Radon Gas

Question?
What type of pipe must be used when relocating the vent to a non-centralized location below the slab?
In the absence of specific requirements for the type of piping, provided the piping is 100mm in diameter, opens at or near the centre of the slab as specified by Division B Clause 9.13.4.3.(3)(b) and meets Division A Article 1.2.2.1. (The piping meets the requirements to be used sub surface in contact with soil or has a CCMC evaluation report) the piping would be acceptable.

Alberta Municipal Affairs Staff have spoken with Technical staff at the NRC regarding the use of perforated piping. It was stated perforated pipe can be used and may be more preferred as it permits more entry points for extraction should the end become clogged or if water was present.

The NRC – NBC 2010 Part 9 users guide has also been reviewed and the document also speaks to the use of perforated pipe being permitted in this application.

Therefore, perforated pipe (weeping tile), or solid pipe (PVC) could be used for this installation.

Background Information:
2014 Alberta Building Code requirements
9.13.4.3. Providing for the Rough-in for a Subfloor Depressurization System
1) Floors-on-ground shall be provided with a rough-in for subfloor depressurization consisting of
a) a gas-permeable layer, an inlet and an outlet as described in Sentence (2), or
b) clean granular material and a pipe as described in Sentence (3).

3) The rough-in referred to in Clause (1)(b) shall include
a) clean granular material installed below the floor-on-ground in accordance with Sentence 9.16.2.1.(1), and
b) a pipe not less than 100 mm in diameter installed through the floor, such that
i) its bottom end opens into the granular layer required Clause (a) at or near the centre of the floor and not less than 100 mm of granular material projects beyond the terminus of the pipe measured along its axis (see A-9.13.4.3.(2)(b) and (3)(b)(i) in Appendix A),
ii) its top end permits connection to depressurization equipment and is provided with an airtight cap, and
iii) the pipe is clearly labelled near the cap and, if applicable, every 1.8 m and at every change in direction to indicate that it is intended only for the removal of radon from below the floor-on-ground.
A-9.13.4.3.(2)(b) and (3)(b)(i) Effective Depressurization. To allow effective depressurization of the space between the air barrier and the ground, the extraction opening (the pipe) should not be blocked and should be arranged such that air can be extracted from the entire space between the air barrier and the ground. This will ensure that the extraction system can maintain negative pressure underneath the entire floor (or in heated crawl spaces underneath the air barrier). The arrangement and location of the extraction system inlet(s) may have design implications where the footing layout separates part of the space underneath the floor.

Illustrated Users Guide – NBC 2010 Part 9 Housing and Small Buildings
9.13.4. Soil Gas Control
9.13.4.3. Providing Rough-in for a Subfloor Depressurization System
"The extraction opening (the pipe) should not be blocked and should be arranged such that air can be extracted from the entire space between the air barrier and the ground. This will ensure that the extraction system can maintain negative pressure underneath the entire floor (or in heated crawl spaces underneath the air barrier). Locating the capped pipe near the center of the floor might restrict floor layout options. If it is desired to locate the pipe rough-in close to an exterior wall or into a service area of a basement, perforated pipe can be used to connect the vertical pipe to the center of the floor. If the subfloor space is interrupted by internal footings, it is important to ensure that the collection system is capable of depressurizing all areas should this become necessary."

Response from NRC
Provided by Bruce Schultz, City of Calgary

Please see attached response from NRC and the illustration below.

The illustration below is an attachment provided by NRC regarding the use of perforated pipe. This drawing identifying perforated pipe as an acceptable pipe to be used below a slab, and provides clarity to the misunderstanding provided by the previous illustrations within the Appendix of the ABC, which depict solid piping.
Reducing Levels in Existing Homes: A Canadian Guide for Professional Contractors
Chapter 5: Mitigation of Exposed Soil
5.2 Sub-Membrane Depressurization
.... "An alternative to a concrete slab is a flexible membrane. This can be maneuvered into areas where the headroom is low and spread over the soil. Perforated piping or porous material is placed on the soil to ensure the fan suction is distributed to the edges of the membrane and acts as the gas collector.

Chapter 9: Fan and Piping Installation

9.6 Piping

The preferred piping is solvent welded 100 mm Schedule 40 PVC or ABS. This is used for domestic drain, waste and vent plumbing, and the pipe, fixtures, and the skills to install the piping are readily available. A lighter Schedule 20 pipe is available, and is satisfactory where the pipe is unlikely to be damaged. The Plumbing Code can be used as a guide to installation.

References from Other Provinces

British Columbia
Safety Services Branch - Information Bulletin
Question 3: Can I use perforated pipe below the air barrier system?
Answer: Yes, you may have multiple inlets on the same radon vent pipe and the perforations act as inlets. The material that serves as the gas permeable layer should project beyond the perforations to facilitate effective depressurization. The pipe must be sealed where it penetrates the air barrier system to maintain its integrity and must be air tight from that joint until termination.
October 28, 2015

Mr. Bruce G Schultz  
Codes Officer  
City of Calgary  
2 Easterbrook Place  
Airdrie, AB  
T4B 2H2

Re: Rough-in for subfloor depressurization system; specifically type of pipe to be installed

Dear Mr. Schultz:

Thank you for your inquiry.

Your question:

This article refers to a pipe that is required to be installed under the concrete floor slab in a house. I understand that the material the pipe is made of if is not specified and not a factor. However, the question has arisen of whether or not the pipe has to be solid or can be perforated. The NRC Illustrated Guide to Part 9 states that it can be perforated to connect the pipe from the center of the floor to the vertical section penetrating the floor. The question then is why does the pipe have to terminate at the center of the floor if it can be perforated? If the pipe is solid and terminates at the center of the area of the slab then it will draw equally from all areas under the slab. If the pipe is perforated it will draw more from the immediate area of the pipe and very little from the further distances. There is also less logic for it to extend to the center of the floor slab area. If the pipe is permitted to be perforated could you please provide the logic for this to assist in our interpretation and application of this article with contractors.

Canadian Codes Centre response:

We acknowledge that the wording in the Illustrated User's Guide – NBC 2010, Part 9 Housing and Small Buildings is not consistent with the illustration and leaves room for interpretation when it comes to the use of perforated pipe. Thank you for bringing this matter to our attention. We will note this for the next round of technical updates to the illustrated guide.

Perforated pipes are often used by radon mitigators as a collection loop (around the perimeter of the foundation a few feet in from the edge), while solid pipes are typically used to connect the collection pipes or pit with the vertical rough-in (see attached figure taken from the draft CAN CGSB-149, "Radon Control Options for New Low-Rise Residential Construction.")

Having said that, it is worth noting that while using perforated pipe for the connection between a “central” suction pit and the rough-in (as illustrated in the illustrated guide) might make a small (but difficult-to-quantify) difference in where the radon is being collected, it will still
work sufficiently well – knowing that the prescriptive construction with gravel is slightly over
designed and that the fans used in radon mitigations are often more powerful than needed.

The views expressed in this response are those of the staff of the Canadian Codes Centre from the
National Research Council Canada, Construction, who assists the committees that are responsible
for the preparation of the National Model Codes. These views should not be considered as official
interpretations of legislated requirements based on the National Building Code, the National Fire Code,
the National Plumbing Code, or the National Energy Code for Buildings. The final responsibility for an
official interpretation rests with the authority having jurisdiction.

Regards,

Morched Zeghal
Technical Advisor, Canadian Codes Centre/NRC Construction
1200 Montreal Road, Bldg. M-23A, 2nd Flr.
Ottawa, Ontario K1A 0R6
www.nationalcodes.nrc.gc.ca

Enc.
Radon Gas – Pipe Blockages

Question?
Are Building SCO’s seeing pipe blockages in the field, and are they asking for these blockages to be removed?

The intent of the requirements as set out under Article 9.13.4. is to ensure that depressurization from below the slab can be achieved if / when a radon mitigation system is installed.

Although the sentences within the legislation do not specifically address the removal of blockages, the Appendix notes as well as the NBC User’s Guide, provide guidance that the pipe openings should not be blocked and should be arranged such that air can be extracted from the entire space between the air barrier and the ground.

Therefore, it would seem appropriate that an SCO should be enforcing the intent of the ABC, and asking for blockages to be removed.

Background Information:
2014 Alberta Building Code
9.13.4.3. Providing for the Rough-in for a Subfloor Depressurization System (See Appendix A.)
1) Floors-on-ground shall be provided with a rough-in for subfloor depressurization consisting of
   a) a gas-permeable layer, an inlet and an outlet as described in Sentence (2), or
   b) clean granular material and a pipe as described in Sentence (3).
2) The rough-in referred to in Clause (1)(a) shall include
   a) a gas-permeable layer installed in the space between the air barrier and the ground to allow
      the depressurization of that space,
   b) an inlet that allows for the effective depressurization of the gas-permeable layer (see A-9.13.4.3.(2)(b) and (3)(b)(i) in Appendix A), and
   c) an outlet in the conditioned space that
      i) permits connection to depressurization equipment,
      ii) is sealed to maintain the integrity of the air barrier system, and
      iii) is clearly labelled to indicate that it is intended only for the
          removal of radon from below the floor-on-ground.
3) The rough-in referred to in Clause (1)(b) shall include
   a) clean granular material installed below the floor-on-ground in accordance with Sentence
      9.16.2.1.(1), and
   b) a pipe not less than 100 mm in diameter installed through the floor, such that
      i) its bottom end opens into the granular layer required Clause (a) at or near the centre of the
          floor and not less than 100 mm of granular material projects beyond the terminus of the pipe
          measured along its axis (see A-9.13.4.3.(2)(b) and (3)(b)(i) in Appendix A),
      ii) its top end permits connection to depressurization equipment and is provided with an airtight
          cap, and

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iii) the pipe is clearly labelled near the cap and, if applicable, every 1.8 m and at every change in direction to indicate that it is intended only for the removal of radon from below the floor-on-ground.

