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Proposed Change 1826

Code Reference(s):	NBC20 Div.B 10.9.36. (first printing)
Subject:	Alteration of Existing Buildings
Title:	Replacement of Fenestration, Doors and Skylights
Description:	This proposed change introduces requirements for the replacement of fenestration, doors and skylights.
Related Proposed Change(s):	PCF 1812, PCF 1813, PCF 1824, PCF 1829, PCF 1839, PCF 1850

This change could potentially affect the following topic areas:

- | | |
|--|---|
| <input type="checkbox"/> Division A | <input checked="" type="checkbox"/> Division B |
| <input type="checkbox"/> Division C | <input checked="" type="checkbox"/> Design and Construction |
| <input type="checkbox"/> Building operations | <input checked="" type="checkbox"/> Housing |
| <input checked="" type="checkbox"/> Small Buildings | <input type="checkbox"/> Large Buildings |
| <input type="checkbox"/> Fire Protection | <input type="checkbox"/> Occupant safety in use |
| <input type="checkbox"/> Accessibility | <input type="checkbox"/> Structural Requirements |
| <input checked="" type="checkbox"/> Building Envelope | <input checked="" type="checkbox"/> Energy Efficiency |
| <input type="checkbox"/> Heating, Ventilating and Air Conditioning | <input type="checkbox"/> Plumbing |
| | <input type="checkbox"/> Construction and Demolition Sites |

General information

See the summary for subject Alteration of Existing Buildings.

Problem

See the "Problem" section of the summary for the subject Alteration of Existing Buildings.

The requirements for the energy performance of fenestration, doors or skylights described in Subsection 9.36.2. of Division B of the National Building Code of Canada (NBC) theoretically already apply to the alteration of existing buildings, but the enforcement of the application of Code requirements to alterations and any relaxations depends on the interpretation of the authority having jurisdiction that balances the cost of complying with the Code against the benefits of achieving the Code's environment objective.

Applying all requirements for the minimum energy performance of fenestration, doors and skylights in Section 9.36. to an alteration, as if the building were newly constructed, could result in alterations that go far beyond their original scope.

However, if voluntary upgrades to fenestration, doors and skylights are not required to achieve at least a reasonable level of energy-efficient performance, an opportunity may be lost to reduce energy use in the existing building (and gain the related cost savings in energy billing).

This proposed change would also potentially save installation costs compared to later upgrades to better products, which would involve reconstructing wall openings and flashing.

Justification

This proposed change clarifies the application of the requirements for the energy performance of fenestration, doors and skylights in Article 9.36.2.7. to existing buildings. This proposed change would also facilitate a consistent interpretation of the Code when the costs of compliance are balanced against the benefits of achieving the Code's environment objective.

This proposed change allows for some relaxation of the requirements when they are applied to existing buildings, which prevents an alteration from going far beyond its original extent. This proposed change also contains sufficient detail for the voluntary alteration of fenestration, doors and skylights.

PROPOSED CHANGE

[10.9.36.] -- Energy Efficiency

[10.9.36.1.] --- Replacement Fenestration, Doors and Skylights

- [1] --)** Except for maintenance and repair, and except as provided in Sentences (2) and (3), the energy performance of replacement fenestration, doors or skylights shall comply with Article 9.36.2.7. (See Note A-10.9.36.1.(1).)
- [2] --)** Where only a glazing unit is replaced, the replacement glazing unit shall conform to Table 9.36.2.7.-C or have a level of energy performance equivalent to that of the existing glazing unit, whichever provides the higher level of energy performance.
- [3] --)** Where fenestration, doors or skylights are replaced, the interfaces between wall/ceiling assemblies and the replacement fenestration, doors or skylights shall conform to Sentence 9.36.2.10.(10).

Note A-10.9.36.1.(1) Energy Performance of Replacement Fenestration, Doors and Skylights.

Generally, replacing old fenestration products in an existing building with new products conforming to Article 9.36.2.7. will sufficiently improve energy performance. However, some recently constructed Part 9 buildings may have been designed and constructed to exceed the Code requirements for energy performance. Where making alterations to these buildings with the intent of replacing existing fenestration, doors or skylights, Sentence 10.1.1.5.(1)-2025 (PCF 1824) requires that the energy performance level of the replacement building component not be less than that of the replaced component. For these buildings in particular, the selection of the appropriate fenestration products needs to take into account the design of the existing fenestration products. For example, if an existing building has triple-glazed, vinyl-framed windows, the replacement windows should have these same overall characteristics, even though these characteristics may exceed the minimum requirements set out in Article 9.36.2.7.

Given that glazing can only be replaced and not repaired, it is important to use replacement glazing that provides a level of energy performance similar to that of the existing glazing. In order to provide adequate replacement glazing, the supplier will typically be able to determine the energy-performance characteristics of the existing glazing by performing a simple visual inspection or by considering the technical description of the existing glazing components and construction details.

For a building designed to a specific energy performance tier as specified in Section 9.36., the energy performance characteristics of the existing fenestration should ideally be identified in the documentation retained by the authority having jurisdiction and any replacement fenestration product should meet or exceed these energy performance characteristics.

Solar heat gain through windows in the summer is an important aspect that is often not considered in the design of fenestration for energy efficiency, which may focus on design for the winter (i.e., limiting thermal transmittance to the exterior).

