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Preface

The 2015 National Building, Fire, Plumbing and Energy Codes of Canada are the 14th editions of these model codes. New editions of the National Model Construction Codes are published every five years.

Information transfer is an important step following a code cycle and the subsequent publication of new Code editions. This *Get to know the newest editions of the Codes!* handbook is one of several information products designed to help Code users, enforcement officials and other stakeholders understand and apply the technical changes to the 2015 National Building Code of Canada (NBC), National Fire Code of Canada (NFC), National Plumbing Code of Canada (NPC) and National Energy Code of Canada for Buildings (NECB). The ultimate goal of this initiative is to promote adoption and effective implementation of Codes across the country.

Other information products supporting the 2015 Code editions include on-site presentations/seminars, online presentations and workshops. Whereas the on-site and online presentations offer information on the significant changes to the 2015 Codes only, this handbook provides detailed information on the majority of technical changes that were implemented in all four Code documents. It can serve as a stand-alone product or be used to complement information delivered during the on-site and online Code presentations. Information about all of these products is available on the National Research Council of Canada (NRC) website[1].

It is important to note that the seminars and handbook provide information on the incremental changes to the 2015 Code editions. They are not intended to teach users how to use or interpret the National Model Construction Codes.

Regulation of Construction in Canada

The National Model Construction Codes–the NBC, NFC, NPC, NECB and their associated User's Guides–are now collectively referred to as Codes Canada. The name, National Model Construction Codes, was updated to Codes Canada in order to more accurately reflect the diverse range of products as well as the broad range of topics and technologies they include. The name change to Codes Canada also applies to the Canadian Codes Centre itself.

In Canada, provincial and territorial governments have the authority to enact legislation that regulates building design and construction within their jurisdictions. This legislation may include adoption of Codes Canada either without changes or with modifications to suit local needs. It may also include the enactment of other laws and regulations regarding building design and construction, and requirements for professional involvement. Essentially, the role of Codes Canada is to help promote consistency across the provinces and territories.

Development Process

The Canadian Commission on Building and Fire Codes (CCBFC) is responsible for the content of Codes Canada. The CCBFC is an independent body of volunteers from across the country which includes all facets of the code-user community. Members of the CCBFC and its standing committees include builders, engineers, skilled trade workers, architects, building owners, building operators, fire and building officials, manufacturers, and representatives of general interests.

[1] http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/code_seminars.html

The CCBFC is advised on scope, policy and technical issues pertaining to the Codes by the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC), a committee of senior representatives from provincial and territorial ministries responsible for the regulation of buildings, fire safety and plumbing in their jurisdictions.

The NRC provides technical and administrative support to the CCBFC and its standing committees through Codes Canada. NRC publishes the Codes and periodic revisions to address pressing issues.

The broader code-user community also makes a significant contribution to the development process by submitting requests for changes or additions to the Codes and by commenting on proposed changes during the public reviews that precede each new edition. The CCBFC takes into consideration the advice received from the provinces and territories as well as Code users' comments at each stage of Code development.

The scope and content of Codes Canada are determined on a consensus basis, following the review of technical, policy and practical issues.

More information on the Code development process and guidelines for requesting changes to the Codes are available at http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre_index.html

Printed copies of this information may also be requested from the Secretary of the CCBFC at:
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National Building Code

Part 3 – Fire Protection, Occupant Safety and Accessibility

Outline

This material highlights changes to Part 3 of the National Building Code and covers the following topics:

- Foamed Plastics
- Smoke Tightness
- Component Additive Method
- Self-service Storage Buildings
- Buildings on Sloping Sites
- Mid-rise Combustible Construction
- Fire Alarm and Detection Systems
- Stairs, Ramps, Handrails and Guards in Public Spaces
- Means of Egress, Electromagnetic Locks on Doors and Signs
- Accessibility
- Other Changes

FOAMED PLASTICS

Combustible Materials Permitted, Articles 3.1.4.1. and 3.1.4.2.

Sheet metal protection over exposed foamed plastics is considered an ignition barrier, which helps to prevent the ignition of foamed plastics. When ignited, burning foamed plastics generate smoke that could potentially impede people to safely evacuate a building. The use of sheet metal as a method for protecting foam plastic insulation was introduced in the 2015 National Building Code (NBC) for major occupancies other than group A, B or C. An explanatory Note was added to Article 3.1.4.1. to remind Code users that the current requirements for combustible construction using combustible materials do not waive the requirements regarding construction type and cladding stated in Article 3.2.3.7.

The changes introduce two new Sentences (Sentences 3.1.4.2.(2) and (3)) for the protection of walk-in coolers or freezers consisting of factory-assembled panels containing foamed plastic insulation (Figure 1). In addition, new Sentence 3.1.4.2. (3) is a pointer to Article 3.1.13.2. for the flame-spread rating required for doors.

Figure 1: Walk-in cooler and freezer

Noncombustible Construction, Articles 3.1.5.1., 3.1.5.5., 3.1.5.6., 3.1.5.7., 3.1.5.14. and 3.1.5.15.

Article 3.1.5.5. clarifies that the intent of the provisions is to provide protective measures to limit flame propagation along the exterior surface of the exterior wall assembly from a fire within the building. The title of the Article was replaced to clarify that these requirements apply to combustible cladding on exterior walls.

With respect to combustible components for exterior walls, Article 3.1.5.6. was added to permit the use of combustible components, other than combustible cladding, as part of an exterior wall assembly of a building required to be of noncombustible construction. With this new Article, the intent is to ensure proper protection measures are in place on the exterior surface of an exterior wall assembly preventing the fire spread along the exterior surface of the wall from a fire within the building.

The requirements for factory-assembled panels in a building required to be of noncombustible construction were relocated to Article 3.1.5.7. where all the provisions were combined (i.e., walk-in cooler or freezer, interior and exterior wall and ceiling applications). This helps Code users to determine the required protection measures for factory-assembled panels containing foamed plastic insulation.

A reference to explanatory Note A-3.1.4.1.(1) in Article 3.1.5.1. was also added to remind Code users that the provisions for spatial separation and exposure protection are independent of the type of building construction.

In the previous edition of the NBC published in 2010, requirements for both combustible and foamed plastic insulation were prescribed in the same Article. In some cases, the provisions only referred to combustible insulation while others referred to foamed plastic insulation which may have led to confusion and mistaken application of the Code provisions. In the 2015 NBC, Article 3.1.5.14. combines all the requirements for the protection of combustible insulation while Article 3.1.5.15. combines all the requirements for the protection of foamed plastic insulation.

Article 3.1.5.14. is now dedicated to combustible insulation and its protection from adjacent spaces within a building. The combustibility of the insulation is rated based on its flame-spread rating and provided with specific protection measures. A new interpretation was added to this Article to clarify the requirements for the protection of combustible insulation, excluding foamed plastics, from adjacent spaces within a building.

SMOKE TIGHTNESS

Fire Separations and Closures, Articles 3.1.8.4., 3.1.8.5., 3.1.8.7., 3.1.8.9., 3.1.8.11. and 3.1.8.14.

Statistically, approximately 80% of fire deaths are caused by smoke inhalation. Preventing the passage of smoke in specific areas is expected to significantly reduce the likelihood of smoke propagation in the means of egress, which should contribute to ensure the safety of persons trying to escape a building in the event of a fire (Figure 2).

Figure 2: Smoke tightness

New requirements for the installation of smoke dampers and combination smoke/fire dampers are provided in the 2015 NBC as well as leakage rates for these dampers. Sentences 3.1.8.4.(3) and 3.1.8.4.(4) were introduced for leakage-rated doors, dampers or combination fire/smoke dampers (Figure 3).

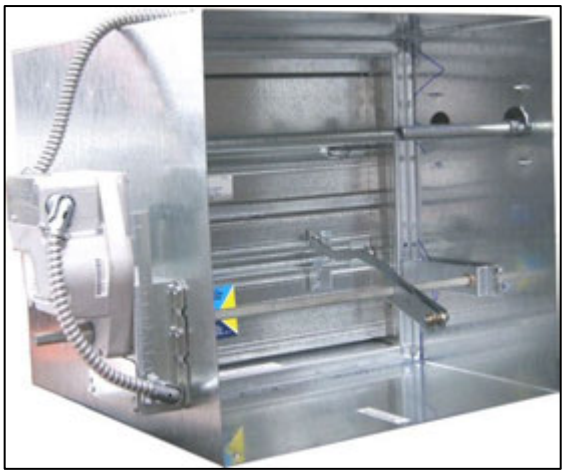


Figure 3: Smoke damper in air-transfer opening and ducts

New Sentence 3.1.8.4.(3) references CAN/ULC-S112.1, "Standard for Leakage Rated Dampers for Use in Smoke Control Systems," for the classification of smoke dampers and combination smoke/fire dampers. New Sentence 3.1.8.4.(4) references ANSI/UL-1784, "Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives," for the classification of leakage-rated fire doors. There is no Canadian standard available at this time.

New Sentences 3.1.8.5.(3) and (7) reference NFPA 105, "Standard for Smoke Door Assemblies and Other Opening Protectives," for the installation of leakage-rated smoke dampers, or combination smoke/fire dampers used as a closures in fire separations and fire doors.

New Sentence 3.1.8.5.(6) was introduced to stipulate where leakage-rated fire doors are required. In some cases, the specific location proposes to address the vulnerability of occupants who may be asleep when the hazard of smoke spread occurs. This is supported by statistics where the vast majority of deaths from fire are due to smoke inhalation.

New Sentence 3.1.8.5.(8) was introduced to stipulate where leakage-rated fire doors are required for dwelling units served by a public corridor.

New Sentences 3.1.8.8.(1) and (2) restructure the exemptions for fire dampers by combining all the fire damper exemptions and listing them under specific applications for each Sentence.

Article 3.1.8.9. waives the requirements for smoke dampers when specific criteria are met as the risk of smoke spread when the specific criteria are met is reduced.

Specific information on the installation of smoke dampers is provided in Article 3.1.8.11.

Due to confusion related to its structure, Article 3.1.8.14. was re-written in a top-down hierarchy fashion for a better understanding of the requirements. Moreover, the application of Article 3.1.8.14. was expanded to include all closures as defined by the NBC.

Protection on Floor Areas with a Barrier-Free Path of Travel, Article 3.3.1.7.

A higher level of smoke protection is warranted in critical areas of the building required for the safety of the occupants during the evacuation of the building. To reduce smoke spread, doors leading to protected floor areas must be protected by leakage-rated doors.

Explanatory Note A-3.3.1.7.(1)(b) clarifies that the floor area on either side of a horizontal exit is permitted to be considered as a zone for the application of Article 3.3.1.7.

COMPONENT ADDITIVE METHOD (APPENDIX D)

Many of the values found in Subsection D-2.3. of the 2010 NBC were based on fire-resistance data generated over four decades ago for typical wall, floor/ceiling and roof/ceiling assemblies used at that time. Since then, new fire test research was performed using construction materials, products and techniques that are currently in use, which has provided new insights into the fire resistance of current light-frame assemblies. Four major consortium projects on the fire resistance of wall (load and non-loadbearing) and floor/ceiling assemblies were completed by NRC in recent years, as well as other smaller or related projects. The wealth of new information provided data supporting the update and expansion of Subsection D-2.3. in the 2015 NBC with new material and assemblies of materials, including new structural members.

The changes include replacing the term “wallboard” with “board” to clear the confusion with the application of gypsum board in a horizontal configuration. It also clarifies the application of Articles D-2.3.1., D-2.3.3. and D-2.3.13. This clarification of terminology for gypsum board ensures consistent application of the NBC and provides uniform vocabulary throughout the NBC and its referenced North-American documents.

SELF-SERVICE STORAGE BUILDINGS, SECTION 3.9.

Today, there are just over 3,300 self-storage facilities operating in Canada, providing over 65 million square feet of rentable space. Each year, the industry adds approximately 10 to 20 new facilities and more than 1,000,000 square feet of rentable space into the Canadian marketplace. However, only a few jurisdictions (Ontario, Manitoba and Alberta) have requirements for self-storages. As such, the “most applicable” Codes have been used/applied by other jurisdictions. This resulted in a variety of interpretations and lengthy review periods/approval processes ranging from six to twelve months.

Section 3.9. was added to address self-service storage buildings (Figure 4). It specifies the requirements for building area, spatial separation, access route and floor areas. Defining the requirements for self-service storage buildings paves the path for consistent provisions through all the provinces and territories and concurrently permits for a considerable reduction in approval times by the authorities having jurisdiction.

Figure 4: Self-service storage buildings

BUILDINGS ON SLOPING SITES

This change expands the building size to four storeys and the occupancy types to assembly as well as business and personal services when dealing with sloping sites.

A building with a height determined in accordance with the new Sentence 1.3.3.4.(2), Division A, is not expected to increase the risk to life safety or fire spread beyond the compartment, storey, or building of origin in comparison to existing 4-storey Group A, C or D buildings not located on sloping sites.

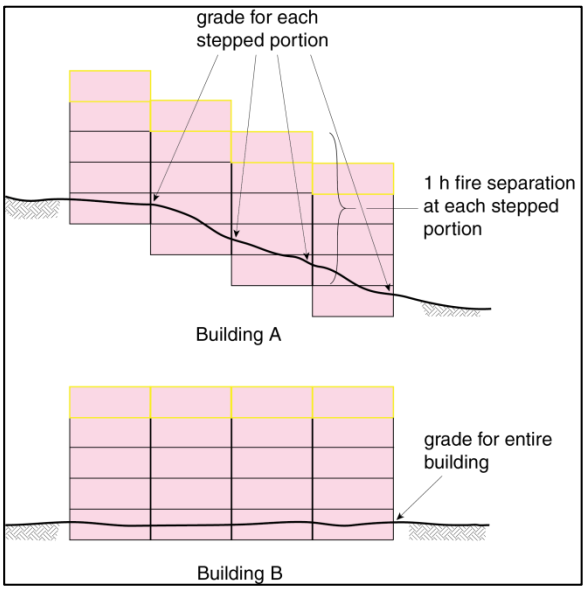


Figure 5: Buildings on sloping sites

MID-RISE COMBUSTIBLE CONSTRUCTION

Group C, up to 6 Storeys, Sprinklered, Article 3.2.2.50. and Group D, up to 6 Storeys, Sprinklered, Article 3.2.2.58.

Two additional options for building size and construction relative to occupancy were introduced in the 2015 NBC: one for Group C major occupancy and one for Group D major occupancy in Subsection 3.2.2.

The requirements are not limited to engineered wood, i.e. they include light-frame wood construction as well.

Building Area, Clauses 3.2.2.50.(1)(d) and 3.2.2.58.(1)(d)

The first step is to define the physical limits of a 6-storey combustible construction building.

In the NBC, "building area" means the greatest horizontal area of a building above grade within the outside surface of exterior walls or within the outside surface of exterior walls and the centre line of firewalls.

For a 6-storey combustible construction building, the maximum building area would be 1 500 m² with an aggregate area of 9 000 m², i.e. historically, the NBC assumes that the fuel load of a 1-storey building of 9 000 m² is somehow equivalent to a 6-storey building with a maximum building area of 1 500 m² in terms of fuel load and evacuation (see Table 1).

Table 1: Group C, up to 6 storeys, sprinklered

No. of storeys	Maximum area, m²
1	9 000
2	4 500
3	3 000
4	2 250
5	1 800
6	1 500

The building area for a 6-storey combustible construction building represents a 75% reduction in building area compared to a 6-storey noncombustible construction building.

The same principle was used to address Group D major occupancies. Table 2 shows the new height and area for a Group D major occupancy.

For a 6-storey combustible construction building, the maximum floor area would be 3 000 m² with an aggregate area of 18 000 m².

Table 2: Group D, up to 6 storeys, sprinklered

No. of storeys	Maximum area, m²
1	18 000
2	9 000
3	6 000
4	4 500
5	3 600
6	3 000

The building area for a 6-storey combustible construction building represents approximately a 58% reduction in building area compared to a 6-storey noncombustible construction building.

Building Height, Clauses 3.2.2.50.(1)(c) and 3.2.2.58.(1)(c)

For building height, a maximum height limitation for both the floor level of the upper storey and the roof level applies:

> c) it has a height of not more than 18 m measured between the floor of the first storey and the uppermost floor level that does not serve a rooftop enclosure for elevator machinery, a stairway or a service room used only for service to the building, …

The 18 m from the floor of the first storey to the uppermost floor level includes mezzanines.

Building Height, Clauses 3.2.2.50 (2)(c) and 3.2.2.58.(2)(c)

A 25-m limit to the highest point on the roof also applies to determine the combustibility of the roof. This represents the level of comfort using an effective hose stream of water to potentially extinguish and/or limit a fire on a roof made of combustible material. This is determined in view of firefighter access with extension ladders (with exceptions).

The requirement states that where the roof assembly has a height greater than 25 m measured from the floor of the first storey to the highest point of the roof assembly, the roof assembly shall be constructed of noncombustible construction or fire-retardant-treated wood.

Roof assemblies and coverings are permitted to be evaluated separately (to the 25-m limit) to determine the construction type and roof covering classification when the roof assemblies are at different elevations and are non-contiguous.

Construction of Exposing Building Face, Sentences 3.2.3.7.(3), 3.2.3.7.(4) and Exterior Cladding, Article 3.1.4.8.

To ensure the hazard of fire spread on the face of the exterior walls is not increased compared to the current permitted cladding construction requirement, the following limit to the combustibility of cladding used on the exterior wall applies:

- a maximum of 10% of the surface of the building face, or
- no limit if the material is subjected to testing in conformance with CAN/ULC-S134, “Standard Method of Fire Test of Exterior Wall Assemblies,” and satisfies the performance criteria stated in the NBC.

The designers must still comply with the construction requirements of the exposing building face under Article 3.2.3.7.

Streets, Article 3.2.2.10.

Building Perimeter

According to a new provision introduced in the 2015 NBC, to allow access for firefighters to the building perimeter that would be acceptable for them in response to a fire emergency, 6-storey Group C and D major occupancies combustible construction buildings require that not less than 25% of the building perimeter be within 15 m of a street or streets.

Large buildings sub-divided by firewalls (such as shown in Figure 6 with the red colour) must still meet the 25% perimeter rule. In this case, the building in the middle would not conform to the new 25% perimeter rule while the other two would.

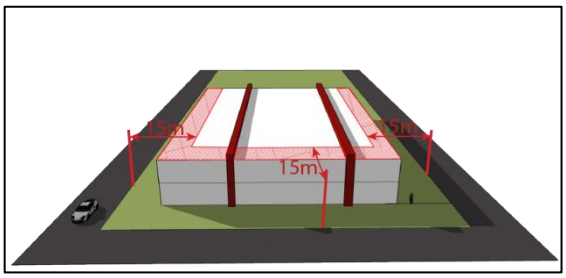


Figure 6: Building perimeter within 15 m of a street or streets

This new provision has a significant impact on infill projects in urban areas where street access on more than one side of a building is not always possible.

Access Route Design, Article 3.2.5.6.

Building Height

A change introduced in the 2015 NBC limits the elevation of the access route relative to the uppermost floor level to 20 m to facilitate firefighter access to the upper floors, and the roof of the building.

This requirement was found necessary to limit the potential construction of a 6-storey combustible building on the top of a hill and having its roof higher than the 25-m height limit, i.e. the level of comfort using effective hose streams for firefighters to fight a fire on the roof of such building, which affects the construction of the roof covering.

Superimposed Major Occupancies, Article 3.2.2.7.

In the 2015 NBC, occupancy combinations are still permitted as currently is the case for almost all major occupancies. The Code allows assembly, mercantile, low- and medium-hazard major occupancies and storage garage combinations as shown in Figure 7 for Group C major occupancies and in Figure 8 for Group D major occupancies.

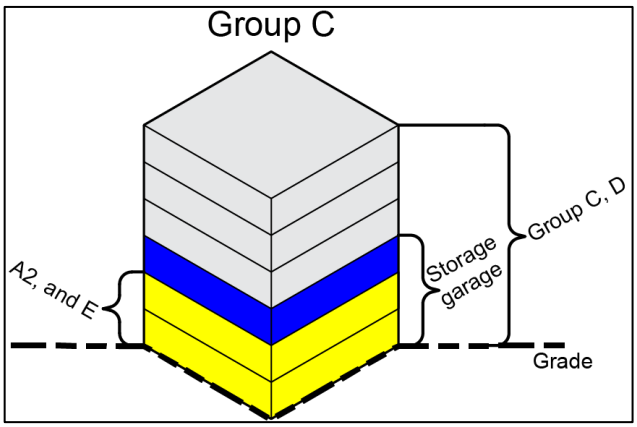


Figure 7: Group C major occupancy

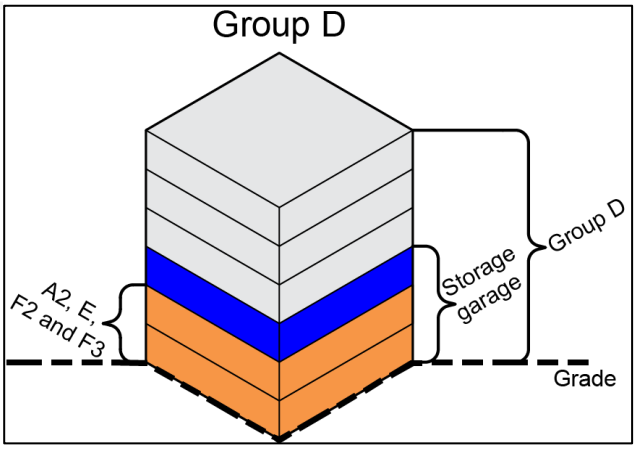


Figure 8: Group D major occupancy

There are slight differences between both Group C and D major occupancies when combining Group E and Group F2 and F3 major occupancies. To this extent, no Group F2 and F3 major occupancies are allowed under Group C major occupancies other than a storage garage, which is defined by the NBC as "a building or part thereof intended for the storage or parking of motor vehicles and containing no provision for the repair or servicing of such vehicles."

In the 2015 NBC, one point worth mentioning is the increase in the fire-resistance rating of the floor assembly for assembly major occupancies from 1 to 2 h [Table 3.1.3.1. forming part of Sentence 3.1.3.1.(1)].

Automatic Sprinkler Systems, Article 3.2.5.12.

In the 2015 NBC, sprinkler protection requirements were increased for 6-storey combustible construction buildings from NFPA 13R, "Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies," to NFPA 13, "Standard for the Installation of Sprinkler Systems." Most concealed spaces within floor and roof assemblies must be sprinklered. Additionally, exterior balconies must be sprinklered to address fire spread on the surface of the exterior wall assembly from one storey to another.

A designer can choose to limit the design to the more stringent requirements for 5- and 6-storey combustible buildings and apply them to a 4-storey combustible building because of the larger permitted building area. In this case, the permission to use NFPA 13R would still apply if the building falls within the scope of the NFPA standard for residential occupancies as permitted by NBC Subclause 3.2.5.12.(2)(a)(i).

FIRE ALARM AND DETECTION SYSTEMS, SUBSECTION 3.2.4.

Fire alarm and detection systems play a key safety role and since technology and research in this area progresses at a very rapid pace, new provisions are required in order to keep the NBC up-to-date.

Residential Fire Warning Systems, Article 3.2.4.21.

The ULC Committee on Fire Alarm and Life Safety Equipment and Systems developed CAN/ULC-S540, "Standard for Residential Fire and Life Safety Warning Systems: Installation, Inspection, Testing and Maintenance." The systems addressed by this standard were not accepted in the previous edition of the NBC and were installed in addition to systems already required in the Code.

The NBC now recognizes these systems and allows that they be installed in dwelling units of residential and care occupancies, in lieu of the currently required interconnected smoke alarms.

The occupants now have the option of installing a residential fire warning system with enhanced features such as the interconnection of heat detectors, carbon monoxide alarms, other life safety devices and remote monitoring capabilities.

Integrated Systems Testing, Subsection 3.2.9.

The 2010 NBC had provisions on the commissioning of integrated fire protection and life safety systems, but they were silent on how this testing must be done. In addition, the term "commissioning" may have been misleading relative to the intent of the NBC and within the commissioning community.

The 2015 NBC now refers to a new national standard of Canada developed to address these tests and the term "commissioning" was replace by "integrated systems testing."

The Code community now has access to CAN/ULC-S1001, "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems," which provides the methodology for verifying and documenting that interconnections between building systems satisfy the intent of their design and that the systems function as intended by the Code.

Voice Communication Systems, Article 3.2.4.22.

Voice communication systems are efficient means to address occupant movement during an emergency situation. The 2010 NBC expanded the application of these systems to more buildings.

Common Intelligibility Scale, Sentence 3.2.4.22.(1)

The previous intent that the common intelligibility scale (CIS) level of 0.70 be attained by the voice communication system was proving to be an incorrect and unachievable target in the NBC. The current growing body of knowledge and experience is showing that the level may only be met, in certain areas, using various criteria, but certainly not throughout a building as stipulated.

As was done in other standards on this issue, the 0.70 target was changed from being a mandatory level to that of a voluntary target level with guidance information. Nevertheless, the explanatory Note on this issue was enhanced to further guide Code users.

Voice Communication and Visible Fire Signals, Sentence 3.2.4.22.(6)

When visual signals and audible alarm devices are installed, the requirement to silence audible devices during use of the voice communication system may also cause the visual signals to cease. Hearing persons can hear the voice communication message so it doesn't negatively impact them. However, this can be detrimental to individuals who are deaf or hard of hearing as they would not know what was happening, and this could delay their evacuation.

The 2015 NBC requires visual alarm devices to operate continuously even during a voice communication transmission, so that individuals who are deaf or hard of hearing continue their evacuation until otherwise communicated to them.

Clarification of Provisions on Fire Alarm Systems

Following requests for clarification, the NBC was amended to improve its clarity on requirements for fire alarm systems.

Fire Alarm Requirement for Low- and Medium-Hazard Occupancies, Sentence 3.2.4.1.(4)

Clause 3.2.4.1.(4)(h) in the previous edition of the NBC was unclear regarding the Code intent. Did the occupant load limit stated apply only to a medium-hazard occupancy?

An editorial change clarifying the Code intent was made in the 2015 NBC which states that an occupant load more than 75 above or below the first storey applies to a medium-hazard industrial occupancy and a low-hazard industrial occupancy.

Signals to the Fire Department - Fire Alarm Monitoring Installation, Note A-3.2.4.7.(4)

The regulatory community has frequently requested interpretations on what is meant by the “signals to the fire department” and the interconnection between the fire alarm system control unit and the fire alarm transmitter.

The revised explanatory Note A-3.2.4.7.(4) in the 2015 NBC clarifies the intent of the Code and the application of CAN/ULC-S561, “Standard for the Installation and Services for Fire Signal Receiving Centres and Systems.” This standard applies to the notification signal as well as to the compliance of the hardware.

Type of Auxiliary Equipment to be Controlled from the Central Alarm and Control Facility in High Buildings, Sentence 3.2.6.7.(2)

Subclause 3.2.6.7.(2)(i)(i) in the 2010 NBC did not specify which auxiliary equipment had to be controlled from the central alarm and control facility in high buildings, creating confusion among Code users.

An editorial clarification made to the 2015 NBC provides guidance to Code users. The new Subclause captures the intent of the NBC and refers to auxiliary equipment that manages smoke movement in high buildings.

STAIRS, RAMPS, HANDRAILS AND GUARDS IN PUBLIC SPACES, SECTIONS 3.3. AND 3.4.

Stairs, ramps, handrails and guards are important features that increase the safety and movement of occupants within buildings. The new provisions in the 2015 NBC provide clarification, enhance occupant safety where required, and offer some construction flexibility for the industry.

Definitions, Division A, Article 1.4.1.2.

Following requests for clarification, the NBC was amended to improve its clarity on requirements for stairs and ramps.

Flight

For manufacturers of prefabricated stairs, a flight is the floor-to-floor stair while for architects, a flight is the set of steps between landings. Such a variance created difficulty in applying Code requirements. A new definition was therefore added to the 2015 NBC and clarifies that a flight means a series of steps between landings. This definition will help ensure that the requirements on stairs are uniformly applied by Code users.

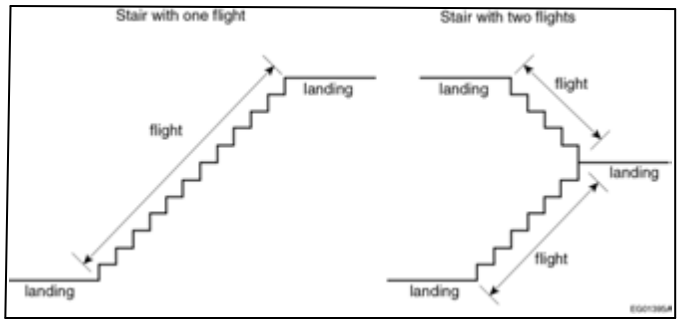


Figure 9: Flight

Run

The term "run" is used many times in the NBC; however confusion between the meaning of the terms "run" and "tread depth" was observed among Code users and the regulators due partly to the terminology used in the U.S. Codes, where the term "tread depth" is used instead of the correct term "run."

The 2015 NBC includes a new definition which states that "run" means the horizontal distance between two adjacent tread nosings. This will facilitate the proper interpretation and implementation of the Code requirements.

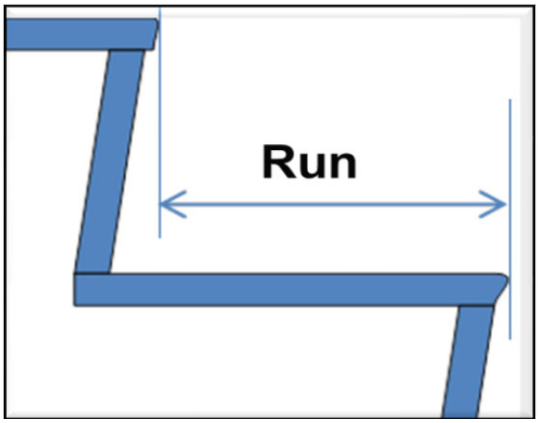


Figure 10: Run

Tapered Treads

The multiple terms to designate non rectangular treads were ambiguous, confusing and not aligned with the current practice in other international Codes. Part 3 referred to "tapered treads," while the term "angled treads" was used in Part 9 to designate steps in curved stairs. Part 9 also used the term "winder" to designate treads that converge to a point, which were only allowed inside dwelling units under certain conditions.

The term "tapered tread" is now defined to unify the meaning in the 2015 NBC and facilitate a proper interpretation and enforcement. The traditional term "winder" was however kept and still refers to specific treads that converge to a point inside dwelling units.

Curved Flights and Open Risers

Curved flights and open-riser stairs are impressive architectural features in a building lobby. However, design requirements were changed to enhance user safety.

Curved Flights and Tapered Tread Dimensions, Articles 3.3.1.16. and 3.4.6.9.

The previous edition of the NBC used various terms to designate curved flights and tapered treads, creating confusion among Code users. Furthermore, while the run dimension of rectangular treads of public stairs was increased many years ago, the dimension of tapered treads in stairs that provide access to exits was still based on previous values. Finally, there were no provisions requiring uniformity among tapered treads in a curved flight.

The NBC now uses the proper terminology for curved flights and tapered treads uniformly. The method for measuring the dimension of tapered treads was revised to ensure that run dimension at the expected walking line – 300 mm from the centre line of the inner handrail – will provide sufficient foot space (at least 280 mm) and uniformity among treads.

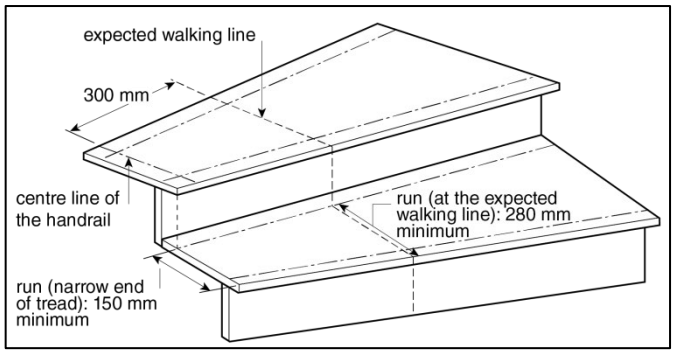


Figure 11: Tapered tread dimensions

Open risers, Article 3.4.6.8.

Open risers on public stairs are hazardous to ambulant persons with disabilities and cause a visual distraction. People who wear leg braces or prosthetic devices need a solid riser to guide their foot up over the riser to the next step and, to maintain balance, those who use canes or crutches place them against the riser of the step above the one they are on to move up. Therefore, open risers are only permitted in private, fire escape and service stairs, and in Part 9 buildings, as well as in industrial occupancies other than storage garages.

Handrails, Article 3.4.6.5.

Handrails are helpful to a variety of users providing support and stability when using ramps and stairs.

Graspability of Handrails, Sentence 3.4.6.5.(5)

Sharp or abrasive elements on handrails may harm users. Individuals who depend on using handrails would likely apply a larger force or grasp the handrail more fully when negotiating stairs or ramps.

A change was made in the 2015 NBC to require that all handrails be free of any sharp or abrasive elements.

Furthermore, the notion of "graspable portion" of handrails stated in Clause 3.4.6.5.(3)(b) of the 2010 NBC was difficult to enforce, and may have resulted in a handrail cross-section that did not represent good ergonomics in terms of shape and dimensions. In order to generate substantial pulling forces, the fingers and thumb must be able to wrap around the under surface of the handrail and not only over a "graspable portion" of the handrail.

Therefore, the term "graspable portion" was deleted to enable handrails with irregular cross-section to:

- permit hand approach from all directions in both normal use and emergency fall-arrest conditions,
- allow a firm grip,
- work for a wide range of hand sizes, and
- take into consideration the challenges of older and/or adults with disabilities, who have limited strength and balance and fall frequently on stairs.

Continuity of Handrails, Sentence 3.4.6.5.(9)

The provisions in the previous edition of the NBC regarding continuity of handrails did not reflect the intent stated in the Appendix Note. In some cases, the requirement limited design flexibility and was confusing. In other cases, the requirement allowed situations that contradicted Code intent.

The new wording in the 2015 NBC states that handrails shall be provided for the full length of the stair flight, from the bottom to the top riser, complying with the intent stated in explanatory Note A-9.8.7.2. and other international regulations.

Height of Handrails, Sentence 3.4.6.5.(7)

The requirements in the 2010 NBC limited handrail height to 965 mm. However, studies have shown that higher handrails perform as well as lower handrails. Handrails installed at a height of up to 1 070 mm are now permitted. This change:

- offers more flexibility in design,
- permits that handrails be located at the top of guards up to 1 070 mm, and
- harmonizes the requirement of handrail height on stair flight and landing, which allows a smoother handrail transition between stairs and landings.

This change also applies to ramps except for those located in the accessible path of travel.

Reachability of Handrails, Sentence 3.4.6.5.(3)

The previous rule was asking for intermediate handrails in wide stairs where the width was exceeding 2 200 mm. The reachability of a handrail based on an ergonomic analysis and field observations indicated that the maximum distance to a handrail should not exceed 750 mm.

The 2015 NBC requires that intermediate handrails be provided so that:

- a handrail is reachable within 750 mm,
- at least one portion of the stair or ramp between two handrails is the minimum width required, and
- all other portions of the stair or ramp between two handrails have a clear width of 510 mm or more.

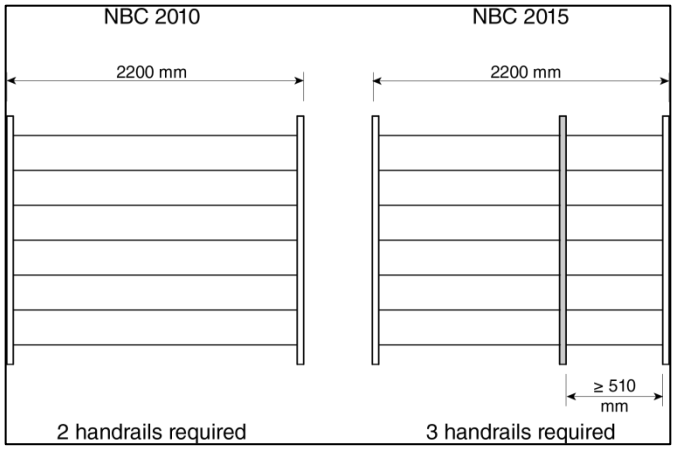


Figure 12: Handrail locations

The 2015 NBC also clarifies that handrails shall be located along the most direct path of travel, where a stair or ramp is wider than its required exit width.

Handrails in Step Aisles, Article 3.3.2.10.