A-9.13.4.3.(2)(b) and (3)(b)(i) Effective Depressurization.
To allow effective depressurization of the space between the air barrier and the ground, the extraction opening (the pipe) should not be blocked and should be arranged such that air can be extracted from the entire space between the air barrier and the ground. This will ensure that the extraction system can maintain negative pressure underneath the entire floor (or in heated crawl spaces underneath the air barrier). The arrangement and location of the extraction system inlet(s) may have design implications where the footing layout separates part of the space underneath the floor.

2010 NBC User's Guide
9.13.4.3. Providing the Rough-In for Subfloor Depressurization Systems
....The extraction opening (the pipe) should not be blocked and should be arranged such that air can be extracted from the entire space between the air barrier and the ground. This will ensure that the extraction system can maintain negative pressure underneath the entire floor (or heated crawl spaces underneath the air barrier).
.......If the subfloor space is interrupted by internal footings, it is important to ensure that the collection system is capable of depressurizing all areas should this become necessary....
Existing Secondary Suites

Question?
What Constitutes an Existing Secondary Suite? If a secondary suite has been recognized by the local municipality for years, but without the necessary building permits in place, how should these existing secondary suites be reviewed by the Building SCO?

An “existing” secondary suite is one that is occupied and has been deemed compliant with the requirements of the Alberta Building Code, or in compliance with the 2014 Alberta Fire Code.

For suites which have been in existence for some time, and an SCO can confirm that this is the case, i.e. through taxation records etc. it would be acceptable to require permitting and acceptance to the 2014 AFC requirements, rather than the 2014 ABC.

2014 AFC
2.16.1.1. Application
2.16.2. General
2.16.1. Scope
2.16.1.1. Application
1) Except as provided in Sentence (2), secondary suites shall conform to the requirements of the ABC.

2) Secondary suites that existed on or before 31 December 2006 shall conform to the requirements of Subsection 2.16.2.

2.16.2. General
2.16.2.1. Height of Rooms and Spaces
1) Unless acceptable to the authority having jurisdiction, the height of rooms or spaces in a secondary suite over the required minimum area in accordance with Table 9.5.3.1. of Division B of the ABC shall be not less than 1.95m.

2.16.2.2. Bedroom Windows
1) Except as permitted in Sentence 9.9.10.1.(1) of Division B of the ABC, each bedroom within a secondary suite shall have at least one outside window that meets the requirements of Articles 9.7.1.2. and 9.7.1.3. of Division B of the ABC.

2.16.2.3. Exit Stairs
1) Exit stairs shall have a clear width of not less than 860 mm.

2.16.2.4. Landings
1) Landings for stairs shall be at least as wide as the stairs and not less than 900 mm in length.

2.16.2.5. Handrails and Guards
1) Handrails and guards shall conform to the requirements of Subsections 9.8.7. and 9.8.8. of Division B of the ABC.
2.16.2.6. Public and Exit Corridor Width
1) The clear width of every public corridor and exit corridor shall be not less than 860 mm.

2.16.2.7. Unenclosed Exterior Stair or Ramp
1) Where an unenclosed exterior exit stair or ramp provides the only means of egress from a secondary suite and is exposed to the hazards of fire from unprotected openings in the exterior wall of another dwelling unit, the openings shall be protected in conformance with Articles 9.10.13.5. and 9.10.13.7. of Division B of the ABC.

2.16.2.8. Exit Doors
1) Every exit door or door that provides access to exit from a secondary suite shall be
   a) not less than 1 980 mm high,
   b) not less than 810 mm wide, and
   c) permitted to swing inward.

2.16.2.9. Means of Egress
1) Except as permitted in Sentence (2), each dwelling unit shall be provided with at least one
   exit that leads directly to the outside.
2) Dwelling units may share a common exit meeting the requirements of Article 2.16.2.10.

2.16.2.10. Protection of Exits
1) Every exit, other than an exit doorway, shall be separated from adjacent floor areas by not
   less than one layer of 12.7 mm thick gypsum wallboard or equivalent material on each side of
   the walls. (See Appendix A.)

2.16.2.11. Dwelling Unit Separations
1) Dwelling units shall be separated from each other by not less than one layer of 12.7 mm thick
   gypsum wallboard or equivalent material on the ceiling and on each side of the walls.

2.16.2.12. Protection of Public Corridors
1) A public corridor shall be separated from the remainder of the building by not less than one
   layer of 12.7 mm thick gypsum wallboard or equivalent material on each side of the walls.

2.16.2.13. Furnace Room Separations
1) A furnace room shall be
   a) separated from the remainder of the building by not less than one layer of 12.7 mm thick
      gypsum wallboard or equivalent material on the ceiling and on each side of the walls, or
   b) protected by an automatic sprinkler system using up to nine heads with no isolation valve
      between the heads and the domestic water supply designed and installed by a journeyman
      plumber or sprinkler fitter.
2) A door shall be provided to each furnace room.

2.16.2.14. Heating and Ventilation Systems
1) For an existing secondary suite, a single heating and ventilation system may be used to serve
   both the secondary suite and main dwelling unit.

2.16.2.15. Smoke Alarms
1) Smoke alarms conforming to CAN/ULC-S531, “Smoke-Alarms,” shall be installed in accordance
   with Subsection 9.10.19. of Division B of the ABC in each dwelling unit.
2) Smoke alarms shall be installed by permanent connections to an electrical circuit and, when
   acceptable to the authority having jurisdiction, the interconnection of smoke alarms can either
be hard wired or wireless so that activation of one smoke alarm will cause all alarms within both
dwelling units to sound. (See Appendix A.)
3) Smoke alarms shall be installed in areas that are common to both dwelling units and
connected in conformance with Sentence (2).

2.16.2.16. Carbon Monoxide Alarms
1) Carbon monoxide alarms conforming to CSA 6.19, "Residential Carbon Monoxide Alarming
Devices," shall be installed in accordance with Sentence 9.32.3.9.(2) of Division B of the ABC in
the primary and secondary dwelling units.
2) Carbon monoxide alarms shall be installed by permanent connections to an electrical circuit
and interconnected so that the activation of one carbon monoxide alarm will cause all alarms
within both dwelling units to sound. (See Appendix A.)
3) Carbon monoxide alarms shall be installed in areas that are common to both dwelling units
and connected in conformance with Sentence (2).

2.16.2.17. Inspection, Testing and Maintenance of Smoke Alarms and Carbon Monoxide
Alarms
1) Smoke alarms and carbon monoxide alarms required by this Section shall be inspected,
tested and maintained in conformance with the manufacturer's instructions.
SECONDARY SUITES

DISCUSSION
Section 9.37. of the Alberta Building Code 2006 deals with situations where a new secondary suite will be added to a new house at the time of construction or to an existing house as a renovation. Questions have been raised concerning the application of the Alberta Fire Code 2006 for secondary suites that existed prior to December 31, 2006.

For a secondary suite that existed prior to December 31, 2006, if a homeowner takes out a building permit to perform work in this particular secondary suite, is it required to upgrade every aspect of the secondary suite to the current requirements in the Alberta Building Code?

INTERPRETATION
The answer to the question is “No”. The homeowner would be permitted to only perform the work necessary to ensure that the existing secondary suite meets the requirements of the Alberta Fire Code without having to meet all of the requirements stipulated under Section 9.37. of the Alberta Building Code 2006.

For example, a homeowner with a secondary suite that existed prior to December 31, 2006 would not have to install a separate heating system (current requirement from the Building Code) if all they are doing is upgrading their bedroom window sizes or installing new smoke alarms. For details on situations involving the upgrading requirements for existing secondary suites, please refer to STANDATA_FCI-08-07 issued under the Alberta Fire Code.

This INTERPRETATION is applicable throughout the province of Alberta.
Secondary Suites

Issue:

Questions have been raised concerning the application of the Alberta Fire Code (AFC) to existing secondary suites prior to December 31, 2008.

The secondary suite requirements from the AFC come into force on December 31, 2008 and apply to existing buildings. These amendments apply to a dwelling unit that contains living accommodations being used as a secondary or basement suite.

Requirements in the Alberta Building Code for secondary suites have been adopted and came into force on December 31, 2006, and apply to all new construction.

Interpretation:

This Interpretation Bulletin supports the intent to give owners of existing secondary suites time to bring their properties into compliance with the AFC requirements; however, the provisions of the Safety Codes Act also give the authority having jurisdiction discretionary powers to alleviate any safety concerns they may have with existing secondary suites. Some or all of the secondary suite requirements from the AFC may be used to bring an existing secondary suite to an acceptable level of safety prior to the December 31, 2008 effective date.

It should be noted that owners are responsible to obtain any necessary permits issued by the authority having jurisdiction for construction or renovation approvals. Municipalities should apply the AFC requirements as a minimum standard to upgrade existing secondary suites. These requirements are not intended to be used for major renovation or retrofit projects where other Codes may apply.

Additional Information:

Anyone requiring further information can contact Safety Services at 1-866-421-6929.