Impact analysis

The costs associated with the replacement of existing windows, doors and skylights with products having higher thermal-resistive characteristics, such as lower U-values and/or higher energy ratings, and related installation were assessed. Using the widely recognized energy-savings estimation software program, RESFEN[1], input parameters were used to calculate the impact of windows on heating and cooling costs for residential houses in different locations (93 U.S. cities), house type (one- or two-storey, new or existing wood-frame or masonry), size (1 700 ft.² for one-storey and 2 600 ft.² for two-storey), foundation type (basement, crawlspace or slab-on-grade) and HVAC system type (gas furnace/electric air conditioning or electric heat pump). The total window area was assumed to be equal to 15% of the total floor area of the house, and the windows were equally distributed in the ordinal directions.

RESFEN allows the type of window to be selected, which was predetermined by the climate zone of the designated city. The annual energy saving cost was calculated for whole-house replacements for the existing types of window to be replaced by windows with a higher energy rating. Types of existing window can be selected from the window library as a built-in pull-down list. The prices for natural gas and electricity were based on the average price in each State in 2013–2014 and 2012–2013, respectively.

This impact analysis assesses the costs and benefits, as applicable, without providing user-specific information, which may differ greatly and add complexity (e.g., opaque/glazed doors, separate consideration on skylights with solar heat gain coefficient, energy rating contribution to heating vs. cooling, heating and cooling degree-days, percentage of fenestration areas to gross wall area ratio).

Calculation Basis

According to National Resources Canada, space heating accounts for 64% of the energy used in the average Canadian house as a result of Canada's cold climate. Annual average energy use is 130 GJ, which implies 83 GJ is used for annual space heating. Average cooling accounts for 1.6% of the energy used in the average Canadian house. Annual average energy use is 130 GJ, which implies 2 GJ is used for space cooling.

According to the ENERGY STAR guide[2], typical annual energy savings of around 10% and around 30% are expected where replacing double-pane and single-pane windows, respectively, with ENERGY STAR-rated windows, which are typically available for purchase in most climate zones.

It follows that annual average energy savings of 10% represents 8.3 GJ and 0.2 GJ of energy savings in space heating and cooling, respectively, when double-pane windows are replaced with ENERGY STAR-rated windows. The average energy cost in Canada is around \$0.179/kWh (1 GJ is 277.79 kWh). With the specified replacement windows, the annual average energy cost savings is expected to be around \$412 and \$10, respectively. Therefore, the combined total of annual energy cost savings is \$422.

It also follows that annual average energy savings of 30% represents 25.5 GJ and 0.6 GJ of energy savings in space heating and cooling, respectively, when single-pane windows are replaced with ENERGY STAR-rated windows. With the specified replacement windows, annual average energy cost savings is expected to be around \$1 267 and \$30, respectively. Therefore, the combined total of annual energy cost savings is \$1 297.

This information is summarized in Table 1.

Table 1. Calculation of Possible Energy Savings with ENERGY STAR-rated Replacement Windows

Type of Energy Use or Savings	Amount
Total average energy use for average Canadian house[3]	130 GJ
Annual average energy use for space heating[3]	$130 \times 64\% = 83 \text{ GJ}$
Annual average energy use for cooling[3]	$130 \times 1.6\% = 2 \text{ GJ}$
Total average energy use for space heating and cooling	$83 + 2 = 85 \text{ GJ}$

Average percentage energy savings from window replacement[2]	10%–30%
Average energy savings from window replacement	8.5 (85 × 10%) – 25.5 (85 × 30%) GJ
Average energy cost in Canada[4, see Table 1.]	\$/kWh
Average energy cost in Canada	\$49.7 (0.179/kWh × 1 GJ/277.79 kWh)/GJ
Average energy cost savings from 10% window replacement	\$422 (8.5 GJ × \$49.7/GJ)
Average energy cost savings from 30% window replacement	\$1 297 (26.1 GJ × \$49.7/GJ)

The average lifespan of residential windows is expected to be more than 20 years. The average cost of 20 new windows, including installation, that are ENERGY STAR-rated and widely available in the market, is around \$20 000.

Benefits

This proposed change, linked to the energy objective of the Code, would have benefits that should be expressed in quantitative terms as monetary savings or as incremental annual energy savings.

For this impact analysis, benefits are measurable based on the reduction of both energy costs and total energy consumption associated with replacement windows having higher energy ratings.

References

- (1) RESFEN Software, Windows and Daylighting (lbl.gov). <https://windows.lbl.gov/resfen-documentation>. Note: RESFEN software is free to download; the user's manual contains complete details on archetypical houses used and other conditions applied when using RESFEN.
- (2) National Fenestration Rating Council. Window Savings Estimates. <https://www.nfrc.org/windows-doors-skylights/window-savings-estimates/>
- (3) National Resources Canada. Water heaters. <https://natural-resources.canada.ca/energy-efficiency/products/water-heaters/13735>
- (4) Home Depot. Cost for Replacement Window Installation. <https://www.homedepot.ca/en/home/ideas-how-to/windows-doors/window-replacement-cost.html>

Enforcement implications

It is expected that a consistent set of provisions that apply to the alteration of existing buildings would help reduce the administrative and enforcement work of assessing the degree to which any particular requirement could be relaxed without affecting the level of performance of the building with respect to the Code objectives.

This proposed change would aid enforcement by identifying the work necessary to improve the energy performance of an alteration.

Who is affected

Designers, engineers, architects, manufacturers, builders, specification writers and building officials.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[10.9.36.1.] -- ([1] --) no attributions

[10.9.36.1.] -- ([1] --) no attributions

[10.9.36.1.] -- ([2] --) [F92,F95-OE1.1]

[10.9.36.1.] -- ([3] --) no attributions