In previous editions of the NBC, the installation of handrails in aisles with steps serving assembly occupancies such as stadiums and arenas was not mandatory. Following injuries and based on research and on the review of international practice on this issue, a new requirement on handrails in aisles with steps was added allowing various configurations that will enhance the safety in use for spectators in assembly occupancies, without limiting the normal circulation of a crowd (moving in counterflow or passing others).

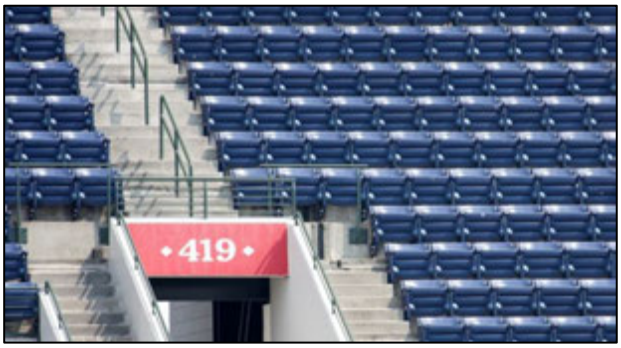


Figure 13: Handrails in step aisles

Guards, Articles 3.3.1.18., 3.3.5.10. and 3.4.6.5.

The NBC defines guards as protective barriers around openings in floors or at the open sides of stairs, landings, balconies, mezzanines, galleries, raised walkways or other locations to prevent accidental falls from one level to another. The 2015 NBC includes many changes on guards to clarify and harmonize where they are required, and how to design them.

Required and Exempted Guards, Sentences 3.3.1.18.(1) and 3.4.6.6.(1)

The previous edition of the NBC required the installation of guards based on the elevation of the walking surface. However, this height varied from one provision to another for no apparent reason:

- more than 600 mm for raised floors,
- more than 2 risers for interior stairs, and
- more than 400 mm for interior ramps.

Furthermore, Part 9 included requirements where the walking surface is adjacent to a sloped ground whereas Part 3 was silent on this matter.

Finally, Part 3 and Part 9 exempted guard installation for stairs and ramps that provided access for maintenance purposes only. Raised platforms and walkways provided for the same purposes were exempted from guard installation in Part 9 only.

The new requirements in the 2015 NBC on guards use a unique criterion (walking surface elevation of 600 mm) to determine where a guard is required and to harmonize Part 3 and Part 9 requirements, which will facilitate enforcement. It also clarifies the requirement where the elevated walking surface is adjacent to a sloped ground and harmonizes Part 3 and Part 9 regarding maintenance platforms exempting guards where access is provided for maintenance purposes only. The access to these locations is already regulated by other codes (Occupational Health and Safety Regulations).

Vehicle Guards, Sentences 3.3.5.4.(6) and (7)

Whereas Part 4 of the NBC has loading requirements for vehicle guardrails, Part 3 was silent where such guardrails must be installed. To harmonize Part 3 with Part 9, an application requirement was added to Part 3 to clarify that vehicle guardrails shall be installed at every opening through floors and at the perimeter of floors and ramps where they are located 600 mm or more above the adjacent ground or floor level. In addition, the height of the curb required at the locations mentioned above was reduced from 150 to 140 mm, to avoid potential conflict with the requirement addressing climbability of guards (Sentence 3.3.1.18.(3)).

Height of Guards, Sentence 3.4.6.6.(2)

Part 3 of the NBC accepted that guards protecting a stair flight be lower than guards surrounding ramps or landings for no apparent reason. Part 9 of the NBC requires that guards serving exit stairs be not less than 1 070 mm while Part 3, which applies to larger buildings, allows guards serving stairs to be as low as 920 mm.

A change was introduced in the 2015 NBC to harmonize Part 3 and Part 9 guard height serving flight of exit stairs to 1 070 mm. Additionally, this change establishes a unique guard height for Part 3 buildings (see Articles 3.3.1.14. and 3.3.1.18. for guard height in access to exit). As another change now allows handrails to be installed up to 1 070 mm, the top rails of 1 070 mm guards could still act as handrails without the need to install additional elements. The installation of the handrails at the top railing of a 1 070-mm guard also eliminates the height change of handrails at the transition from stair flights to landings (goose neck issue).

Openings in Guards, Articles 3.3.1.18. and 3.3.5.10.

The size of openings through guards in industrial occupancies was too restrictive. Larger openings are allowed by some Canadian regulations and international codes and standards. The NBC now allows openings of up to 535 mm in guards located in industrial occupancies other than storage garages. In these buildings, where unsupervised young children are not expected, the new opening size allowed does not represent an additional risk for the occupants. Furthermore, this change harmonizes the NBC provisions with other international and occupational health and safety codes and standards widely used around the world.

Figure 14: Industrial guards

The wording "unless it can be shown that the size of the openings that exceed this limit does not present a hazard" was deleted from the previous edition as the NBC, which is an objective-based code, already allows alternative solutions for any provision (NBC 2010, Division A, Clause 1.2.1.1.(1)(b)). The current wording was therefore considered redundant.

Finally, a new provision was added to harmonize Part 3 and Part 9 regarding openings through non-required guards. The intent is to prevent children from getting their head stuck between balusters.

Design to Limit Climbing of Guards, Sentences 3.3.1.18.(4) and 3.4.6.6.(7)

The NBC restricted the design of guards that may facilitate climbing. The introduction of the requirement in 1975 and the following amendments that expanded the requirement to more locations were not supported by evidence, and had a great impact on the ornamental railing industry that resulted in limiting guard design choices available to consumers with no apparent benefit.

The review of U.S. and Australian regulations indicated that the Canadian market was the most restrictive on this issue. Also, the review of research and statistics related to incidents around guards did not permit the establishment of the relationship between the ornamental design and children falling. Therefore, the NBC was amended to require that the design of guards does not facilitate climbing in locations where the elevation difference is more than 4.2 m, which represents the floor-to-floor elevation of typical high-end Canadian homes. Finally, an exception for industrial occupancies was added in Part 3 to be consistent with Part 9 requirements.

MEANS OF EGRESS, ELECTROMAGNETIC LOCKS ON DOORS AND SIGNS, SECTIONS 3.2., 3.3. AND 3.4.

After an incident is detected, occupants of a building must be provided with secured means of egress. These means must provide:

- sufficient capacity,
- various routes to alternative protected areas,
- routes that are free of locked doors or obstructions, and
- routes clearly identifiable through functioning signage.

This section will review changes that were included in the NBC to address the needs of the occupants and building owners without compromising on physical security or life safety.

Means of Egress, Sections 3.3. and 3.4.

Exit Width of Principal Entrances, Sentences 3.3.1.17.(6) and 3.4.2.6.(2)

Under the 2010 NBC provisions, the principal entrance for high density assembly occupancies could be constructed with small entrance capacity to allow entrance control or large entrance capacity, but very small exit capacity.

In the past, catastrophic events have occurred following fires in non-sprinklered nightclubs and discotheques (Kiss nightclub in Brazil, the Santika Pub in Thailand, the Lame Horse Night Club in Russia, the Ozone Disco Club in the Philippines, the Beverly Hills Supper Clubs, the Station Nightclub and the Coconut Grove Nightclub in the U.S.).

Therefore, a new requirement was introduced in the 2015 NBC asking that the principal entrance counts for at least one half of the required exit width and applies to buildings that:

- contain an assembly occupancy, Division 2 (dance halls and licensed beverage establishments),
- are not sprinklered (having 2 storeys and less in building height), and
- have an occupant load more than 250.

Having an increase exit capacity at the most familiar egress door through which occupants likely came in will enhance efficient egress to a safe place in an emergency situation.

Emergency Crossover Access to Floor Areas, Article 3.4.6.18.

The provision in the previous edition of the NBC did not capture stairwells that were serving storeys below grade such as storage garages, or stairwells that could serve several floors in a building no more than six storeys. Situations can occur where multiple storey exits and their stairwells are not equipped with the appropriate means to exit the stairwell should conditions within the stair become untenable.

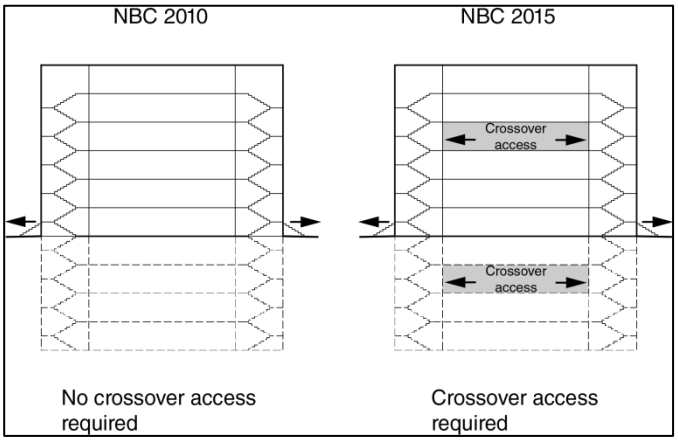


Figure 15: Crossover access

The change introduced in the 2015 NBC addresses a gap in the application of the crossover floors and captures situations where multiple levels exist below grade. Building height was taken out of the equation, and this subject was considered in the same context as a dead-end corridors.

The change to the 2015 NBC integrates better signage, which will enable occupants to locate unlocked doors more rapidly. It maintains the same restriction of not having multiple storeys without crossover access (stairwell not serving multiple consecutive storeys). Furthermore, in order to address security concerns where the access is through a tenant space, the use of electromagnetic locks (ELMs) on crossover access doors is now permitted under a series of conditions.

This change, which requires crossover access for lower buildings (4, 5 and 6 storeys) and allows EMLs on crossover access doors has the following cost impact:

- it represents an increase of costs for a four-, five-, and six-storey building, and
- this new provision represents a decrease of costs for buildings over six storeys, when the crossover access is through a single tenant floor.

Minimum Distance between Exterior Discharges of Exits, Sentence 3.4.2.3.(4)

In some building designs, the exterior doors of the stairwells serving the same floor areas exist in close proximity. Any incident (fire, bomb threat, etc.) close to the exterior doors would simultaneously block the two exits, trapping occupants. The previous edition of the NBC was silent on this matter.

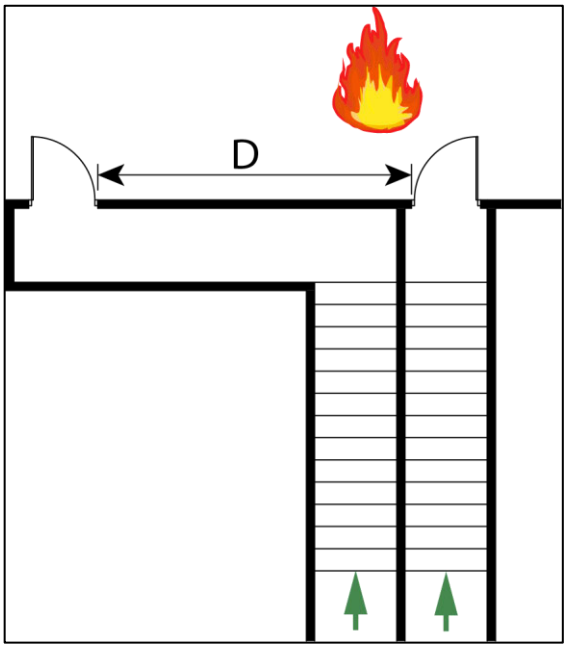


Figure 16: Distance between exterior discharges of exits

New requirements in the 2015 NBC introduce a minimum remoteness between the exterior discharges of exits. This will limit the probability that two exits will simultaneously be blocked by one exterior incident (fire, bomb threat, etc.).

Egress from Service Spaces, Sentence 3.3.1.14.(2) and Note A-3.3.

The wording in the 2010 NBC on egress from service spaces was contradictory and led to confusion on the intent of the Code.

There were requirements within Section 3.3. that applied specifically to service rooms and service spaces that were not addressed in Section 3.6. Therefore, the exception for service rooms and service spaces was deleted from the explanatory Note A-3.3.

Also, this change clarifies that Sentence 3.3.1.14.(2) does not apply to exits serving service rooms and service spaces. Therefore, the user can no longer interpret Sentence (2) as being an exception to providing proper exit facilities.

Transparent Doors and Panels, Article 3.3.1.19.

The 2010 NBC requirements did not consider people with low vision who may have difficulty adequately identifying transparent doors and panel glasses.

The provision was changed to require that the markings for glazed transparent doors, sidelights and panels be visually contrasting, well located, and large enough.

Furthermore, when transparent glazing is provided to facilitate the view from either side of a doorway, there was no provision

setting the maximum height of the bottom edge of this vision glass to accommodate children, people of short stature and those who use wheelchairs. Sentence 3.3.1.19.(6) of the 2015 NBC now requires that where provided, vision glass in doors or transparent sidelights have its lowest edge no higher than 900 mm above floor level.

Sliding Doors, Sentences 3.3.1.11.(5) and 3.4.6.12.(2)

Part 9 of the 2010 NBC allowed the installation of sliding doors as an exit door under a series of conditions (i.e. warehouse buildings and accessory buildings serving single dwelling units). There was no such exemption in Part 3 buildings.

The change introduced in the 2015 NBC harmonizes Part 3 and Part 9 for the use of sliding doors as an access to exit and exit door. This permission is limited to small area storage rooms of 28 m² area for an occupant load of one person in storage occupancies.

Threshold at Doorways, Articles 3.3.1.13. and 3.4.6.11.

The 2010 edition of the NBC had no limit on the height of a door threshold, other than in a required accessible path of travel, which could cause someone to trip and/or fall.

Except where doorways are used to confine the spillage of flammable liquids within a service room and where there is a risk of blockage by ice or snow, the 2015 NBC now requires that the threshold at doorways be not more than 13 mm higher than the finished floor surface.

Limited height of threshold will improve the safety and mobility of all occupants and especially those with reduced stepping capacity and who use any small wheeled devices for mobility, such as walkers.

Electromagnetic Locks on Doors, Sections 3.3. and 3.4.

Electromagnetic Locks on Access to Exit Doors, Article 3.3.1.13.

The 2010 NBC limited the use of electromagnetic locks on exit doors only for no apparent reason.

The 2015 NBC now allows that electromagnetic locks be installed on access to exit doors. The unlocking mechanisms of these locks are subject to the same requirements as those for exit doors.

Furthermore, where an occupant is required to actuate more than one unlocking device during evacuation in any egress path, all unlocking devices on the path shall release within not more than 15 seconds.

Electromagnetic Locks in Treatment and Care Occupancies, Article 3.4.6.16.

The 2010 NBC required that all electromagnetic locks be installed with a mechanism capable of releasing the locks within 15 seconds. This could endanger the well-being of residents with cognitive issues living in nursing homes by allowing them to open the exit door and leave the facility unescorted. Staff in nursing homes cannot be expected to respond within 15 seconds of every attempt to open an exit door. Once outdoors, confused residents are vulnerable to many hazards, such as being improperly dressed for the weather, not knowing how to return, failing to receive important medications, etc.

The 2015 NBC now allows that doors serving treatment and care occupancies be locked by electromagnetic devices not equipped with the 15-second delay released mechanism. The locking device must release upon a series of strict conditions such as:

- the actuation of the alarm signal system,
- the loss of power,
- the actuation of a switch in a location continually monitored, inside locked spaces, and
- the activation of a manual station installed within 0.5 m from the door.

Finally, an emergency lighting system must be installed where these locks are installed.

Additional Means of Egress Changes

Exit Signs and Referenced Standards, Article 3.4.5.1.

The wording of the 2010 NBC led to confusion regarding the application of referenced standards on exit signs.
The intent of the provision was to request the run man pictogram for all exit signs. The exception in Clause 3.4.5.1.(2)(b) was deleted to avoid misinterpretation that exit signs with the word “Exit” is still permitted as shown in the standards referenced in Sentence 3.4.5.1.(3) of the 2015 NBC.

Also, Clause 3.4.5.1.(2)(c) was editorially revised to clarify that the standard ISO 7010 is referenced only for the pictogram symbols stated in Subclauses 3.4.5.1. (2)(i) to (iv).

Finally, the explanatory Note A-3.4.5.1.(4) was revised to clarify that the charging requirements are indicated on the photoluminescent exit signs.

Obstruction of Exterior Exit Doors, Article 3.4.6.11.

Some exterior exit doors are difficult to recognize from outside the buildings. Adjacent storage or parking may occur and obstruct these doors, delaying or impeding occupants from evacuating the building.

The 2015 NBC now requires that, where an exit door leading directly to the outside is subject to being obstructed by parked vehicles or storage because of its location, a visible sign or a physical barrier prohibiting such obstructions be installed on the exterior side of the door. This new requirement applies to existing and new buildings.

Emergency Lighting in Public Washrooms, Article 3.2.7.3.

Public washrooms were not required to be provided with emergency lighting. Such protection would be beneficial in the interest of public convenience and safety in these occasionally used unfamiliar areas and where many people could simultaneously be located during a power shortage.

The 2015 NBC was amended to require emergency lighting in public washrooms that are equipped to serve more than one person at a time.

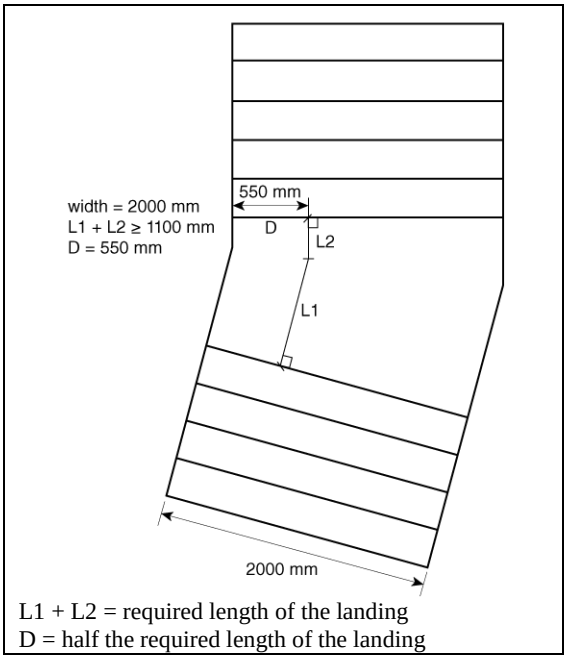
Landing Dimensions, Article 3.4.6.4.

There was no technical basis for the provisions that relate to the dimensions of landings in Parts 3 and 9 of the NBC and there was no justification for the discrepancy between Part 3 and Part 9 requirements.

Part 9 regulates landings dimensions based on their turning angles and allows some flexibility, for the reason of reducing the foot print of a stair, for landings inside dwelling units. Part 3 regulates the landing dimensions for straight runs and in other than straight runs without any specific reference to the turning angles.

When the landing turns less than 90 degrees, the 2010 NBC required that the length of the landing match the width of a stair, which imposed unnecessarily big landing dimensions for wide stairs.

The change in the 2015 NBC establishes that, except where the landing is turning 90 degrees or more, the length of the landing need not be more than the lesser of the required width of stair, or 1 100 mm. This length should be measured in accordance with Figure 17.



L1 + L2 = required length of the landing
D = half the required length of the landing

Figure 17: Landing dimensions

The new dimensions for a turning landing will not consume floor space and be expensive to build.

ACCESSIBILITY, SECTIONS 3.7. AND 3.8.

Knowledge on the relatively new issues related to accessibility is growing rapidly to better serve Canadians with various disabilities. However, requirements on accessibility in the NBC have not been revised for years.

A recent environmental scan revealed that the NBC was 25 % up-to-date compared to provincial Codes and international standards.

The 2015 NBC was amended with a series of changes on low-cost and no-cost items that enhance accessibility and safety without creating additional financial burdens to building owners. These changes address problems related to:

- common design requirements on grab bars, faucets, accessible controls and door hardware,
- accessible path of travel, and
- accessible plumbing facilities.

These changes are detailed below.

In addition, Code users benefit from a reorganization of Section 3.8. in the 2015 NBC. Subsection 3.8.2. is now dedicated to the application requirements of all accessibility provisions, whereas Subsection 3.8.3. contains solely design requirements.

Code users also have the option to use CSA B651, “Accessible Design for the Built Environment,” for the design requirements in lieu of those contained in Subsection 3.8.3. As an

internationally well-respected Canadian accessibility standard, CSA B651 offers a highly credible single source for accessibility requirements.

As some buildings are required to comply with the NBC and CSA B651, this alternative eliminates some compliance difficulties for designers and building owners as well as building officials.

Common Design Criteria

Faucets, Article 3.7.2.3.

The 2010 NBC wording for lavatories permitted some types of faucets that did not meet the Code intent and also restricted the use of some other types of faucets that provided acceptable performance.

The provision was edited to clarify which types of faucets, in addition to handle types, serving a lavatory, meet the intent of the NBC of being usable by all.

Grab Bars, Article 3.7.2.8.

Design of grab bars must ensure that they will perform as intended. The 2010 NBC did not provide specific design criteria.

The provision was changed to add to the load requirement and include other criteria:

- slip-resistant surface,
- absence of sharp or abrasive elements,
- diameter of the cross-section, and
- clearance from the wall.

These additional criteria for the design of grab bars provide an enhanced level of safety for users.

Controls, Article 3.8.3.8.

Also within this Section is a change related to common control criteria to make controls operable by people who have difficulty grasping objects. These were previously stated in many provisions in the NBC and differed in wording without justification.

Furthermore, there was no requirement prohibiting the installation of controls in confined locations such as in a space formed by two walls limiting the accessibility to someone who uses a wheelchair.

In the 2015 NBC, the requirements were changed to:

- group common criteria on controls – operable by a closed fist, with a limited force – in one provision in Subsection 3.8.3., and
- clarify that the provision applies to other controls such as faucets and door hardware, and specify locations where controls shall be installed (not in corners).

These changes provide better guidance to Code users on how to make controls usable by all.

Door Hardware, Sentences 3.3.1.13.(3), 3.4.6.16.(1) and 3.8.3.6.(4)

In the previous edition of the NBC, the requirements on the opening devices for doors in an accessible path of travel, as well as other doors intended for public use, did not include all criteria that would make them operable by all people, including those with dexterity limitations.

The provision was changed to specify the installation height of opening devices on doors in an accessible path of travel. Also, a cross-reference to control design criteria was added for all doors intended for public use. Door hardware is now subjected to criteria making them usable by all.

Accessible Path of Travel

General Design Requirements, Article 3.8.3.2.

Requirements addressing the design of path of travel were inappropriately located in the Subsection on general requirements, where they were often missed by designers.

The change introduced in the 2015 NBC relocates the design requirements regarding paths of travel in the more appropriate Subsection 3.8.3. and now:

- require that they be beveled at a maximum slope of 1 in 2 at changes in level between 6 mm and 13 mm, and
- provide guidance on the use of carpet and surfaces producing glare or being heavily patterned in the new explanatory Note A-3.8.3.2.

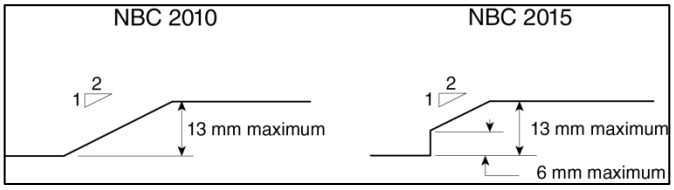


Figure 18: Small change in elevation in accessible path of travel

Ramps, Article 3.8.3.5.

The 2010 NBC requirements were silent on many criteria regarding ramp design.

The provisions were modified to specify minimum requirements for ramps and landings; the types of surfaces and flooring for steeper ramps; their cross slope; drainage; and edge protection. These features enhance the usability and safety for all users.

Doorways and Doors, Article 3.8.3.6.

In the previous edition of the NBC, the application of the provisions on doorways to sliding doors was not stated, creating enforcement confusion. The 2015 NBC was clarified so that except where stated otherwise, Article 3.8.3.6. applies to sliding doors as well as swinging doors. The use of sliding doors in areas that are accessible is an efficient way to reduce the manoeuvring space required at doors.

In addition, the previous edition of the NBC did not specify which type and where the activation devices for power-assisted doors should be located and did not state the minimal safety requirements for these doors.

The provision was modified to specify that power-assisted doors shall be activated automatically or through the use of a control. The location of the control – from the door swing and from the floor – is now stated.

Minimum safety requirements for their operation were also identified:

- maximum stopping force to stop the door, and
- a cane-detectable guard where the door swing opens into the path of travel.

Accessible Plumbing Facilities

Drinking Fountains, Article 3.8.3.10.

The Article on accessible drinking fountains in the previous edition of the NBC was vague and silent on several elements. The enforcement of such requirements was difficult and may have produced a device that did not perform as intended, resulting in an inaccessible drinking fountain.

The provision was modified to clarify the elements required for an accessible drinking fountain:

- clear floor space (800 x 1 350 mm),
- knee space,
- spout location,
- spout height,
- water flow height, and
- automatic operation allowance.

Water-closet Stalls, Article 3.8.3.11.

The NBC requirements on accessible water-closet stalls had not been updated for several years and were lacking many key elements that would greatly improve their use by people with various disabilities.

The provisions were modified to update in the 2015 NBC the requirements regarding the following elements in accessible water-closet stalls:

- maximum latch force,
- alignment of door with transfer space,
- clear opening width (850 mm),
- outward swinging door, unless additional space inside,
- D-handle on each side of the door,
- L-shaped grab bar on side wall,
- horizontal grab bar on rear wall,
- distance specification from wall to centerline of water closet (460 to 480 mm), and
- clear floor area of 1 500 by 1 500 mm in front of accessible stall.

Universal Washrooms, Article 3.8.3.12.

The requirement on accessible single-user washrooms in the previous edition of the NBC used terminology that is out-of-date, did not address the location of toilet paper dispensers and had limited criteria regarding the locking device of the door. A change in the 2015 NBC replaces the term “universal toilet room” with “universal washroom” in Sentences 3.7.2.2.(2) and (3), 3.8.2.3.(4) and Article 3.8.3.12. This new term is more appropriate.

It also clarifies criteria for locking devices and toilet paper dispensers, making them more easily usable by people with disabilities. Finally, the change harmonizes requirements for universal washroom elements – water closet, grab bars, door and toilet paper dispenser – with those in other accessible washrooms.

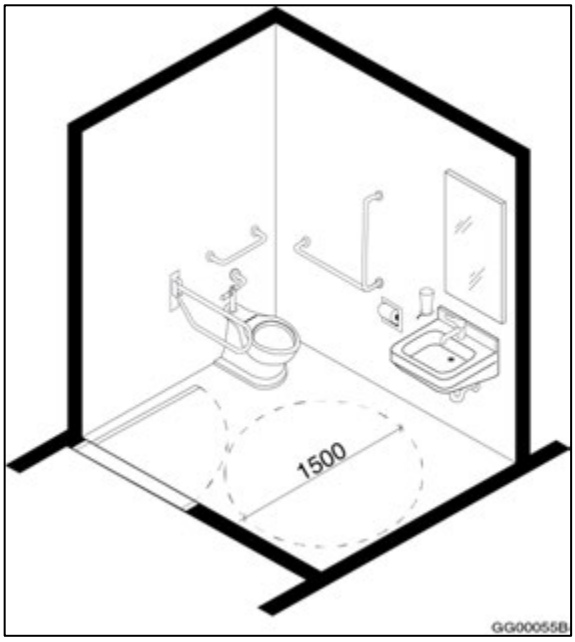


Figure 19: Universal washroom

Water Closets, Article 3.8.3.13.

Water closet technologies have changed and the NBC requirements on accessible water closets were no longer current.

The provisions for water closets were updated in the 2015 NBC to improve accessibility and safety as well as to reflect the following requirements:

- increase minimum seat height from 400 to 430 mm,
- allow automatic flushing as an option,
- add location and operation criteria for flush controls where no automatic flush is provided, and
- require toilet tank lids to be securely located.

Urinals, Article 3.8.3.14.

In the previous edition of the NBC, many elements of Article 3.8.3.10. regarding accessible urinals were missing, unclear or incomplete.

The provisions for urinals were updated in the 2015 NBC to improve their use and accessibility for individuals with various disabilities. They now require the following:

- that a urinal be located on an accessible route,
- specify that the rim of the urinal be not more than 430 mm above floor level,
- add criteria for clear width unobstructed by privacy screens,
- allow automatic flushing as an option,
- add location and operation criteria for flush controls where no automatic flush is provided, and
- clarify requirements for grab bars.

Lavatories, Article 3.8.3.15.

The previous edition of the NBC was unclear on the location of soap dispensers at lavatories.

Specifically, the location of accessories serving accessible lavatories should be established while taking into consideration that their controls must be within the direct reach of a person in a seated position directly in front of the accessible lavatory. As such, soap dispensers and faucets must now be located so that they are usable by a person from the same seated position directly in front of the accessible lavatory.

Showers, Article 3.8.3.16.

Article 3.8.3.13. of the 2010 NBC on accessible showers did not address the issue of the obstruction of controls and transfer space that is created by shower doors and curtains. The Article also did not require a sufficient number of grab bars that would maintain a user's safety and balance. Moreover, the threshold requirement did not permit a small vertical drop on a floor.

Changes introduced in the 2015 NBC enhance the accessibility and safety of barrier-free showers. The Code now requires additional grab bars and a longer hose for hand-held shower heads in addition to clarifying that no doors or curtains shall obstruct the controls or transfer space. Furthermore, the changes propose a relaxation by permitting a vertical threshold not more than 6 mm.

Bathtubs, Articles 3.7.2.9. and 3.8.3.17.

The 2010 NBC did not require the installation of bathtubs in hotel and motel rooms, nor in accessible dwelling units. Nevertheless, when provided in these locations, bathtubs must comply with accessibility and safety criteria.

The 2015 NBC now clarifies the clear floor space next to the tub, the clearance over the transfer rim, the location of faucets and grab bars and hand-held shower head design.

OTHER CHANGES

Fire Rating of Cables in Air Plenums, Articles 3.1.4.3. and 3.1.5.18.

The increase in demand for data cables as well as the pressure to switch to emerging and better performing wires and cables, without removing old ones, resulted in crowded plenums with increasing risk of fire (Figures 20 and 21).

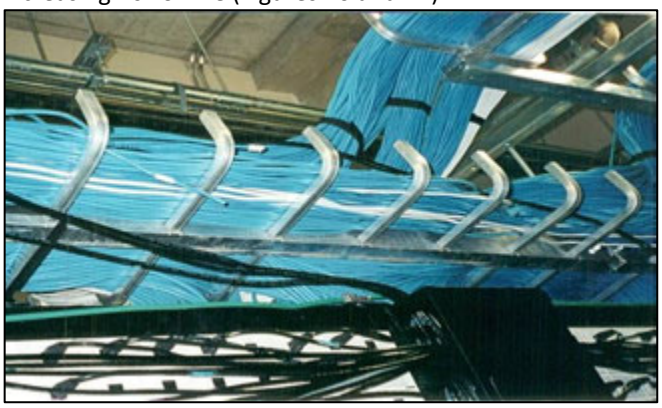


Figure 20: Fire rating of cables in air plenums

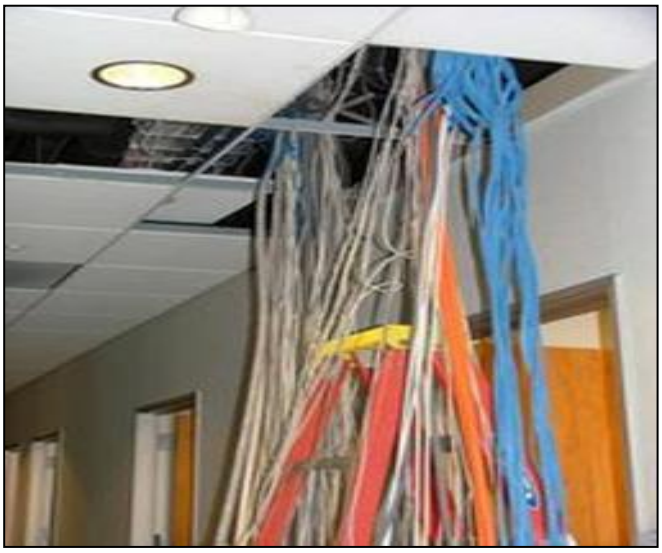


Figure 21: Fire rating of cables in air plenums

Sentence 3.1.4.3.(2) and Article 3.1.5.18. include changes that enhance the fire protection of plenums. Specifically, the rating of plenums used in buildings of

- noncombustible construction increased from FT4 to FT6. This will help control and minimize the amount of smoke generated by cables burning inside air plenums and reduce the flame spread on these cables in the event of a fire;
- combustible construction increased from FT1 to FT4.

Sentence 3.1.4.3.(3) addresses the case where totally enclosed noncombustible raceways are used in plenums. It allows an exception to the FT6 requirements for exposed wiring components where the wiring extends from the plenum not more than nine metres in length including dropping down to the floor level. As per Sentence 3.1.4.3.(3), exposed components of wiring systems with combustible insulation, jackets or sheathes must be FT4 rated. It should be noted that without this exception, the new requirements could force the use of FT6 rated cables in metallic raceways, which could not be justified from a fire protection basis.

The exemption from the FT4 or FT6 requirements of cables or wires within plenum spaces that are used for the transmission of signals in security, radio, and television broadcasting, closed circuit television or community television systems was deleted in Articles 3.1.4.3. and 3.1.5.18. of the 2015 NBC as these cables are now available in these ratings.

Heavy Timber Construction, Article 3.1.4.7.

Strandboard has been recognized for many years as an alternative to plywood in most applications. Sentence 3.1.4.7.(6) was modified to include strandboard as it appeared to be missing from the 2010 NBC and there was sufficient evidence to demonstrate its adequacy.

Minor Combustible Components, Article 3.1.5.2.

The list of minor combustible components permitted in a building required to be of noncombustible construction could be interpreted by Code users as restricted to materials listed in Clauses 3.1.5.2.(1)(a) through Clause (h), which are general in nature and intended to include other similar materials not listed. To avoid such misinterpretation, new Clause (b) was added to identify self-adhesive tapes as a minor combustible component permitted in a building required to be of noncombustible construction.

Combustible Interior Finishes, Article 3.1.5.12.

In the 2010 NBC, there was confusion in the application of the requirements related to combustible interior finishes in a building required to be of noncombustible construction.

Sentence 3.1.5.12.(1) now clearly states that Sentences 3.1.5.12.(2) and (3) are permissions provided a number of conditions are met. It also clearly indicates which interior finishes are allowed as combustible interior finishes in a building required to be of noncombustible construction.

Decorative Wood Cladding, Article 3.1.5.24.

Article 3.1.5.24. now permits that decorative wood cladding be used on canopies on a building. It was recognized that the use of fire-retardant-treated decorative wood cladding on canopies poses little additional risk.

Penetrations in Fire Separations and Fire-Rated Assemblies, Subsection 3.1.9.

The penetration of fire separations and fire-rating assemblies by outlet boxes was clarified to avoid the misinterpretation that all outlet boxes require a fire stop. Clarification was provided for conditions permitting electrical outlet boxes to penetrate a fire separation, or a membrane forming part of an assembly required to have a fire-resistance rating, without the need for a fire stop. Article 3.1.9.4. was added to identify the conditions related to outlet box penetrations.

Fire Block Materials, Article 3.1.11.7.

There could be significant fire spread through a building via concealed spaces and the risk is heightened in buildings of combustible construction.

Some wood products can perform as well as solid lumber of the same thickness with respect to resistance to fire. These wood

products are now permitted to be used as fire block materials in those locations in which solid lumber was permitted in the 2010 NBC. Strandboard was qualified with oriented strandboard in Clause 3.1.11.7.(4)(b).

Corridors, Article 3.1.13.6.

New Sentence 3.1.13.6.(6) was added to clarify that the flame-spread rating of the interior ceiling finish in a public corridor of a sprinklered building could be limited to 150. The requirement is based on the floor area being sprinklered as opposed to the entire building being sprinklered as the fire behaviour is mostly impacted by the floor area being sprinklered.

Roof Coverings, Article 3.1.15.2.

Steel building systems (SBS) have no "roof covering." The outer membrane is steel in the form of "steel panels" understood to be noncombustible. As such, Sentence 3.1.15.2.(2) clarifies that under certain conditions an SBS does not require a Class A, B or C classification and is not required to be tested in accordance with CAN/ULC-S107, "Standard Methods of Fire Tests of Roof Coverings." A steel panel making up the roof of an SBS does not produce Class A, B or C burning brands, is not a roof assembly with wood roof deck that is called for in a fire test, etc.

Storage Garage Considered as a Separate Building, Article 3.2.1.2.