For details on requirements pertaining to the upgrading of secondary suites in existing buildings, please refer to the AFC.
Off-Site Reviews

Question?
How and when will CSA A277, “Procedures for factory Certification of Buildings” be applied, and who will monitor for compliance?
The CAN/CSA-A277 standard is enforceable as of May 1, 2015. Factory buildings constructed after this date are required to meet the CSA-A277 standard.

Factory constructed buildings shall be certified in accordance with CSA A277, “Procedure for Factory Certification of Buildings,”

A-1.1.1.1.(2) Factory-Constructed Buildings
Third-party certification agencies conduct periodic audits of the manufacturing plants, review the building plans, inform the manufacturer of deficiencies, and distribute labels.

Organizations have been accredited for the purpose of providing the auditing of manufacturers by the Standards Council of Canada.

A-1.1.1.1.(2) Factory-Constructed Buildings
The labelling program for manufactured homes is a cooperative effort between Alberta Municipal Affairs and third-party certification agencies accredited by the Standards Council of Canada. Third-party certification agencies conduct periodic audits of the manufacturing plants, review the building plans, inform the manufacturer of deficiencies, and distribute labels.

Background Information:
2014 Alberta Building Code requirements
2.4.5. Off-Site Review
2.4.5.1. Factory-Built Assemblies
1) Where a component of a building is assembled off the building site in such a manner that it cannot be reviewed on site, off-site reviews shall be carried out to determine compliance with this Code.

2) Except as provided in Sentence (3), factory-constructed and other off-site-constructed buildings that are constructed after 01 May 2015 shall be certified in accordance with CSA A277, “Procedure for Factory Certification of Buildings,” by an organization accredited for this purpose by the Standards Council of Canada, to confirm that the building complies with the technical requirements, or objectives and functional statements, of this Code.
Trailers on F2 Sites

Question?
Take an F-3 building with a wall some 150 feet long by 24 feet high = 3600 square feet. With a typical metal building the exterior walls are metal & insulation which provided no fire rating so the imaginary centre for this building to another structure would be some 70 feet.

If the existing building is classified as and F-2 occupancy the imaginary centre line would be 90 feet for the same size wall.

Now with the fire department unable to respond within ten minutes these measurements must be doubled (140 feet & 180 feet)

Now we must take into consideration the trailer limiting distances that will be putting the units on the neighbours property. Limiting distances are determined by the distances between the building and either:
1) the property line,
2) the centerline of a public thoroughfare, or
3) an imaginary line between buildings.

Although heat flux from buildings on neighboring properties can be a consideration during fires, limiting distances are taken from the three options stated above, and are not required to review the locations of buildings on neighboring properties.

The ABC also permits the use of creating a single imaginary building from two separate buildings on the same property. In these situations, the total building footprint area, would be included in the calculations for determining exposing building face.

Background Information:

2014 Alberta Building Code requirements
9.10.14.3. Limiting Distance and Fire Department Response
1) Except for the purpose of applying Sentences 9.10.14.4.(2), (3), (8) and (9), and Sentences 9.10.14.5.(3), (8) and (12), a limiting distance equal to half the actual limiting distance shall be used as input to the requirements of this Subsection, where
a) the time from receipt of notification of a fire by the fire department until the first fire department vehicle capable of beginning suppression activities arrives at the building exceeds 10 min in 10% or more of all calls to the building, and
b) any storey in the building is not sprinklered. (See A-3.2.3. and A-3.2.3.1.(8) in Appendix A.)

3.2.3.1. Limiting Distance and Area of Unprotected Openings
8) A limiting distance equal to half the actual limiting distance shall be used as input to Tables 3.2.3.1.B. and 3.2.3.1.C., where
   a) the time from receipt of notification of a fire by the fire department until the first fire
department vehicle capable of beginning suppression activities arrives at the building exceeds
10 min in 10% or more of all fire department calls to the building, and
   b) any storey in the building is not sprinklered. (See Appendix A and A-3.2.3. in Appendix A.)

A-3.2.3. Fire Protection Related to Limiting Distance versus Separation Between Buildings.
Code provisions that address protection against fire spread from building to building use the
limiting distance (see the definition in Article 1.4.1.2. of Division A) for a building rather than
using them distance between adjacent buildings on separate properties, since this would result
in situations where the design and construction of a building on one property affects the design
and construction of a building on an adjacent property.

The Code requirements that deal with reducing the probability of building-to-building fire spread
were originally developed based on the assumption that the exposing building faces of adjacent
buildings are of similar size and configuration, and are equidistant from the shared property line.
Where buildings are of different sizes, the smaller building may be subject to a higher heat flux
in the event of a fire compared to the larger building. Where buildings are closely spaced and
not equidistant from the property line, the construction of the building with the greater limiting
distance does not recognize the proximity of the building with the lesser limiting distance.

The Code has more stringent requirements for buildings with lesser limiting distance as regards
the maximum area and spacing of unprotected openings, and the construction, cladding and fire
resistance of walls. This increased stringency recognizes that the fire hazard is greater where
buildings are closer together and that adjacent buildings may have exposing building faces of
different sizes, configurations or limiting distances, which could further increase the hazard.

The authority having jurisdiction may also address limiting distances through legal agreements
with the parties involved that stipulate that the limiting distance be measured to a line that is not
the property line. Such agreements would normally be registered with the titles of both
properties.

2010 NBC User’s Guide
Limiting Distance and Fire Department Response
“Limiting distance” is another concept that is used in establishing spatial separation. It is the
distance from an exposing building face to a property line, the centreline of a street or public
thoroughfare, or an imaginary line between two buildings or two fire compartments on the same
property.

The original calculations on which the requirements for spatial separations in the NBC were
based were for distances between buildings. A building permit, however, only regulated the
property for which it was issued, not adjacent properties. The calculated distances were,
therefore, reduced and measured to the property line (or centreline of a street, or an assumed
line between two buildings on the same property), with the understanding that any building on
the opposite side of the line would adhere to the same spatial separation criteria.....
Definition of Spatial Separations

The requirements for the physical or spatial separation of buildings exist to limit the probability that fire will spread from one building to an adjacent building during the time required for emergency responders to perform their duties, which could lead to damage to adjacent buildings. The National Building Code (NBC) limits the number of openings in the exposing building face and restricts the type of construction of the exterior wall of the building based on the use of the building and its placement with respect to property lines or other buildings on the same site. Spatial separation requirements exist for property protection rather than to protect the life safety of the occupants. Spatial separations as described in this handout apply to all commercial buildings, regardless of size or occupancy.

Determination of Spatial Separation Requirements

Requirements are determined through the application of Subsections 9.10.14 and 9.10.15 for buildings falling within the scope of Part 9 of the NBC 2010, and Subsection 3.2.3 for buildings within the scope of Part 3. Buildings are permitted to have a proportion of openings in an exterior wall based on limiting distance and the size of the exposing building face. The closer an exposing building face is to a property line or the face of another building, the higher the fire-resistance rating required for that building face and the more stringent the construction requirements for that exterior wall. For example, buildings located next to a property line are required to be built of non-combustible construction and have a fire-resistance rating of 1 or 2 hours, depending on the occupancy contained within the building.

The NBC defines the following commonly used terms as indicated below:

Exposing Building Face refers to that part of the exterior wall of a building which faces one direction and is located between ground level and the ceiling of its top storey, or if a building is divided into fire compartments, the exterior wall of a fire compartment facing in one direction.

Limiting Distance is defined as the distance from the exposing building face to a property line, lot line, centerline of a street or public thoroughfare, or an imaginary line between two buildings on the same site.

Unprotected Opening refers to a doorway, window or opening other than one equipped with a closure having the required fire-protection rating, or any part of a wall forming part of the exposing building face that has a fire-resistance rating less than that required for the exposing building face.

Fire-Resistance Ratings for Exterior Walls

The fire-resistance rating of an assembly, including an exterior wall assembly, may be determined based on tests conducted in accordance with CAN/ULC-S101. This is typically provided in the form of a ULC, cUL or Intertek listed assembly. Or, the assembly may be assigned a fire-resistance rating using Appendix D as per Article 3.1.7.1. An exterior wall assembly is rated for exposure to fire from inside the building as per Article 3.1.7.3.

The following options for obtaining the required fire-resistance ratings of exterior walls may be considered:

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<th>1 Hour Rating</th>
<th>2 Hour Rating</th>
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<td>Concrete Block</td>
<td>Concrete Block*</td>
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<td>Design under D-2.3&quot;</td>
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<td>1 layer of 5/8&quot; FR GWB + thermal barrierf</td>
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D01/07/2014

Continued on page 2
### Design under D-2.3

The Component Additive Method described in Appendix D can be used to design an exterior wall assembly with the required fire-resistance rating for a maximum 90 minute rating.

### Thermal Barrier

Exterior wall assemblies shall have an outer membrane consisting of sheathing and exterior cladding with spaces between the studs filled with insulation as per D-2.3.5(2) in addition to the fire-rated gypsum board applied to the inside face of the exterior wall. This sheathing membrane or thermal barrier is considered to have a 15 minute fire-resistance rating based on Appendix D from the NBC 2010.

Where the building construction does not typically include sheathing (i.e. pre-engineered metal buildings), an additional layer of 5/8" Type X (or Fireguard) gypsum board applied to the inside face of the wall is acceptable in order to achieve the required 1 or 2 hour fire-resistance rating. An extra layer of rated drywall is not required for a ¾ hour fire-resistance rating.

