.1.1.2.] 5.1.1.2. ([1] 1) no attributions

[5.1.1.2.] 5.1.1.2. ([2] 2) no attributions

~~**[5.1.1.2.] 5.1.1.2. ([3] 3) no attributions**~~

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