In the 2010 NBC, the provisions of Article 3.2.1.2. applied only in relation to Subsection 3.2.2. Consequently, even though the storage garage was a separate building, some authorities having jurisdiction would consider the storage garage as a storey in determining the building height for the purposes of Sentence 3.2.5.12.(2) regarding the use of NFPA 13R, "Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies." As such, when a 4-storey residential building was constructed over such a garage, this resulted in NFPA 13, "Standard for the Installation of Sprinkler Systems requirements," being mandated instead of NFPA 13R.

Similarly, with this approach used in addressing one- and two-family dwelling units constructed over the top of such a storage garage, NFPA 13 instead of NFPA 13D, "Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes," would be mandated, since the residences would be considered as containing a non-residential occupancy. In doing so in both cases, the sprinkler protection requirement becomes more stringent than the minimum level of performance intended by the Code in terms of sprinkler protection for a residential occupancy.

The change to Sentence 3.2.1.2.(1) clarifies the sprinkler requirement for a storage garage in single- and multi-family residential buildings.

Combustible Projections, Article 3.2.3.6.

The intent of Sentences 3.2.3.6.(2) and (3) is to address the issues of fire impingement from building to building through soffits because of their proximity. Where the property line is next to a street, lane or public thoroughfare (i.e., where the building is located on a corner lot), it was clarified in Sentence 3.2.3.6.(4) that the face of a roof soffit is only permitted to project to the property line, where it faces a street, lane or public thoroughfare.

Emergency Power for Building Services, Article 3.2.7.9.

The addition of the reference to Article 3.3.3.6. in Clause 3.2.7.9.(1)(c) assures that the ventilation system in areas of refuge are powered by an emergency power supply, thus reducing the likelihood of filling the space with smoke in the event of a fire.

Combustible Sprinkler Piping, Article 3.2.5.13.

Chlorinated polyvinyl chloride (CPVC) piping has been listed for use in residential dry-pipe sprinkler systems. It is now permitted to be installed in limited areas of ordinary-hazard occupancies, and in limited exposed areas. Due to these new advancements in the listing of CPVC piping, changes were made to the Code so that CPVC sprinkler piping could be used if installed in accordance with the manufacturer's specifications and listings.

Limits to Smoke Movement, Article 3.2.6.2.

When air-handling units are automatically shut off, positive pressure is lost in the corridors and stairwells, which reverses the direction causing the following problems:

- smoke and fire moves from the suites (now higher air pressure due to fire) into the corridors (new low pressure zone due to fan shutdown),
- smoke and fire is drawn from the suites into the corridors to the stairwells caused by the stack effect when building pressurization units are turned off, and
- firefighters' control of air-handling units is lost and may become irreversible due to fire alarm system override.

These problems reduce life safety and increase danger to evacuating occupants and to responding firefighters from exposure to smoke.

Sentence 3.2.6.2.(6) was added to require corridor pressurization units to remain on to resist or limit the movement of smoke and to protect the means of egress for occupants and access for responding firefighters.

Central Alarm and Control Facility, Article 3.2.6.7.

This change clarifies which smoke management systems are targeted by Clause 3.2.6.7.(2)(i). In the 2010 NBC, Subclause 3.2.6.7.(2)(i)(i) did not specify the type of auxiliary equipment. An editorial clarification was made to this Subclause to help Code users and provide guidance. The new Subclause captures the intent of the NBC.

Exceptions to Special Protection, Article 3.2.8.2.

The provision in Clause 3.2.8.2.(6)(d) was updated as, in the past, it was considered overly restrictive to require the reduction of a permitted building area by half simply due to the presence of a small unprotected stair opening between floors in an unsprinklered building or an interconnected floor space in a sprinklered building that does not conform to the requirements of Articles 3.2.8.3. to 3.2.8.8.

Safety within Floor Areas, Articles 3.3.1.2., 3.3.1.20. and 3.3.4.6.

In the 2010 NBC, provisions did not classify dangerous goods as hazardous materials under the Workplace Hazardous Materials Information System (WHMIS). Thus, there were instances where dangerous goods could be classified under the Transportation of Dangerous Goods (TDG) and not under WHMIS and vice versa. This could expose users of such products to significant safety risks during handling, or could lead to fire or explosion hazards when segregation requirements with incompatible stored dangerous goods were not properly identified and followed.

The WHMIS classification system was introduced into the NBC to adequately address the hazards related to the use and storage of dangerous goods in a building or facility. Explanatory Note A-3.3.1.2.(1) was clarified for hazardous substances in light of the revised definition of dangerous goods, which includes classified controlled products under the WHMIS.

Ductwork used in the ventilation systems of laboratories are required to

- exhaust to the outdoor dust, fumes, gases, vapour or other impurities or contaminants having a potential to create a fire or explosion hazard, and
- ensure there is no return into the building as per Part 6.

Sentence 3.3.1.20.(2) now requires that a duct of an exhaust ventilation system handling contaminants with a potential to create a fire or explosion hazard be enclosed when penetrating a fire separation required to have a fire-resistance rating.

Article 3.3.4.6. contains a signpost to the requirements in Section 5.8. for airborne noise where changes introduce a new rating to assess the protection of occupants in dwelling units rather than assessing the performance of the separating building assembly.

National Building Code

Part 4 – Structural Design

Outline

This material highlights changes to Part 4 of the National Building Code and covers the following topics:

- Load Combinations
- Live Loads Due to Use and Occupancy
- Snow Loads
- Wind Loads
- Earthquake Load and Effects
- Glass
- Parking Structures
- Ground Snow Load Values

LOAD COMBINATIONS, ARTICLE 4.1.3.2., TABLES 4.1.3.2-A AND 4.1.3.2-B

The load combinations listed in the previous edition of the National Building Code (NBC) published in 2010 raised some safety concerns when the ratio of Live (L) and Snow (S) is close to 1 in areas of high snow loads. This is why, in Tables 4.1.3.2-A and 4.1.3.2-B of the 2015 NBC, the companion load factor was increased from 0.5 to 1.0 for both L and S when both L and S are considered together.

In addition, if L is a storage use combined with S, the companion load factor for L was increased from 1.0 to 1.5 as both loads are storage types with a higher risk of the simultaneous occurrence of these loads.

LIVE LOADS DUE TO USE AND OCCUPANCY, SUBSECTION 4.1.5.

Loads on Guards and Handrails, Article 4.1.5.14.

In order to more closely reflect the real loads on a guard, which generally are those acting away from the floor adjacent to the guard, the specified load was reduced to 50% of the required load when acting inwards.

In addition, a new requirement was added to limit the size of the opening between vertical elements within a guard to the limit required in Part 3 of the NBC when subjected to a specified load of 0.1 kN on each of two adjacent individual elements applied in opposite directions in the in-plane direction of the guard. The load chosen (0.1 kN) is deemed to be representative of the force that might be applied in the lateral direction, and one that can be approximated on site by an inspector by manually pushing the elements under scrutiny.

Loads on Vehicle Guardrails, Article 4.1.5.15.

To address situations where a guard serves as both vehicle guardrail and a guard, Article 4.1.5.15. was modified to clearly state that the requirements for each type of guard need not be assumed to be applied simultaneously.

Loads on Walls Acting as Guards, Article 4.1.5.16.

In the 2010 NBC, the provisions for walls acting as guards prescribed the design lateral live load but did not state a direction. The NBC now states that the design lateral live load for walls acting as guards acts outward only.

Whenever a wall or partial height wall separates a higher level from a lower level and where the difference between levels is greater than 600 mm, that wall must be designed to resist the appropriate outward lateral design loads prescribed in Subsection 4.1.5.14. of the NBC, or 0.5 kPa acting outward, whichever produces the more critical effect.

SNOW LOADS, SUBSECTION 4.1.6.

Much of the guidance on snow loads provided in the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B) was moved to the body of the Code, as this was already the norm in the industry.

Specified Snow Load, Article 4.1.6.2.

Basic Roof Snow Load Factor, Sentence 4.1.6.2.(2)

The calculation of the basic roof snow load factor (C_b) was modified based on current research as follows:

$$C_b = 0.8 \text{ for } l_c \leq \left(\frac{70}{C_w^2}\right), \text{ and}$$

$$C_b = \frac{1}{C_w}\left[1 - (1 - 0.8C_w)\exp\left(-\frac{l_c C_w^2 - 70}{100}\right)\right] \text{ for } l_c > \left(\frac{70}{C_w^2}\right)$$

where:

l_c = characteristic length of the upper or lower roof, defined as $2w\text{-}w^2/l$, in m
w = smaller plan dimension of the roof, in m, and
l = larger plan dimension of the roof, in m

In addition, the values (C_b) were tabulated for ease of use for various roof sizes and wind exposure factors.

Wind Exposure Factor, Sentence 4.1.6.2.(4)

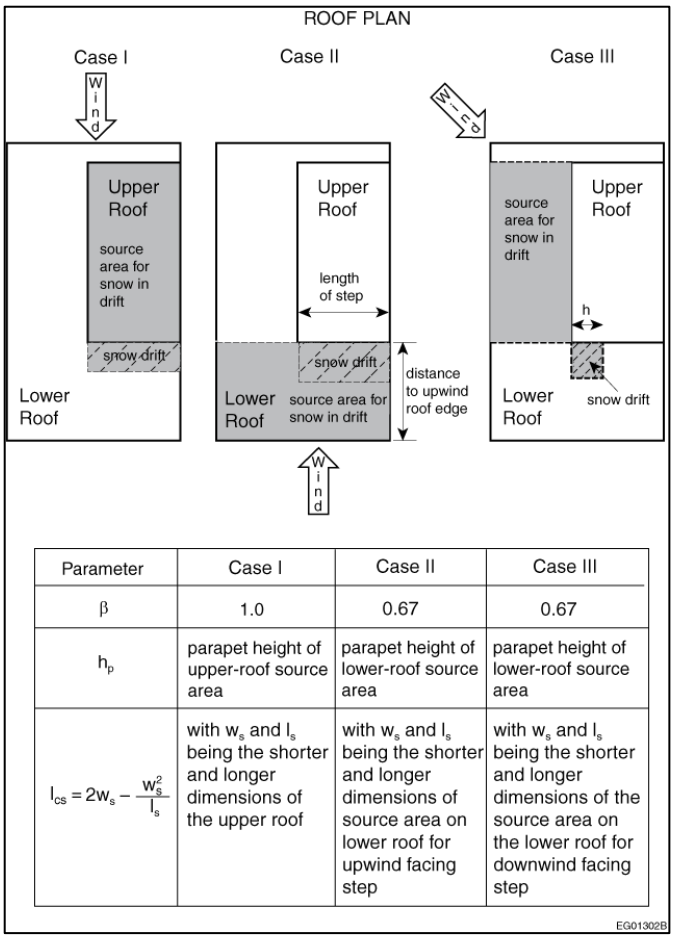
The wind exposure factor (C_w) was reduced from 1.0 to 0.75 in rural areas. The reduced wind exposure factor is applied in rural areas only. In urban areas, it is unlikely that the building will be exposed on all sides to wind over open terrain for the duration of its expected service life.

Accumulation Factor, Sentence 4.1.6.2.(8)

The accumulation factor (C_a, previously called shape factor) is now described in Articles 4.1.6.5. through 4.1.6.12. for a number of different roof shapes.

Multi-level Roofs, Article 4.1.6.5.

The calculations of the accumulation factor (C_a) for multi-level roofs was modified to better account for drifting from an upper-level roof into a roof step (Case I), drifting over a lower-level roof into a roof step (Case II), and for drifting up against a roof projection (Case III). The calculations now use a more consistent methodology to cover all three types of accumulation (Figure 1).



Parameter	Case I	Case II	Case III
β	1.0	0.67	0.67
h_p	parapet height of upper-roof source area	parapet height of lower-roof source area	parapet height of lower-roof source area
$l_{cs} = 2w_s - \frac{w_s^2}{l_s}$	with w_s and l_s being the shorter and longer dimensions of the upper roof	with w_s and l_s being the shorter and longer dimensions of source area on lower roof for upwind facing step	with w_s and l_s being the shorter and longer dimensions of the source area on the lower roof for downwind facing step

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Figure 1: Snow load cases for lower level roofs

Snow Drift at Corners, Article 4.1.6.8.

Drifts at the corners of multi-level roofs can be the result of drifting from several directions. These drift shapes provide a common basis for design (Figure 2). They are largely based on engineering judgments and are consistent with snow observations.

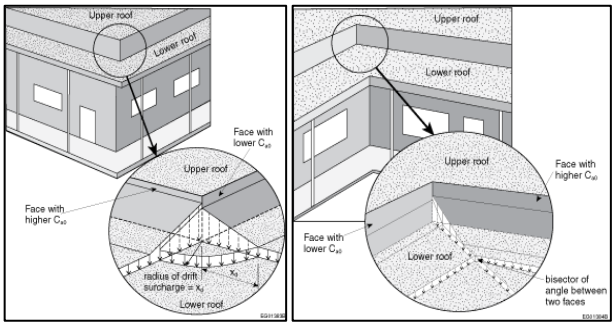


Figure 2: Snow loads at corners

In addition, consideration is now given to drift loads adjacent to significant vertical obstructions (Figure 3), such as elevators, air-conditioning and fan housings, small penthouses and wide chimneys.

In the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B), the drift was assumed to reach a height equal to 0.67h, (h = height of the projection) and to extend a distance of 2h out from the projection. In the 2015 NBC, the peak load (C_{a0}) and the drift extension (x_d) were modified to better account for the actual snow distribution as follows:

a) C_{a0} is now taken as the lesser of

$$0.67\frac{\gamma h}{C_b S_s} \text{ and } \frac{\gamma l_0}{7.5 C_b S_s} + 1$$

b) x_d is now taken as the lesser of 3.35h and $(2/3)l_0$, where

h = height of the projection, and
l_0 = longest horizontal dimension of the projection

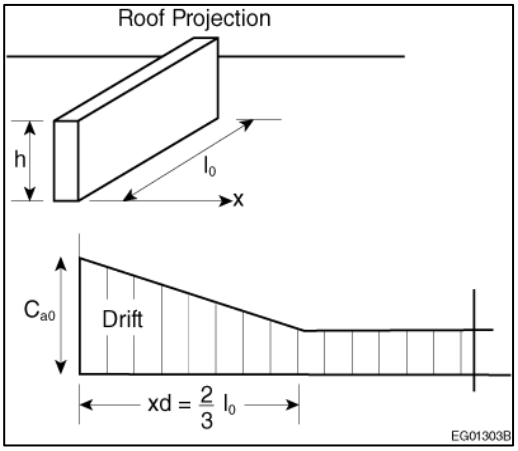


Figure 3: Snow drifting at roof projections

Arch Roofs, Curved Roofs and Domes, Article 4.1.6.10.

Heavy unbalanced loads often occur as a result of the transfer of snow from one side of the roof to the other.

A slight change to the calculation of the accumulation factor (C_a) for arch and curved roofs has now been reduced to two load cases from three (Figure 4).

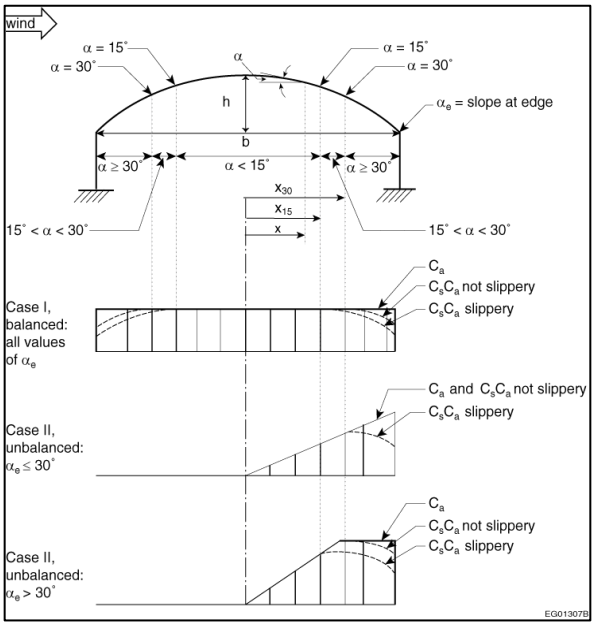


Figure 4: Accumulation factors for arch roofs and curved roofs

This unbalanced snow distribution is especially important for domes and for buildings such as arenas, which have long spans and in which a collapse might be catastrophic.

The calculation of snow distribution for domes was also modified and a new figure was added (Figure 5).

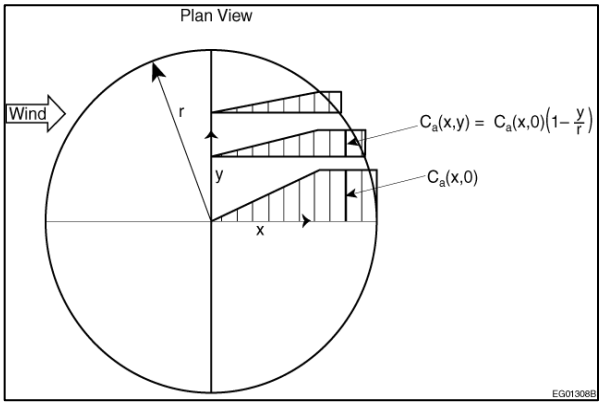


Figure 5: Unbalanced snow accumulation factor on a circular dome

Snow Loads Due to Sliding, Article 4.1.6.11.

The calculation of snow loads due to sliding from an upper level roof onto a lower level roof was modified to ensure that the extra load on the lower roof is considered for all slopes of the upper roof when the upper roof is slippery (Figure 6).

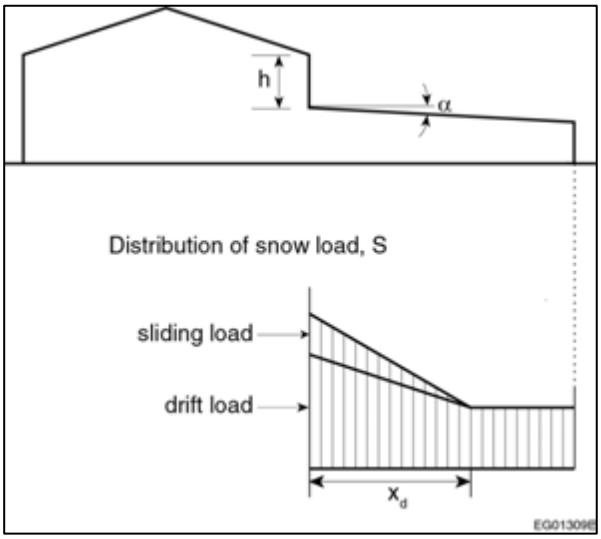


Figure 6: Snow distribution on lower roof with sloped upper roof

Valleys in Curved or Sloped Roofs, Article 4.1.6.12.

The calculation of snow loads in valleys of curved or sloped roofs was moved from the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B) to the main body of the Code (Figure 7).

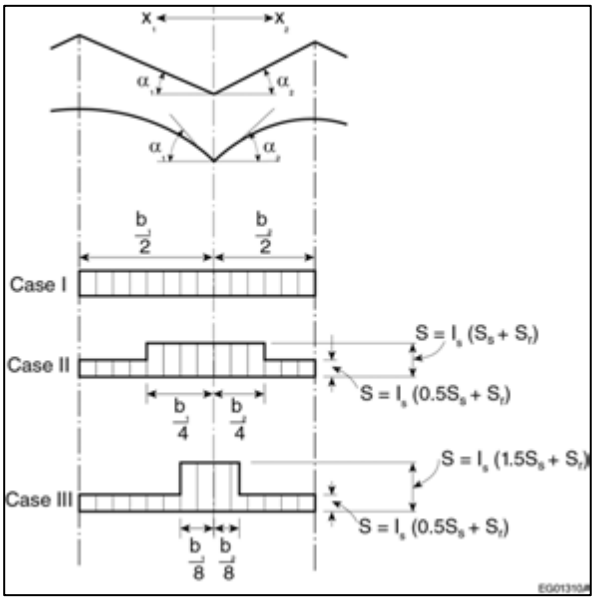


Figure 7: Snow loads in valleys of sloped or curved roofs

Specific Weight of Snow, Article 4.1.6.13.

To calculate loads due to snow on roofs, an estimate of the specific weight (γ) is necessary.
The specific weight of snow on roofs (γ) obtained from measurements at a number of stations across Canada varied from about 1.0 to 4.5 kN/m^3.

A formula for the specific weight of snow, which is provided in the American Society of Civil Engineers 7 (ASCE 7), was adopted for the 2015 NBC as it was consistent with the Canadian experience. The specific weight of snow (γ) in areas of snow build-up as a function of the snow depth for the purposes of calculating snow loads in drifts is as follows: (γ) needs to be taken as 4.0 kN/m^3 or $0.43S_S + 2.2$ kN/m^3, whichever is less.

Snow Removal, Article 4.1.6.14.

A statement prohibiting the reduction of design snow loads on the basis of snow removal by various means was added.

Ice Loading of Structures, Article 4.1.6.15.

A provision concerning ice loading on lattice structures or other building components or appendages was introduced to account for loads due to ice accretion on the exposed surfaces, referencing CSA S37, "Antennas, Towers and Antenna-Supporting Structures."

WIND LOADS, SUBSECTION 4.1.7.

Much of the guidance on wind loads provided in the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B) was moved to the body of the Code, as this was already the norm in the industry.

Specified Wind Load, Article 4.1.7.1.

The three methods for determining wind loads (static, dynamic and wind tunnel) were more clearly defined.

In addition, a new provision was added indicating that computational fluid dynamics (CFD) is not permitted to be used independent of the wind tunnel procedure. This is because the ability of CFD to achieve the appropriate level of accuracy and reliability in the context of the highly complex turbulent flows around buildings has not been yet verified. Furthermore, no accepted consensus standards exist that define appropriate CFD procedures (e.g. turbulence closure method, resolution of the computational grid, time step requirements, length of the simulation, number of wind directions to simulate, modeling of surroundings, modeling of upwind terrain, etc.).

Internal Gust Factor, Sentence 4.1.7.3.(10)

The formula of the internal gust factor (C_{gi}) for large structures enclosing a single unpartitioned large volume (such as hangars) was moved from the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B) to the main body of the Code.

$$C_{gi} = 1 + \frac{1}{\sqrt{1 + \frac{V_0}{6950\,A}}}$$

where:

V_0 = internal volume, in m^3, and
A = total area of all exterior openings of the volume, in m^2

Topographic Factor, Article 4.1.7.4.

A separate topographic factor (C_t) was introduced in the formulae of wind pressure (Figure 8).

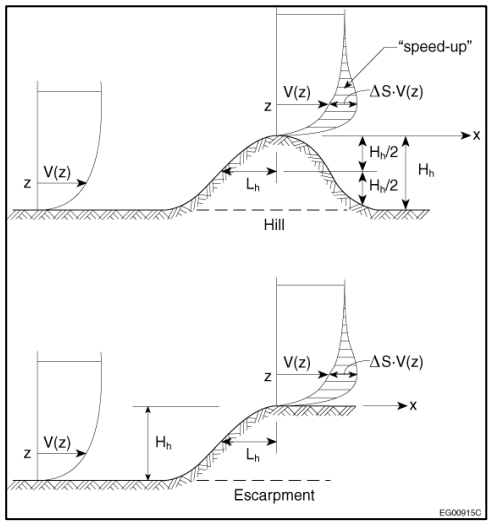


Figure 8: Speed-up of mean velocity on a hill or escarpment

Hills and escarpments increase wind speed near the ground. This is now reflected in the topographic factor for buildings located in such areas. The method to be used for both static and dynamic procedures is given in Article 4.1.7.4.

External Pressure Coefficients, Article 4.1.7.5.

Article 4.1.7.5. provides the external pressure coefficients (C_p) for designing buildings of any height.

Sentences 4.1.7.5.(2) and 4.1. 7.5.(3) provide the pressure coefficients (C_p) for the design of the main structural system (Figure 9).

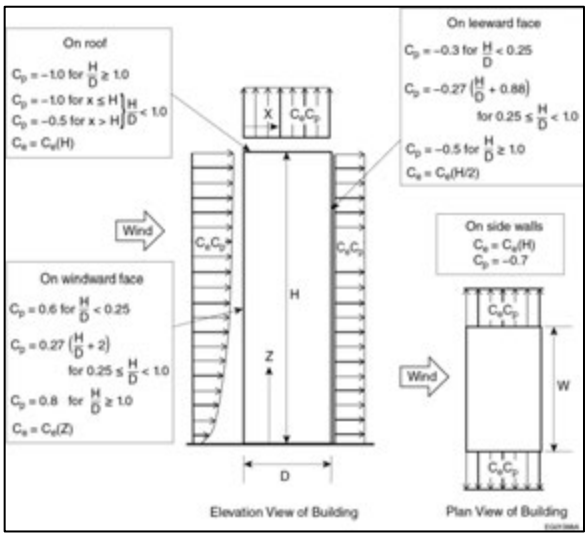


Figure 9: Pressure coefficients for main structural system on rectangular buildings

In addition, the reference dimensions (W and D) used for the determination of cladding loads were redefined regardless of wind direction (Figure 10).

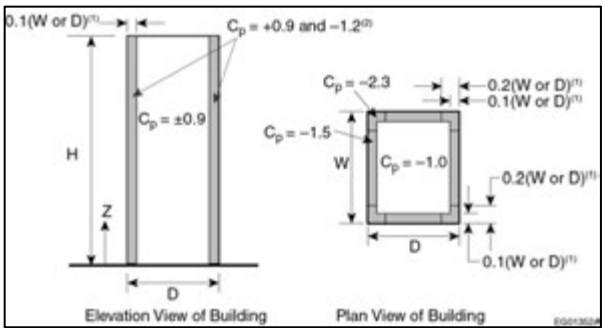


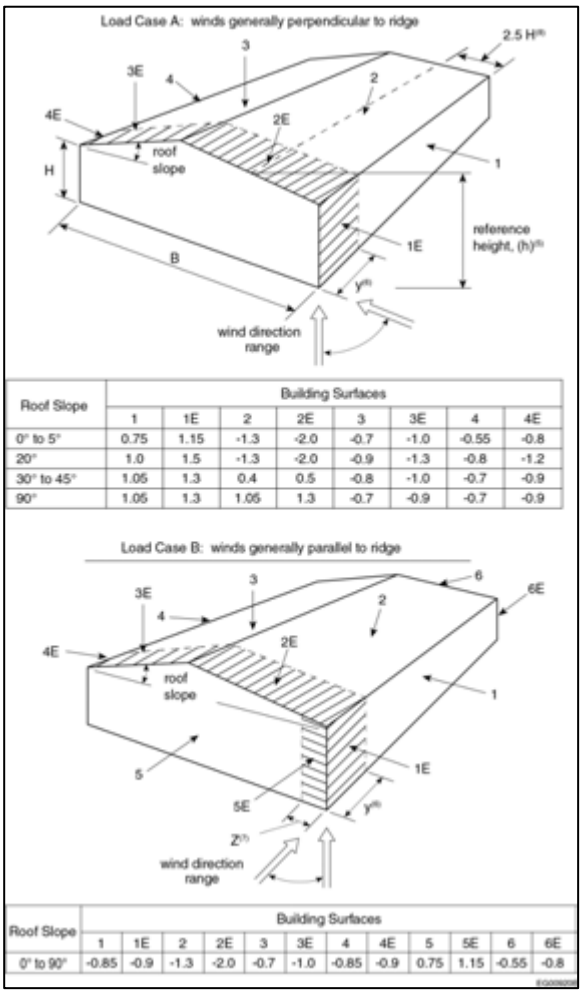
Figure 10: Pressure coefficients for roof and wall claddings and secondary structural supports of cladding on rectangular buildings

External Pressure Coefficients for Low Buildings, Article 4.1.7.6.

Article 4.1.7.6. provides the external pressure coefficients for designing buildings with heights less than 20 m.

For the design of cladding and secondary structural members on individual walls, such as purlins and girts, the coefficient values are now provided (Figures 11 and 12). These coefficients are based on gust pressures; consequently, they include an allowance for gust effect factor (C_g), and therefore represent the product (C_pC_g).

These coefficients apply to the tributary area associated with the particular element or member over which the wind pressure acts.



Roof Slope	Building Surfaces							
	1	1E	2	2E	3	3E	4	4E
0° to 5°	0.75	1.15	-1.3	-2.0	-0.7	-1.0	-0.55	-0.8
20°	1.0	1.5	-1.3	-2.0	-0.9	-1.3	-0.8	-1.2
30° to 45°	1.05	1.3	0.4	0.5	-0.8	-1.0	-0.7	-0.9
90°	1.05	1.3	1.05	1.3	-0.7	-0.9	-0.7	-0.9

Roof Slope	Building Surfaces											
	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
0° to 90°	-0.85	-0.9	-1.3	-2.0	-0.7	-1.0	-0.85	-0.9	0.75	1.15	-0.55	-0.8

Figure 11: External peak values of (C_pC_g) for primary structural actions arising from wind load acting simultaneously on all surfaces of low buildings (H ≤ 20 m)

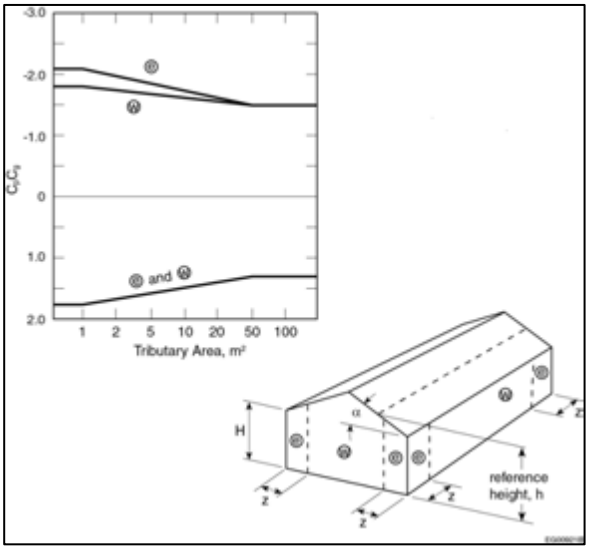


Figure 12: External peak values of (C_pC_g) on individual walls for the design of cladding and secondary structural members

Internal Pressure Coefficient, Article 4.1.7.7.

The User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B) material on the internal pressure coefficient (C_{pi}) was moved to the main body of the Code. Three basic building opening categories are now provided in Article 4.1.7.7.

Table 4.1.7.7.
Internal Pressure Coefficients
Forming Part of Sentence 4.1.7.7.(1)

Building Openings	Values for C_{pi}
Uniformly distributed small openings amounting to less than 0.1% of the total surface area of the building	−0.15 to 0.0
Non-uniformly distributed openings of which none is significant or significant openings that are wind-resistant and closed during storms	−0.45 to +0.30
Large openings likely to remain open during storms	−0.70 to +0.70

Dynamic Procedure, Article 4.1.7.8.

All factors and coefficients for the dynamic procedure, including the exposure factor (C_e) and the gust effect factor (C_g) in the User's Guide – NBC 2010, Structural Commentaries (Part 4 of Division B), are now given in Article 4.1.7.8.

In addition, the topographic factor (C_t) covered in Article 4.1.7.4. is also used in the Dynamic Procedure to account for speed-up over hills and escarpments.

Exterior Ornamentations, Equipment and Appendages, Article 4.1.7.11.

A procedure for evaluating the effect of wind loads on exterior non-building components was introduced. It includes:

i. Reference to CSA S37, "Antennas, Towers and Antenna-Supporting Structures," to include the effects of icing,
ii. Addressing group effect in the design where there are a number of similar components. The net increase in force may be based on using the total area for all similar components in determining the force as opposed to the summation of forces based on the individual elements,
iii. An explanatory Note to account for loads that could be transferred from appendages, as they may increase the overall forces in the design of the building structure.

Full and Partial Wind Loading, Article 4.1.7.9.

In some cases, partial wind loading can cause a more severe effect than full loading as it can produce additional torsion. In fact, reduced but simultaneous loading along both major axes can produce higher stresses in some structural members versus wind acting along any one major axis. Hence, Sentence 4.1.7.9.(1) requires all buildings to be designed for partial loading as well as full loading.

Low buildings designed according to the Static Procedure do not need to have further unbalanced loads. However, tall buildings, in addition to being designed for the full wind load along each of the principal axes (Case A, Figure 13), should be checked for maximum additional torsion arising from partial loadings. These partial loadings are created by applying the wind pressure to only part of the building face areas (Case B, Figure 13).

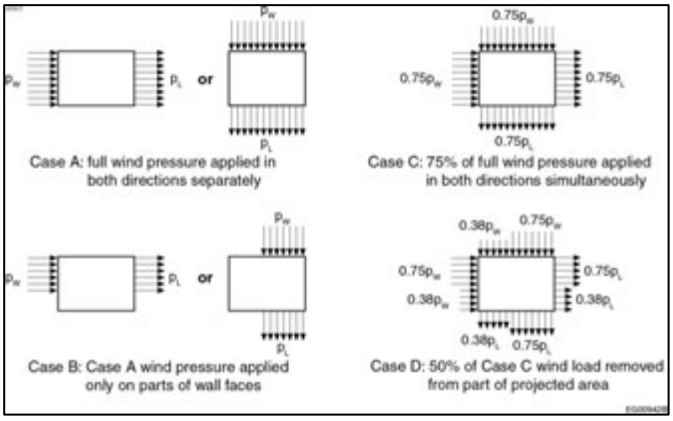


Figure 13: Full and partial loading

Wind Tunnel Procedure, Article 4.1.7.12.

Specific requirements for wind tunnel procedure were introduced for the design of the main structure as well as claddings and need to be conducted in accordance with ASCE/SEI-49, "Wind Tunnel Testing for Buildings and Other Structures."

In addition, new provisions were introduced as follows:

i. When an adjacent building provides sheltering, the loads for the main structural system shall be no lower than 80% of the loads determined from wind tunnel tests with the effect of the sheltering removed (as applied to either base shear for shorter buildings as they tend to be shear dominant or base moment for taller buildings) (See Sentence 4.1.7.12.(2).)
ii. Wind loads on the main structure and cladding can be determined using wind tunnel test results and shall not be less onerous than those determined by analysis in accordance with Article 4.1.7.3. (See Sentence 4.1.7.12.(3).)

EARTHQUAKE LOAD AND EFFECTS, SUBSECTION 4.1.8.

Significant changes to the earthquake provisions were introduced in the 2015 NBC. These changes were essential to ensure that the level of protection in the NBC for seismic hazard is consistent with the objectives of the NBC. The updates incorporate the ongoing improvement in knowledge on seismic hazard and its geographical distribution throughout the country. A brief rationale, along with the nature of these changes, is presented in this section.

Seismic Design in Low Hazard Areas, Article 4.1.8.1.

Previously, designers were allowed to ignore earthquake loads at locations where the design spectral acceleration at 0.2 seconds time period, S(0.2), was less than or equal to 0.12. This exemption was withdrawn. Designers are now required to consider earthquake loads for the design of buildings at all locations in Canada. New triggers were defined for identifying locations with low seismic hazard and a simplified approach was introduced in Article 4.1.8.1. for seismic design at such locations.

Data indicates that earthquakes as large as magnitude 7 can occur in locations which are considered as low hazard. Consequently, these locations are no longer exempted from seismic design. The new requirements ensure that buildings at such locations meet the life safety and structural protection objectives of the NBC.

Article 4.1.8.1. introduces a minimum lateral earthquake design load for all regions based on the region's seismicity and predicted ground motions, along with a self-contained simplified analysis procedure. The trigger at which the simplified procedure can be used is set at $I_E F_s S_a(0.2) = 0.16$ and $I_E F_s S_a(2.0) = 0.03$. These triggers are higher than the trigger in the 2010 NBC for I = 1.0 buildings.

The simplified procedure uses techniques and methods that are similar to those used for analyzing wind loads, and only requires designs to satisfy the non-seismic portions of the appropriate CSA design standards. The procedure is based on taking the requirements in Subsection 4.1.8. that only apply to low hazard zones, making some slightly conservative simplifications, and placing them all in Article 4.1.8.1.

The simplified method has some restrictions. For example, it cannot be used for post-disaster or high importance buildings built with unreinforced masonry. The method is conservative; therefore, the option to design using detailed requirements can be exercised if this is a concern.

Updates to Seismic Design Data for Selected Locations in Canada, Table C-3

Seismic hazard values in Table C-2 of Appendix C were updated and are now provided in Table C-3. The new values are based on updates to the earthquake catalogue, seismic source zones, fault sources for the Cascadia subduction zone and certain other active faults, and revisions to Ground Motion Prediction

Equations (GMPEs). A probabilistic model was used to combine all inputs. Such regular updates are essential to ensure that NBC requirements incorporate ongoing improvement in knowledge of seismic hazard and continue to provide the required level of protection stipulated in the NBC. The probability level used to define the Design Ground Motion was retained. However, the NBC now uses mean hazard results instead of median hazard results.