### 3 layers of 5/8" Fire Rated (FR) Gypsum Wallboard (GWB)

5/8" thick, 40" wide FireGuard Gypsum Board applied in three layers on the interior side. The base layer is applied horizontally to the studs with 1" Type S, self-drilling, self-tapping Bugle head steel screws 24" on center. The second layer is applied horizontally with the horizontal joints offset 24" from the horizontal joints in the base layer and with any vertical butt joints centered between studs. Vertical butt joints are staggered between succeeding courses. The second layer is secured with 1 5/8" Type S, self-drilling, self-tapping, Bugle head steel screws 16" on center to stud framing and with 1 ½" Type G, #10 laminating screws, 16" on center and spaces 2" from any vertical butt joints. The face layer is applied vertically to the studs with 2 ¼" Type S, self-drilling, self-tapping Bugle head steel screws 12" on center. Any horizontal butt joints in the face layer are staggered 24" between adjoining panels. At horizontal butt joints, 1 ½" Type G, laminating screws are driven 12" on center at 2" from both sides of the joint. The face layer joints are covered with paper tape and joint compound. Exposed screw heads are covered with joint compound. (Based on Warnock Hersey (Intertek) Design No. DGWA 180-01 – 1995 Certification Listings)

### Concrete Block

Concrete block that is used in construction that is required to have a fire-resistance rating greater than 90 minutes must meet the requirements of Table D-2.1.1 for the required rating or be constructed in conformance with a listed assembly for concrete blocks. Typically, 8 inch concrete block is considered to have a 2 hour fire-resistance rating.

### Equivalents

Equivalents must be based on actual building code data, listing information from ULC or Intertek etc., or documented past performance of the type of assembly being proposed. Equivalents must be presented by an architect or engineer licensed to practice in the province of Saskatchewan.

### Special Cases For Spatial Separation Requirements

#### Buildings Facing a Street

Article 3.2.3.10 of the NBC permits an exposing building face that faces a street and is at the same level as the street to have unlimited unprotected openings if the limiting distance is not less than 9 m.

A “street” is defined by the NBC as “any highway, road, boulevard, square or other improved thoroughfare 9 m or more in width, which has been dedicated or deeded for public use, and is accessible to fire department vehicles and equipment.”
This definition of a street means that only property deeded for public use as a street may be considered as a street with respect to the requirements of Subsection 3.2.3. There are two cases where a building can be considered to face a street, as outlined below. The first is where the building faces a true street that in every way meets the definition of a street as shown in the figure below in Case (i). The other case is where the building faces a public lane that is at least 6 metres wide, and has a limiting distance to the centerline of the public lane as shown in Case (ii) below. Private access roads that are not deeded for public use are not considered to be streets, regardless of size.

Buildings Facing a Lane

City lanes which are 6 metres in width, but do not meet the criteria of a street above, do not qualify as a street with respect to spatial separations. However, the limiting distance for an exposing building facing a lane is permitted to be measured from the centerline of the lane to the face of the building, thus allowing more openings and possibly relaxed construction requirements.

Buildings on the Same Site

The limiting distance for each face of buildings where they face other buildings can be taken as the measurement from an imaginary line between the two buildings, to each exposing building face of the building. Each building is required to meet spatial separation requirements with respect to that imaginary line. Under special circumstances, buildings on the same site may be grouped in order to avoid spatial separation requirements between the two buildings. Only accessory buildings of industrial occupancy are permitted to be grouped with the main building on the site. When buildings are grouped, the aggregate area of the buildings, construction type and ratings of both buildings must be such that they may be considered as one building for classification purposes. Single storey self storage warehouses are permitted to be grouped as indicated in the handout for such buildings.
These guidelines apply to multiple tenant self storage warehouses which do not exceed one storey in building height, do not have a basement and each unit opens directly to the exterior. The following items are considered to meet the intent of the National Building Code (NBC) 2010. All other requirements of the NBC 2010 apply to these types of buildings.

1. **Occupancy Classification**: Self storage warehouses are classified as Medium Hazard Industrial (Group F, Division 2) occupancies.

2. **Building Area (for classification purposes only)**: A group of self storage warehouses on the same property may be considered as one building. Multiple groupings may be considered for a site. Where the open space between the grouped buildings is at least 9 m wide, the building area of the grouping does not include the open space between the buildings. Where the open space between the grouped buildings is less than 9 m wide, then the building area of the grouping must include the open space between the buildings in addition to the area of the buildings grouped. A building grouping must be classified under Subsection 3.2.2 or Part 9 and all applicable construction requirements, fire-resistance ratings and sprinkler requirements will apply to each building in the group as if this was one large building.

3. **Spatial Separations**: The construction of any exposing building face and the area of unprotected openings facing a property line or other buildings on the same property are to conform to the spatial separation requirements of Subsection 3.2.3 or 9.10.14, whichever is applicable based on the building classification.

   EXCEPTION: If a group of self storage warehouses on the same property is to be considered as one building under item 2, spatial separation requirements need not apply to those building faces within the group that face each other, provided that:
   - The exposing building faces are at least 9 m apart where the space between the buildings is not included in the building area, and
   - The exposing building faces are at least 6 m apart where the space between the buildings is included in the building area.

   Spatial separation requirements apply between separate groupings of buildings.

4. **Drawings** submitted in support of a building permit application must be signed and sealed by an architect or engineer licensed to practice in the province of Saskatchewan for buildings that are greater than 600 m² in building area or where a “grouped” building is greater than 600 m² in building area.

5. **Exits**: An overhead door can be accepted as an exterior exit provided:
   a. It serves only one individual tenant space,
   b. The space it serves does not exceed 50 m² in area, and
   c. The travel distance within that space does not exceed 10 m.

   Where two exits are required, one of the exits may be an overhead door provided they are spaced as required by the NBC.

6. **Washrooms**: Washroom facilities need only be provided for employees, not for tenants.

7. **Fire Department Access Routes** within the site and access to the site must:
   a. Be designed in accordance with the requirements of Articles 3.2.5.5 and 3.2.5.6,
   b. Where gates are installed in the access to the site, the gate opening is to have a clear width opening of not less than 6 metres,
   c. Be provided with fire hydrants as prescribed by the NBC.

23/07/2015
Waterproof Wall Finish

Question?
When freestanding tubs are installed within a bathroom, when should the surrounding walls be protected with a waterproof finish?
The Alberta Building Code speaks to a waterproof finish being required above the rims of bathtubs. The intent behind this requirement is that these areas which would be subject to periodic wetting should be protected.

The argument could be made that the sentence is specific to **above the rim**, and because of this it would seem appropriate that the requirement would only be applicable in situations where the rim of the tub butted up to the adjacent wall.

In previous discussions on this topic, it was thought that if there is no wall that is contiguous with the bathtub, such as a free-standing bathtub, the requirements of the ABC would not be applicable as the amount of wall area which would be subjected to the water splash, and possible damage from pooling of water should be minimal.

Background Information:
2014 Alberta Building Code
9.29.2.1. Where Required
1) Waterproof finish shall be provided to a height of not less than
   a) 1.8 m above the floor in shower stalls,
   b) 1.2 m **above the rims** of bathtubs equipped with showers, and
   c) 400 mm **above the rims** of bathtubs not equipped with showers.

9.29.2.2. Materials
1) Waterproof finish shall consist of ceramic, plastic or metal tile,
   sheet vinyl,
   tempered hardboard, laminated thermosetting decorative sheets or
   linoleum.

2010NBC User’s Guide
9.29.2. Waterproof Wall Finish
Certain wall surfaces are subject to periodic wetting from shower spray or splashing, and must therefore be protected with finishes that will not deteriorate or absorb water. Such finishes can consist of tiles or various composition, sheet vinyl, tempered hardboard, plastic laminates or
linoleum. Showers and bathtub units may be designed with molded plastic enclosures that require no additional protection.
9.29.2.1. Where Required
This Article lists the requirements for waterproof wall finish to provide a reasonable durable wall finish that will not deteriorate from frequent exposure to water splash in shower and around bathtubs.
Shower stalls must have water proof wall finish to at least 1.8m (5ft 11inches) above the floor. Waterproof finishes must be provided to at least 1.2m (4') above the top of the bathtub rim that has a shower nozzle, and to at least 400mm (16 in.) above one that does not.
Window Labels

Question?
Regarding CSA A440, just a general discussion about looking for the labels, at which stage of inspections, content required on the labels, can we trust the labels?
Building SCO's should be confirming labels are placed on windows and doors. There is not specific timeline for this, however replacement of the labels is an onerous task which can be avoided if looked at sooner rather than later.

Should we be involved in determining where windows are designed with rough or open terrain in mind? Should we be involved in determining or verifying the Performance Class?
Building SCO's can only ensure that the labels are installed, and meet the requirements as required for each specific area.

Fenestration Canada has a quick reference calculator which can be used to determine the minimum Performance Grade for windows and doors for each area.

Link to Fenestration Canada website: www.fenestrationcanada.ca/calculator

Determining open or rough terrain can be difficult due to current conditions, vs. future conditions. In most situations, designing under rough terrain conditions should be acceptable.

Background Reference Information

6.4 Markings
6.4.1 Product manufacturer
All fenestration products shall bear a permanent marking indicating the fenestration product manufacturer's identity in a location that is visible when the product is installed.

6.4.2 Performance rating
Performance ratings shall be indicated on a label using primary and secondary designators in accordance with Clauses 4.4.2 and 4.4.3 of AAMA/WDMA/CSA 101/I.S.2/A440 and shall include
(a) positive design pressure, where applicable;
(b) negative design pressure, where applicable;
(c) water penetration test pressure; and
(d) the Canadian air infiltration and exfiltration level.

**Note:** Performance rating labels may be non-permanent.

### 2014 Alberta Building Code

**9.7.4.2. General**

1) Manufactured and pre-assembled windows, doors and skylights and their installation shall conform to
   c) the remainder of this Subsection, and
d) the applicable requirements in Subsection 9.7.6.
   (See Appendix A.)

**9.7.4.3. Performance Requirements**

1) **Performance grades** for windows, doors and skylights shall be selected according to the Canadian Supplement referenced in Clause 9.7.4.2.1(b) so as to be appropriate for the conditions and geographic location in which the window, door or skylight will be installed.

2) Windows, doors and skylights shall conform to the performance grades selected in Sentence (1) when tested in accordance with the Harmonized Standard referenced in Clause 9.7.4.2.1(a).

3) The minimum level of performance required for windows, doors and skylights shall be that of the Performance Class R.

4) Exterior wood doors shall conform to CAN/CSA-O132.2 Series, "Wood Flush Doors," and shall have legibly indicated on them
   a) the name of the manufacturer,
   b) the standard according to which they were produced, and
c) that they are of an exterior type.

### A-9.7.4.2.(1) Standards Referenced for Windows, Doors and Skylights.

**Canadian Requirements in the Harmonized Standard**


**Standards Referenced for Excluded Products**

Clause 1.1, General, of the Harmonized Standard defines the limits to the application of the standard with respect to various types of fenestration products. A list of exceptions to the application statement identifies a number of standards that apply to excluded products. Compliance with those standards is not required by the Code; the references are provided for information purposes only.
Label Indicating Performance and Compliance with Standard
The Canadian Supplement requires that a product’s performance ratings be indicated on a label according to the designation requirements in the Harmonized Standard and that the label include
• design pressure, where applicable,
• negative design pressure, where applicable,
• water penetration test pressure, and
• the Canadian air infiltration and exfiltration levels.

It should be noted that, for a product to carry a label in Canada, it must meet all of the applicable requirements of both the Harmonized Standard and the Canadian Supplement, including the forced entry requirements.

5.10.2. Windows, Doors and Skylights
5.10.2.1. General
1) This Subsection applies to windows, doors and skylights, including their components, that separate
a) interior space from exterior space, or
b) environmentally dissimilar interior spaces.

2) For the purpose of this Subsection, the term “skylight” refers to unit skylights, roof windows and tubular daylighting devices.

3) Where a wired glass assembly is installed in a required fire separation, it need not conform to the requirements of this Subsection. (See Appendix A.)

5.10.2.2. Applicable Standards
(See Appendix A.)
1) Windows, doors and skylights shall conform to the requirements in

2) Performance grades for windows, doors and skylights shall be selected according to the Canadian Supplement referenced in Clause (1)(b) so as to be appropriate for the conditions and geographic location in which the window, door or skylight will be installed.

3) Windows, doors and skylights shall conform to the performance grades selected in Sentence (2) when tested in accordance with the Harmonized Standard referenced in Clause (1)(a).

A-5.10.2.2. Manufactured Windows, Doors and Skylights.
Design Values
CSA A440S1 requires that the individual performance levels achieved by the product for structural resistance, water penetration resistance and air leakage resistance be reported on the product’s performance label.

Storm Doors and Windows
Where storm doors and storm windows are not incorporated in a rated window or door assembly, they should be designed and constructed to comply with the applicable requirements of Part 5 regarding such properties as appropriate air leakage and structural loads.

**Forced Entry Test**
Even though the performance label on rated windows, doors and skylights does not explicitly indicate that the product has passed the forced entry resistance test, products are required to pass this test in order to be rated.
Window Labels

Question?
A question has come up between an AHJ and a Builder. A window was provided with a secondary marking indicating that testing was N/A. Upon realizing their error, the window supplier would like to site apply the appropriate marking on the window. The AHJ is indicating that the marking cannot be site applied by the window manufacturer unless additional field testing be completed, or the window must be replaced.

Although the standard requires that testing is to be done by the manufacturer, I am unable to find legislation which specifically requires the secondary marking to be applied prior to installation, or that it cannot be applied by the supplier after the installation. (This could also be the situation where a label is removed prior to inspection)

Could you please provide me with some guidance on if the secondary label can only be applied through the manufacturer, and where this documentation would be found.

Thank you.

Stephanie Martin
Building Safety Codes Officer
Safety Services, Alberta Municipal Affairs
Phone: 1-866-421-6929

Response from Fenestration Canada
(Question was forwarded to Fenestration Canada from NRC)
Ms. Martin,

The code centre has asked me to comment on this issue. I am the technical consultant for Fenestration Canada (the window and door manufacturers association).

You are correct there is no requirement in the code that the label be applied prior to installation. In cases like this in other jurisdictions across the country the AHJ have asked for test reports to prove that the labels applied in the field are correct.

Field testing to replicate the lab testing required by code is possible for air and water, but not possible for the structural test. In a situation like this before requiring the removal of a window, review of a test report and the application of a label in the field would be a better solution.

The removal of a labels prior to final inspection has been a problem and Fenestration Canada has been educating manufacturers on the need to have the labels in place for final inspection.

I hope this information helps.

If you have any further questions please do not hesitate to contact me.

Jeff Baker
Technical Consultant
Fenestration Canada
Air Barrier Systems

Question?
Windows and doors must be sealed to air and vapor barrier. What are the best methods? Are sealing of both air and vapor barriers necessary?
An air barrier systems can be exterior or interior. However, both roles can be performed by the same product. The most common air barrier systems are sealed sheet polyethylene, sealed sheathing membrane, sealed gypsum wallboard, and concrete. In cases where the same product performs the role of both the air barrier and the vapour barrier, the product must be continuous and sealed.

Windows, doors and skylights are required to be installed as per the NAFS CSA- A440.4-2007 standard and the CSA A440S1 standard.

Additionally, windows, doors and skylights must be sealed to air and vapour barriers.

Background Information:
2014 Alberta Building Code requirements 9.7.6.1. Installation of Windows, Doors and Skylights
1) The installation of windows, doors and skylights shall conform to CAN/CSA-A440.4, “Window, Door, and Skylight Installation,” except that
   a) shims used to support windows, doors and skylights are permitted to be made of treated plywood, and
   b) protection from precipitation for walls incorporating windows or doors and for roofs incorporating skylights, and the interfaces of these walls with windows or doors and of roofs with skylights, shall conform Section 9.27.

2) The installation of manufactured and pre-assembled windows, doors and skylights and the field assembly of manufactured window and door combination units shall conform to the manufacturer’s instructions.

3) Windows, doors and skylights shall be sealed to air barriers and vapour barriers.

9.25.3.3. Continuity of the Air Barrier System
6) Penetrations of the air barrier system, such as those created by the installation of doors, windows, electrical wiring, electrical boxes, piping or ductwork, shall be sealed to maintain the integrity of the air barrier system over the entire surface.
9.36.2.9. Airtightness
3) Windows, doors and skylights and their components shall comply with the minimum air leakage requirements stated in
a) AAMA/WDMA/CSA 101/I.S.2/A440, “NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights” (Harmonized Standard), and

A-9.36.2.10.(b) Sealing the Air Barrier System with Sheathing Tape.
One method of sealing air barrier materials at joints and junctions is to apply sheathing tape that has an acceptable air leakage characteristic, is compatible with the air barrier material and resistant to the mechanisms of deterioration to which the air barrier material will be exposed. Where an assembly tested to CAN/ULC-S742, “Air Barrier Assemblies – Specification,” includes sheathing tape as a component, the sheathing tape will have been tested for compatibility and resistance to deterioration and will be referenced in the manufacturer’s literature as acceptable for use with that air barrier assembly.

A-9.36.2.10.(9) Sealing the Air Barrier around Windows, Doors and Skylights.
A continuous seal between windows, doors and skylights and adjacent air barrier materials can be achieved by various means including applying exterior sealant, interior sealant, low-expansion foam or sheathing tape in combination with drywall, polyethylene, a closed-cell backer rod, or a wood liner.

CAN/CSA-A440.4-2007
Window, Door, and Skylight Installation

5 General principles
5.1 General
5.1.1 General requirements
The general requirements for the practice of installing windows, doors, and skylights include health and safety considerations in order to provide satisfactory structural performance and control of air leakage, condensation, and rain penetration, for
(a) thermal comfort (in the occupied interior space); and
(b) the prevention of indoor air quality problems caused by pollutants released from biological growth or decomposition of building materials.

These requirements shall apply to the installation of new and retrofit windows, doors, and skylights. The concept of critical barriers, terrain, moisture index, and exposure is discussed in Annex A. Guidance on the application of these concepts to determine an appropriate moisture penetration control strategy and examples of appropriate details for each exposure rating are provided in Annex A.

5.1.2
The completed installation of windows, doors, and skylights shall control the following:
(a) moisture flow (liquid and vapour);
(b) condensation;
(c) insect entry;
(d) thermal transmission;
(e) air flow;
(f) rain penetration; and
(g) movement due to wind pressure differentials.

5.3 Continuity with the wall
Continuity shall be maintained between elements in the window, door, or skylight and the wall to provide resistance to rain penetration, air leakage, heat transfer, and vapour diffusion.