Site Properties, Table 4.1.8.4.-A

The site coefficients (F(T)) given in Article 4.1.8.4. are appropriate for buildings on hard rock where V_s = 1600 m/s. Some rock sites, especially those on the Canadian Shield, have V_s in range of 2000 to 3000 m/s and will experience weaker shaking than on a reference hard rock site. Note (2) of Table 4.1.8.4.-A was revised to provide the necessary adjustment for such sites.

Period-based Site Coefficients (Foundation Factors), Sentences 4.1.8.4.(4) and (5)

In recent years, extensive records have been gathered on the seismic response of a wide variety of soil sites worldwide. This expanded database has allowed the development and use of the period-dependent site factors for the first time in the NBC. The use of period-based factors provides a more accurate representation of hazard.

The site classifications, as shown in Table 4.1.8.4.-A., have not been changed. However, the short and mid-period amplification factors, F_a and F_v respectively, were replaced by period dependent factors, (F(T)) for fundamental periods 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s, and 10.0 s, as well as for PGA (peak ground acceleration) and PGV (peak ground velocity). These values are given in Tables 4.1.8.4.-B to 4.1.8.4-I.

The measure of ground motion intensity for determination of foundation factors was changed from the $S_a(0.2)$ and $S_a(1.0)$ to an adjusted measure of PGA, PGA_{ref}. The attenuation of short-period ground motion in eastern Canada is less than in the West. The direct use of PGA would give F(T) values with larger non-linear de-amplification effects in the East than is appropriate for their sustained level of shaking. This could have potential safety implications. Consequently, an adjustment factor has been provided for determining appropriate foundation factors at eastern sites as per Sentence 4.1.8.4.(4).

Design Spectral Acceleration Equations, Sentence 4.1.8.4.(9)

Revised equations for determining design spectral acceleration at various periods for a site using new period-based foundation factors are provided in Sentence 4.1.8.4.(9). Equations are provided for design spectral acceleration, S(T), at T = 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s and 10 s.

For some localities, design spectral acceleration at time period of 0.5 seconds, S(0.5), is larger than the design spectral acceleration at 0.2 seconds, S(0.2). This change was necessary because it is not a good practice to design on the basis of a spectrum in which the S value increases with the period. The period of a structure becomes longer as the structure responds in the inelastic range. If S(0.5) is larger than S(0.2), the structure attracts higher forces and can fail if it is not designed for the higher forces generated at 0.5 second period. As a consequence, S(0.2) is now specified as the greater of $F(0.2)S_a(0.2)$ and $F(0.5)S_a(0.5)$.

New Seismic Force Resisting Systems (SFRSs) and Other Updates, Table 4.1.8.9.

Changes were made to concrete SFRSs in Table 4.1.8.9. to coordinate with changes in CSA A23.3 -14, “Design of Concrete Structures.” Table 4.1.8.9. now includes two new categories of coupled wall systems: “moderately ductile coupled walls” and “moderately ductile partially coupled walls.” A new category for two-way slabs without beams was also added with a relatively low ductility-related force modification factor and stringent height restrictions to reflect the poor performance of such a structural system in earthquakes.

The height restrictions on moment-resisting frames of conventional construction have been increased for some cases to reflect the design and detailing requirements in the Standard. New requirements for the seismic design of tilt-up construction having different levels of ductility were added. The height limits for tilt-up construction are based on construction practice in the Vancouver area.

Changes were made in Table 4.1.8.9. to coordinate with the updates in CSA S304-14, “Design of Masonry Structures.” Ductile shear walls were introduced as a new category under masonry. Limited ductility (masonry) shear walls were deleted.

Tall industrial buildings classified as Group F occupancy are commonly built using steel structures. The SFRS for these buildings is typically steel concentrically braced frames. The structures are generally much taller than the height limits currently specified for steel concentrically braced frames in Table 4.1.8.9. for moderate and high seismicity regions. Such structures cannot be built using the provisions in the NBC. Specific provisions were introduced in Annex M of CSA S16-14, “Design of Steel Structures,” for the seismic analysis and design of these structures. New explanatory Note A-Table 4.1.8.9. was added for reference to the Annex in the standard.

Existing footnote (2) in Table 4.1.8.9. was amended to clarify that the maximum height specified in the Table is measured above grade.

Structural Irregularity due to Gravity-Induced Lateral Demand, Table 4.1.8.6. and Article 4.1.8.10.

A building with inclined columns has a pre-disposition to lean along the direction of inclination in an earthquake event. Offset columns, cantilevered floor plates, or eccentric floor spans imposing large differences in gravity loads to different sides of the Seismic Force Resisting Systems (SFRS) have a similar effect and induce significant additional lateral demands in a building. This can result in large residual displacements and consequent instability of the building in an earthquake. A new irregularity (Type 9) termed as Gravity-Induced Lateral Demand (GILD) was added to Table 4.1.8.6. to deal with such buildings.

A trigger to check the existence of a Type 9 irregularity is now provided in Table 4.1.8.6. A procedure to incorporate its effect in design is provided in Sentences 4.1.8.10.(5), (6) and (7). Post-disaster buildings are not allowed to have Type 9 irregularities as stipulated in Sentence 4.1.8.10.(2).

Figure 14: Buildings with gravity-induced lateral demand

Higher Mode Factors, M_v, and Base Overturning Reduction Factor, J, Table 4.1.8.11.

Values of higher mode factors, M_v, and base overturning reduction factors, J, could no longer be used due to changes in the shape of uniform spectra and subsequent revisions in hazard values. New values for these factors were derived from the uniform hazard spectra and are provided in Table 4.1.8.11.

Previously, the spectral shapes for cities in the geographical east were steeper than those in the geographical west when the ratio $S_a(0.2)/S_a(2.0) = 8$ was used as the demarcation between the geographical west and east. This is no longer true. A new spectral ratio S(0.2)/S(5.0) was developed to separate the geographical west from the geographical east. Based on the new spectral shapes, M_v and J factors were obtained for four different values of the spectral ratio S(0.2)/S(5.0) equal to 5, 20, 40 and 65 and four different periods 0.5, 1,0, 2.0 and 5.0 s. Linear interpolation must be carried out to obtain M_v and J for intermediate values of the spectral ratio. The M_v and J values are then used to obtain $M_vS(T_a)$ and J, respectively, for intermediate values of the fundamental period.

Hazard Cap Static Force Procedure and Dynamic Analysis Procedure, Clause 4.1.8.11.(2)(c) and Sentence 4.1.8.12.(6)

Clause 4.1.8.11.(2)(c) and Sentence 4.1.8.12.(6) provide the maximum value of earthquake force for static and dynamic analysis procedures respectively. The maximum design force was capped at a fraction (2/3) of the force at 0.2 second period for structures which were not built on Class F soil and had at least a minimum amount of ductility. This relaxation was provided in recognition of the better performance exhibited by such structures in past earthquakes.

As a result of changes in uniform hazard spectra, the cut-off was found to be lower than the earthquake force at 0.5 second period. Consequently, the relaxation (use of 2/3 of force at 0.2 second) does not apply to structures with 0.5 second period. Allowing the relaxation for 0.5 second buildings would have resulted in unsafe designs. The cut-off for maximum design force is now revised to account for both (2/3)S(0.2) and S(0.5).

Flexible Diaphragms, Sentences 4.1.8.11.(4) and 4.1.8.15.(4)

Many single-storey buildings with steel or wood roof diaphragms are small in height but are comparatively large in length (e.g., a warehouse). The span of roof diaphragms in such buildings is much larger than the height of the building. These buildings tend to have higher lateral flexibility and longer fundamental period resulting in an inelastic higher mode response to earthquake loads.

A new expression was added in Sentence 4.1.8.11.(4) for determining fundamental time period of such buildings in view of their special behavior. The inelastic higher mode response of such structures can also lead to magnified forces or magnified deformations in their SFRS and roof diaphragms. New requirements were added in Sentence 4.1.8.15.(4) to account for these.

Effect of Foundation Flexibility, Sentences 4.1.8.13.(2), 4.1.8.15.(10) and 4.1.8.16.(1)

Previously, the effect of foundation flexibility and footing rotational stiffness on the lateral deflections obtained from linear elastic analysis did not need to be considered. Research has shown that this effect can have a noticeable impact on increasing the expected displacements in a structure. This could create unsafe conditions for other structural elements not part of the SFRS if their integrity is sensitive to displacements. Sentence 4.1.8.13.(2) was updated to address this gap.

A common assumption in modeling a structure is to use a model fixed at the foundation. New Sentence 4.1.8.15.(10) was added to stress the fact that a fixed base assumption may not be conservative enough for the calculation of forces. Displacements in the structure and foundation movements also need to be considered in the design. Ignoring these additional displacements could result in an unsafe design.

Foundation Provisions for Seismic Design, Sentences 4.1.8.15.(9), 4.1.8.16.(2), (3) and (4)

The approach to design foundations as capacity protected elements and provide exceptions for allowing their design as rocking foundations (not-capacity protected) is continued in the 2015 NBC. However, significant changes were made to provisions in this regard.

Sentence 4.1.8.15.(9) provides the exemption to the capacity design philosophy of protecting the foundation by making its overturning resistance greater than the overturning capacity of the SFRS, provided certain conditions stated in Sentence 4.1.8.16.(4) are met. The previous SFRS design force upper limit cut-off for "rocking foundations" was deleted as recent studies have shown that this cut-off is unconservative for many soils.

New Sentence 4.1.8.16.(2) requires that foundations be designed to resist the lateral load capacity of the SFRS, regardless of the earthquake loads used to design the SFRS. This is a particularly important application of the capacity design philosophy, allowing the structure to dissipate energy inelastically while the foundation remains essentially linear elastic.

An exception to the requirement for designing foundations for the overturning capacity of the SFRS is given in new Sentence 4.1.8.16.(3) which is a force cut-off clause, and new Sentence 4.1.8.16.(4), which is a special case allowing the footing resistance to be less than the wall capacity demand.

Sentence 4.1.8.16.(3) is a force cut-off clause for capacity protected foundation design. Gravity load provides, or contributes to, the overturning resistance for many elements. Examples are uplift in frame columns and footings and in overturning resistance of foundations in general. There is no inherent "overstrength" component in the gravity load. Consequently, a force cut-off based on R_dR_o of 1.3 is not appropriate. Sentence 4.1.8.16.(3) therefore requires the use of a force cut-off based on R_dR_o = 1.0 for such elements.

In order to capture overstrength of the soil or rock, a factor of 1.5 is applied to the bearing resistance as the typical ultimate resistance of the soil or rock is about 2.0 times the factored resistance. For other elements in the foundation, use of 1.3 times the factored resistance is appropriate.

Sentence 4.1.8.16.(4) provides a requirement for rocking footings. In order to apply Sentence 4.1.8.16.(4), the footing and supported SFRS must be free to rotate and uplift on the soil or rock. This is a special case as many typical structures do not satisfy this condition because they are usually constrained in some way. Some examples include footings on piles, caissons (i.e. drilled piers), footings with soil or rock anchors, and raft foundations.

Site Stability and Liquefaction, Article 4.1.8.17. and Sentence 4.1.8.16.(10)

Previously, the provisions for site stability and liquefaction did not require consideration of site properties as provided in Article 4.1.8.4. in assessing the potential of a site for these effects. Necessary revisions to require consideration of site properties such as site class were added.

Updates to Elements of Buildings, Article 4.1.8.18.

Free-Standing Steel Pallet Storage Racks, Sentence 4.1.8.18.(13)

Pallet storage racks can be tall and heavily loaded, posing a significant risk to life in an earthquake if not properly designed. These types of structures were not previously covered in the NBC. Requirements are now provided in Sentence 4.1.8.18.(13) and Table 4.1.8.18. to address the gap.

Figure 15: Failure of steel pallet storage racks in Northridge earthquake

Free-standing storage racks at or below grade that are surrounded by, but not otherwise connected to the building structure, now need to be analyzed either as separate structures or as elements of structures, non-structural components and equipment (categories 23 and 24 in Table 4.1.8.18.).

Racks mounted on building floors above grade shall be designed using provisions in Table 4.1.8.18. or using the Linear Dynamic Analysis Method where both the rack and the building structures are considered.

Seismic Design of Glazing, Sentences 4.1.8.18.(14) and 4.1.8.18.(15)

Glass falling out of a window frame in an earthquake poses a hazard to life safety. When a building deforms during an earthquake, openings distort and become out of square. Any window or partition rigidly attached to columns or walls at the edges of the opening must also deform. Brittle materials like glass cannot tolerate any significant deformation. Glass will crack once the space between the window frame and glass closes, and the deformation of the building structure starts pushing directly on glass. Once cracked, the inertial forces in the out-of-plane direction can cause portions of glass to dislodge and fall, potentially injuring passers-by underneath. Such glazing failures have been commonly observed in earthquakes especially in glazing systems for high-rise buildings.

Requirements were introduced in Sentences 4.1.8.18.(14) and (15) to address this issue. Cases where seismic hazard is low, where falling glass does not pose significant risk to life safety, or where there is sufficient clearance between the glass and the frame, were exempted.

Elevators and Escalators, Table 4.1.8.18.

Elevators are sensitive to storey drift and acceleration in an earthquake. Damage such as bent guide rails, dislodged elevator cabs and counterweights, and failure of oil tank tie-downs have been observed. Requirements for machinery and guide rails for elevator and escalators, including their anchorages, were added in Table 4.1.8.18. to reduce the risk of injury from these components in an earthquake event. Reference to ASME A17.1/ CSA B44, “Safety Code for Elevators and Escalators,” was also added as a footnote to Table 4.1.8.18. In applying this standard, the designer should use ground motion parameters that are consistent with those used in the explanatory Note A-4.1.8.18.

New Explanatory Note and Other Minor Revisions

Experience during earthquakes has demonstrated that the failure or detachment of non-loadbearing structural elements, architectural components, mechanical and electrical equipment (henceforth referred to as “parts or portions”) can present a major threat to life safety. According to recent studies in Canada, the United States and Europe, parts and portions represent between 60 to 80% of the loss exposure of buildings to earthquakes and account for over 78% of the total estimated national annualized earthquake loss.

Article 4.1.8.18. provides the requirements for parts and portions, and their connections to the building. Reference to CAN/CSA S832, “Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings,” was added to explanatory Note A-Table 4.1.8.18. to provide additional guidance to users.

Duplicate references to ducts and cable trays in Table 4.1.8.18. were removed and the scope of Clause 4.1.8.18.(8)(f) was expanded to apply the definition of a ductile connection to all parts of Article 4.1.8.18.

Seismic Isolation, Articles 4.1.8.19. and 4.1.8.20.

Seismic isolation, used widely in many countries for the design of new buildings, was introduced in the NBC. The fundamental goal of seismic isolation is to reduce the earthquake-induced forces and energy transmitted into the structure. This is achieved by interposing an isolation system with low horizontal stiffness between the substructure and the superstructure of a building.

During an earthquake, lateral displacements occur primarily in the isolation system along the isolation interface, while lateral loads transmitted to the structure and its relative lateral displacements are greatly reduced. Seismic isolation is particularly suited to buildings in regions of high seismicity and

buildings with irregularities. The technique can also be used for the seismic retrofit or upgrade of existing buildings. New Code provisions for the use of seismic isolation in a building are provided in Articles 4.1.8.19. and 4.1.8.20.

Figure 16: Seismic isolation using lead rubber bearing

Supplemental Energy Dissipation, Articles 4.1.8.21. and 4.1.8.22.

Supplemental energy dissipation devices, often referred to as dampers, can be inserted into a structural system to reduce the seismic response of the overall building by absorbing or dissipating the seismic energy within such devices. This technique is particularly suited to buildings in regions of high seismicity and can be effectively used for seismic retrofit or upgrade of existing buildings.

Displacement-dependent devices rely on relative displacements within the device for the dissipation of energy and are typically based on either metallic yielding or frictional sliding. Velocity-dependent devices dissipate energy in either solid or fluid components within the devices and depend primarily on the relative velocities within the devices. New Code provisions for supplemental energy dissipation are provided in Articles 4.1.8.21. and 4.1.8.22.

Figure 17: Illustration of supplementary energy dissipation device-viscous damper

GLASS, SUBSECTION 4.3.6.

Design of Glass, Article 4.3.6.1.

The 2010 NBC referenced CAN/CGSB 12.20, "Structural Design of Glass for Buildings," as the design basis for glass. Now, both CAN/CGSB 12.20 and ASTM E 1300, "Standard Practice for Determining Load Resistance of Glass in Buildings," are referenced in order to provide designers with the flexibility of using either standard.

A load adjustment factor of 1.0 is required on the wind load (W) when using ASTM E 1300, and a load adjustment factor of 0.75 is required when using CAN/CGSB 12.20.

PARKING STRUCTURES, SUBSECTION 4.4.2.

Design Basis for Parking Structures and Repair Garages, Article 4.4.2.1.

Repair garages now need to be designed in accordance with CSA S413, "Parking Structures," as they also contain vehicles which can contaminate the structure in the same manner as parking structures.

GROUND SNOW LOAD VALUES, APPENDIX C

The ground snow load values (S_s) in Table C-2, Climatic Design Data for Selected Locations in Canada, were updated using a similar approach to the one used in the NBC 1990 edition.

As a result, S_s values remained unchanged for 85% of the locations, have increased for 11% of the locations, and have decreased for 4% of the locations in Canada.

The Yukon, Northwest Territories and Nunavut accounted for the greatest proportion of increases.

National Building Code

Part 5 – Environmental Separation

Outline

This material highlights changes to Part 5 of the National Building Code and covers the following topics:

- Dynamic Wind Uplift Resistance
- Other Fenestration Assemblies
- Roofing, Dampproofing and Waterproofing
- Sound Transmission
- Exterior Insulation Finish Systems
- Other Changes

DYNAMIC WIND UPLIFT RESISTANCE, ARTICLE 5.2.2.2.

Rationale

Load calculations in Part 4 of the National Building Code (NBC) take into account wind through the gust factor. However, practitioners had no means to show Code compliance because there were no explicit methods to validate the wind resistance of roofing-membrane assemblies. The insurance industry was also interested in this knowledge because roof cover failures are one of the major causes of insurance claims after high wind events.

Why Dynamic Testing?

Many stakeholders saw the need for dynamic testing when determining wind uplift resistance. While static testing has been used for a long time, it is known that static testing does not reflect the dynamic nature of wind in real life (Figure 1). Dynamic testing provides a realistic understanding of roof-membrane aspects such as fastener, tearing and peeling strength of membranes and membrane seams, and permits identifying the weakest links in a roofing-membrane system.

Factory Mutual (FM) revised its prescriptive requirements such as those related to the number of fasteners and also delisted a significant portion of approved roof assemblies soon after major wind events such as Katrina, Ivan and Charley.

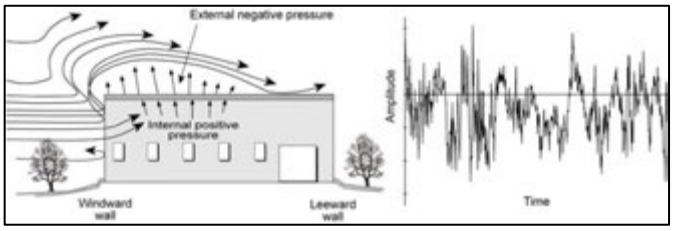


Figure 1: Pressure on a roofing assembly

By consulting stakeholders, a Task Group identified other standards that used static testing and were applied by the industry. From its review of those standards, it concluded that ANSI/FM 4474, "American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures," and ANSI/UL 580, "Standard for Tests for Uplift Resistance of Roof Assemblies," were not suitable for inclusion in the 2015 NBC.

CAN/CSA-A123.21, "Standard Test Method for Dynamic Wind Uplift Resistance of Membrane-Roofing Systems"

The Special Interest Group for the Dynamic Evaluation of Roofing Systems (SIGDERS) developed CAN/CSA-A123.21, "Standard Test Method for Dynamic Wind Uplift Resistance of Membrane-Roofing Systems," over a period of 20 years and at least 400 assemblies were tested during the development of this standard. Members of SIGDERS include all major industry stakeholders (manufacturers, associations, building owners, insurance and designers). The standard was presented in 16 Canadian cities (with over 800 attendees) as part of the NRC Building Science Insight Seminar Series held in 2005.

The Roofing Contractors Associations of British Columbia (RCABC) and Quebec (QMRA) already included CAN/CSA-A123.21 into their approval and warranty programs.

The Canadian Roofing Contractors Association, which is considered the national voice for the Canadian roofing industry, endorsed dynamic uplift resistance testing and stated that: "Referencing this standard is a great step forward for the roofing industry as it recognizes the dynamic response of low

slope roofs under dynamic wind loading. It will facilitate the construction of robust roofs that will meet the specific performance requirements of the particular construction. The resulting increased economic efficiency and performance reliability will benefit consumers, roofing product manufacturers and installers."

Systems to be Tested to CAN/CSA-A123.21

The scope of the standard CAN/CSA-A123.21 referenced in the 2015 NBC clearly indicates that only membrane roofing systems whose components' resistance to wind uplift is achieved by fasteners or adhesives need to be tested (Figure 2).

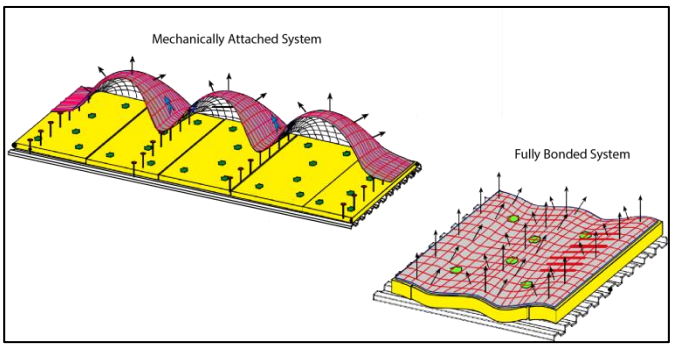


Figure 2: Assemblies covered by CAN/CSA-A123.21

The explanatory Note to Sentence 5.2.2.2.(4) reiterates this and clarifies that systems that use ballasts to secure the membrane against wind uplift do not need to be tested. Examples of such ballasts include gravel or pavers.

Acknowledging that the resistance to wind uplift is limited to the configurations tested, a reference to ANSI/SPRI WD-1, "Wind Design Standard Practice for Roofing Assemblies," was included in the 2015 NBC. It includes a rational and acceptable calculation procedure to extrapolate the test data obtained from testing to CAN/CSA-A123.21 to non-tested configurations. The explanatory Note A-5.2.2.2.(4) dictates that the wind load calculations be carried in accordance with Part 4 of the 2015 NBC.

Sentence 5.2.2.2.(5) excludes some systems with a proven performance record from testing to CAN/CSA-A123.21. The inclusion of this exception in the body of the Code acknowledges the fact that the acceptance of these systems falls under the competence of authorities having jurisdiction. It provides them with the needed flexibility when dealing with systems with proven past performance.

Number of Testing Laboratories

The dynamic testing table was first established at NRC under the SIGDERS (Figure 3). However, NRC has been vetting similar tables. As it stands today, there are two Canadian and one U.S. laboratories equipped to test to CAN/CSA-A123.21. Three more laboratories (one Canadian and two U.S.) are in the process of acquiring the capability of testing to the CAN/CSA-A123.21 standard.

Figure 3: NRC's table for dynamic uplift resistance testing

During the Code development process, committees determined that Canada does not need more than three to four testing labs because not all systems need to be tested and extrapolation tools will be provided. Furthermore, major companies supplying about 70% of the Canadian market already tested their common systems as part of the standard development and their involvement in the SIGDERS's program.

OTHER FENESTRATION ASSEMBLIES, SUBSECTION 5.9.3.

Curtain walls, window walls, storefronts and glazed architectural structures are now referred to as "other fenestration assemblies." An example of such assemblies is provided in Figure 4.

Figure 4: Example of other fenestration assemblies

Rationale

In the last decade, other fenestration assemblies, especially window walls and curtain walls, have become more common. Historically, the performance requirements for these building envelope systems were left to the specifying architect or building professional. In other words, guidance on the minimum performance that may be required to prevent system failures related to criteria such as condensation, air leakage, water penetration, structural load, etc. was not included in the Code. As a result, there have been many instances where design professionals were referencing incorrect or non-applicable standards, e.g., CSA A440-00, "Windows." Furthermore, there were no clear or harmonized definitions of other fenestration products.

In the last decade, there has also been an increasing rate of large-scale failures of other fenestration assemblies, mainly in British Columbia and Ontario. As a result of concerns raised by the design, construction and insurance industries, Pro-Demnity, the professional liability insurance of architects in Ontario, issued a "Window Wall Endorsement" to their policies in 2009. It requires all designs to abide by a new "standard" for window wall design and installation to qualify for coverage. The Ontario's Home Warranty provider (TARION) also requires that window wall constructions comply with the Pro-Demnity requirements. However, stakeholders pointed out that this new "standard" addressed only one of the failure aspects and applied only to one jurisdiction.

Scope of Changes

The NBC now includes a new Subsection 5.9.3. to address "other fenestration assemblies." It covers the following aspects:

- structural and environmental loads,
- heat transfer,
- air leakage, and
- water penetration.

For the structural and environmental loads, as well as the heat transfer aspects, the relevant general requirements of Part 5 are reiterated by referring to the relevant sections of the Code.

For air leakage, the requirements set a level of performance for both the fixed and operable portions of the fenestration assemblies:

- 0.2 L/(s·m^2) for fixed portions, and
- 1.5 L/(s·m^2) for operable portions.

It should be noted that Sentence 5.9.3.4.(3) gives a list of systems that are exempt from complying with the air leakage requirements as they perform different functions than "other fenestration assemblies."

Explanatory Note A-5.9.3.4.(2) clarifies that:

- ASTM E 283, "Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen," is the applicable test method for determining the rate of air leakage in the laboratory, and
- ASTM E 783, "Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors," is the applicable test method for field testing for air leakage.

For water penetration, the requirements come shy of setting a performance level as there is not enough information to set a national one. However, Sentence 5.9.3.5.(2) provides the standard to which other fenestration assemblies have to be tested to. Furthermore, the explanatory Note A-5.9.3.5.(2) points to the relevant standard (ASTM E 1105, "Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference") if field testing for water penetration is to be conducted.

Similar to air leakage, Sentence 5.9.3.5.(4) provides a list of systems that are exempt from complying with water penetration requirements because they perform different functions than "other fenestration assemblies."

Explanatory Note A-5.9.3. recognizes that AAMA standards can be used to evaluate the performance of other fenestration assemblies. However, the 2015 NBC only refers to ASTM standards in the body of the Code. The reason the list of relevant AAMA standards is only provided in the explanatory Note is that most of them are not consensus documents. In other words, the decision on the evaluation of performance of "other fenestrations assemblies" is left to the authorities having jurisdiction.

ROOFING, DAMPPROOFING AND WATERPROOFING, SECTION 5.7. AND TABLE 5.9.1.1.

Sections 5.7. (Surface Water) and 5.8. (Moisture in the Ground) in previous editions of the NBC had many issues, including the following:

- they were overly prescriptive,
- they were not structured consistently with other Sections in Part 5,
- their limitations were cumbersome and often confusing, and
- the referenced standards were withdrawn or outdated, resulting in unacceptable performance.

These sections are now combined into one section (Section 5.7., Surface and Ground Water) and rewritten to:

- make it clear that waterproofing is the default,
- clarify situations where dampproofing is allowed, and
- delete the obsolete standards.

Outdated material standards in Table 5.9.1.1. were replaced with more up-to-date ASTM standards where appropriate. However, some outdated CGSB material standards were kept because there were no acceptable replacement standards, and the CGSB standards – although outdated – still require acceptable levels of performance. This approach was also followed in Part 9 of the NBC.

Outdated installation standards were deleted in Table 5.9.1.1. as appropriate replacements could not be found. This approach was not followed in Part 9 of the NBC.

SOUND TRANSMISSION, SECTION 5.8.

In the previous editions of the NBC, the sound transmission requirements focused on laboratory rating of the separating assembly, rather than performance of the system. Advances in the field of acoustical research made it clear that this fell well short of achieving a level of performance consistent with the objectives of the Code. The previous provisions encouraged an over-simplified design approach that resulted in frequent investment in the wrong elements. Most importantly, the design approach failed to provide a functional requirement that established a minimum acceptable performance necessary to satisfy the NBC Objective of Noise Protection (OH3), which addresses the protection of occupants from noise.

The previous provisions relied on the sound transmission class ratings which address sound transmitted directly through the assemblies (Figure 5). However, sound is transmitted via other (indirect) paths as shown in Figure 6. They are called flanking paths.

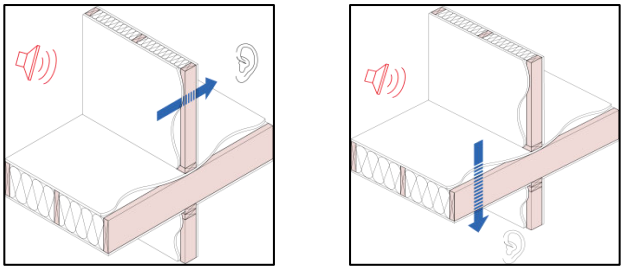


Figure 5: Direct sound transmission (STC)

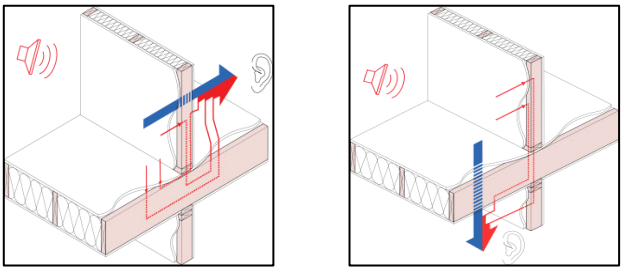


Figure 6: Direct and flanking sound transmission (ASTC)

A new metric called apparent sound transmission class (ASTC) rating was introduced in the 2015 NBC. It is the sum of all flanking sound transmission paths (indirect paths) and the direct sound transmission path. ASTC ratings better relate to what is heard by the occupants and address the performance of the complete assembly without having to overdesign.

Three ASTC compliance paths are included in the 2015 NBC:

- sound transmission measurements (field testing),
- detailed method or simplified method for calculating ASTC (Articles 5.8.1.4. and 5.8.1.5.), and
- prescriptive tables using the existing Tables 9.10.3.1.-A or 9.10.3.1.-B and the new Table 9.11.1.4. to address flanking.

The NRC acoustics group developed a web application (software) called soundPATHS (Figure 7) which models both direct and flanking sound transmission. It calculates ASTC according to the design compliance path in the 2015 NBC. This tool identifies areas of overdesign and the potential for cost savings. Though it is currently available only for wood-frame construction, other types of construction will be added later.

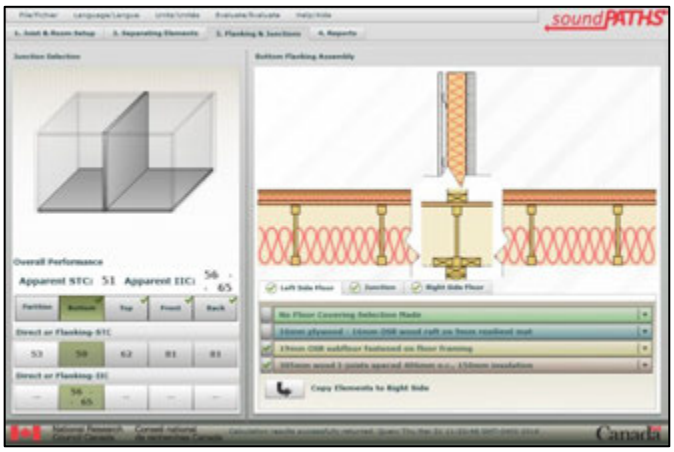


Figure 7: NRC's soundPATHS

EXTERIOR INSULATION FINISH SYSTEMS, SUBSECTION 5.9.4. AND NOTE A-5.9.4.

In previous editions of the NBC, there were no explicit requirements related to exterior insulation finish systems (EIFS). Subsection 5.9.4. was added to address EIFS. It references CAN/ULC S716.1, "Standard for Exterior Insulation and Finish Systems (EIFS) - Materials and Systems." However, the explanatory Note A-5.9.4.1. clearly indicates that referencing this standard does not preclude the use of other component materials that may also meet the intent of the Code.

The two related standards CAN/ULC S716.2, "Standard for Exterior Insulation and Finish Systems (EIFS) - Installation of EIFS Components and Water Resistive Barrier," and CAN/ULC S716.3, "Standard for Exterior Insulation and Finish Systems (EIFS) - Design Application," are only referenced in the explanatory Note as they were found to be prescriptive and may limit the choices of professionals. The explanatory Note also provides guidance on design options and considerations. Particular attention is given to the drainage cavity. The EIFS Practice Manual (Figure 8) is referenced and is available for free from the EIFS Council of Canada website.

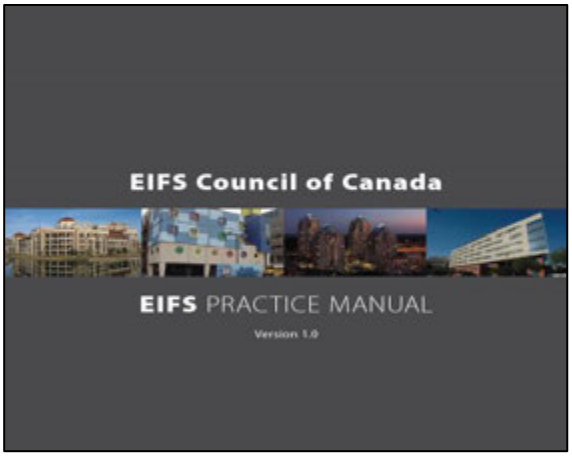


Figure 8: EIFS Practice Manual (Courtesy of EIFS Council of Canada)

OTHER CHANGES

Vegetative Roofing Systems, Sentence 5.6.1.2.(2)

Vegetative roofing systems (green roofs) are gaining popularity. However, there were no provisions in the NBC pertaining to them.

The standard ANSI/GRHC/SPRI VR-1, "Procedure for Investigating Resistance to Root Penetration on Vegetative Roofs," is now referenced in Sentence 5.6.1.2.(2) to avoid compromising the integrity of the assemblies installed to provide protection from the ingress of precipitation in green roofs.

Fenestration, Notes A-5.3.1.2. and A-5.9.2.3.(1)

The Appendix Note A-5.3.1.2. in the previous edition of the NBC published in 2010 was modified to avoid misinterpretation and the use of improper methods which may result in failure. The change highlights the fact that the condensation requirements of AAWA/WDMA/CSA 101/I.S.2/A440, "NAFS - North American Fenestration Standard/Specification for Windows, Doors, and Skylights," are optional and that fenestration products (windows, doors and skylights) that meet the requirements of this standard do not necessarily meet the condensation requirements for a given project.

The explanatory Note A-5.9.2.3.(1) was added to provide guidance on the installation details and field testing of fenestration products.

Deletion of Duplication, Sentences 5.3.1.3.(3), 5.6.1.2.(1), and 5.6.1.2.(2)

A few requirements were deleted from the body of Part 5 as they referred to standards that are already referenced in Table 5.9.1.1. This includes the 2010 NBC Sentences 5.3.1.3.(3), 5.6.1.2.(1) and 5.6.1.2.(2).

Multiple Functions, Sentence 5.1.4.1.(2) and Note A-5.1.4.1.(2)

Materials, components and assemblies that fulfill multiple functions are becoming more common. However, they are often used with only one function in mind. Sentence 5.1.4.2.(2) and the associated explanatory Note A-5.1.4.1.(2) were added to draw attention to the fact that these materials need to fulfill all the intended functions and to highlight the proper design and construction procedures that take into account all applicable functions. This will help to anticipate potential unintended consequences.

Resistance to Deterioration, Note A-5.1.4.2.

In the previous editions of the NBC, the Appendix Note A-5.1.4.2. addressed resistance to deterioration without providing guidance on how to fulfill it. A reference to CSA S478, "Guideline on Durability in Buildings," was added to the explanatory Note to fill this gap.

Air Leakage, Sentence 5.4.1.2.(1)

ASTM E 2178, "Standard Test Method for Air Permeance of Building Materials," was added to Sentence 5.4.1.2.(1) as a testing standard for air barrier materials because the previous editions of the NBC did not provide such information.

Combustible Construction, Notes A-5.1.4.1.(6)(b) and (c), A-5.1.4.2. and A-5.6.2.1.