6 Preparation of openings and mounting procedures
6.1.3
The sheathing membrane shall be folded into the rough opening at the top and sides, and corner inserts shall be installed at the top corners to lap under the membrane at the top of the opening and over the membrane at the sides.

6.1.4
Except as provided in Clause 9.3, the sheathing membrane shall be folded into the rough opening at the bottom, and corner inserts shall be installed at the bottom corners to lap under the membrane at the sides of the opening and over the membrane at the sill.

6.4.1.3 Sheathing
Windows, doors, and skylights shall be installed in frame walls and roofs into the rough opening after the structural exterior sheathing is in place and the sheathing membrane is installed into the opening according to Clauses 6.1.3 and 6.1.4 and shingled to shed water. The sheathing membrane at the head shall be installed in accordance with the requirements of Clauses 6.1.3, 10.2.2, and 10.2.5.2 so that water is shed to the exterior.

No components (e.g., brick mould) of an installed window shall impede the drainage of incidental water.

8 Air leakage control at the frame-to-wall or frame-to-roof junction (air barrier)
Note: The control of both air leakage and vapour diffusion is a concern in the construction of a building. Both these mechanisms can move moisture into a wall or roof, with the potential to cause material deterioration. However, the amount of moisture moved into a wall or roof resulting from vapour diffusion is far less than that moved resulting from air leakage. If adequate vapour diffusion control is provided across the opaque portion of the building envelope, vapour diffusion through small discontinuities at a frame-to-wall or frame-to-roof junction is unlikely to have significant adverse consequences unless the building envelope is subject to high interior moisture loads or a very large temperature differential for extended periods.

However, any breach in the continuity of the air barrier system might allow significant amounts of moisture to move into the wall from both the interior and exterior. Therefore, although vapour diffusion cannot be ignored, the control of air leakage is far more important at the junction of a window or door with the wall. In this Clause, the emphasis is placed on the control of air leakage rather than control of vapour diffusion. The installer should understand the design of the wall or roof and how air leakage control is intended to be managed, as this affects the appropriate selection of air leakage control method for window, door, or skylight installation. The installer should also understand how vapour diffusion is intended to be managed and should maintain the continuity of the vapour diffusion control across the frame-to-wall or frame-to-roof junction. See also Clause 9.

8.1 General requirements
8.1.1
The plane of air tightness in the wall or roof assembly shall be sealed to the air tightness plane in the window, door, or skylight assembly.

Notes:
(1) Air leakage through the intersection between the window, door, or skylight and the wall or roof assembly should be similar to that of a fixed window (specifically, 0.25 m3/h/m) in accordance with CAN/CSA-A440/A440.1.

(2) Means of providing a seal include exterior sealant, interior sealant, drywall and adhesive tape, polyethylene and tape, polyethylene-return, polyethylene-wrap, wood liner, drywall, and foam.

8.3 Polyethylene-wrap method

Note: This method involves applying a polyethylene skirt around the perimeter of the window, door, or skylight frame before it is installed into the rough opening and then folding back and sealing the skirt to the polyethylene in the wall when the window, door, or skylight is installed.

8.3.1

This method shall be used only where
(a) polyethylene is installed in the wall and is intended to serve as the airtight component of the air barrier system; and
(b) the window, door, or skylight frames are wood.

8.3.2

A polyethylene skirt shall be applied around the perimeter of the window, door, or skylight frame, and the window, door, or skylight shall be installed and sealed as follows:
(a) A 600 mm (24 in) wide strip of 0.15 mm (6 mil) polyethylene shall be cut that is long enough to go around the frame of the window, door, or skylight, with approximately 900 mm (36 in) extra to allow for corner folds.
(b) A bead of sealant shall be applied around the perimeter of the frame toward the inside. All joints between the frame and any jamb extensions shall be sealed.
(c) The polyethylene strip shall be laid over the bead of sealant, placing a pleat in the strip on both sides of each corner. The pleats allow the flap to be folded back against the polyethylene sheeting covering the walls. The polyethylene shall be stapled to the frame through the sealant, and sealant shall be injected into the pleats. Special attention shall be given when sealing the polyethylene folds at the window corners. This process shall be continued around the entire frame, and the polyethylene shall be joined to itself with sealant and staples overlapping a minimum distance of 50 mm (2 in). During this process, only enough staples shall be used to hold the polyethylene in place.
(d) Sheathing or duct tape shall be placed over the sealant bead, and staples shall be placed through the tape at 400 mm (16 in) intervals to prevent the polyethylene from pulling off the frame during installation.
(e) The window, door, or skylight shall be placed into the rough frame opening, and it shall be shimmed into place by installing the shims between the polyethylene flap and the opening, and not between the polyethylene flap and the frame.
(f) The rough opening gap shall be insulated.
(g) After applying the wall polyethylene, the window, door, or skylight openings shall be cut out. A bead of sealant shall be applied between the wall polyethylene and the window, door, or skylight polyethylene flaps. The two sheets of polyethylene shall be stapled together to the rough opening framing, through the bead of sealant, at 400 mm (16 in) intervals.

Note: Care should be taken to ensure that the polyethylene flap is not punctured by the shims during installation.

8.3.3

The treatment of doors shall be the same as that of windows, except that, since the door sill rests on the floor, the air barrier at this point shall be joined to the air barrier that passes around the joist header.
8.7 Exterior sealant method

Note: This method involves sealing the window or door frame to the exterior finish.

8.7.1
This method shall be used only where the exterior finish is intended to serve as the airtight element of the air barrier system, as in the case of a face-sealed assembly.

8.7.2
A closed-cell backer rod shall be installed between the window, door, or skylight frame and the cladding. The backer rod shall
(a) be pushed into the gap in accordance with the sealant manufacturer's recommendations;
(b) be 30 to 50% larger in diameter than the gap, so that it must be compressed into the gap. Different thicknesses of backer rod may be necessary since the gap between the rough opening and the window frame may vary;
(c) be of a continuous length to avoid joints in the material; and
(d) not be punctured during installation.

8.7.3
Exterior sealant shall be applied to the exterior side of the joint over the backer rod in a continuous manner to provide an even, unbroken sealant bead sufficient to fill the gap between the window unit and the rough opening.

Annex A (informative)

Installation guidelines

A.2 Installation

A.2.1 General

Three basic strategies for rain penetration control are considered for the illustration of detailing principles: face seal, concealed barrier, and rainscreen. These broad categories reflect strategies that are acceptable for varying exposure conditions. The development of a window installation detail is a four-step process as follows:

Step 1 — Identify the exposure rating for the building.
Step 2 — Identify an appropriate water penetration control strategy based on exposure ratings.
Step 3 — Identify the critical barriers in the adjacent wall and window assemblies.
Step 4 — Design the window installation so that all critical barriers in both the wall and window are continuous through the interface detail.
A.2.3 Step 2 — Identify an appropriate water penetration control strategy based on exposure ratings

A.2.3.1
The exposure rating can be used as guidance in the selection and design of the interface detail, with high-exposure categories dictating more moisture tolerant rain penetration control strategy such as rainscreen.

A.2.3.2
The three moisture control strategies are defined as follows:
(a) Face-sealed — A system where the water-shedding surface is coincident with the water-resistive barrier and air barrier on the exterior surface. In face-sealed systems there is no ability for water to drain behind the cladding, and therefore the exterior cladding layer must resist 100% of the exterior wetting. Face-sealed EIFS and stucco with a waterproof coating are examples of walls that use this moisture control strategy.
(b) Concealed barrier — Similar to the rainscreen approach, the water-shedding surface is at a different location than the water-resistive barrier. However, a more significant amount of water contacts and remains in contact with the water-resistive barrier because of discontinuities in the water-shedding surface, air barrier, the lack of a clear air space or drainage plane between the water-shedding surface and the water-resistive barrier, poor pressure equalization characteristics, or a combination of these variables. The risk of water penetration for a concealed barrier system usually falls somewhere between a face-sealed and a rainscreen system. The effective performance of a concealed barrier system is therefore dependent on the management of the variables described above (continuity of water-shedding surface, location and continuity of air barrier, and drainage capability between the water-shedding surface and the water-resistive barrier). Conventional stucco and some drained EIFS systems are examples of concealed barrier wall systems.
(c) Rainscreen — An assembly where the water-shedding surface is not coincident with the water-resistive barrier and air barrier. The water-resistive barrier is located to the interior of the water-shedding surface, and there is a continuous vented air space between the water-shedding surface and the water-resistive barrier that creates a capillary break. The flow of exterior moisture (rain) through the water-shedding surface is effectively minimized, and the vented airspace facilitates drainage of the minimal water that may get past the water-shedding surface. Brick masonry veneer walls are an example of a conventional rainscreen wall assembly. A variant of the conventional rainscreen assembly is the exterior insulated rainscreen assembly. In this system the building insulation is placed on the exterior of the water-resistive barrier, which allows a fully waterproof air and vapour barrier to be used. This type of system is often used in high-exposure locations such as direct water or oceanfront, where increased humidity control or air tightness is required, and on mid- to high-rise buildings.

A.2.3.3
Once the exposure is known and the water management strategy has been selected, it is possible to develop appropriate window installation details. The exposure of the wall should be used to determine the water management strategy for window installation as follows:
(a) High exposure — Rainscreen installation is recommended.
(b) Moderate exposure — Rainscreen is recommended; concealed barrier is acceptable.
(c) Low or no exposure — Rainscreen, concealed barrier, and face-sealed are acceptable.