There was no change to the building envelope requirements applicable to the 6-storey combustible construction buildings, since Part 5 is mostly made of performance-based criteria rather than prescriptive requirements. However, several explanatory Notes were amended to draw attention to specific issues for designers and engineers including clarification related to:

- more robust drained and vented wall assemblies (similar to assemblies used in high-rise buildings),
- effects of inter-storey drift on assemblies,
- wood shrinkage,
- design of anchor points for maintenance personnel, and
- consideration of roof venting capabilities given fire blocking requirements.

In short, higher building means more exposure to elements and higher loads. For example, at high heights, wind loads act to pull the exterior wall away from the building like a suction cup. Standard metal ties permitted for 4-storey combustible buildings create a weak point and can easily be broken when subjected to the new loads. Strapping may be required to more evenly distribute the loads.

To the same extent, since the wind load is higher for a 6-storey building, windows commonly used for 4-storey buildings cannot be used in 6-storey combustible construction buildings.

Compliance with Applicable Standards, Table 5.9.1.1.

Table 5.9.1.1 includes applicable standards that materials and components, and their installation, need to meet. The changes to the Table are as follows:

Replacements

The following standards were replaced mainly because the industries have been adhering to new standards for many years. The following is the list of replacements:

- ANSI/HPVA HP-1, "American National Standard for Hardwood and Decorative Plywood," replaces CSA O115-M, "Hardwood and Decorative Plywood,"
- ASTM C 840, " Standard Specification for Application and Finishing of Gypsum Board," replaces CSA A82.31-M, "Gypsum Board Application," and
- CAN/CSA A82, "Fired Masonry Brick Made from Clay or Shale," replaces CAN/CSA A82.1-M, "Burned Clay Brick (Solid Masonry Units made from Clay or Shale)," and CAN3-A82.8, "Hollow Clay Brick."

Deletions

Several standards were deleted for one or more of the following reasons:

- they were outdated,
- the materials addressed were not manufactured/used in Canada,
- the information was covered by another referenced standard, or
- they were not relevant to Part 5.

The following includes the list of deletions:

- CSA A82.30-M, "Interior Furring, Lathing, and Gypsum Plastering,"
- ANSI A208.1, "Particleboard,"
- AWPA M4, "Standard for the Care of Preservative-Treated Wood Products,"
- CAN/CSA A82.27, "Gypsum Board,"
- CAN/CGSB 34.22, "Asbestos-Cement Drain Pipe,"
- CSA A82.4-M, "Structural Clay Load-Bearing Wall Tile,"
- CSA A82.5-M, "Structural Clay Non-Load-Bearing Tile," and
- CSA/CAN3-A165.4-M, "Autoclaved Cellular Units."

Additions

The following standards were added mainly because the materials addressed have been used in practice for many years but no direct means of compliance were provided in the Code. The following is the list of additions:

- ASTM C 1658, "Standard Specification for Glass Mat Gypsum Panels,"
- CAN/ULC-S710.1, "Standard for Thermal Insulation – Bead-Applied One Component Polyurethane Air Sealant Foam, Part 1: Material Specification" and CAN/ULC-S711.1, "Standard for Thermal Insulation – Bead-Applied Two Component Polyurethane Air Sealant Foam, Part 1: Material Specification," and
- ASTM C 726, "Standard Specification for Mineral Wool Roof Insulation Board."

National Building Code

Part 6 – Heating, Ventilating and Air-conditioning

Outline

This material highlights changes to Part 6 of the National Building Code and covers the following topics:

- Reorganization
- Outdoor Design Conditions
- Separation Distances
- Indoor Air Contaminants
- Evaporative Equipment
- Drain Pans
- Other Changes

REORGANIZATION OF PART 6

The provisions in Part 6 of the previous edition of the National Building Code (NBC) were reorganized as a result of difficulties in determining where to insert new Code requirements. Most of the material was loaded into one Section (6.2.) with little sub-division. Part 6 was cumbersome to use and lacked an organized flow.

The reorganization of Part 6 resulted in a logical sequence of requirements that are divided into smaller pieces and separated according to major mechanical elements. To facilitate access to information, general provisions are now grouped at the front end, followed by system-specific provisions.

Although this will present a minor inconvenience to memory attentive Code users, the reorganized Part 6 will allow for a more intuitive use of the Part in the future.

Part 6
Heating, Ventilating and Air-conditioning
6.1. General
6.2. Planning
6.3. Ventilation Systems
6.4. Heating systems
6.5. Thermal Insulation Systems
6.6. Refrigeration and Cooling Systems
6.7. Piping Systems
6.8. Equipment Access
6.9. Fire Safety Systems
6.10. Objectives and Functional Statements
Notes to Part 6

Figure 1: Index of the reorganized Part 6

OUTDOOR DESIGN CONDITIONS, SENTENCES 6.2.1.2.(2), 6.2.1.2.(3) AND 6.3.2.14.(2)

We don't live in a bubble so we can't assume that the outdoor air is "fresh" or "clean." What kind of outdoor air are we using to ventilate our indoor environments? These concerns are why measures to reduce the levels of the air contaminants of concern present in the outdoor air used for ventilation purposes were introduced in the previous edition of NBC published in 2010.

In the 2015 NBC, source data for outdoor air quality of the geographic area of the building site were updated to reflect new maximum acceptable levels for ground level ozone and particulate matter. The geographic areas are the "big bubbles" identified by Environment Canada in conjunction with the provinces and territories.

Requirements were added to assess the outdoor air quality conditions of the local area of the building site (the "little bubble" shown in Figure 2). These provisions are based on common sense. The local area of the building site, including its immediate surroundings, should be investigated to identify contaminants that may be of concern if allowed to enter the building. Sources of contaminants could include dumpsters, incinerators, loading docks, manufacturing plants, etc.

Requirements to include devices that reduce the concentrations of contaminants before their entry into the building were also added. The overall goal is to prevent the accumulation of contaminants of concern in excessive concentrations which could be introduced to indoor occupied spaces.

Figure 2: Local area of the building site

SEPARATION DISTANCES, ARTICLES 6.3.2.9. AND 6.3.3.1.

Part 6 goes even further by identifying typical site-specific sources of outdoor air contaminants and provides explicit requirements to address these. For instance, minimum distances of outdoor air intakes from sources of contaminants are specified to prevent their entry inside indoor occupied spaces. Sources of contaminants could include thoroughfares, sanitary vents and discharge from cooling towers.

Furthermore, vented products of combustion are to be discharged away from the building at specified minimum distances from certain outdoor occupiable spaces and building components such as doors or operable windows. This is to prevent the re-entry of contaminants of concern.

Figure 3: Vented products of combustion

INDOOR AIR CONTAMINANTS, ARTICLE 6.3.1.6.

Legionella is a pathogenic bacteria capable of producing diseases in humans, sometimes fatally. It is but one of many contaminants of concerns that may be unintentionally released into the indoor environments.

Clarity was needed as to what was meant by “air contaminants”. Code users are now directed to the applicable authority having the responsibility of determining the target contaminants of concern, their acceptable concentrations and exposure, as well as the methodology used to determine these values.

Additional information is provided regarding the health concerns with the growth and spread of bio-contaminants. The potential adverse health effects include respiratory allergic reactions, asthma and infectious diseases ranging from influenza to Legionnaires’ disease.

Figure 4: Legionella, one of the indoor air contaminants of concern

EVAPORATIVE EQUIPMENT, ARTICLES 6.3.2.15. AND 6.3.2.16.

We are all aware of the recent Legionnaires’ disease outbreaks in both the U.S. and Canada which resulted in numerous deaths. The cause of the illnesses was as a result of exposure to airborne transmission of Legionella containing aerosols generated by building systems.

To prevent the growth and spread of biological contaminants such as Legionella, design applications for evaporative equipment were clarified and expanded to address the health risks. For instance, the distance between the air intakes of cooling towers in relation to sources of organic matter, which

may serve as a nutrient source for bacterial growth, are specified. Also, products of cooling tower blow-downs are to be connected to the building's drainage system.

The key to minimizing the growth of biological contaminants is regular maintenance and testing. In order to ensure that these important activities are safely performed, access ports, service platforms, fixed ladders and restraint connections must be installed.

Figure 5: Safe access to cooling tower

DRAIN PANS, ARTICLE 6.3.2.2.

Condensate from dehumidifying cooling coil assemblies and condensate-producing heat exchangers can produce mold. This bio-contaminant could be dissipated into airstreams and contaminate the indoor air.

A requirement was added for the proper installation of an adequate drain pan where condensate may be present. This ensures the proper disposal of the condensate which reduces the potential for mold growth that could be entrained into the airstream and cause adverse health effects on the occupants.

Figure 6: Contaminated drain pan condensate

OTHER CHANGES

A number of other less impactful changes were made.

Storage Garages, Note A-6.3.1.4.(1)

There was confusion on the application of "storage garages" and the nature of the activities within. The intent was to provide ventilation for running engines' exhaust. However, where motor vehicles are parked for an extended period without their engines running, this additional ventilation is not required. To remove the ambiguity, explanatory information was added to clarify that the requirements for "storage garages" do not apply to car dealership showrooms, for example.

Figure 7: Running engine's exhaust

Commercial Cooking Equipment, Article 6.3.1.7.

The referenced standard NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," exceeds the related requirements of the NBC for the fire-resistance rating of enclosures of vertical service spaces. To remove the conflicting requirements, changes were introduced in the NBC to harmonize the application for the fire-resistance rating of fire separations enclosing grease ducts for commercial cooking operations with other standards used in North America.

Figure 8: Commercial cooking operation

Laundry-drying Equipment, Note A-6.3.2.10. (7) and (8)

Laundry drying appliances have been shown to be a major cause of fires in buildings. This is as a result of the build-up of lint in the exhaust ducts. Explanatory information was added to remind Code users that the venting of clothes dryers forms part of the ventilation system and that regular maintenance is required. Lint traps should be readily accessible for servicing to reduce the risk of fire associated with the build-up of lint and inadequate venting.

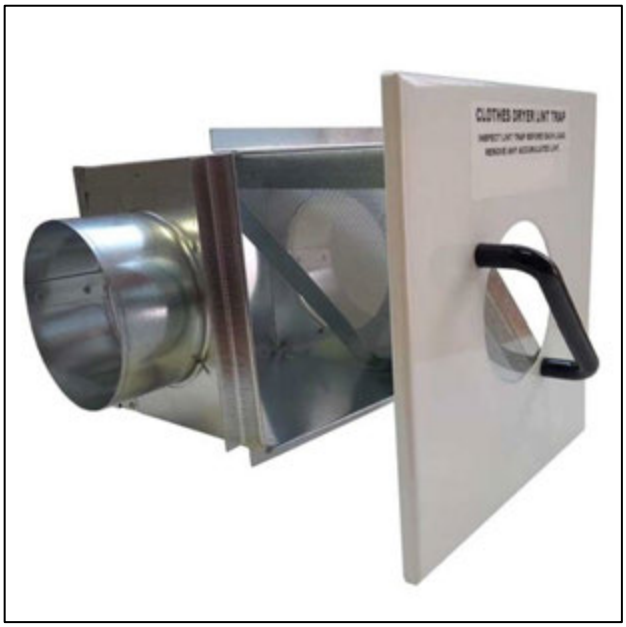


Figure 9: Lint trap in clothes dryer duct

Duct Coverings and Linings, Note A-6.3.2.5.

The NBC did not refer to a document that addresses the design and installation of thermal insulation. A best practices guide was therefore included in the Notes to address this void. Although considered a valuable resource, the document is not consensus based and refers to specific manufacturers and products by name, which is not appropriate for Code documents.

Explanatory information qualifies the reference. As a result, with all explanatory Notes, this document is not enforceable.

Figure 10: Insulated ducting

National Building Code

Part 9 – Housing and Small Buildings

Outline

This material highlights changes to Part 9 of the National Building Code and covers the following topics:

- Airborne Sound Transmission
- Roofing, Dampproofing and Waterproofing Standards
- Exterior Insulation Finish Systems
- Stairs, Ramps, Handrails and Guards
- Low Permeance Materials
- Lateral Loads (Seismic)
- Snow Loads
- Protection Near Cooktops
- Masonry Terminology
- Fire Alarm Systems
- Security Systems that Affect Egress
- Exit Signs and Markings
- Dryer Vents
- Protection of Foamed Plastics
- Penetrations Through Fire Separations
- Fire Stop Flaps
- Soft Conversion
- Structural Design of Glass
- Spatial Separations
- Fire Resistance and Sound Transmission Class Ratings
- Main Entrance Doors
- Garage and Carport Foundation Drainage
- Energy Efficiency Consistency with the National Energy Code for Buildings (NECB)
- Referenced Standards Updates

AIRBORNE SOUND TRANSMISSION, SECTION 9.11.

The requirements for airborne sound transmission in the National Building Code (NBC) were introduced in 1995. They were based on the best available information at that time and focused on the sound transmission class rating (STC) of the separating wall or floor when tested in a laboratory, rather than the performance of the wall and floor system. Advances in the field of acoustical research showed that this concept fell short of achieving the intended level of performance. They were also inconsistent with the NBC Objective of Noise Protection (OH3), which addresses the protection of occupants from noise.

The previous requirements rated only the sound going directly through the separating wall or floor in a laboratory setting (Figure 1) rather than the sound that the occupant actually hears.

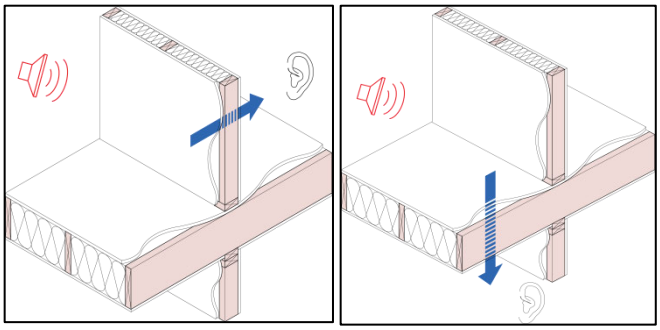


Figure 1: Sound going through separating wall/floor (STC)

The revised provisions specifically address the transmission of airborne noise through all available pathways (Figure 2). This includes the direct path through the separating wall or floor but also includes the so called “flanking” paths of walls, floors and ceilings that run alongside the separating wall or floor. The resulting measurement that takes into account all sound transmitted is called the apparent sound transmission class (ASTC) rating. Using the ASTC rating brings the Code requirements closer to the intended performance expectation of the complete wall and floor system of a dwelling unit.

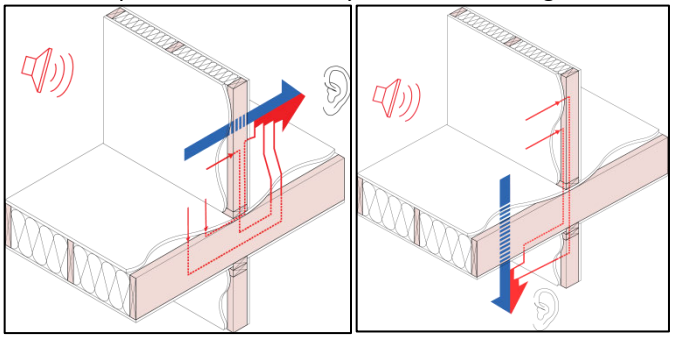


Figure 2: Flanking sound through assembly (ASTC)

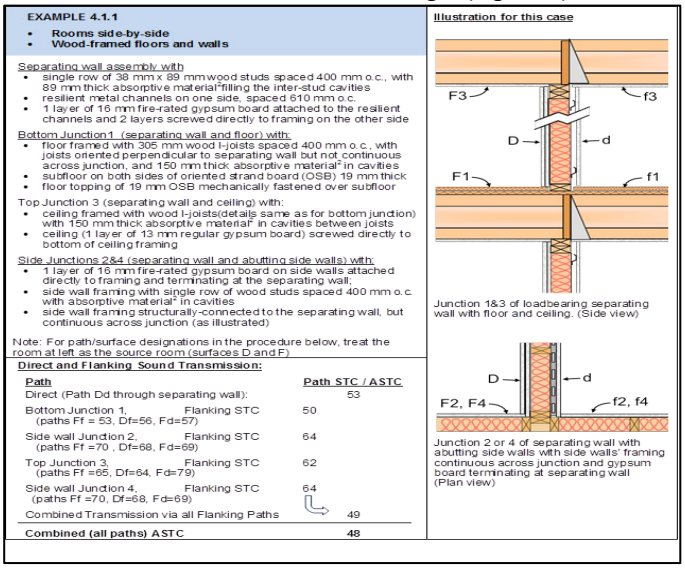
The ASTC is a truer measure of the actual sound level perceived by occupants, as it includes noise transmitted through wall, ceiling and floor junctions (i.e., flanking noise). The ASTC will facilitate design optimization and shift the focus away from the separating assembly, which tends to be overdesigned, to the more critical floor-wall junctions. No change in performance is intended with the 2015 requirements. The design requirement is for an ASTC rating of 47 for the complete system (separating wall/floor and flanking walls/floors). In most cases, this would yield the same performance (from the point of view of the occupant) as if the separating element and each of the surrounding wall, floor and ceiling elements met the 2010 minimum Code requirements of STC 50.

There are two acceptable solutions. Codes users can either provide an ASTC rating directly (through test or calculation) or provide a deemed-to-comply construction. All compliance paths apply to Part 9 and Part 5 buildings.

While measurement methods (for STC ratings) and deemed-to-comply prescriptive solutions (for STC ratings) were already in the 2010 NBC, the design and calculation method is new in the 2015 NBC.

To help with designing and calculating the ASTC, references to ISO 15712-1, "Building Acoustics - Estimation of Acoustic Performance of Buildings From the Performance of Elements - Part 1: Airborne Sound Insulation Between Rooms," are included in Articles 5.8.1.4. and 5.8.1.5., which allow a detailed and a simplified calculation method.

Technical concepts, terminology, and calculation procedures relating to the detailed and simplified ASTC calculation methods in the standard are discussed in detail, with numerous worked examples, in the NRC publication entitled "Guide to Calculating Airborne Sound Transmission in Buildings" (Figure 3).



EXAMPLE 4.1.1

- **Rooms side-by-side**
- **Wood-framed floors and walls**

Separating wall assembly with
- single row of 38 mm x 89 mm wood studs spaced 400 mm o.c., with 89 mm thick absorptive material[a] filling the inter-stud cavities
- resilient metal channels on one side, spaced 610 mm o.c.
- 1 layer of 16 mm fire-rated gypsum board attached to the resilient channels and 2 layers screwed directly to framing on the other side

Bottom Junction 1 (separating wall and floor) with:
- floor framed with 305 mm wood I-joists spaced 400 mm o.c., with joists oriented perpendicular to separating wall but not continuous across junction, and 150 mm thick absorptive material[a] in cavities
- subfloor on both sides of oriented strand board (OSB) 19 mm thick
- floor topping of 19 mm OSB mechanically fastened over subfloor

Top Junction 3 (separating wall and ceiling) with:
- ceiling framed with wood I-joists(details same as for bottom junction) with 150 mm thick absorptive material[a] in cavities between joists
- ceiling (1 layer of 13 mm regular gypsum board) screwed directly to bottom of ceiling framing

Side Junctions 2&4 (separating wall and abutting side walls) with:
- 1 layer of 16 mm fire-rated gypsum board on side walls attached directly to framing and terminating at the separating wall;
- side wall framing with single row of wood studs spaced 400 mm o.c. with absorptive material[a] in cavities
- side wall framing structurally-connected to the separating wall, but continuous across junction (as illustrated)

Note: For path/surface designations in the procedure below, treat the room at left as the source room (surfaces D and F)

Direct and Flanking Sound Transmission:

Path		Path STC / ASTC
Direct (Path Dd through separating wall):		53
Bottom Junction 1, (paths Ff = 53, Df=56, Fd=57)	Flanking STC	50
Side wall Junction 2, (paths Ff =70 , Df=68, Fd=69)	Flanking STC	64
Top Junction 3, (paths Ff =65, Df=64, Fd=79)	Flanking STC	62
Side wall Junction 4, (paths Ff =70, Df=68, Fd=69)	Flanking STC	64
Combined Transmission via all Flanking Paths		49
Combined (all paths) ASTC		**48**

Illustration for this case

Junction 1&3 of loadbearing separating wall with floor and ceiling. (Side view)

Junction 2 or 4 of separating wall with abutting side walls with side walls' framing continuous across junction and gypsum board terminating at separating wall (Plan view)

Figure 3: Example in NRC Guide

NRC also publishes an online tool developed by the NRC acoustics group called "soundPATHS" which allows the Code user to apply certain changes to the design and see the resulting impact on the ASTC rating (Figure 4).

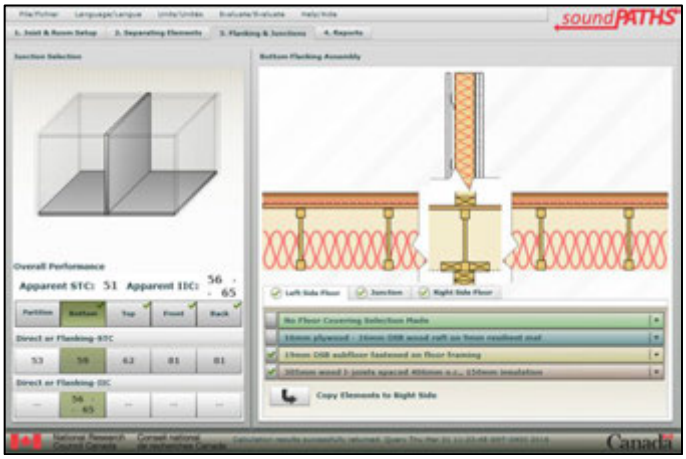


Figure 4: Screen shot of soundPATHS program

The tool calculates the ASTC rating according to the design method in the 2015 NBC and may identify areas of overdesign and the potential for cost savings. The tool currently applies only to wood-frame construction, but there are plans to include other types of construction at a later time.

ROOFING, DAMPPROOFING AND WATERPROOFING STANDARDS, SUBSECTIONS 9.13.2., 9.13.3. AND 9.26.2.

Many of the standards referenced for roofing, dampproofing and waterproofing materials and their respective application standards were withdrawn by the CGSB. Even those CGSB standards that were not withdrawn were outdated and sometimes obsolete. In general, withdrawn standards are not a problem in the Code if they still satisfy the intent of the Code provisions. One issue with these old standards is that there may be an increased liability for contractors and designers who use materials that are tested to up-to-date standards, but which are not listed in the Code. This also creates problems with enforcement when trying to figure out if a particular material complies with the Code requirements.

Figure 5: Foundation dampproofing

To resolve the problem with the outdated material standards, outdated standards were replaced with new up-to-date ASTM standards. In cases where no acceptable replacement standards existed, the old CGSB standards are still referenced. Obsolete standards (for materials that are no longer used in the industry) were removed.

Most outdated installation standards were deleted and some have been replaced with key prescriptive Code requirements. Enforcement will benefit from up-to-date standards. Similar changes were also made to Part 5 of the 2015 NBC.

EXTERIOR INSULATION FINISH SYSTEMS (EIFS), SUBSECTION 9.27.13.

Part 9 of the 2010 NBC did not have prescriptive requirements for exterior insulation finish systems (EIFS). The only compliance route for EIFS as a cladding system was through building envelope design conforming to Part 5. However, designers often encountered the problem that performance limits for EIFS described in practice guides and industry documents were not clear.

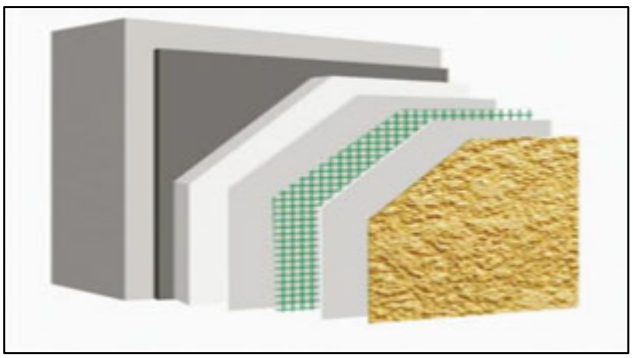


Figure 6: EIFS example

New requirements were added to Section 9.27, "Cladding," to include EIFS as an acceptable cladding system.

An entirely new Subsection 9.27.13. on EIFS contains general requirements for EIFS and references to three ULC standards:

- ULC S716.1,"Standard for Exterior Insulation and Finish Systems (EIFS) – Materials and Systems,"
- ULC S716.2,"Standard for Exterior Insulation and Finish Systems (EIFS) – Installation of EIFS Components & Water Resistive Barrier," and
- ULC S716.3,"Standard for Exterior Insulation and Finish Systems (EIFS) – Design Applications."

Additional conditions were introduced to permit EIFS with "rainscreen" design to be deemed to comply with the cladding requirements for high-moisture regions. The rainscreen design calls for a geometrically defined drainage cavity with a minimum depth of 6 mm and an open area of not less than 13% of the full area of the EIFS panel (Figures 7a and 7b). This ensures that an adequate drainage area is provided on every board that does not rely on the installation process.

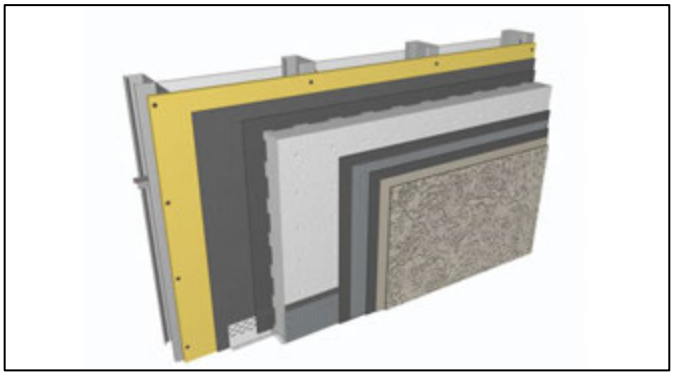


Figure 7a: EIFS with geometrically defined drainage cavity

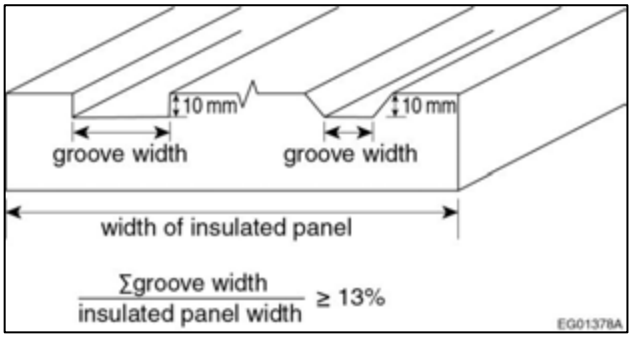


Figure 7b: Dimension of insulation drainage cavity

The section of the handbook on Part 5 describes the differences in how the ULC standards have been referenced and how EIFS design is regulated for large buildings.

STAIRS, RAMPS, HANDRAILS AND GUARDS, SECTION 9.8.

Stairs, ramps, handrails and guards are important features that increase the safety when occupants move within buildings. The new provisions in the 2015 NBC provide clarification, enhance occupant safety and offer some flexibility for the industry.

Definitions, Division A, Article 1.4.1.2.

Following requests for clarification, three new defined terms relating to stairs and ramps have been added to the 2015 NBC.

Flight

For manufacturers of prefabricated stairs, a flight is the floor-to-floor stair while for architects a flight is the set of steps between landings. This difference created confusion and difficulties in applying Code requirements. By way of the new defined term, the term “flight” in the NBC now means a series of steps between landings. This will help ensure that the requirements on stairs are uniformly applied by Code users.

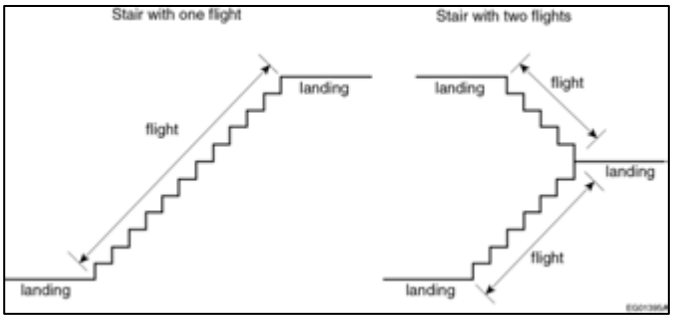


Figure 8: Description of flight

Run

Regulators, builders and designers were confused about the meaning and the difference of the terms “run” and “tread depth” due partly to the terminology used in the U.S. Codes, where the term “tread depth” is used instead of the correct term “run.”

The 2015 NBC now defines the term “run” to mean the horizontal distance between two adjacent tread nosings. This will facilitate the proper interpretation and implementation of the Code requirements.

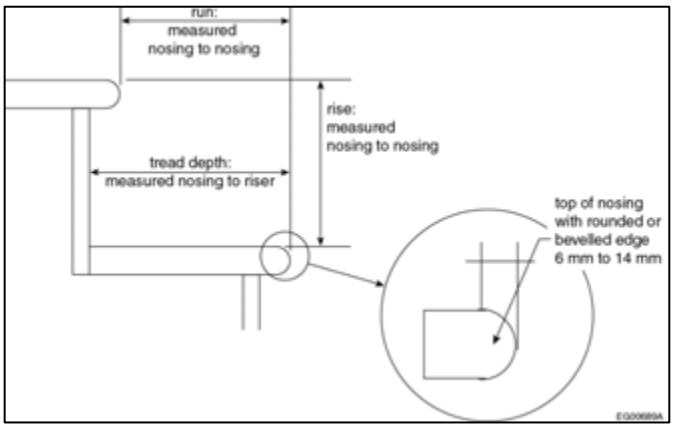


Figure 9: Description of run

Tapered Treads

Previous NBC editions had multiple terms to designate non rectangular treads, which were ambiguous, confusing and not aligned with the current practice in other international Codes. Part 3 referred to “tapered treads,” while the term “angled treads” was used in Part 9 to designate steps in curved stairs. Part 9 also used the term “winder” to designate treads that converge to a point, which were only allowed inside dwelling units under certain conditions.

The term “tapered tread” is now a defined term to unify the meaning in the 2015 NBC and facilitate a proper interpretation and enforcement. The traditional term “winder” was however kept and still refers to specific treads that converge to a point inside dwelling units.

Curved Flights

Curved flights are impressive architectural features often found in lobbies. The 2015 NBC contains new design requirements to enhance user safety on curved stairs.

Curved Flights and Tapered Tread Dimensions, Articles 9.8.3.1. and 9.8.4.3.

While the required run dimension of rectangular treads of public stairs was increased many years ago, the dimension of tapered treads in stairs that provide access to exits was still based on previous values. There were also no provisions requiring uniformity among tapered treads in a curved flight.

The NBC now uses the proper terminology for curved flights and tapered treads uniformly. The method for measuring the dimension of tapered treads was revised to ensure that run dimension at the expected walking line – 300 mm from the centre line of the inner handrail – will provide sufficient foot space (at least 280 mm for public stairs and 255 mm for private stairs) and uniformity among treads.

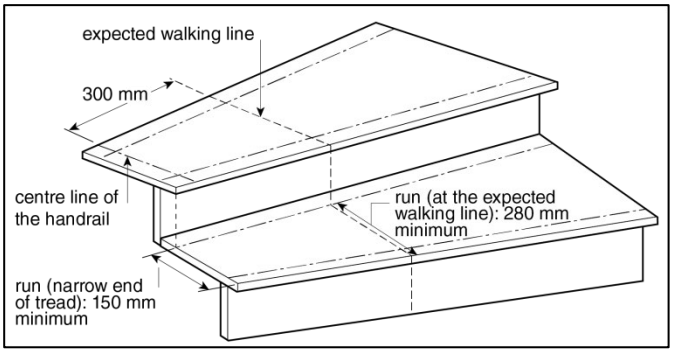


Figure 10: Tapered tread dimensions

Handrails, Subsection 9.8.7.

Handrails are important because they help prevent falls no matter how the fall was caused. They are helpful to all users of the stairs by providing support and stability. This applies to using ramps and stairs.

Graspability of Handrails, Article 9.8.7.5.

Sharp or abrasive elements near handrails may harm users. Individuals who depend on using handrails would likely apply a larger force or grasp the handrail more fully when negotiating stairs or ramps.

A change to Sentence 9.8.7.5.(1) increases the clearance between a handrail and a rough or abrasive surface to 60 mm.

In residential applications, handrails often have a more complex cross-section, where only a portion is graspable. The explanatory Note to Sentence 9.8.7.5.(2) provides guidance on providing recesses wide and deep enough – on both sides – to accommodate a person's fingers and thumb, where the configuration or dimensions of the handrails would not allow a person's fingers and thumb to reach the bottom of the handrail.

Continuity of Handrails, Article 9.8.7.2.

The provisions in the previous edition of the NBC regarding continuity of handrails did not reflect the intent stated in the Appendix Note. In some cases, the requirement limited design flexibility and was confusing. In other cases, the requirement allowed situations that contradicted Code intent.

The new wording in the 2015 NBC states that handrails shall be provided for the full length of the stair flight, from the bottom to the top riser, complying with the intent stated in explanatory Note A-9.8.7.2. and other international regulations. In dwelling units, the handrails may be interrupted at landings by newel posts or volutes on the bottom tread. No interruption is allowed for stairs with winders.

In the revised Article 9.8.7.2., Sentence 9.8.7.2.(1) states the general requirement for the continuity of handrails, Sentence 9.8.7.2.(2) states the condition where the continuity of at least one handrail should include landings and Sentence 9.8.7.2.(3) provides an exception for stairs serving dwelling units. This wording reflects current practice regarding the installation of handrail support in dwelling units.

Height of Handrails, Article 9.8.7.4.

The requirements in the 2010 NBC limited handrail height to 965 mm. However, studies have shown that higher handrails perform as well as lower handrails. Handrails installed at a height of up to 1 070 mm are now permitted. This change:

- offers more flexibility in design,
- permits that handrails be located at the top of guards up to 1 070 mm, and
- harmonizes the requirement of handrail height on stair flight and landing, which allows a smoother handrail transition between stairs and landings.

This change also applies to ramps except for those located in the accessible path of travel.

Reachability of Handrails, Sentence 9.8.7.1.(2)

The previous rule was asking for intermediate handrails in wide stairs where the width was exceeding 2 200 mm. The reachability of a handrail based on an ergonomic analysis and field observations indicated that the maximum distance to a handrail should not exceed 750 mm.

The 2015 NBC clarifies that handrails shall be located along the most direct path of travel, where a stair or ramp is wider than its required exit width.

Guards, Subsection 9.8.8.

The NBC defines guards as protective barriers around openings in floors or at the open sides of stairs, landings, balconies, mezzanines, galleries, raised walkways or other locations to prevent accidental falls from one level to another. The 2015 NBC includes many changes on guards to clarify and harmonize where they are required, and how to design them.

Required Guards, Sentence 9.8.8.1.(1)

The previous edition of the NBC required the installation of guards based on the elevation of the walking surface. However, this height varied from one provision to another for no apparent reason.

The 2015 NBC uses a walking surface elevation of 600 mm as a unique criterion to determine where a guard is required.

Vehicle Guards in Garages, Article 9.8.8.4.

The NBC requires a curb at the perimeter of floors and ramps that have no exterior walls. The minimum height of this curb was reduced from 150 to 140 mm, to avoid potential conflict with the requirement addressing climbability of guards (NBC Sentence 9.8.8.6.(1)).

Openings in Guards, Article 9.8.8.5.

The size of openings through guards in industrial occupancies was too restrictive. Larger openings are allowed by some Canadian regulations and international codes and standards. The NBC now allows openings of up to 535 mm in guards located in industrial occupancies other than storage garages. In these buildings, where unsupervised young children are not expected, the new opening size allowed does not represent an additional risk for the occupants. Furthermore, this change harmonizes the NBC provisions with other international and occupational health and safety codes and standards widely used around the world.

Figure 11: Industrial guards

The wording “unless it can be shown that the size of the openings that exceed this limit does not present a hazard” was deleted because the objective-based code approach already allows for alternative solutions to any provision (NBC 2010, Division A, Clause 1.2.1.1.(1)(b)). The current wording was therefore considered redundant.

Loads on Guards, Article 9.8.8.2.

In the 2010 NBC, Part 4 specified that the concentrated load on guard elements serving public stairs had to be applied outward over an area of 100 mm by 100 mm whereas Table 9.8.8.2. of Part 9 was silent about where to apply the load. This resulted in guard elements in Part 9 buildings being subjected to a more stringent load than those in Part 3 buildings.

The change to the third column of Table 9.8.8.2. resolves the difference between Part 4 and Part 9 and provides a minimum surface on which the concentrate load would apply.