The installation water management strategy should not be compromised to match the water penetration strategy for the wall.
A.2.4 Step 3 — Identify the critical barriers in the adjacent wall and window assemblies

A.2.4.1 Critical barrier refers to materials and components that together perform a specific function within a wall or window assembly. All of these functions are critical to the successful performance of the assembly and must be maintained across the interface between the window and the wall.

A.2.4.2 Critical barriers may be defined as follows:
(a) Vapour barrier — elements installed to control the diffusion of water vapour.
(b) Air barrier — the assembly installed to provide a continuous barrier to the movement of air.
(c) Water-resistive barrier — the water-resistive barrier refers to the surface farthest into an assembly from the exterior that can accommodate some exterior moisture (in the form of liquid water) without causing damage to interior finishes or materials within the assemblies.
(d) Water-shedding surface — the outermost surface of the building envelope (and components including windows, doors, and skylights) intended to prevent the bulk of incidental water from passing beyond its plane. Typical examples are external flashings and seals that direct water away from the building components.
(e) Thermal barrier — the assembly installed to provide a continuous barrier to the flow of heat.

Note: For clarity, the thermal barrier is described in the text but is not shown graphically on the drawings.

A.2.4.3 The critical barriers are illustrated in Figure A.2 for a typical wall assembly. In this detail, the vapour barrier is the polyethylene sheet. Based on the assumption that an airtight drywall approach is used, then the air barrier is the interior gypsum board. The water-resistive barrier is the sheathing paper, since any moisture to the outside of this surface is able to drain down the cavity between the stucco and the sheathing paper or dry to the exterior, whereas moisture located to the interior of this material will wet or damage moisture-susceptible materials, such as the sheathing and studs, and is not able to readily drain or dry. The exterior surface of the stucco is the water-shedding surface in this assembly, which deflects the majority of the exterior moisture (rain) that impacts the wall surface. The thermal barrier consists of the insulation within the wall space.
Figure A.2
Critical barriers for typical rainscreen wall assembly
(See Clause A.2.4.3.)

A.2.4.4
When designing a window interface detail, all of the critical barriers must be carried from the wall across the window interface and into the window system at the appropriate locations so that no discontinuities in the critical barriers exist that would affect performance (see Figure A.3). In the example in Figure A.3, the vapour barrier is provided by materials of low vapour permeability located near the interior of the wall and window assembly and including the polyethylene sheet, window frame, and the interior sheet of glass. The air barrier is provided by the drywall, seal to the sub-sill, seal between the sub-sill and the window frame, the window frame, the seal between the window frame and the glazing, and the glazing. The moisture barrier function is provided by the glazing, the seal between the glazing and the window frame, the seal between the window frame and the sub-sill membrane, the sub-sill membrane, and the exterior sheathing paper. The water-shedding surface consists of the glazing, the glazing tape between the glazing and window frame, the exterior surface of the window frame, the sealant between the window frame and the sill drip flashing, the sill drip flashing, and the exterior surface of the stucco cladding. The thermal barrier consists of the batt insulation in the wall cavity, the insulation between the frame and rough opening, the thermal break in the window frame, and the insulated glazing unit.
A.2.5 Step 4 — Design the window installation
The following details showing sample window installation sequences have been provided for the three basic water penetration control strategies. These samples do not cover the full range of possibilities and are provided to illustrate the principles of continuity of critical barriers and construction sequencing.

The details shown are not the only way to achieve the performance objectives for a specific set of variables. Building specific parameters, including micro-exposure conditions, availability and cost of materials, and aesthetics, must be considered to develop appropriate details for a particular application. In addition, the sequencing of the construction of materials may vary for each detail. Actual sequencing of the construction depends on a variety of coordination issues.
- Framing
- Wall sheathing
- Sloped wood sub-sill (optional)
- Sheathing paper
- Metal angle
- Sill membrane flashing
- Corner membrane flashing
- Jamb membrane flashing

(a) Install sub-sill flashing

- Perimeter insulation
- Window
- Sheathing paper

(b) Prepare window opening

- Sheathing paper
- Shims
- Wood strapping

(c) Install window and complete water-resistive barrier

(d) Install strapping

Maximum exposure rating: HIGH

Figure A.7
Example of rain screen installation — Wood siding — Window sill/jamb detail
(See Clause A.3.)
(e) Install trim board

- Backer rod and interior sealant
- Wall insulation
- Vapour retarder
- Wood stool
- Interior gypsum board

(f) Install cladding, flashing, exterior sealant, and complete water-shedding surface

(g) Install interior sealant, insulation, and interior finishes to complete air, thermal, and vapour barriers

(h) Check continuity of critical barriers

Maximum exposure rating: LOW

Figure A.7 (Concluded)
Figure A.8
Example of rain screen installation — Wood siding — Window head/jamb detail
(See Clause A.3.)

(Continued)
(e) Install trim board

- Wood siding
- Backer rod and interior sealant
- Wall insulation
- Vapour retarder
- Interior gypsum board

(f) Install flashing and sheathing paper and complete water-resistant and air barriers

(g) Install exterior sealant, insulation, and interior finishes to complete water-shedding, thermal, and vapour barriers

(h) Check continuity of critical barriers

Maximum exposure rating: HIGH

Figure A.8 (Concluded)
Heat Recovery Ventilator Certification

Question?
What type of certification does a Heat Recovery Ventilator (HRV) require? Are passive HRV’s tied into the furnace fan as the blower acceptable. Under 9.32.3.10.(1) the air flow of an HRV must be tested and conform to the requirements of the CAN/CSA-C439 standard.

With HRV’s being a highly promoted option under ABC 9.36, ensuring certified units are being installed will become important for SCO’s to confirm. There are manufacturers who have designed versions of HRV’s without the internal fans who will be asking for approvals for their products.

Approvals for products not tested in conformance with the CSA-C439 standard can only be approved through an alternative solution proposal, and must still provide imperial data that they can meet the intent of the ABC requirements.

Background Information:

Heat-recovery ventilator (HRV)
A factory-assembled packaged unit including fans or blowers that transfers heat between two isolated airstreams.

2010 NBC Intent Statements

Intent 1:
To limit the probability that the performance of heat recovery ventilators will fall significantly below expectations, which could lead to inadequate ventilation.

This is to limit the probability of the inadequate control of:

- airborne pollutants,
- oxygen and other components necessary for breathable air, or
- relative humidity and indoor air temperatures.

This is to limit the probability of:

- negative effects on the air quality of indoor spaces, or
- the inadequate thermal comfort of persons.

This is to limit the probability of harm to persons.

2014 Alberta Building Code requirements

9.36.3.9. Heat Recovery from Ventilation Systems
1) This Article applies where a self-contained mechanical ventilation system is installed whose principal exhaust component is equipped with heat-recovery capability. (See Appendix A.)
2) Where an integrated mechanical system (IMS) with a heat-recovery ventilator provides the principal exhaust ventilation, the IMS shall
a) be tested in accordance with CSA P.10, “Performance of Integrated Mechanical Systems for Residential Heating and Ventilation,” and
b) have a minimum overall thermal performance factor conforming to Table 9.36.3.10.

3) When tested in conformance with the low-temperature thermal and ventilation test methods described in CAN/CSA-C439, “Rating the Performance of Heat/Energy-Recovery Ventilators,” heat-recovery ventilators described in Sentence (1) shall have a sensible heat-recovery efficiency of
a) at least 60% at an outside air test temperature of 0°C for locations with a 2.5% January design temperature greater than or equal to −10°C, and
b) at least 60% at an outside air test temperature of 0°C and at least 55% at an outside air test temperature of −25°C for locations with a 2.5% January design temperature less than −10°C. (See Appendix A.)

4) The requirements of Sentence (3) shall be met using a principal ventilation rate not less than that required in Section 9.32. (See A-9.36.3.9.(3) in Appendix A.)

9.32.3.10. Fans
1) Except as provided in Sentence (4), capacity ratings for required fans shall be determined in accordance with
a) CAN/CSA-C260-M, “Rating the Performance of Residential Mechanical Ventilating Equipment,” or
b) HVI Publication 916, “Airflow Test Procedure.”

4) Fans in heat recovery ventilators used to provide one or more required fans shall have their airflow at normal temperature rated in accordance with CAN/CSA-C439, “Rating the Performance of Heat/Energy-Recovery Ventilators.”

A-9.36.3.9.(3) Efficiency of Heat-Recovery Ventilators (HRVs). HRVs are required to be tested in conformance with CAN/CSA-C439, “Rating the Performance of Heat/Energy-Recovery Ventilators,” under different conditions to obtain a rating: to be rated for colder locations, HRVs must be tested at two different temperatures, as stated in Clause 9.36.3.9.(3)(b), whereas their rating for locations in mild climates relies only on the 0°C test temperature, as stated in Clause 9.36.3.9.(3)(a).

The performance of an HRV product and its compliance with Sentence 9.36.3.9.(3) can be verified using the sensible heat recovery at the 0°C and/or −25°C test station (i.e. location where the temperature is measured) published in the manufacturer’s literature or in product directories, such as HVI’s Certified Home Ventilating Products Directory.

The rating of HRVs also depends on the flow rate used during testing. Therefore, the minimum flow
rate required in Section 9.32. needs to be taken into consideration when selecting an HRV product.

2010 NBC User’s Guide
9.32.3.10 Fans
This article provides a standard means for rating the air-moving capacity and sound rating of fans, blowers and other ventilating equipment. A second purpose is to restrict the level of noise generation of air-moving equipment so that it does not cause undue annoyance to the occupants. Air flow capacity ratings must be based on a static pressure differential as indicated in NBC Table 9.32.3.10.A.
Heat recovery ventilators used to provide one or more of the required fans must be rated in accordance with CAN/CSA-C439-09, “Rating the Performance of Heat/Energy-Recovery Ventilators.”
The principal ventilation fan is intended to be capable of running for long periods. Even the supplemental exhaust fans may be used for significant periods. Therefore, all fans that are mounted such that their sound is likely to intrude on the household, other than kitchen exhaust fans, are required to have reasonably low sound ratings so that building occupants will not turn them off before the need for ventilation has been met.

More Information on HRV’s

National Research council
http://www.nrcan.gc.ca/energy/products/categories/cooling-ventilating/ventilating/hrv/15197

HVI Certification
http://www.hvi.org/
Building Collapse / Failures

Question?
Who should owners be providing information to when they have a building failure or collapse?
There has been a wording change within the 2014 ABC which specifically states that the Authority Having Jurisdiction must be notified when a building failure or collapse occurs.

The previous Notice "Building Collapse Reporting" which was advertised in 2011 and 2014, refers to the previous Code requirements.

Background Information:
2014 Alberta Building Code requirements
2.2.16. Building Failures
2.2.16.1. Reporting Failures
1) Except as required by Sentence (2), if a failure occurs in a building regulated by this Code that causes, or has the potential to cause, injury or loss of life, the owner shall submit a report to the authority having jurisdiction, and if requested, to the Chief Building Administrator, that includes
   a) the name and address of the owner of the building,
   b) the name and address of the building involved in the failure,
   c) the name and address of the constructor or the person who supervised the construction of the building,
   d) the nature of the failure, and
   e) a description of the remedial action that is being undertaken.

2) If a structural collapse occurs in a building regulated by this Code, the owner shall submit a report to the Chief Building Administrator and the authority having jurisdiction that includes
   a) the name and address of the owner of the building,
   b) the name and address of the building,
   c) if involved, the name and address of
      i) the registered architectural professional who designed the building,
      ii) the registered engineering professional who designed the structure of the building,
      iii) the registered engineering professional who reviewed the construction of the building, and
      iv) the constructor who supervised the construction of the building,
   d) the nature of the structural collapse, and
   e) a description of the remedial action that is being undertaken.
NOTICE

Building Collapse Reporting

Excessive snowfall this winter has resulted in an increasing number of structural collapses (such as full or partial roof collapses) in buildings across the province. The owner of a building that has experienced a structural collapse is required to submit a report to the Chief Building Administrator for the Province of Alberta on the nature of the collapse and remedial action for building safety as described in the 2006 Alberta Building Code.

Municipalities and other authorities that administer the Safety Codes Act are advised to have their building safety codes officer notify the building owner to submit a report to the Chief Building Administrator if a collapse has taken place.

All reports should be submitted to the following address:
Alberta Municipal Affairs, Safety Services
16th Floor, Commerce Place
10155 – 102 Street
Edmonton, Alberta T5J 4L4
Attention: Chief Building Administrator

1. During the construction, alteration or demolition of any building, including an incomplete or abandoned building, building owners are responsible to take precautions to ensure that no person is exposed to undue risk in accordance with Sentence 8.1.2.2.(1) of Division B of the Alberta Building Code 2006;
2. obtain a building permit from the Authority Having Jurisdiction prior to construction, alteration or demolition including for the removal of construction debris;
3. comply with the Safety Codes Act and all other applicable regulations for safety of persons and property.

The report submitted to Alberta Municipal Affairs shall include information described in Sentence 2.2.15.1.(2) of Division C of the Alberta Building Code 2006, which states:

2.2.15. Building Failures

2.2.15.1. Reporting Failures

... 2) If a structural collapse occurs in a building regulated by this Code, the owner shall submit a report to the Chief Building Administrator that includes
a) the name and address of the owner of the building,
b) the name and address of the building,
c) if involved, the name and address of
   i) the registered architect who designed the building,
   ii) the professional engineer who designed the structure of the building,
   iii) the professional engineer who reviewed the construction of the building, and
   iv) the constructor who supervised the construction of the building,
d) the nature of the structural collapse, and
e) a description of the remedial action that is being undertaken.

February 18, 2011

For more information, please call 1-866-421-6929 or visit www.municipalaffairs.alberta.ca.
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Micro-Breweries

Question?
Can a distillery be classified as an occupancy other than an F1, if it is not listed in any other classification group?
Although distilleries are listed as an F1- High Hazard Occupancy, the specific use of the building can be looked at to determine if other classifications can be permitted.

An alternative solution can be proposed by a professional, by demonstrating that the F1 classification, and the high level of combustible and flammable or explosive materials which are inherent in these classifications, will not be part of the design in the building in question.

If the alternative solution proposal can show through imperial data, that the levels of combustible or flammable materials do not exceed that of a medium hazard or a low hazard classification, it could be reasonable to permit an F2 or even an A2 building classification.

Background Information:
2014 Alberta Building Code requirements

Group F, Division 1
Bulk plants for flammable liquids
Bulk storage warehouses for hazardous substances
Cereal mills
Chemical manufacturing or processing plants
Distilleries
Dry cleaning plants
Feed mills
Flour mills
Grain elevators
Lacquer factories
Mattress factories
Paint, varnish and pyroxylin product factories
Rubber processing plants
Spray painting operations
Waste paper processing plants
underneath the air barrier). The arrangement and location of the extraction system inlet(s) may have design implications where the footing layout separates part of the space underneath the floor.

1.4.1.2. Defined Terms
High-hazard industrial occupancy (Group F, Division 1) means an industrial occupancy containing sufficient quantities of highly combustible and flammable or explosive
materials which, because of their inherent characteristics, constitute a special fire hazard.

*Medium-hazard industrial occupancy* (Group F, Division 2) means an *industrial occupancy* in which the *combustible* content is more than 50 kg/m² or 1 200 MJ/m² of *floor area* and not classified as a *high-hazard industrial occupancy*.

*Low-hazard industrial occupancy* (Group F, Division 3) means an *industrial occupancy* in which the *combustible* content is not more than 50 kg/m² or 1 200 MJ/m² of *floor area*. 
Screw Piles

Question?
What information should be provided to the AHJ when screw piles are being used as the foundation support for the structure?
The requirements for screw pile installations are not found within Part 9. Steel pile design requirements are found within Part 4. The design for a screw pile foundation must be based on a subsurface investigation. Drawings and field reviews must be completed by the designer (a registered engineering professional) or another suitable qualified person.

SCO's must ask for designs specifying the installation requirements for each screw pile, and confirmation for each unit following the installation from the designer/suitable qualified person.

Background Information:
2014 Alberta Building Code requirements
4.2.2.1. Subsurface Investigation
1) A subsurface investigation, including groundwater conditions, shall be carried out by or under the direction of a registered engineering professional having knowledge and experience in planning and executing such investigations to a degree appropriate for the building and its use, the ground and the surrounding site conditions.

4.2.2.2. Drawings
1) Drawings associated with foundations and excavations shall conform to the appropriate requirements of Section 2.2. of Division C. (See Article 2.2.4.6. of Division C.)

4.2.2.3. Field Review
1) A field review shall be carried out by the designer or by another suitably qualified person to ascertain that the subsurface conditions are consistent with the design and that construction is carried out in accordance with the design and good engineering practice. (See Appendix A.)

A-4.2.2.3.(1) Responsibilities of the Designer as Defined in Part 4. In certain situations, such as when the design is highly technical, it may be necessary for the “other suitably qualified person” to be someone responsible to the designer. In such cases the authority having jurisdiction may wish to order that the review be done by the designer.

Section 9.15. Footings and Foundations
4.2.3.8. Steel Piles
1) Where steel piles are used in deep foundations and act as permanent load-carrying members, the steel shall conform with one of the following standards:
a) ASTM A 252, “Welded and Seamless Steel Pipe Piles,”
b) ASTM A 283/A 283M, “Low and Intermediate Tensile Strength Carbon Steel Plates,”
c) ASTM A 1008/A 1008M, "Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable;"

d) ASTM A 1011/A 1011M, "Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength;" or

e) CSA G40.21, "Structural Quality Steel."

2.2.4.6. Information Required on Foundation Drawings

1) Foundation drawings submitted with the application to build or excavate shall be provided to indicate
a) the type and condition of the soil or rock, as well as the groundwater conditions, as determined by the subsurface investigation,
b) the factored bearing pressures on the soil or rock, the factored loads when applicable and the design loads applied to foundation units, and
c) the earth pressures and other loads applied to the supporting structures of supported excavations.

2) When required, evidence that justifies the information on the drawings shall be submitted with the application to excavate or build.

4.2.4. Design Requirements

4.2.4.1. Design Basis

1) The design of foundations, excavations and soil- and rock-retaining structures shall be based on a subsurface investigation carried out in conformance with the requirements of this Section, and on any of the following, as appropriate:
a) application of generally accepted geotechnical and civil engineering principles by a registered engineering professional especially qualified in this field of work, as provided in this Section and other Sections of Part 4,
b) established local practice, where such practice includes successful experience both with soils and rocks of similar type and condition and with a foundation or excavation of similar type, construction method, size and depth, or
c) in situ testing of foundation units, such as the load testing of piles, anchors or footings, carried out by a person competent in this field of work. (See Appendix A.)