Design to Limit Climbing of Guards, Sentence 9.8.8.6.(1)

The NBC restricted the design of guards that may facilitate climbing. The introduction of the requirement in 1975 and the amendments that followed expanded the requirement to more locations. This expansion was not supported by evidence, but had a great impact on the ornamental railing industry resulting in limiting guard design choices available to consumers with no apparent benefit.

The review of U.S. and Australian regulations indicated that the Canadian market was the most restrictive on this issue. Also, the review of research and statistics related to incidents around the climbing of guards did not permit the establishment of the relationship between the ornamental design and children falling. Therefore, the NBC was amended to require that the design of guards does not facilitate climbing in locations where the elevation difference is more than 4.2 m, which represents the floor-to-floor elevation of typical high-end Canadian homes.

Landing Dimensions, Article 9.8.6.3.

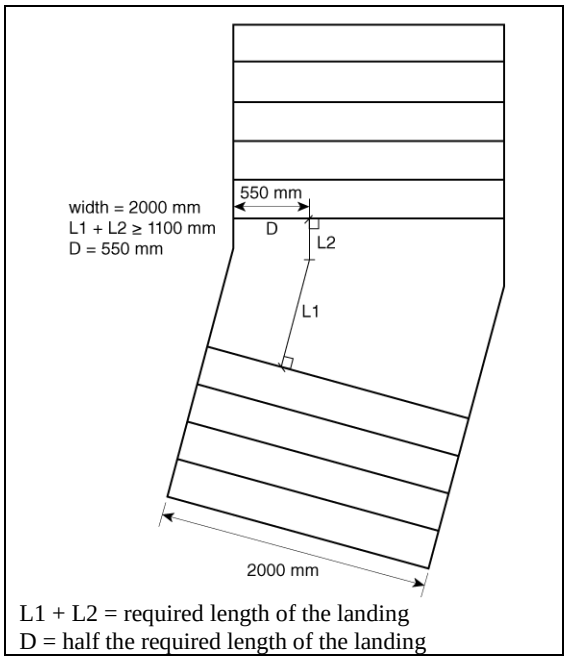
There was no technical basis for the provisions that relate to the dimensions of landings in Parts 3 and 9 of the NBC and there was no justification for the discrepancy between Part 3 and Part 9 requirements.

Part 9 regulates landings dimensions based on their turning angles and allows some flexibility, for the reason of reducing the foot print of a stair, for landings inside dwelling units.

When the landing turns less than 90 degrees, Part 9 of the 2010 NBC required that the length of the landing match the width of a stair, which imposed unnecessarily big landing dimensions for wide stairs.

The change in the 2015 NBC establishes that, except where the landing is turning 90 degrees or more, the length of the landing need not be more than the lesser of the required width of stair,

or 1 100 mm. This length should be measured in accordance with Figure 12. Additional information is also provided in explanatory Note A-3.4.6.4.



L1 + L2 = required length of the landing
D = half the required length of the landing

Figure 12: Landing dimensions

The new dimensions for a turning landing will not consume floor space and be expensive to build.

Spiral Stairs, Articles 9.8.3.1. and 9.8.4.7.

Spiral stairs that converge at the inside of the turn at a supporting column were not permitted in the NBC. The User's Guide – NBC 1995, Housing and Small Buildings (Part 9) states that spiral stairs that converge to a very small run (or a zero run) at the centre support are unsafe because they can have a near vertical drop from floor level to floor level.

In recent years, spiral stairs have gained in popularity. They can be attractive features and may be used where little space is available.

The review of national and international regulations (British Columbia, Quebec, Australia, U.S. and U.K.) showed that the majority of long established codes and regulations have requirements for the construction of spiral stairs without any known problems. The review also indicated that the NBC restriction was based on perception rather than on evidence.

A new provision allowing the use of spiral stairs in dwelling units and in Part 9 buildings under certain conditions was introduced in the 2015 NBC.

Sentence 9.8.4.7.(1) provides construction specifications and Sentence 9.8.4.7.(3) ensures that spiral stairs would not be installed as an exit stair.

The construction's parameters are mainly based on NFPA's 101 Safety Code. Spiral stairs are allowed:

- as a secondary stair in dwelling units,
- as a means of egress where they serve not more than 3 persons in dwelling units and other Part 9 buildings. For example in:
  - 1 bedroom in a loft,
  - a 25 m^2 mezzanine (270 square feet) in an office, or
  - a 10 m^2 mezzanine (100 square feet) in a mercantile occupancy.

Spiral stairs are not allowed in exits.

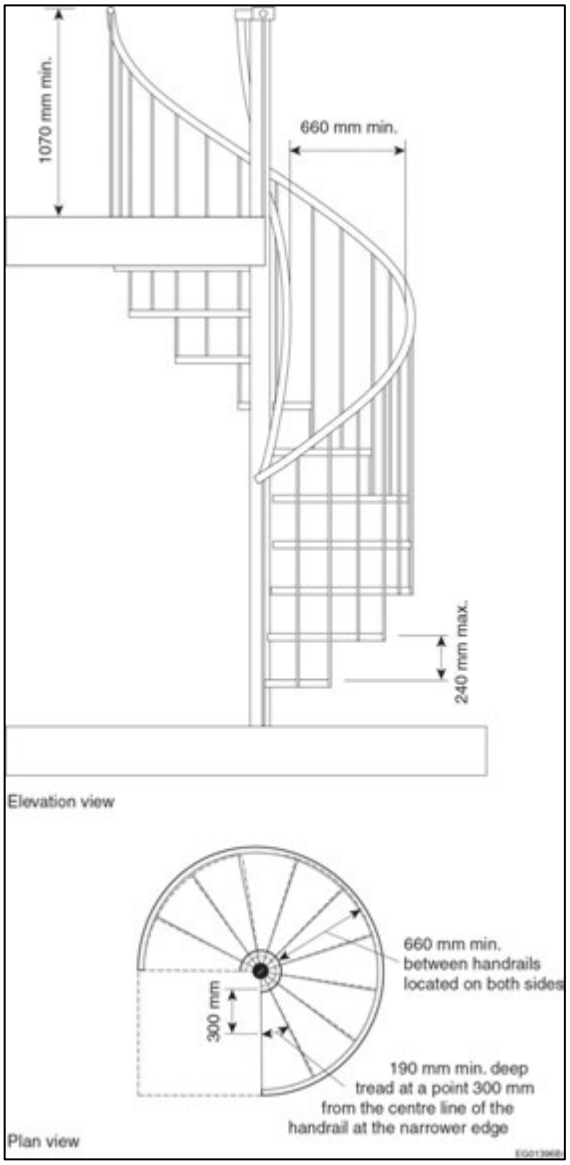


Figure 13: Elevation and plan view of spiral stairs

Mixed-run Flight in Dwelling Units, Articles 9.8.3.1., 9.8.4.5. and 9.8.7.1.

Stair flights where both tapered and rectangular treads can be used are not permitted in the NBC. In dwelling units, only one set of traditional winders as described in Article 9.8.4.6. is allowed between two floor levels.

A new provision allowing the use of stair flights where both tapered and rectangular treads can be used in dwelling units was introduced in the 2015 NBC.

Sentence 9.8.4.5.(1) sets general requirement for tapered treads and rectangular treads within one flight. For safely and usability reason, a consistent run dimension should be maintained, throughout the flight, along what is called the travel line generally located at 300 mm away from the center line of the inside handrail at the narrow end of the tread.

The measurement is taken to the center line of the handrails because handrails are stair features that dictate the users' location in the curved flight.

Sentence 9.8.4.5.(2) allows some flexibility in mixed-run flights if certain conditions are met. It explains that where tapered treads are located at the bottom of the flight, consistent run between the tapered and the rectangular treads is not required provided that the run of the tapered treads is equal or larger than the run of the rectangular treads above.

The rule is that one should not travel from larger treads to narrower ones, in the descending motion, as this, according to research, could lead to misstep and falls in stairs.

Figure 14 shows examples of stairs' configurations that would be permitted or not permitted following the rules explained above.

For safety reasons, where a flight of stairs consists of tapered treads, or a mix of tapered treads and rectangular treads, new Sentence 9.8.7.2.(5) requires that one handrail be installed along the narrow end of the treads.

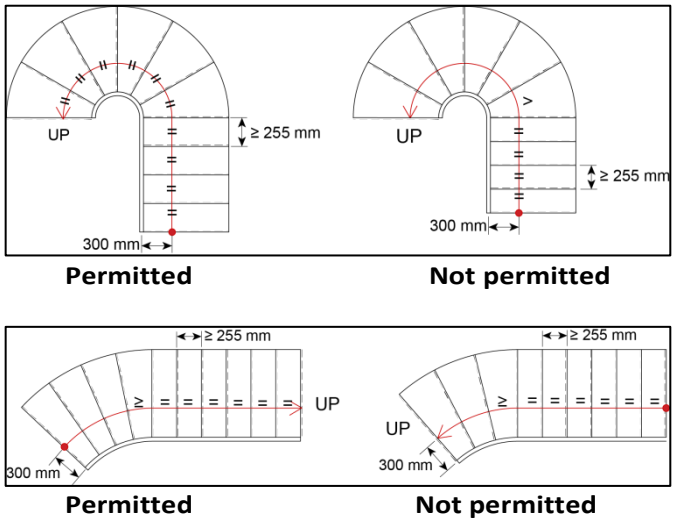


Figure 14: Examples of stairs' configurations

Ramp Width, Article 9.8.5.2.

The 2010 NBC Part 9 specified minimum ramp width in terms of "clear width." Referring to clear width is not technically valid because the term "clear width" is only justified when the objective of accessibility is identified.

Furthermore, the reference to "exit ramps and public ramps" was confusing for the Code users and added no value to the requirement which in fact stated a general requirement for the width of ramps regardless of whether or not it is an exit or a public ramp.

The change in the 2015 NBC states a minimum ramp width of 1 100 mm for "all ramps" serving other than dwelling units or houses with a secondary suite regardless of the occupancy of the building and whether it is an exit, a public, an interior or an exterior ramp.

Sentence 9.8.5.2.(3) was deleted as the factor of 8 mm/person used to determine the minimum clear width of ramps did not apply to ramps but to stairs.

LOW PERMEANCE MATERIALS, ARTICLE 9.25.5.1.

The building envelope system (walls, roofs, windows and floors) is designed to keep the heat in the building. At the same time, the moisture created in the building and carried by the warm air should not be trapped within the wall, roof or floor assemblies. The NBC therefore regulates the water vapour permeance of building envelope materials to minimize the risk of condensation inside the assembly.

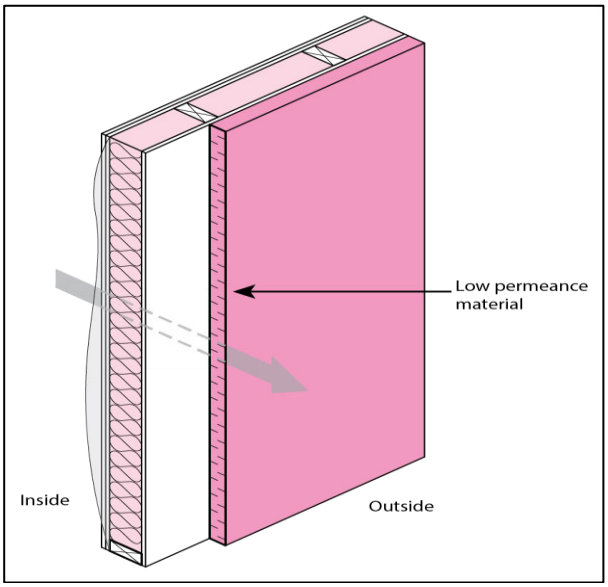


Figure 15: Assembly with low permeance material

This is why an assembly may have to meet a minimum ratio of outboard to inboard thermal resistance values if a material with low air and vapour permeance is part of the assembly.

Recent research questioned the criterion used in the Code that determines whether additional thermal requirements apply or not. The criterion that would trigger the additional requirements is a water vapour permeance of less than 60 ng/(Pa·s·m^2) while building envelopes with materials that have a water vapour permeance equal or greater than 60 ng/(Pa·s·m^2) would not need to add additional insulation to the exterior.

NRC carried out modeling for several assemblies and configurations of insulating sheathing materials. The modeling showed that the effect of moisture within wall assemblies with insulating sheathing products was minimal.

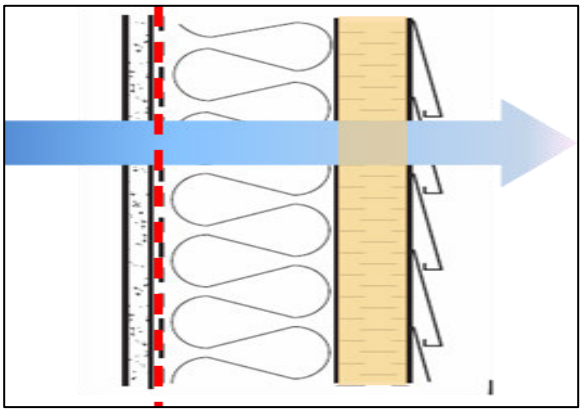


Figure 16: Path of moisture travel

A change was introduced in Article 9.25.5.1. to permit insulating sheathing materials with a water vapour permeance between 30 and 60 ng/(Pa·s·m^2) and a thermal resistance of at least 0.7 m^{2}K/W (R4) in locations with a heating degree-day of less than 6000. Assemblies meeting these criteria are now exempted from having to meet the more stringent outboard/inboard insulation requirements.

LATERAL LOADS (SEISMIC), TABLE C-3 OF APPENDIX C AND SUBSECTION 9.23.13.

Changes were made to the seismicity values assigned for locations in Canada listed in Table C-3 of Appendix C of the 2015 NBC (Figure 17). The impact is that some regions will require more stringent prescriptive solutions than before due to the higher spectral hazard values. The new seismic data change also produced more regions where the spectral hazard of $S_a(0.2)$ is greater than 1.2. These regions would fall outside the limits of the prescriptive solutions in Part 9 and would require design in accordance with Part 4. This would have become a serious issue especially in some more remote areas with difficulties accessing professional engineers.

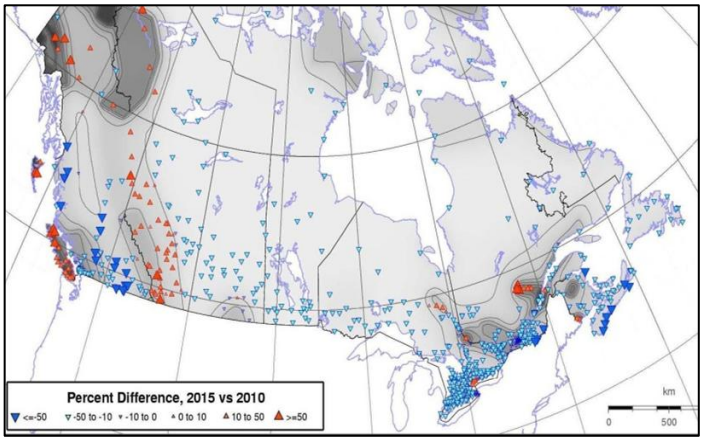


Figure 17: Location of seismicity values

The design changes made to Part 4 of the 2015 NBC result in higher seismic design forces for the same spectral hazard value. The building would therefore be subject to higher forces, and would therefore require a higher level of resistance.

The Part 9 requirements in the 2010 NBC:

- did not address areas where the spectral hazard $S_a(0.2)$ is greater than 1.2,
- required insufficient anchorage of braced wall panels to foundation,
- did not require additional nailing for top plate splices in braced wall panels, and
- did not account for the increased load on the structure predicted by current design methods.

Construction of braced wall bands with a higher level of resistance now requires additional features such as anchor bolts with reduced spacing and nailing of the splices in wall top plates, perpendicular blocking between wall studs and thicker

sheathing (Figure 18).

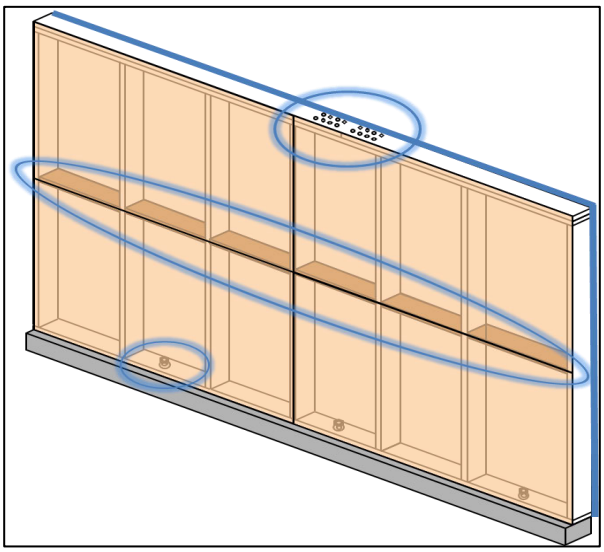


Figure 18: Prescriptive solutions for braced wall bands

The changes add new, more stringent prescriptive solutions in Part 9. This will provide prescriptive requirements for areas where the spectral hazard exceeds $S_a(0.2)$ of 1.2. Where $S_a(0.2)$ is greater than 0.7, additional requirements for anchorage of walls and top plate splicing were introduced to resist higher loads.

SNOW LOADS, TABLE C-2

Table C-2 in the 2015 NBC was updated with new snow loading values for locations across Canada (Figure 19). Several locations saw increases to their snow loading values. However, a review of values and the current design requirements resulted in no changes to the Part 9 design requirements for snow loads. There was no evidence of failures due to snow loads found in buildings built to current requirements that would have justified changing the design requirements.

Figure 19: Map with revised snow load values

PROTECTION NEAR COOKTOPS, ARTICLE 9.10.22.2.

In the 2010 NBC, Article 9.10.22.2. specified a minimum vertical clearance of 750 mm from the cooktop to framing, finishes and cabinetry installed directly above the location of the cooktop (Figure 20). The clearance could be reduced to 600 mm if the framing, finishes and cabinetry were non-combustible, or were protected by a metal range hood projecting at least 125 mm beyond the face of the framing, finishes and cabinets. However, it was unclear if the lesser clearance of 600 mm also applied to the underside of microwave ovens that were installed above the cooktop.

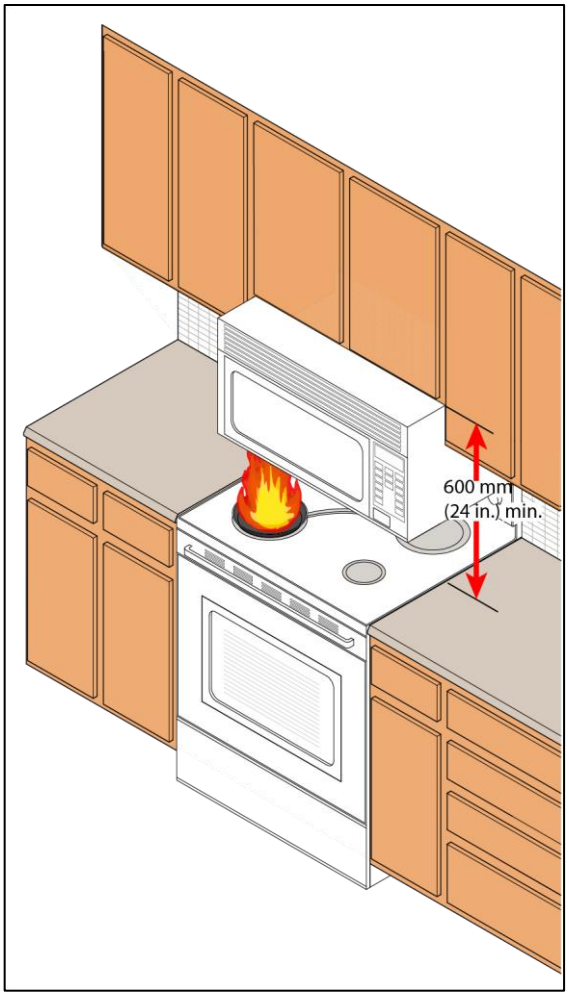


Figure 20: Description of clearances above cooktop

The new explanatory Note A-9.10.22. clarifies that the clearances specified in Article 9.10.22.2. are for the framing, finishes and cabinets only. Microwave ovens are already regulated to address fire safety and, similar to range hoods, do not need to meet the minimum clearances specified in Article 9.10.22.2.

MASONRY TERMINOLOGY, DIVISION A, ARTICLE 1.4.1.2.

Wording in many Sentences throughout the 2010 NBC referred to "solid" masonry units, which traditionally are referred to as units with up to 25% voids (i.e. solid for more than 75% net area). In addition, many provisions only referred to "solid masonry" which does not clearly state whether this refers to "solid masonry units" or "solid masonry construction." The 2010 NBC also did not define what constitutes "solid masonry construction."

Changes in the masonry standards prompted a review of the terminology used in the Code in order to be consistent.

- The new edition of the referenced standard for clay brick replaces the term "solid" with both "solid" and "cored."
- The new edition of the referenced standard for concrete masonry replaces the term "solid" with "fully solid" and "semi solid." In the latest CSA standards, "solid" and "fully solid" units are 100% solid, while "cored" and "semi-solid" units have voids less than 25%.

As all the above mentioned product standards are referenced in Sentence 9.20.2.1.(1), it would not have been clear to Code users to which products the wording applies.

Two new definitions were therefore introduced into the 2015 NBC.

The defined term "solid masonry" is used in Section 9.20. and a few other provisions throughout the NBC. This term now clearly describes methods of constructing masonry and therefore delineates the term "solid masonry" from the term "solid masonry unit." The definition also describes a number of acceptable ways of constructing what can be considered "solid" masonry construction.

The defined term "solid masonry unit" is consistent with the standard referenced in Sentence 9.20.2.1.(1). The definition also explicitly references acceptable product types ("fully solid," "cored" and "semi-solid") for clay brick and concrete masonry.

Without this harmonization, the occurrences of solid masonry or masonry would have been ambiguous within the NBC itself and inconsistent with the terminology used in the referenced product standards.

FIRE ALARM SYSTEMS, ARTICLE 9.10.1.2.

Fire alarm and detection systems play a key safety role in active fire protection. In order to keep the NBC up-to-date with technology and research in this area that progresses at a very rapid pace, new provisions were introduced.

Testing of Integrated Fire Protection and Life Safety Systems, Article 9.10.1.2.

The 2010 edition of the NBC introduced changes to Parts 3 and 9 requiring that fire protection and life safety systems be tested (commissioned) as a whole to ensure the proper operation and interrelationship of these systems (i.e. fire alarm systems, sprinklers, standpipes, smoke control, ventilation, pressurization, door hold-open devices, elevator recalls, smoke and fire shutters and dampers, emergency power, emergency lighting, etc.) but did not provide common bases for testing that would simplify the enforcement. In addition, the term "commissioning" may have been misleading relative to the intent of the NBC and within the commissioning community.

The 2015 NBC now references a new standard for the testing of integrations between two or more fire protection and life safety systems. CAN/ULC-S1001,"Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems," provides the methodology for verifying and documenting that interconnections between building systems satisfy the intent of their design and that the systems function as intended by the Code.

The term "commissioning" was replaced with "integrated systems testing" which removes the confusion between the intent of the Code which is to ensure that integration of systems are properly installed, and the meaning of the term "commissioning" within the commissioning community which is to ensure that systems are installed in accordance with contractual requirements.

Residential Fire Warning Systems, Article 9.10.19.8.

The ULC Committee on Fire Alarm and Life Safety Equipment and Systems developed CAN/ULC-S540, "Standard for Residential Fire and Life Safety Warning Systems: Installation, Inspection, Testing and Maintenance." The systems addressed by this standard were not accepted in the previous edition of the NBC and were installed in addition to systems already required in the Code.

The NBC now recognizes these systems and allows that they be installed in dwelling units of residential occupancy, in lieu of the currently required interconnected smoke alarms. This standard provides the minimum requirements for the design, installation,

inspection, testing and maintenance of residential fire warning systems

The occupants now have the option of installing a residential fire warning system with enhanced features such as the interconnection of heat detectors, carbon monoxide alarms, other life safety devices and remote monitoring capabilities.

Both the new option and the existing interconnected smoke alarms will provide detection and audible signals to alert the occupants of an emergency situation.

SECURITY SYSTEMS THAT AFFECT EGRESS

Location of Exits, Article 9.9.8.4.

In some buildings, exterior doors of stairwells that serve floors exit close to each other. Any incident (fire, bomb threat, etc.) that happens close to these exterior doors would simultaneously block the exits, trapping occupants and preventing them from evacuating to a safe place.

The change to the explanatory Note A-9.9.8.4. clarifies the reasons for the requirements in Subsection 9.9.8. regarding remoteness between the exterior discharges of exits and limits the probability that two exits will simultaneously be blocked by a possible exterior incident. The Code text is now considered to be clear.

Visibility of Exits, Article 9.9.11.2.

Some exterior exit doors are difficult to recognize from outside the buildings. Adjacent storage or parking may obstruct these doors, delaying or impeding occupants from evacuating the building in an emergency situation. The change requires signs that would prohibit parking and storage from obstructing the exterior side of exit doors.

EXIT SIGNS AND MARKINGS, ARTICLE 9.9.11.3.

To avoid misinterpretation problems that exit signs with the word "Exit" are still allowed, the following changes to Clauses 9.9.11.3.(2)(b) and (c) clarify the intent of the 2015 NBC regarding the application of referenced standards for exit signs:

- Sentence 9.9.11.3.(2) requires that the running man pictogram be used for all exit signs,
- all aspects of graphical symbols listed in Subclauses 9.9.11.3.2.(c) (i) to (iv) should comply with the referenced standard ISO 7010, and
- Sentence 9.9.11.3.(3) is not an exception to Sentence 9.9.11.3.(2) but an additional requirement for all internally illuminated exit signs.

DRYER VENTS, ARTICLE 9.32.1.3.

There are currently no explicit requirements for laundry-dryer exhaust vents in Part 9.

There are no provisions to require the venting of laundry-drying appliances to the outdoors. The discharge of contaminated and moisture-laden air into a building environment can create poor indoor air quality, a fire hazard and excessive humidity. This could cause adverse health effects on the occupants due to the particulates and other contaminants (volatile organic compounds - VOC) and due to possible mould growth. For example, exposure to particulates at certain levels can cause various health effects such as eye irritation and respiratory illnesses as well as trigger asthma and allergy related symptoms. Also, excessive humidity can accelerate a chemical reaction that triggers an increase in the off-gasing from materials and fabrics, and can encourage the growth of viable organisms such as mould and bacteria.

The collective venting of multiple installations of laundry-drying appliances, for example in a common laundry room of multi-unit residential buildings, may cause a build-up of lint in the exhaust ducts when one or more laundry-drying appliances are not in use, which poses a fire hazard. Lint traps should be readily accessible for servicing to reduce the risk of fire associated with the build-up of lint and inadequate venting (Figure 21).

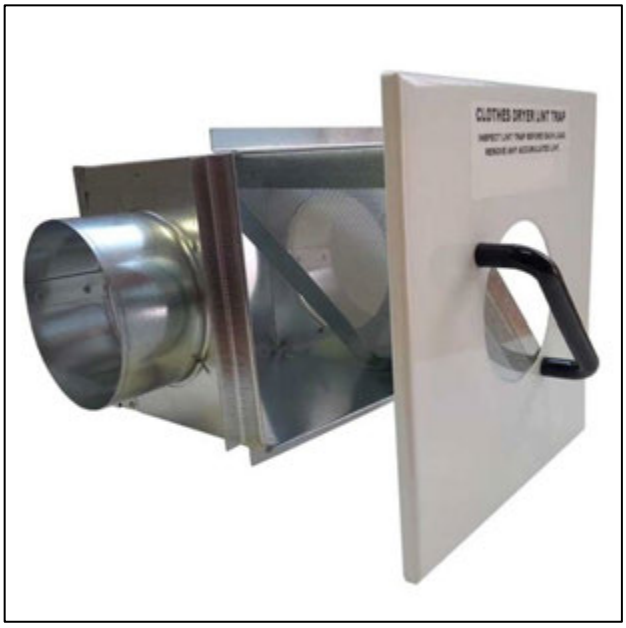


Figure 21: Lint trap in clothes dryer duct

The introduction of Article 9.32.1.3., Venting of Laundry-Drying Equipment, controls the source of the contaminants by requiring the venting of laundry-drying appliances to the outdoors. This reduces the amount of particulates and the level of humidity in the indoor building environment, therefore improving the indoor air quality of the building. Control of the source of the contaminants also reduces the probability of a fire hazard and the deterioration of the building assembly.

Moreover, the new change allows for proper maintenance of the exhaust vent.

In addition, requiring a common exhaust duct with a central exhaust fan creates a continuous negative pressure in the plenum, preventing any back draft or short-circuiting of the air to non-operating drying appliances. This will reduce the risk of fire associated with the build-up of lint.

PROTECTION OF FOAMED PLASTICS

Architectural Foamed Plastic, Sentence 9.10.17.10.(1)

Code users identified the need for more clarity in applying requirements for the protection of foamed plastics. Clause 9.10.17.10.(1)(b) was restructured editorially and a cross-reference to new explanatory Note A-3.1.4.2. clarifies that foamed plastic interior finish materials are not part of a wall or ceiling assembly and should not require to be protected. It also clarifies that a concealed space is made of any space out of sight that may be provided with an opening for repair and periodic inspections only, thus allowing temporary occupancy for specific purposes.

Walk-in Cooler or Freezer, Sentence 9.10.17.10.(2)

To avoid possible hazardous installation, a new Sentence 9.10.17.10.(2) determines the required protection measures for walk-in coolers or freezers consisting of factory-assembled walls, floor and ceiling panels containing foamed plastic insulation.

Figure 22: Walk-in cooler and freezer

Foamed Plastic Insulation on Heating Ducts, Sentence 9.33.6.4.(6)

In addition to the existing requirement for foamed plastic insulation on ducts to be tested to ASTM C 411, "Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation," as stated in Sentence 9.33.6.4.(4), the Code now clarifies that when used for insulating galvanized steel, stainless steel or aluminum air duct, foamed plastic insulation is required to meet the conditions under Subclauses 9.33.6.4.(6)(a) to (e) to minimize the fire or smoke hazard.

PENETRATIONS THROUGH FIRE SEPARATIONS

Fire Blocks in Concealed Spaces of Part 9 Buildings, Sentence 9.10.16.1.(5)

Roof spaces and other concealed spaces do not require sprinkler protection in a building required to be sprinklered in accordance with NFPA 13R, “Standard for the Installation of Sprinkler Systems in Residential Occupancies up to an Including Four Stories in Height.” The likelihood of a fire growing uncontrolled is significantly increased where such fire could reach the unprotected concealed spaces in a sprinklered building.

To reduce the potential of uncontrolled fire spread, unprotected concealed spaces of combustible construction in sprinklered buildings are now required to be separated into small compartments by fire blocks.

FIRE STOP FLAPS, ARTICLE 9.10.13.14.

A change to Article 9.10.13.14. introduces a reference to the new standard CAN/ULC-S112.2, "Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies," in lieu of out-of-date and very prescriptive requirements specified in Appendix D.

This change eliminates the restrictive construction requirements and allows more flexibility in choosing fire stop flaps.

SOFT CONVERSION, NOTE A-9.4.2.1.(1)

The NBC Preface states that "All values in the NBC are given in metric units. A conversion table of imperial equivalents for the most common units used in building design and construction is located at the end of the Code." The table that is referenced in the Preface only provides the factor for conversions from mm to inches (25.4 / 1 = 0.03937). This suggests that the metric values in the NBC are exact conversions. The metric dimensions provided for spacing between framing (and possibly other related space dimensions) are provided as 300 mm, 400 mm and 600 mm. However, these metric dimensions are not exact conversions of the imperial size in which lumber material is supplied.

While it can be argued that "everybody knows," this is inconsistent with the entire remainder of the NBC, where exact metric conversions are used. For example, the conversion for a two-by-four framing member was converted to the exact dimensions of the milled product which is 38 mm x 89 mm. The CWC Span Book explicitly states that their imperial tables yield slightly more conservative values than the metric tables. There should not be a difference in span because of a simple conversion from imperial sizes to metric ones.

Explanatory Note A-9.4.2.1.(1) was added to explain how soft conversions in the Code are stated with clear explanations on how, for example, 12 inches in the Code is stated as 300 mm, but is actually 305 mm.

STRUCTURAL DESIGN OF GLASS, ARTICLE 9.6.1.3.

The NBC references CAN/CGSB-12.20-M89, "Structural Design of Glass for Buildings," in Part 4 and Part 9. However, this standard has not been maintained since 1989. A reference to ASTM E 1300, "Standard Method for Determining Load Resistance of Glass in Buildings," was added to offer a method of structural design for glass which is actively maintained. The ASTM E 1300 standard does not however address all of the elements and is only based on the allowable stress design and not the limit states design on which the NBC Part 4 is based.
As a result, designing according to either standard will require the wind load factors from Part 4, which is highlighted by a cross-reference to Part 4 to ensure consistency and design flexibility.

In addition, Code users already referred to Tables in Part 9 for the maximum allowable glass area in doors as an acceptable prescriptive solution.

In the 2015 NBC, the Tables for maximum glass area for windows were moved from the Appendix to the body of the Code. This allows the Tables to be used as an acceptable solution and makes them enforceable.

SPATIAL SEPARATIONS

Roof Soffits Projections, Articles 9.10.14.5. and 9.10.15.5.

The intent of Sentences 9.10.14.5.(9) and (10) as well as 9.10.15.5.(8) and (9) is to address the issues of fire impingement from building to building through soffits because of their proximity. Where the property line is next to a street, lane or public thoroughfare (i.e., where the building is located on a corner lot), it was clarified in Sentences 9.10.14.5.(11) and 9.10.15.5.(10) that the face of a roof soffit is only permitted to project to the property line, where it faces a street, lane or public thoroughfare.

FIRE RESISTANCE AND SOUND TRANSMISSION CLASS RATINGS, TABLE 9.10.3.1.-A

The listing for assembly EW1 in Table A-9.10.3.1.-A of the 2010 NBC excluded the use of glass fibre insulation. EW1 was the only fire-rated exterior assembly listed in the Table. However, assemblies using glass fibre insulation exist and some have demonstrated achieved ratings of 45 minutes and 1 hour, respectively.

To allow the use of glass fibre insulation, a new listing for assembly EW2 was created in the 2015 NBC with construction specifications using glass fibre (Figure 23).

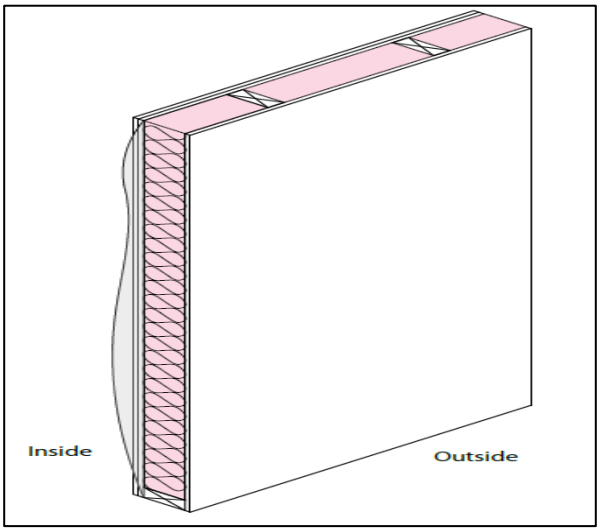


Figure 23: New wall assembly EW2 with glass fibre insulation

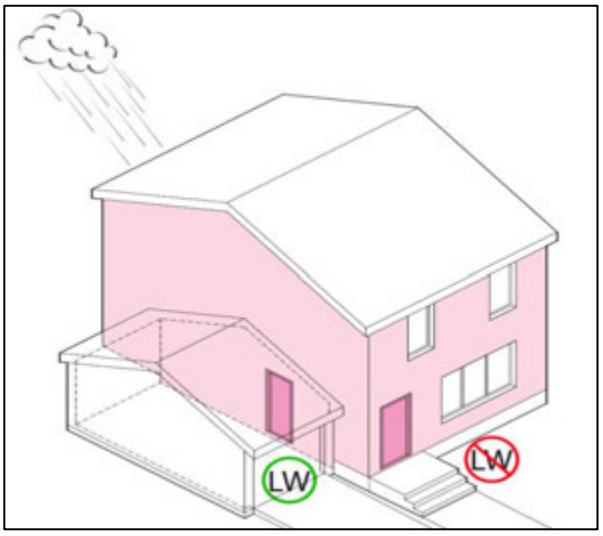


Figure 24: Location of limited water doors

Additional changes were made to use consistent terminology in assembly EW1, to include new construction options in assemblies EW1 and EW2 to use masonry veneer cladding, and to review several Table Notes based on acceptable sheathing types and the use of glass fibre insulation.

MAIN ENTRANCE DOORS, ARTICLES 9.7.1.1., 9.7.3.1. AND 9.7.4.2.

In the 2010 NBC, the term "main entrance doors" was used in Sentence 9.7.1.1.(1) to describe the application of Section 9.7. There was some confusion as there were some doors that may be considered "main entrance doors" and that met the testing requirements required in the referenced standard (NAFS) prescribed in Sentence 9.7.4.2.(1). However, some of the required tests may not have met the intent of the Code. For example, some side-hinged doors could comply with the standard when water penetration was tested under zero pressure difference, but would not have met the intent of the Code, which required doors to "resist the ingress of precipitation into interior space" while having loads imposed upon them.

The explanatory Note for Sentence 9.7.4.2.(1) now clarifies that the use of "Limited Water" rated doors is only acceptable in locations where the door is protected, such as under carports (Figure 24). Doors that have passed the test at the driving rain wind pressure for the building location may be installed anywhere.

There was also some confusion as to whether or not Sentence 9.7.3.1.(3) applied to suite entrance doors or not.

Changes were made to Sentence 9.7.3.1.(3) to qualify the application of the air leakage performance criterion by providing guidance on certain ventilation designs pressurizing the hallways and using suite entrance doors as fresh air intakes.

GARAGE AND CARPORT FOUNDATION DRAINAGE, ARTICLE 9.35.3.3.

In the 2010 NBC, Article 9.35.3.3. permitted the use of mud sills as foundation for small detached garage of less than 55 m² and exempted these garages from the requirements for foundation drainage. Small garages with concrete foundations, however, are not exempt from the foundation drainage requirements even if the finished grade around the garage is at or near the elevation of the slab.

A change to Article 9.35.3.3. extends the exemption for small detached garages to include detached garages of the same size where the finished grade is at near or at the elevation of the garage's floor slab and slopes away from the foundation.

The risk of flooding and its consequences are independent of the foundation type and are the same for small detached garages.

ENERGY EFFICIENCY CONSISTENCY WITH THE NATIONAL ENERGY CODE FOR BUILDINGS (NECB)

When the energy efficiency requirements were introduced in Section 9.36. of the NBC in 2012, every effort was taken to try

and be consistent with the general requirements found in the 2011 NECB. The following changes to Section 9.36. are in response to changes introduced in the 2015 NECB for consistency.

Determination of Thermal Characteristics of Materials, Components and Assemblies, Article 9.36.2.2.

One option for determining the effective thermal resistance of an opaque building assembly is to test the assembly to the ASTM C 1363 standard. Testing criteria listed in Clause 9.36.2.2.(4)(b) specify an outdoor temperature of -35°C. However, temperatures typically used in testing laboratories for thermal resistance testing of assemblies specify an outdoor temperature of only -18°C. The change was made to the requirements in Clause 9.36.2.2.(4)(b) to harmonize with the testing industry and the NECB.

Airtightness, Article 9.36.2.9.

In the 2010 NBC, Article 9.36.2.9. permitted two testing methods for air barrier assemblies. However, the two methods were not equal in that air barrier assemblies tested to the ASTM E 2357 standard were not subject to temperature variations during testing, and there was no indication that testing data may be extrapolated beyond the 1/50 sustained wind load exceeding the 0.65 kPa limit. In addition, the ASTM E 2357 standard did not require the air barrier materials in the assembly to be conditioned to address the impact that weathering/aging has on the air barrier material's resistance to air leakage.

To account for the differences between the ASTM E 2357 and the CAN/ULC-S742 testing procedures, air barrier assemblies tested to the ASTM standard now have two limitations. ASTM E 2357 standard can only be used where

- the building will not be subjected to 1/50 sustained wind loads exceeding 0.65 kPa, and
- the air barrier assembly is installed on the warm side of the thermal insulation of the opaque building assembly.

This ensures that air barrier assemblies tested to the ASTM standard are protected from the temperature differentials and that the wind loading does not go beyond that specified in the standard.

REFERENCED STANDARDS UPDATES

Harwood and Decorative Plywood, Articles 9.27.8.1. and 9.30.2.2.

The industry has not supported the CSA O115-M, "Hardwood and Decorative Plywood," standard referenced in the 2010 NBC for the last decade or so. The industry has been adhering to the ANSI/HPVA HP-1, "Hardwood and Decorative Plywood," standard for almost a decade now. As the ANSI standard was not referenced in the NBC, there may have been a liability for installers where products are not tested/labelled anymore to verify compliance to the NBC.

Referencing the more up-to-date, industry-supported standard in the 2015 NBC helps to reduce liability for installers and maintains the level of performance for these materials.

Gypsum Board, Article 9.29.5.2.

The 2010 NBC referred to the CAN/CSA-A82.27-M, "Gypsum Board," standard as well as two other ASTM standards for gypsum board. However, the CAN/CSA-A82.27-M standard had not been updated since 1991 and was withdrawn by the CSA. A review of the currently referenced ASTM C 1396/C 1396M, "Gypsum Board," standard showed that the scope of the CAN/CSA A82.27 was covered by this ASTM standard, with the exception of a different reference to another standard for flame-spread requirements. By introducing a qualifier to the reference to ASTM C 1396/C 1396M where the flame-spread rating of gypsum board must be determined in accordance with the CAN/ULC-S102 standard, the reference to the CAN/CSA A-82.27 was deleted in Article 9.29.5.2.

Asbestos Drain Pipe, Article 9.14.3.1.

In the 2015 NBC, the reference to CAN/CGSB-34.22, "Asbestos-Cement Drain Pipe," was deleted as the standard had not been updated since 1994 and was withdrawn by CGSB. In addition, the standard dealt with asbestos drain pipe which is not permitted to be used by other regulations.

There are other references to other materials which are acceptable to be used. In addition, this change harmonizes with the requirements in Part 6 of the 2015 NBC.

Mineral Wool Roof Insulation Board, Article 9.25.2.2.

Mineral wool roof insulation boards are used in the construction of Part 9 buildings. However, no clear means of compliance with the Code were provided in the 2010 NBC as the product had been excluded from the referenced CAN/ULC S702, “Standard for Mineral Fibre Thermal Insulation for Buildings.” To address this gap, ASTM C 726, ”Standard Specification for Mineral Wool Roof Insulation Board,” has now been included in the list of standards for materials to comply with.

Autoclaved Cellular Units, Article 9.20.2.1.

The CAN3-A165.4-M, ”Autoclaved Cellular Units,” standard referenced in the 2010 NBC was withdrawn by the CSA and there were no other Canadian manufacturers that produced materials conforming to this standard. The CSA standard was inconsistent with international product standards. Therefore the reference to the CAN3-A165.4 standard was deleted from Article 9.20.2.1. of the 2015 NBC.

Concrete, Article 9.3.1.1.

The 2010 NBC referenced the CSA A23.1-09, “Concrete Materials and Methods of Concrete Construction,” standard for the strength and water-cement ratio of delivered concrete. The 2010 NBC also set the minimum acceptable properties for site-batched concrete. The 2014 edition of the CSA A23.1 standard introduced more stringent requirements for concrete strength and allowable water-cement ratio for buildings to which Part 9 applies.

Figure 25: Residential concrete slab

While some jurisdictions were already using higher strength concrete, the more stringent requirements in the standard would have increased the cost of construction in other regions.

The 2014 CSA standard required 25 MPa, which made residential concrete consistent with other classes of concrete falling within an F2 exposure class, indicating durability increases and permeability reduction as strength increases.

If many areas were already using higher grade concrete, then the cause of the failures was unclear.
A survey to seek additional data on failures in the field did not identify evidence in support of the concrete properties referenced in the 2010 NBC not being acceptable. Many of the problems reported in the survey related to compromised durability and serviceability due to non-Code compliant material or installation practices, not the specified strength. In the absence of sufficient rationale for a change to strength and water-cement ratio requirements, a change to Article 9.3.1.1. introduced a qualifier to the reference to the 2014 CSA standard that maintains the acceptable concrete requirements in the 2010 NBC and avoids increasing the required strength of concrete to address non-Code compliant material or installation.

National Energy Code for Buildings

National Energy Code for Buildings

Outline

This material highlights changes to the National Energy Code for Buildings and covers the following topics:

- Building Envelope – Part 3
- Lighting – Part 4
- Heating, Ventilation and Air-conditioning (HVAC) – Part 5
- Service Water Heating – Part 6
- Performance Compliance – Part 8

GENERAL

A number of changes were implemented in the 2015 edition of the National Energy Code for Buildings (NECB). These changes affect the prescriptive requirements in Parts 3, 4, 5 and 6, and improve the energy performance of buildings, over the previous edition (2011 NECB).

Some of these changes harmonize the NECB requirements with the current ASHRAE 90.1 requirements. Additional changes were made to the document to increase its ease-of-use and clarity. Note that there were no changes to Part 7 of the NECB which deals with electrical power systems and motors.

Climatic Data

Climatic data was incorporated in the 2015 NECB so that the Code is a standalone document and users no longer need to refer to the National Building Code (NBC). The climatic data was also updated with the most recent information from Environment Canada. Some cities have changed zones compared to the 2011 NECB. As detailed later, 15°C heating-degree-day information was incorporated in the 2015 NECB to align with the introduction of requirements for semi-heated buildings.

BUILDING ENVELOPE, PART 3

Opaque Building Assembly Testing, Article 3.2.4.2.

Maximum air leakage and testing procedures for opaque air barrier assemblies that are environmental separators are now found in Part 3. This change adds cross-references to ASTM E 2357, "Standard for Determining Air Leakage of Air Barrier Assemblies," and CAN/ULC-S742, "Standard for Air Barrier Assemblies – Specification," for the air leakage testing of air barrier systems. For air barrier assemblies conforming to CAN/ULC-S742, an air leakage rate no greater than 0.2 L/(s·m^2) at a pressure differential of 75 Pa is now required. However, for air barrier assemblies tested in accordance with ASTM E 2357, the building must be located in an area where the 1-in-50 hourly wind pressures do not exceed 0.65 kPa, and the air barrier assembly must be installed on the warm side of the thermal insulation of the opaque building assembly.

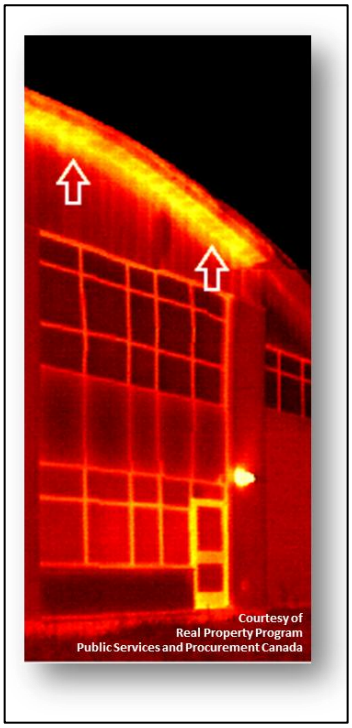


Figure 1: Air leakage made visible by infrared thermography

This change helps distinguish which test standards focused on durability of the air barrier materials, such as concrete block masonry with two coats of paint. These air barrier test requirements limit the unwanted air leakage from heated buildings, as opposed to those minimum requirements in Part 5 of the NBC that address issues such as condensation and occupant comfort.

The change also adds guidance in the form of an explanatory Note for greater clarity.

These new requirements could reduce regulatory burden by providing guidance on verifying compliance to authorities having jurisdiction. The requirements are aligned with the 2015 NBC housing energy requirements.

Semi-heated Buildings

In the previous edition of the NECB, building envelope components in semi-heated buildings were not subjected to distinct requirements. Semi-heated buildings therefore had to meet the same thermal performance requirements as "conventional" or fully heated buildings. When considering the lower heating set-point temperature for semi-heated buildings, the 2011 NECB requirements would be considered more stringent than requirements for similar heated buildings. To address this discrepancy, the NECB 2015 introduces a reduced heating degree day value, which could lead to less stringent maximum overall thermal transmittance values for opaque elements, fenestration, and doors in semi-heated buildings.

Semi-heated Building Definition, Sentence 1.2.1.2.(2)

In the previous edition of the NECB, the term "semi-heated building" was defined in an Appendix Note. With the introduction of prescriptive semi-heated building requirements in Part 3, the definition of the term was moved from an Appendix Note, which is not enforceable, to Division B, Sentence 1.2.1.2.(2), which is enforceable.

In addition, the definition of "semi-heated building" in the 2011 NECB limited buildings with a set-point temperature of 18°C while the revised definition lowers this set-point temperature to 15°C.

Prescriptive Requirements for Semi-heated Buildings, Sentences 3.2.2.2.(2), 3.2.2.3.(3), 3.2.2.4.(2), and Articles 3.2.3.2. and 3.2.3.3.

The 2011 NECB did not contain prescriptive thermal requirements for building envelopes of semi-heated buildings. It only addressed semi-heated buildings in the detailed building trade-off compliance path and the performance path. This meant that the requirements for semi-heated buildings resulted in them being much more energy-efficient.

To address this issue, a relaxation for the maximum overall thermal transmittance of above-ground opaque building assemblies, of fenestration, of doors, and of building assemblies in contact with the ground is provided by permitting the calculation of heating-degree-day category at 15°C instead of at 18°C.

An excerpt from Table C-1 in the NECB shows how this relaxation is applied in the Code.

Climatic Information by City in Appendix B	Degree-Days below 15°C	Degree-Days below 18°C
100 Mile House, BC	4040	5030
Honey Harbour, ON	3470	4300
Happy Valley Goose Bay, NFDL	5700	6670

Heating degree-days of building location, °C-days					
Zone 4: Less than 3000	Zone 5: 3000 to 3999	Zone 6: 4000 to 4999	Zone 7A: 5000 to 5999	Zone 7B: 6000 to 6999	Zone 8: Greater than or equal to 7000
Maximum overall thermal transmittance (U-value, W/(m²·K))					
Walls	0.315	0.278	0.247 (min R-24)	0.210 (min R-27)	0.210	0.183
Roofs	0.227	0.183	0.183	0.162	0.162	0.142
Floors	0.227	0.183	0.183	0.162	0.162	0.142

Figure 2: Overall thermal transmittance of above-ground opaque building assemblies (from 2015 NECB)

100 Mile House based on degree-days below 18°C has a value of 5030. It therefore falls between 5000 to 5999 heating degree-days and is in Zone 7a (same as Calgary), which requires a maximum overall U-value for walls of 0.210. This is about R-27 in imperial units. Roofs and floors in Zone 7a can have a maximum overall U-value of 0.162, which is about an R-35.

However, if the building is semi-heated, the degree-days below 15°C have a value of 4040 and the site would fall in Zone 6 and the requirement is now 0.247. This means insulating to R-24 instead of R-35. This relaxation also applies if the performance path for compliance method is used.

Removal of the Detailed Trade-off Path, Section 3.3.

Part 3 of the previous edition of the NECB had two trade-off paths: a detailed and a simple one. The detailed trade-off path was based on the whole building performance compliance path of Part 8 with non-building envelope parameters kept constant or specified as defaults. Given that the complexity and effort to demonstrate compliance using the detailed trade-off path is comparable to full building modeling (Part 8), it was removed from the 2015 NECB.

The simple trade-off path, which is a simple sum of products of thermal transmittance and surface area of envelope assemblies,

remains in the 2015 NECB. Figure 3 below highlights the change in compliance in Part 3.

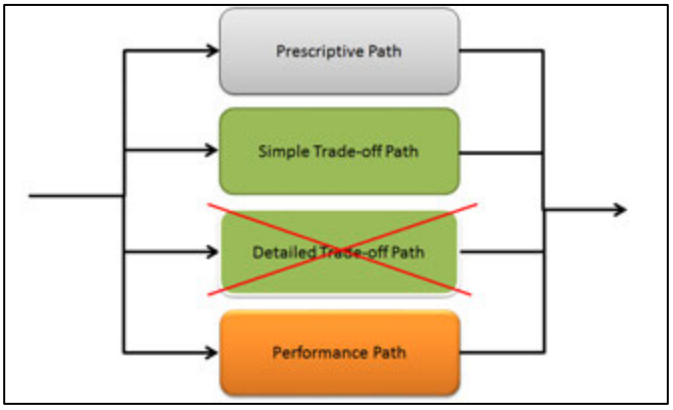


Figure 3: Part 3 compliance paths

Changes for Greater Clarity and Ease of Use

A number of smaller changes were made for greater clarity and ease of use in Part 3. These are captured in the following.

Application and Limitations – Semi-heated Buildings, Article 3.3.1.1.

The language in the previous edition of the NECB was not clear with respect to the simple trade-off path not applying to semi-heated buildings. A change was made to Article 3.3.3.1., which defines the application and limitations of the simple trade-off path, explicitly stating that the trade-off path cannot be applied to semi-heated buildings.

Limitations to Part 3 Performance Compliance, Article 3.4.1.2.

Changes were made to Article 3.4.1.2. which sets limitations on the use of the performance compliance path for the modeling of the building envelope.

The 2011 NECB required that the prescriptive requirements for thermally active building envelope elements be followed even when using the performance path. This limitation was removed since the performance compliance calculations can account for these elements.

Furthermore, since the performance compliance calculations cannot adequately account for air leakage, the prescriptive air barrier requirements in Subsection 3.2.4. must now be applied.

Explanatory Material in the Code Requirements, Sentence 3.1.1.7.(5)

The statement that the thermal requirement is “equivalent to one layer of glass” is explanatory and was moved in a Note, since explanatory material does not belong in the body of the Code.

LIGHTING, PART 4

Lighting Power, Sentence 4.2.1.4.(4) and Tables 4.2.1.5. and 4.2.1.6.

The requirements for interior lighting power density (LPD) were made more stringent over those in the previous edition of the NECB. These requirements specify maximum power allowances in either watts/building area (called the “building area method”) or watts/area of space (called the “space-by-space method”).

These revised LPDs were updated to reflect current recommended illuminance levels as published in the new IES Lighting Handbook, 10th Edition. This means that for certain building/space types, the LPDs may have increased over the 2011 NECB (less stringent) to account for these revised illuminance levels. However, overall the requirements for LPDs were made more stringent.

For both the building area method and space-by-space method, buildings and space types were more closely harmonized with analogous ASHRAE 90.1-2013 requirements to facilitate enforcement of the 2015 NECB in jurisdictions that reference both the NECB and ASHRAE 90.1-2013 for compliance. As part of this change, Clause 4.2.1.4.(4)(g) in the 2011 NECB (lighting in spaces specifically designed for use by occupants with special lighting needs) was deleted since there are now space types and associated LPDs that address care occupancy designed to ANSI/IES RP-28. In addition, an explanatory Note was added to give guidance on the “Sports arena facilities” building space type.

In the 2015 NECB, atrium height was reduced from 13 m to 12 m. A computer/server room common space type was also added.

New Interior Lighting Controls Requirements, Subsection 4.2.2.

The stringency of the lighting control requirements was increased by requiring the use of specific lighting controls types in areas where lighting controls were not previously required. This change brings the NECB in line with current standard practice for lighting controls and closer harmonizes the Code with ASHRAE-90.1-2013. For many spaces, the automatic controls are now required to control all, or a portion of the lighting in the space. The control types now include manual; partial automatic; bi-level; automatic daylight responsive controls for sidelighting or toplighting; automatic partial or full off; and scheduled off. For each space type listed in Table 4.2.1.6., the lighting control is either required (marked “X”) or

one of the lighting controls is required (marked “A” or “B”). As part of this work, the requirements of Subsection 4.2.2. were reorganized.

In addition, guidance material in the form of a number of new explanatory Notes were added for ease of interpretation of these new lighting control requirements.

Space Types, Table 4.2.1.6.

Lighting power density requirements using the space-by-space method and minimum lighting control requirements were combined into a single Table for ease of interpretation. An excerpt from this Table is provided in Figure 4 that follows.

Table 4.2.1.6.
Lighting Power Density Using the Space-by-Space Method and Minimum Lighting Control Requirements
Forming Part of Sentences 4.2.1.6.(1), 4.2.2.1.(2), (3), (5), (6), (8), (9), (10), (13), (15), (18) and (20), 4.3.1.3.(5), 4.3.3.2.(1) and 8.4.4.5.(5)

Space Type	Lighting Power Density, W/m²	Type of Lighting Control(s)								
		Manual (see 4.2.2.1.(3))	Restricted to Manual ON (see 4.2.2.1.(6))	Restricted to Partial Automatic ON/Off (see 4.2.2.1.(8))	Bi-Level (see 4.2.2.1.(9))	Automatic Daylight Responsive Controls for Sidelighting (see 4.2.2.1.(10))(f)	Automatic Daylight Responsive Controls for Toplighting (see 4.2.2.1.(13))(f)	Automatic Partial OFF (see 4.2.2.1.(15))	Automatic Full OFF(f) (see 4.2.2.1.(18))	Scheduled Shut-off (see 4.2.2.1.(20))
Common Space Types(e)										
Atrium										
<6 m in height	1.06 per m (height)	X	A	A	–	X	X	–	B	B
≥ 6 m and ≤ 12 m in height	1.06 per m (height)	X	A	A	X	X	X	–	B	B
>12 m in height	4.3 + 0.71 per m (height)	X	A	A	X	X	X	–	B	B
Audience seating area – permanent										
for auditorium	6.8	X	A	A	X	X	X	–	B	B

Figure 4: Excerpt from Table 4.2.1.6.

Each space type, along with LPD requirements, is provided with control requirements. All lighting controls marked with an “X” must be implemented. At least one of the lighting controls marked with an “A” and at least one of those marked with a “B” must be implemented.

Types of Lighting Controls (including Daylighting), Article 4.2.2.1.

For each lighting control type required by Table 4.2.1.6. (Figure 4 above), requirements have been added under Article 4.2.2.1. specifying details of their implementation. For example, consider the “Restricted to Manual ON” lighting control type (fourth column from the right in Table 4.2.1.6.). Under Sentences 4.2.2.1.(6) and (7) the following is required:

> **6)** Except as provided in Sentence (7), none of the lighting in spaces requiring controls that are restricted to “Manual ON” in accordance with Table 4.2.1.6. shall turn on automatically.
> **7)** Sentence (6) need not apply where “Manual ON” operation of the *general lighting* would endanger the safety or security of the *building* occupants.

As a result of the many changes to Article 4.2.2.1., the calculation of the skylighting effective aperture and the sidelighting effective aperture was deleted since it is no longer required to apply lighting control requirements.

For skylighting, the requirements for daylighting areas were changed from “daylighted areas where the skylight effective aperture, as determined in accordance with Article 4.2.2.7., is less than 0.006 (0.6%)” to “daylighted areas where the visual transmittance, VT, of the skylights and roof monitors is less than 0.4.”

For sidelighting, the requirements were changed from “primary sidelighted areas where the sidelighting effective aperture, as determined in accordance with Article 4.2.2.10., is less than 0.1 (10%)” to “sidelighted areas where the total glazing area is less than 2 m^2.”

Lighting Controls in Storage Garages, Article 4.2.2.2.

Specific lighting control requirements were added for storage garages requiring that lighting be automatically reduced when no activity is detected within a lighting zone for 20 minutes.

Lighting for covered vehicle entrances and exits are now required to be separately controlled by a device that automatically reduces the lighting by at least 50% from sunset to sunrise. This requirement serves two purposes: a transition zone of mid luminance is needed at night when traveling from a high luminance zone (garage) to a low luminance zone (street), and vice versa, and this mid luminance zone has a lower electrical consumption and thus saves energy. An explanatory Note was added to provide guidance on this requirement.

Secondary Sidelighted Area, Articles 4.2.2.3. and 4.2.2.4.

The revised daylighting controls for sidelighted areas in Article 4.2.2.1. introduce secondary sidelighted area. Secondary sidelighting area is the floor area directly adjacent to a primary sidelighted area. Calculation methods and explanatory Notes for secondary sidelighted areas are therefore introduced.

Similar changes were made to daylighted areas under roof monitors in Article 4.2.2.4.

Special Applications, Article 4.2.2.6.

Article 4.2.2.3., Additional Requirements for Lighting Controls, of the previous edition of the NECB was reorganized as a result of the changes to Article 4.2.2.1. It was renamed Article 4.2.2.6., Special Applications, and the requirements changed to specifically address special lighting requirements pertaining to guest rooms and hotel suites, which are not addressed anywhere else.

Included in these requirements is the mandatory use of captive key systems to control lighting in guest rooms and suites in commercial temporary lodgings.

Exterior Lighting Controls, Article 4.2.4.1.

The dusk-to-dawn operation of exterior lighting could result in excessive energy use at times where no lighting is required, i.e. when the building is not in use. As such, building facade and landscape lighting must now have the capability to shut off automatically and exterior lighting must now have the capability to reduce the total connected power by at least 30%.

These requirements harmonize the NECB with ASHRAE 90.1-2013 and may facilitate design and enforcement in jurisdictions that reference both the NECB and ASHRAE 90.1.

The Appendix Note A-4.2.4.1.(3) in the previous edition of the NECB was determined to be of little value and was therefore deleted.

Trade-off Path, Section 4.3.

A number of changes were made to the lighting trade-off path in Section 4.3. to align the trade-off path with the prescriptive requirements of Part 4, and to provide additional flexibility to the user of the NECB.

Alignment with Prescriptive Requirements, Tables 4.3.2.8., 4.3.2.10.-A and 4.3.2.10.-B

The trade-off path allows for additional flexibility in the system design over the prescriptive requirements. It allows for design parameters, such as lighting power and control systems, to be traded-off with one another, so long as the total energy use is less than or equal to that of a comparable system meeting the prescriptive requirements. It is therefore important that the trade-off path align itself with the prescriptive requirements.

Tables 4.3.2.10.-B and 4.3.2.8. were modified to include new lighting control requirements. Additional space types were added in Table 4.3.2.10.-A to match the additional space types in Table 4.2.1.6.

Building Energy Estimation Methodology, Article 4.3.1.3.

Qualified references to CSA C873.4., "Building Energy Estimation Methodology – Part 4 – Energy Consumption for Lighting" (BEEM), were added under Article 4.3.1.3., Compliance, as an alternate option for demonstrating compliance within the lighting trade-off path.

The BEEM is more flexible and may be more accurate than calculations using the trade-off path as it includes three daylighting systems (standard systems, light-directing systems and permanent shading systems) and three latitude ranges (30° to 45°, 45° to 60°, 60° to 75°). Due to the fact that the daylighting considerations for the existing trade-off path calculations are based on analysis for a building built in Ottawa, the BEEM results may be more suitable for locations that are much further north or south from Ottawa.

Summary

In the 2015 NECB, the stringency of the lighting control requirements was increased by requiring the use of specific lighting controls types in areas where lighting controls were not previously required. These requirements are based on market studies on contemporary use of technology, and collaboration with the ASHRAE-90.1-2013 lighting technical Committee for modeling. These new lighting power densities and controls were incorporated into one Table for ease of use.

Combined with the changes will be spaces lit more efficiently and introduction of other options for designers on how to demonstrate compliance.

HEATING, VENTILATING AND AIR-CONDITIONING SYSTEMS (HVAC), PART 5

HVAC Equipment, Articles 5.2.12.1. and 5.2.12.2.

A number of changes were made to the HVAC equipment efficiency Table in Part 5 (Table 5.2.12.1.) to enhance its clarity and improve the performance of the stated requirements. The performance of HVAC equipment listed in Table 5.2.12.1. was improved to at least meet the requirements of the federal Energy Efficiency Regulations. New prescriptive performance requirements for gas-fired outdoor packaged units (commonly referred to as "rooftop units") were added.

Equipment type regulated by the Energy Efficiency Regulations was identified in Table 5.2.12.1. Guidance in the form of an explanatory Note was added on the Energy Efficiency Regulations and its relationship with the NECB requirements. This new guidance material also informs the user that the required performance of equipment regulated by the Energy Efficiency Regulations may change without notice between Code cycles. The publication of revisions to these documents does not always coincide with the publication of a new edition of the Code.

A new Article was added to introduce prescriptive requirements for heat rejection equipment under Article 5.2.12.2., Heat Rejection Equipment. These requirements set maximum electrical consumption, in kW per kW of heat rejected, for common heat rejection equipment such as cooling towers and condensers. An excerpt from Table 5.2.12.2. is provided below for information.

Table 5.2.12.2.
Heat Rejection Equipment Performance Requirements
Forming Part of Sentence 5.2.12.2.(2)

Type of Equipment	Heat Rejection Capacity	Standard	Rating Conditions	Performance Requirements,(1) electrical kW / thermal kW(3)
Cooling towers				
centrifugal fan, direct-contact	All capacities	CTI ATC-105(2) and CTI STD-201(3)	35°C entering water 29.4°C leaving water 23.9°C wet bulb	≤ 0.026
propeller or axial fan, direct-contact				≤ 0.013
centrifugal fan, indirect-contact evaporative			38.9°C entering water 32.2°C leaving water 23.9°C wet bulb	≤ 0.061
propeller or axial fan, indirect-contact evaporative				≤ 0.030

Figure 5: Excerpt from Table 5.2.12.2., Heat Rejection Equipment Performance Requirements

Demand Control Ventilation Systems, Article 5.2.3.4.

Mandatory requirements were added for demand control ventilation systems for enclosed semi-heated or conditioned spaces with intermittent use of fuel-powered vehicles or mobile equipment in spaces, such as parking garages and arenas, where ice-surfacing equipment (refer to Figure 6) are used.

Figure 6: Example of a space provided with demand control ventilation systems

Pumping Power Demand, Subsection 5.2.6.

Part 5 of the previous edition of the NECB did not have maximum power requirements for hydronic system pumps, yet when modeling the reference building in accordance with Part 8, Building Energy Performance Compliance Path, a value for power of hydronic system pumps must be provided.

Additionally, hydronic system pumps are commonly oversized in the industry.

To address this issue, new requirements were introduced for the demand of hydronic pump motors under Subsection 5.2.6. These requirements set maximum motor power in W per kW of heat demand of the space.

Sealing of Ducts, Table 5.2.2.3. and Article 5.2.2.4.

The leakage classes from the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) referenced in the previous edition of the NECB were outdated. More current and stringent requirements have been introduced since the publication of the 2011 NECB.

Revised leakage classes for ducts were introduced. In addition, the reference to SMACNA, "HVAC Air Duct Leakage Test Manual," was updated from the 1985 to the 2012 edition.

Piping Insulation, Article 5.2.5.3.

The stringency of piping insulation requirements was increased over the 2011 edition of the NECB. The stringency of these requirements aligns the 2015 NECB with common industry practice.

In Table 5.2.5.3., the minimum thickness of piping insulation was increased. Requirements were added to help ensure that the thickness of insulation for the compliance of a system be that of the insulation after its installation, which means that the thickness of the product before and after installation may change. An explanatory Note was added to provide guidance on the proper installation of insulation.

Sentence 5.2.5.3.(3). of the previous edition of the NECB was deleted since it exempted piping conveying fluid at temperatures below 177°C, located outside the building envelope. Piping located outside the building envelope should not be exempted from Table 5.2.5.3. due to the potentially large difference in temperatures between the temperature of the fluid and the temperature of the ambient air. Additionally, the heat lost by the fluid through pipes located outside the building envelope cannot be recuperated as is often the case with piping located inside the building envelope.

A change was made to Sentence 5.2.5.3.(3) that exempts piping conveying fluid at temperatures greater than 16°C and less than 41°C only if located within the building envelope.

Duct and Plenum Insulation, Article 5.2.2.5.

During installation, insulation can be compressed which leads to a reduction in thermal performance. Sentence 5.2.2.5.(2) was added to ensure that compliance should be determined based on the properties of the installed product.

Sentence 5.2.2.5.(8) puts restrictions on the modification of duct insulation to ensure that the thermal properties of the installed insulation are as close to those of the manufacturer's

specifications. Otherwise, desired insulation thickness could be achieved by cutting or modifying thicker insulation, which may affect the thermal properties of the installed insulation.

Air Economizers, Article 5.2.2.8.

A clarification was added on the application of air economizer fixed dry bulb controls in the Note A-5.2.2.8.(2). Air economizer systems should have an adjustable high-limit shut-off set point range between 21˚C and 24˚C so that energy consumption for cooling can be minimized based on the building's location. When relative humidity is higher, the set point should be closer to 21˚C, whereas a drier location would use a set point approaching 24˚C.

HVAC Trade-off Path – Update of Coefficients, Section 5.3.

The trade-off path allows for additional flexibility in the system design over the prescriptive requirements. It allows for design parameters, such as component efficiencies, to be traded-off with one another, so long as the total energy use of the HVAC system is less than or equal to that of a comparable system meeting the prescriptive requirements. It is therefore important that the trade-off path align itself with the prescriptive requirements.

With the changes to the prescriptive requirements in Part 5 of the NECB, the trade-off-path coefficient Tables (Tables 5.3.2.2., 5.3.2.4., 5.3.2.7. and 5.3.2.8.-A to AA) were outdated. Revised coefficients are therefore provided in the 2015 NECB.

HVAC Trade-off Path – Introduction of Ranges, Section 5.3.

To help ensure correct application of the NECB trade-off path requirements, minimum and maximum ranges of acceptable component input parameters were introduced for each HVAC system type.

The use of input values outside the ranges for which the coefficients were developed were found to demonstrate compliance as expected. For example, reduction of pump mechanical efficiency (ToV_{23} in Table 5.3.2.3.) below a certain range was found to increase overall system efficiency. To help limit this type of issue, maximum and minimum ranges were set for each system, and equipment parameter.

SERVICE WATER HEATING, PART 6

In the previous edition of the NECB, Part 6 only addressed energy of hot service water. But energy is also used to move unheated service water. A change was therefore made to broaden the scope of Part 6 to include energy used for unheated service water. Moving service water and domestic water from one area of a building to the next can represent a significant portion of a building's energy.

Service Water Heating Equipment, Article 6.2.2.1

A number of changes were made to the service water heating (SWH) equipment efficiency Table in Part 6 (Table 6.2.2.1.) to enhance its clarity and improve the performance of the stated requirements. Table 6.2.2.1. now makes the distinction between "instantaneous" and "storage" type water heaters. The performance of SWH equipment listed in Table 6.2.2.1. was improved to at least meet the requirements of the federal Energy Efficiency Regulations.

The explanatory Note added to Sentence 5.2.12.1.(1) on the relationship of the Energy Efficiency Regulations and the requirements of the NECB also applies to service water heating equipment.

Piping Insulation, Article 6.2.3.1.

Sentence 6.2.3.1.(6) was added to help ensure that the thickness of the insulation for compliance with Table 6.2.3.1. be that of the insulation after installation. The explanatory Note added for piping insulation of HVAC equipment also applies to service water heating equipment.

Sentence 6.2.3.1.(7) was added to set requirements for the protection of service water heating pipe insulation. Mechanical damage to, or the weathering of pipe insulation, can greatly reduce its thermal performance.

Maximum Discharge Rates, Articles 6.2.6.1. and 6.2.6.2.

In the previous edition of the NECB, the requirements of the Code were unchanged from draft requirements of 1994 for the 1997 Model National Energy Code for Buildings (MNECB).To reduce the use of hot water, requirements for maximum hot water discharge rate for lavatories and shower heads were made more stringent over the 2011 NECB requirements. Specifically the requirements changed from a flow rate of 9.5 to 7.6 L/min for showers. And for lavatories, new categories distinguish between private and public uses.

Aligned with changes in the 2015 National Plumbing Code, health care facilities are now exempt, in addition to emergency applications that were already exempt. The discharge rate of the 2011 NECB specified hot water. However the requirements were made consistent to apply to all domestic water in the 2015 NECB.

Pressure Booster Systems, Articles 6.1.1.1. and 6.1.1.2. and Subsection 6.2.8.

Booster pumps are typically used for water pressure boosting in mid- and high-rise residential and commercial applications. The energy used by these pumps can be substantial. A new Subsection (6.2.8.) was introduced setting minimum requirements for water-storage tank volume and pressure-sensing controls that reduce the short cycling of booster pumps with low demand. A typical pressure booster system is shown in Figure 7 below.

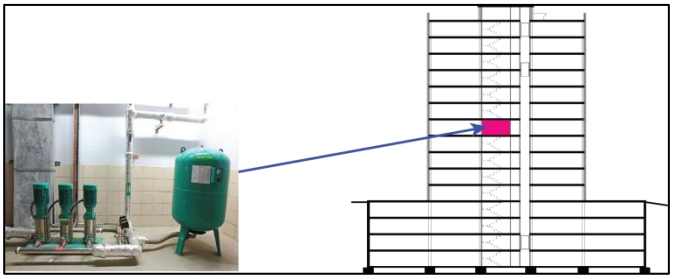


Figure 7: Pressure booster system

To accommodate this change, the requirements pertaining to scope (6.1.1.1.) and application (6.1.1.2.) of Part 6 needed to be broadened to include service water heating and pumping systems.

BUILDING ENERGY PERFORMANCE COMPLIANCE PATH, PART 8

Part 8 of the NECB involves hourly calculations, typically with computer simulations, in which a reference building model is compared to a proposed building model. The parameters of the proposed building model will closely match those of the designed building. The parameters of the reference building, on the other hand, match those of a minimum code compliant, analogous building.

Figure 8: Building energy modeller

For the modelling of reference buildings with purchased energy, the corresponding system has changed from electric to a gas-fired modulating boiler and from cooler to chillers based on size and complying with Table 8.4.3.5.

Default Values, Table A-8.4.3.2.(1)

Default values are provided in the performance path when :

- an aspect is not covered by a Code requirement, or
- it is a variable that can change during operation.

However the default values had not changed since 1999 when the first default values were included in the 1999 “Performance Compliance for Building” supplement to the 1997 MNECB. The updated modeling defaults give more appropriate weight to various components.

Consistency

With changes to prescriptive requirements in Parts 3, 4, 5, and 6 of the Code, a number of changes in Part 8 were needed for consistency to ensure that the reference building model closely matched the prescriptive Code requirements.

Additionally, a number of changes were made to clarify potentially ambiguous or overly restrictive wording in the model ruleset that could be open to interpretations.

National Fire Code

Outline

This material highlights changes to the National Fire Code and covers the following topics:

- Hot Works
- Dangerous Goods
- Fuel-dispensing Stations
- Leak Detection
- Laboratories
- Reuse of Storage Tanks
- Mid-rise Combustible Construction
- Other Changes

HOT WORKS, ARTICLES 5.2.1.1., 5.2.2.3., 5.2.3.1. AND 5.2.3.2.

Hot works include several different operations and processes. Roofing operations are a common cause of hot works fires. The torch application of roofing materials was added to the list of example hot work activities covered by Section 5.2. in the 2015 National Fire Code (NFC). This change clarifies for the Code user that roofing operations must comply with Section 5.2. of the NFC.

The requirement related to the final inspection of a hot work area and adjacent exposed areas was not applied consistently among jurisdictions and the intent to detect slow burning smouldering fires was often overlooked.

The purpose of the final inspection, 4 hours after completion of hot works, is to detect a slow burning smouldering fire which may be concealed and undetectable for long periods of time (even beyond 4 hours). Subclause 5.2.3.1.(2)(c)(ii) now provides an alternative to the final inspection. The alternative is to conduct a comprehensive inspection 60 minutes after the completion of hot works to detect a slow burning smouldering fire before workers leave the job site. Explanatory Note A-5.2.3.1.(2)(c)(ii) provides a description of this comprehensive inspection. It suggests including a visual inspection of any concealed space within the work area or exposed areas adjacent to the hot work area. Where visual inspection of concealed spaces is not possible, such as within a roof assembly, it is recommended that additional equipment such as thermal scanners and infrared thermometers be used to take temperature readings.

Open flames may be present in areas adjacent to hot works, especially when performing open flame torch cutting on the exterior of the building, where the torch flame can be 30 to 40 inches long. In this instance, it is quite possible for the torch flame to reach the other side of the roof or wall assembly (Figure 1).

Figure 1: Hot works

Sentence 5.2.3.1.(3) provides protection against open flames for areas adjacent to hot works in addition to the existing requirements to protect against sparks. The change introduced in the 2015 NFC clarifies that combustible materials in areas adjacent to hot works require protection not only from sparks, but also from open flames.

Fires resulting from hot works often begin in concealed spaces that contain combustible materials. They can remain undetected until they overwhelm the fire department. Additional requirements for fire watches were introduced where combustible materials are exposed to hot works and they cannot be visually inspected directly.

Explanatory Note A-5.2.3.3.(1) was added to clarify that additional equipment such as thermal scanners should be used when combustible materials in the work area cannot be directly observed by the fire watch.

DANGEROUS GOODS (NOMENCLATURE)

In the NFC, dangerous goods were defined under the Transportation of Dangerous Goods Regulations (TDGR). However, the TDGR only applies to dangerous goods in transit. A change was made in the 2015 NFC to harmonize regulated products classified by the TDGR and the Workplace Hazardous Materials Information System (WHMIS) in order to cover all dangerous goods (hazardous products) stored in a building where the NFC applies. This change is in sight with the new defined term for dangerous goods, which combine both TDGR and WHMIS classification of hazardous products (Figure 2).

Figure 2: New nomenclature in the NFC for dangerous goods

Applications and Separations, Articles 3.2.7.1., 3.2.7.6., 4.1.2.1., 5.5.5.5. and Sentence 3.3.4.1.(3)

With the change in nomenclature, WHMIS classifications were introduced into Table 3.2.7.1. related to small quantity exemptions for dangerous goods. Dangerous goods could fall under multiple classes and a methodology to treat precedence of classes for WHMIS with a flowchart and a Table were added as well as a description of the WHMIS classification system.

With the introduction of WHMIS classifications into Table 3.2.7.6. which is related to the separation for the storage of dangerous goods, a methodology to treat dangerous goods provided with both or either TDG and/or WHMIS classification was added, the reaction between acid and base for corrosive substances was clarified and oxidizing gases limitations were introduced.

With respect to outdoor storage of dangerous goods, a change that clarifies the exemption amounts in Table 3.2.7.6. was added for products that have multiple classes as per Sentence 3.3.4.1.(3).

Previously, the NFC addressed highly unstable substances with an emphasis on perchloric acid. New Article 5.5.5.5. was introduced in the 2015 NFC to deal with dangerously reactive materials other than perchloric acid. Thus, provisions for perchloric acid are now located in Article 5.5.5.6. To reduce the likelihood of misinterpretation, explanatory Note A-5.5.5.6. was rearranged so that a statement is provided upfront to the effect that Article 5.5.5.6. is also intended to apply to other highly unstable substances having similar properties to perchloric acid.

FUEL-DISPENSING STATIONS, SUBSECTION 4.6.8., ARTICLES 4.6.2.1., 4.6.2.3., 4.6.4.1., 4.6.4.2., 4.6.8.5., AND SENTENCE 4.1.1.1.(1)

In the previous edition of the NFC published in 2010, there was a contradiction regarding fuel-dispensing stations and the application statement for Part 4 did not include dangerous goods classified as flammable gas.

Dangerous goods classified as flammable gases at fuel-dispensing stations were added to the application statement for Part 4. Changing the application statement in Sentence 4.1.1.1.(1) to include dangerous goods classified as flammable gas at fuel-dispensing stations clarifies the intent that these dangerous goods are to conform to Section 4.6.

The 2010 NFC did not require a valve to prevent an aboveground tank to siphon through a severed pipeline. However, Sentence 4.7.3.2.(2) requires an anti-siphon valve where aboveground storage tanks are used to supply dispensers, while Sentence 4.6.6.5.(5) requires an anti-siphon valve in marine fuel-dispensing stations as per Article 4.6.2.1. Industry recognized this safety issue and in many cases provided an anti-siphon valve despite the absence of a requirement. Clause 4.6.2.1.(4)(e) was added to require an external anti-siphon valve for aboveground storage tanks at fuel-dispensing stations.

Fuel-dispensing stations are exempt from meeting the requirements of Section 4.5. for piping and transfer systems except for piping material. However, many of the provisions of this Section are relevant for fuel-dispensing stations and their application reduces the risk of contamination of the soil and underground water source. In piping systems that transfer flammable and combustible liquids, the hazards associated with leaks, fire ignition, and explosion are the same regardless of whether the piping system is located in a fuel-dispensing station or elsewhere. As such, Article 4.6.2.3. now requires piping systems for fuel-dispensing stations to meet the appropriate requirements of Subsections 4.5.5. and 4.5.6. Sentence 4.6.4.1.(3) was added to require steel shut-off valves at connections on aboveground storage tanks to limit internal stresses and exposure of the valve, which could lead to failure of the valve.

With growing trends for alternate means of energy, Natural Gas Vehicles (NGV) have become increasingly more popular at self-service fuel dispensing stations. The NFC was silent when it came to emergency shut-off devices at dispensing stations for fuels other than flammable or combustible liquids. The application of Sentence 4.6.4.2.(1) was expanded to include

NGV using Compressed Natural Gas (CNG). This change clarifies the requirement for emergency shut-off devices at these dispensing stations.

Clause 4.6.8.5.(1)(g) adds a new requirement for an attendant supervising the fuel-dispensing stations to perform a visual inspection as per Article 4.5.10.5. The intent of this change is to limit the probability that exposed piping system defects or the escape of liquid will go unnoticed.

Training limits the probability of delays in shutting off the flow of liquid during an emergency, which could lead to the escape of liquid not being minimized. A new pointer to Article 4.5.10.2. was added in Sentence 4.6.8.9.(1) for training procedures.

LEAK DETECTION, ARTICLES 4.3.7.2., 4.3.7.4. AND TABLES 4.4.1.2.-B, 4.4.1.2-C

A reference to a withdrawn ULC standard related to secondary containment for aboveground storage tanks was removed in the NFC 2010. However, ULC Standards published CAN/ULC-S668, "Standard for Liners Used for Secondary Containment of Aboveground Flammable and Combustible Liquid Tanks." This standard meets the performance requirement of Sentence 4.3.7.2.(1) and the reference to this standard harmonizes the application of secondary containment across Canada (Figure 3). The reference to this standard is provided in Sentence 4.3.7.2.(2).

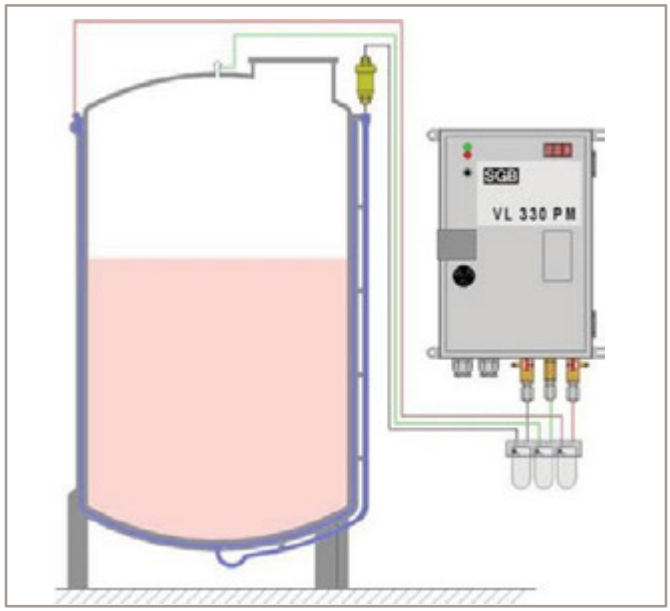


Figure 3: Leak detection

The 2010 NFC did not acknowledge and give credit for the fire protective features of aboveground storage tanks constructed in conformance with CAN/ULC-S655, "Standard for Aboveground Protected Tanks Assemblies for Flammable and Combustible Liquids," to waive the clearance requirements for secondary containment walls from a storage tank. CAN/ULC-S655 is now referenced in Sentence 4.3.7.4.(2) and the maximum capacity of a storage tank that could waive the clearance requirements is also raised from 50 000 L to 80 000 L based, in part, on CAN/ULC-S655.

Sentence 4.3.7.4.(3) was added to clarify that posts or guardrails for the protection of aboveground storage tanks must be installed whenever a storage tank is exposed to damage from collision. This requirement is not related to waiving the clearance between the tank and secondary containment walls specified in Sentence 4.3.7.4.(1).

In the 2010 NFC, there was confusion regarding the requirement for monitoring of double-walled piping systems in addition to leak detection monitoring of the sumps. A Note to Table 4.4.1.2.-B led to confusion regarding leak detection testing and monitoring for aboveground, single-walled storage tanks conforming to Subsection 4.3.7. Note (2) of Table 4.4.1.2.-B was updated to avoid confusion and help clarify that detection testing and monitoring is required for aboveground single-walled storage tanks conforming to Subsection 4.3.7.

The reference to sump monitoring in Table 4.4.1.2.-C of the 2010 NFC was removed and it was clarified that high-tech monitoring in accordance with Table 4.4.1.2.-E is deemed to meet the monitoring requirements. Double-walled underground piping installations can be monitored for leak detection when equipped with a spill containment sump that is monitored in accordance with Table 4.4.1.2.-E. Low-tech monitoring such as visual inspection of the interstitial space can be challenging in this application. For this reason, Note (6) of Table 4.4.1.2.-C was modified to indicate that high-tech monitoring of the interstitial space can be provided.

LABORATORIES, ARTICLES 2.8.2.5., 3.2.7.14., 5.5.3.4., 5.5.4.3., 5.5.5.2., 5.5.5.3, AND NOTES A-5.5.3.4.(1), A-5.5.5.1.(1)

In the 2010 NFC, there were no provisions requiring that the fire safety plan be posted in a location that could be used by emergency response personnel during an emergency operation. Providing ready access of the fire safety plan to the fire department and/or emergency responders during an emergency could significantly improve the response required by the presence of identified dangerous goods within fire compartments (including laboratories). Sentence 2.8.2.5.(3) now requires that the fire safety plan for a building or facility where dangerous goods are stored, used and handled be kept at the principal entrance to the building or the facility (Figure 4).

Figure 4: Mitigating measures

A change to clarify the requirements in Article 3.2.7.14. for placards identifying the presence of dangerous goods in laboratories was introduced in the 2015 NFC. The intent behind this provision is to ensure that the presence of dangerous goods is clearly stated upfront to people and emergency responders so that, in the event of release of dangerous goods either during normal operations or in a fire, proper safety measures are applied to protect the individuals being exposed or conducting emergency responses. Use of placards also helps emergency responders to assess the potential hazards and provide the appropriate measures to mitigate them.

With the expansion of the definition for dangerous goods to introduce controlled products under WHMIS, additional clarification was required to identify dangerous goods not classified under TDGR. Explanatory Note A-3.2.7.14.(1) was updated to clarify that placards conforming to the TDGR can be used to identify the hazards associated with dangerous goods only classified under the WHMIS.

Dangerous goods that are "in use" or stored in a fire compartment present some risk to people, emergency responders and the building in the event of a fire within a laboratory. A change was made to explanatory Note A-5.5.5.1.(1) to clarify that all dangerous goods in a laboratory, including the quantities that are "in use" during normal operations, are to be considered as per Sentence 5.5.5.1.(1).

The term "electrical equipment" used in Sentence 5.5.3.4.(1) was often considered to refer to a machine, rather than to include all equipment capable of generation, transformation, transmission, distribution, supply or utilization of electric power or energy. However, unrated equipment is used in hazardous locations where flammable vapours could be ignited from a spark and start a fire with potential impact on buildings and their occupants. The new explanatory Note A-5.5.3.4.(1) clarifies that electrical equipment manufactured on site needs to conform to CAN/CSA C22.2 No. 61010-1, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements," as required by the Canadian Electrical Code referenced in Sentence 5.5.3.4.(1).

Unless make-up air systems are designed and provided for each exhaust ventilation system, which may be independent for laboratories from the rest of the building, make-up air systems would be part of the air-handling system of the building, which is required to be interlocked with the fire alarm system in the event of detection of smoke within the ducting system. A fire that occurs away from a laboratory that actuates a fire alarm system would shut down exhaust-ventilated enclosures which could lead to the release of dangerous goods in the laboratories. Article 5.5.4.3. now exempts the ventilation system for a power-ventilated enclosure from the requirement to be interlocked with the fire detection, fire alarm or make-up air system.

Sentence 5.5.5.2.(3) introduces a new permission that allows the use of containers for the preservation of animal, human or plant specimens that contain flammable liquids or combustible liquids and that do not fit into traditional containers permitted in Subsection 4.2.3.

Cylinders of dangerous goods classified as compressed gases connected to equipment were previously not considered to count towards the volume in storage since these were classified as "in use." However, significant quantities of dangerous goods could be considered to be "in use." Article 5.5.5.3. was revised to clarify the use of compressed gases in a laboratory.

Specific measures to address hazards associated with dangerous goods classified as toxic gases and compressed gases of pyrophoric materials and adequately protect people using them and buildings and facilities in which they are used were lacking. Article 5.5.5.3. was revised to address these hazards (Figure 5).

Figure 5: Limitation of dangerous goods in laboratories

REUSE OF STORAGE TANKS, ARTICLES 3.1.2.4., 4.3.1.2., 4.3.1.10., AND NOTES A-3.2.7.5.(1)(C), A-4.3.1.2.(2)(B)

New Article 3.1.2.4. was added to address the physical and chemical stability of stored products that could be affected by the manner in which they are stored, i.e. height of storage, temperature, base area of a storage pile, type and construction of containers, etc. The qualification of stability in the new Article provides clarification on the intent of the provision and what factors would need to be taken into consideration in determining the method of storage.

Clause 3.2.7.5.(1)(c) sets the limitations for the maximum base area for the storage of dangerous goods. However, it was unclear whether the limitation applied to dangerous goods only or whether the packaging used to store them should be included in the base area. Explanatory Note A-3.2.7.5.(1)(c) was added to clarify that the intent is to include packaging used to store dangerous goods in the determination of the maximum base area.

The NFC did not have a reference document for atmospheric storage tanks that are constructed of a non-metallic material specifically designed for oil-burner fuels and other combustible liquids. A reference to ULC/ORD-C80.1, "Non-metallic Tank for Oil-Burner Fuels and Other Combustible Liquids," was added to Sentence 4.3.1.2.(1).

In the 2010 NFC, the application of API 12B, "Specification for Bolted Tanks for Storage of Production Liquids," API 12D, "Specification for Field Welded Tanks for Storage of Production Liquids," and API 12F, "Specification for Shop Welded Tanks for Storage of Production Liquids," was limited to tanks used for the storage of crude petroleum at oil fields. However, these tanks were used and found to be acceptable for the storage of many chemicals used in the exploration, production and transmission of petroleum. Changes were introduced in Sentence 4.3.1.2.(2) to permit these tanks to be used in other applications and requirements for emergency venting (Figure 6).

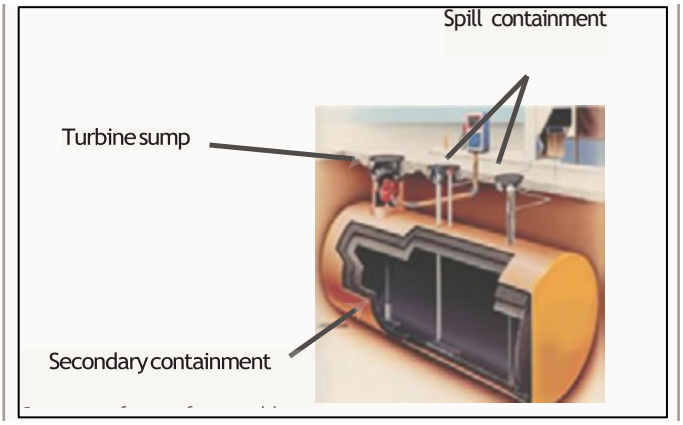


Figure 6: Storage tanks

MID-RISE COMBUSTIBLE CONSTRUCTION, SUBSECTION 5.6.3.

Recent fire loss events in Remy and Surrey in British Columbia as well as Rutherford in Edmonton triggered stringent requirements for construction and demolition sites for 5- and 6-storey combustible construction buildings.

The chosen protection measures address:

- arson and fires caused by smoking material (arson is the leading cause of fire on construction and demolition sites),
- firefighter response time (ability of the first responders to access the site, building, and upper floors, and to get water on the fire, etc.), and
- protection of adjacent properties.

In order to ensure additional specific measures are taken to address the inherent risk associated with the construction of 5- and 6-storey combustible construction buildings, new Subsection 5.6.3. was introduced in the 2015 NFC. It applies solely to buildings conforming to Articles 3.2.2.50. and 3.2.2.58. of Division B of the National Building Code.

OTHER CHANGES

Fire Alarm, Standpipe and Sprinkler Systems, Article 2.1.3.1.

The requirements for voluntarily installed fire protection systems outside of buildings were implied in the Appendix of the 2010 NFC. However, it could have been interpreted that voluntary systems installed in locations outside of buildings do not have to meet the required installation standards. In addition, the information in the Appendix was a non-enforceable portion of the Code.

An expansion of the requirement to install fire alarm, standpipe and sprinkler systems was added in Article 2.1.3.1. based on the philosophy outlined in explanatory Note A-6.1.1.2.(1).

Basement Storage, Article 4.1.5.8.

With some exceptions, basement storage of Class I liquids was restricted. The change introduced in Article 4.1.5.8. permits an increase to 10 L in the quantity of Class I liquids that can be stored in basements or pits. The intent of the change is to ensure that heavier than air flammable vapour would not accumulate in below grade areas. Article 4.1.5.8. was reorganized to distinguish between storage and use. Increasing the quantity that can be stored in a basement from 5 to 10 L for all occupancies (except mercantile) makes the requirements more consistent.

Control of Static Electric Charge, Sentence 4.1.8.2.(1)

The NFC was silent with respect to grounding to remove any static electrical charges that containers or tanks may have. A change was introduced that requires all metallic or electrically conducting material in the transfer system be grounded when Class I flammable liquids are dispensed from or into a container or storage tank. The intent of Sentence 4.1.8.2.(1) is to limit the probability that static electric charges will build up. Grounding connects two or more conducting objects to the ground with a conductor and diffuses static charges to earth.

Materials Provision for Expansion and Contraction, Article 4.5.2.1. and Sentence 4.5.6.14.(2)

Until recently, there was no available Canadian standard for the minimum construction requirements for metallic underground piping. CAN/ULC-S667, "Standard for Metallic Underground Piping for Flammable and Combustible Liquids," was introduced in the 2015 NFC. A product complying with or tested to CAN/ULC-S667 meets the performance requirements stated in Sentences 4.5.2.1.(1) and 4.5.6.14.(1).

Processing Buildings, Article 4.9.4.3.

The wording in the 2010 NFC was ambiguous and limited applicable protection measures to water-based automatic fire suppression systems. It also excluded any fire protection systems designed to control the propagation of a fire or to protect exposed equipment to structural damage and failure. A new requirement was added in Article 4.9.4.3. to perform a risk assessment in process plants in order to identify the applicable fire protection measures to minimize fires and explosions from occurring and mitigate the associated risks to operations.

Dust Collectors, Sentences 5.3.1.3.(2) and 5.3.1.4.(1)

There was a conflict in the Code where some provisions prohibited small enclosureless dust collectors with a capacity up to 2.36 m^3/s (5000 cfm) while other provisions inferred they are permitted via a reference to an NFPA Standard.

Small enclosureless dust collectors are common for small woodworking shops. NFPA has provisions that permit equipment with a capacity of up to 5000 cfm to be used. This served as the basis for updating Sentences 5.3.1.4.(1) and 5.3.1.3.(2). Sentence 5.3.1.3.(2) now requires a dust-collecting system to be installed in conformance with "good engineering practice" with the intent of giving Code users the flexibility of the approach to be used.

Special Processes Involving Flammable and Combustible Liquids and Materials, Section 5.4.

The NFC was not clear on how to address ethanol production. New Subsection 5.4.7. was added in Part 5 to address ethanol production for fuel activities. The new requirements are intended to clarify the applicable Code requirements for the design, construction and safety requirements of these additional processes (Figure 7).

Figure 7: Production of ethanol for fuel

Portable Extinguishers, Article 5.6.1.5.

The portable extinguishers that were required in the 2010 NFC for construction and demolition sites were not commonly used and were not readily available in Canada. In addition, they may not have been sized appropriately to address the hazards found on a construction or demolition site.

The size of portable extinguishers was increased on moveable equipment for construction and demolition sites. In addition, portable extinguishers are now required in designated smoking areas.

Fire Drills in Laboratories, Article 2.8.3.2. and Sentence 5.5.3.1.(2)

In the 2010 NFC, all requirements for fire drill frequencies were included in Article 2.8.3.2., except the ones for laboratories. To keep requirements for fire drill frequencies in one Article, provisions for fire drill frequencies found in Sentence 5.5.3.1.(2) for laboratories were moved to Article 2.8.3.2.

Fire and Smoke Dampers Inspection and Maintenance, Sentence 2.2.2.4.(5)

In the 2010 NFC, the requirements for closure inspection and maintenance provided little guidance on the proper testing of fire dampers and fire stop flaps. The reference to NFPA 80, "Standard for Fire Doors and Other Opening Protectives," was added in Sentence 2.2.2.4.(5) to provide a clear description of the requirements for testing and maintenance other than visual inspections.

Integrated Systems Testing, Article 6.8.1.1.

The 2010 NFC had provisions on the commissioning of integrated fire protection and life safety systems, but they were silent on how this testing must be done. In addition, the term "commissioning" may have been misleading relative to the intent of the NFC and within the commissioning community. The 2015 NFC now refers to a new national standard of Canada developed to address these tests and the term "commissioning" was replaced by "integrated systems testing." The Code community now has access to CAN/ULC-S1001, "Integrated Systems Testing of Fire Protection and Life Safety Systems," which provides the methodology for verifying and documenting that interconnections between building systems satisfy the intent of their design and that the systems function as intended by the Code.

Mass Notification Systems, Note A-2.8.2.1.(1)

Many campuses and facilities are invoking mass notification systems to address events outside of fire (e.g. bomb threats, gas leaks, intruder alerts, etc.). The explanatory Note A-2.8.2.1.(1) was enriched to raise awareness for the users and regulators to consider the procedures and messaging so as to not contradict the life and fire safety systems.

Maintenance of Exit Signs, Article 6.5.1.8.

The wording in the 2010 NFC did not properly address recent changes in exit sign technology, and did not state requirements for periodical inspection of exit signs.

New Article 6.5.1.8. was added to the 2015 NFC to state the inspection interval to ensure that the exit signs will be visible upon failure of the primary power supply.

Obstruction of Exterior Exit Doors, Article 2.7.1.8.

Some exterior exit doors are difficult to recognize from outside the buildings. Adjacent storage or parking may occur and obstruct these doors, delaying or impeding occupants from evacuating the building. The 2015 NFC requires that, where an exit door leading directly to the outside is subject to being obstructed by parked vehicles or storage because of its location, a visible sign or a physical barrier prohibiting such obstructions be installed on the exterior side of the door. This new requirement applies to existing and new buildings.

National Plumbing Code

National Plumbing Code

Outline
This material highlights changes to the National Plumbing Code and covers the following topics:

- Low Lead
- Stainless Steel
- Water-use Efficiency

LOW LEAD – INTERIM CHANGE

The ill effects of exposure to lead on human health have been well known for decades. These can vary and may include cardiovascular problems, decreased kidney functions, and may lead to other health issues in children.

With the requirements for lead content in American jurisdictions having been made more stringent, the need to limit the lead content for plumbing fittings in Canada was therefore recognized. Since this issue was being addressed by standards development organizations, the duplication of requirements in the National Plumbing Code (NPC) was not warranted.

Referenced Standards, Articles 2.2.10.6., 2.2.10.7. and 2.2.10.10.

CSA B125.3, "Plumbing Fittings," and ASME A112.18.1/B125, "Plumbing Supply Fittings," which are referenced in the previous edition of the NPC published in 2010 for the performance of plumbing fittings and supply fittings, respectively, have been updated to include requirements and definitions for low-lead content fittings.

In an effort to harmonize requirements across North American jurisdictions, and include requirements for low lead content fittings, references to the 2012 editions of CSA B125.3 and ASME A112.18.1/B125 were published as an interim change to the 2010 NPC.

STAINLESS STEEL

The use of stainless steel piping has become an acceptable industry practice with more and more buildings being constructed using this material in the plumbing system. In addition, stainless steel is accepted in many Canadian jurisdictions.

Requirements for stainless steel as a plumbing material were therefore added to better reflect current industry practice. Omitting such requirements could lead to enforcement issues when assessing building compliance and, in some jurisdictions, could exclude stainless steel from being installed in buildings all together.

A number of new requirements were therefore added.

Stainless Steel Piping, Subsection 2.2.6.

To help ensure adequate levels of performance of stainless steel plumbing systems, references to a number of standards were added for the performance of tubing, piping, fittings and flanges. These standards address parameters such as pipe wall thickness, dimensional tolerances, heat treatment temperatures, and chemical composition, to help avoid potentially costly failures and leaks of plumbing system components.

Figure 1: Stainless steel is now permitted as a plumbing material

Stainless Steel Pipe, Article 2.2.6.11.

Requirements were added mandating that stainless steel pipes conform to:

- ASME B36.19M, "Stainless Steel Pipe," and
- ASTM A 312/A 312M, "Standard Specification for Seamless, Welded, and Heavily Cold Worked Stainless Steel Pipes."

Only grades 304/304L or 316/316L of stainless steel are permitted for use in a water system. This is to help ensure a system with adequate performance (reduction in pitting/corrosion) and a system that is safe for potable applications.

Stainless Steel Butt Weld Pipe Fittings, Article 2.2.6.12.

Requirements were added mandating that stainless steel butt weld pipe fittings conform to:

- ASME B16.9, "Factory-Made Wrought Buttwelding Fittings," and
- ASTM A 403/A 403M, "Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings."

To ensure a system with homogeneous chemical composition, the grade of the butt weld pipe fittings must match that of the pipe material used.

Stainless Steel Pipe Flanges, Article 2.2.6.13.

Requirements were added mandating that stainless steel pipe flanges conform either to:

- ASME B16.5, "Pipe Flanges and Flanged Fittings: NPS ½ Through NPS 24 Metric/Inch Standard," and ASTM A 182/A 182M, "Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service," or
- AWWA C228, "Stainless-Steel Pipe Flanges for Water Service – Sizes 2 in. through 72 in. (50 mm through 1,800 mm)."

To ensure a system with homogeneous chemical composition, the grade of the butt weld pipe fittings must match that of the pipe material used.

Stainless Steel Threaded Fittings, Article 2.2.6.14.

Requirements were added mandating that stainless steel threaded fittings conform either to:

- ASTM A 182/A 182M, "Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service," or
- ASTM A 351/A 351M, "Standard Specification for Castings, Austenitic, for Pressure-Containing Parts."

To ensure a system with homogeneous chemical composition, the grade of the threaded fittings must match that of the pipe material used.

Stainless Steel Tube, Article 2.2.6.15.

Requirements were added mandating that stainless steel tubing conforms to:

- ASME B16.9, "Factory-Made Wrought Buttwelding Fittings," and
- ASTM A 269, "Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service."

Only grades 304/304L or 316/316L of stainless steel are permitted for use in a water system. This is to help ensure that the plumbing system will have adequate performance (reduction in pitting/corrosion) and will be safe for potable applications.

Allowable Uses of Stainless Steel Piping and Tubing, Article 2.2.6.16.

Restrictions were placed on where stainless steel tubing is permitted to be used in the building; it can only be used on water distribution systems underground and above-ground. Stainless steel tubing is not permitted to be used for the building sewer, the drainage system or the venting system.

These requirements are presented in tabular format as duplicated in Table 1.

Table 1. Permitted uses of stainless steel pipe and tube

Stainless Steel Pipe or Tube	Plumbing Purposes						
	Water Distribution System		Building Sewer	Drainage System		Venting System	
	Underground	Aboveground		Underground	Aboveground	Underground	Aboveground
Stainless steel pipe	P	P	P	P	P	P	P
Stainless steel tube	P	P	N	N	N	N	N
P = Permitted N = Not Permitted							

Stainless Steel Welded Joints, Article 2.3.2.8.

To limit the failure of stainless steel welded joints caused by poor workmanship or design, joints must conform to ASME B31.9, "Building Services Piping." This standard specifies, amongst other requirements, that joints be welded by a qualified tradesperson.

Also, butt weld pipe fittings must be at least as thick as the wall of the pipe used to ensure sufficient strength.

Support of Stainless Steel Piping and Tubing, Article 2.3.4.3. and Table 2.3.4.5.

To help reduce the risk of galvanic corrosion, when hangers or supports of stainless steel pipes or tubes are of a material other than stainless steel, they must be separated and electrically insulated from the pipe or tube. No such additional considerations are needed for stainless steel supports or hangers supporting stainless steel piping.

To ensure adequate support of stainless steel piping and tubing, maximum horizontal spacing was specified. Requirements vary by pipe/tube diameter.

Figure 2: Stainless steel support and pipe – insulation not required

WATER-USE EFFICIENCY

New mandatory requirements for water-use efficiency were added to the 2015 edition of the NPC.

Mandatory requirements limiting the maximum amount of water used by plumbing fixtures and fixture fittings were developed. Mandatory requirements, as the term implies, are requirements that must be followed; for example, limiting the water per flush of urinals.

Choosing Water-Use Efficiency Requirements

The water-use efficiency performance levels were chosen to reflect the market direction. Since the NPC is a minimum Code, its requirements cannot be so stringent that they exclude a significant portion of available products on the Canadian market.

The water-use efficiency requirements were chosen after a careful review of various standards, Codes, product labeling programs, and provincial/territorial requirements. They were also incorporated in the NPC to ensure national regulatory harmonization.

Overall, the performance levels were chosen to improve the water-use efficiency performance of installed products while ensuring that the incremental cost of compliant fixtures and fixture fittings is not significantly higher than the cost of non-compliant products.

New Objectives for Water-Use Efficiency and New Functional Statements, Division A, Sections 2.2. and 3.2.

Code requirements relate to at least one objective, which means that the purpose or goal of a requirement must be stated. The previous edition of the NPC had objectives related to safety, health and the protection of the building or facility from water and sewage damage. Absent from this list was an objective for water usage. Therefore, before requirements related to water-use efficiency could be added, corresponding objectives and sub-objectives were needed.

The new objective and sub-objectives are stated as follows.

OE Environment
An objective of this Code is to limit the probability that, as a result of the design or installation of the plumbing system, the environment will be affected in an unacceptable manner.

OE1 Resources
An objective of this Code is to limit the probability that, as a result of the design or installation of the plumbing system, resources will be used in a manner that will have an unacceptable effect on the environment. The risks of unacceptable effect on the environment due to use of resources addressed in this Code are those caused by— OE1.2 - excessive use of water

Associated with the objectives of the National Model Construction Codes are functional statements. Functional statements are more detailed than the objectives and describe conditions of the plumbing system that help satisfy the objectives.

The following two new functional statements related to water-use efficiency were added.

F130 To limit the unnecessary demand and/or consumption of water for fixtures.

F131 To limit the unnecessary demand and/or consumption of water for fittings.

Flushing Devices, Article 2.6.1.6.

Mandatory water-use efficiency requirements for plumbing fixtures specify the maximum water usage per flush cycle, in litres per flush, for water closets and urinals (Table 2).

Table 2. Water use efficiency requirements added for urinals and water closets

Table 2.6.1.6.
Water Usage per Flush Cycle
Forming Part of Sentence 2.6.1.6.(3)

Fixtures	Maximum Water Usage per Flush Cycle, Lpf
Water closets – residential	
single-flush	4.8
dual-flush: 6.0/4.1 Lpf	4.8
Water closets – industrial, commercial, institutional	6.0
Urinals	1.9

Flush-tank-type urinals must be capable of preventing flush cycles when not in use. However, when these urinals are not in use for an extended period of time, such as those in seasonal buildings, flush-tank-type urinals are permitted to be set up to flush automatically at predetermined intervals. Automatic flushing prevents the depletion of the water seal due to evaporation or backflow conditions.

For retrofits of water closets in residential buildings, less stringent water usage is permitted where it can be shown that the more stringent residential water closet requirements for new buildings would be impractical given the existing building or the municipal infrastructure

Supply Fittings and Shower Heads, Article 2.2.10.6.

Also new to the 2015 NPC are water-use efficiency mandatory requirements for plumbing supply fittings and shower heads (Table 3). Maximum water usage in litres per minute are specified for lavatory supply fittings, kitchen supply fittings and shower heads. It is important to note that these new requirements do not apply to lavatories in health care facilities, emergency eye washes and emergency showers since these applications are often required to have higher flow rates to serve their intended uses.

Similarly, each lavatory in a public washroom must be equipped with a device capable of automatically shutting off the flow of water when the lavatory is not in use. This is to help prevent the discharge of water when the lavatory is not in use.

Table 3. Water flow rates added for supply fittings and shower heads

Table 2.2.10.6.
Water Flow Rates from Supply Fittings
Forming Part of Sentence 2.2.10.6.(2)

Supply Fittings	Maximum Water Flow Rate, L/min
Lavatory supply fittings	
private	5.7
public	1.9
Kitchen supply fittings (except those in industrial, commercial or institutional kitchens)	8.3
Shower heads	7.6

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