

Notes to Part 5

Environmental Separation

A-5 Environmental Separation. The requirements provided in Part 5 pertain to the separation of environmentally dissimilar spaces. Most obvious is the need to separate indoor conditioned spaces from unconditioned spaces, the outdoors or the ground. There are also cases where separation is needed between interior spaces which are intended to provide different environments. (See also Notes A-5.1.1.1.(1) and A-5.1.2.1.(1).)

A-5.1.1.1.(1) Scope. Part 5 provides explicit requirements related to the transfer of heat, air, moisture and sound in various forms. Control of the ingress of radon and other soil gases is addressed by the requirements related to air leakage.

A-5.1.1.2. Maritime Climate. The effects of Vancouver's maritime climate are well documented. The City's prolonged stretches of near continuous rainfall, combined with driving winds produce extended periods of wetting of building exteriors. This extended wetting combined with very mild year round temperatures means that there are limited periods in which the drying of an envelope assembly might occur. These factors create an environment where the possibility of moisture induced deterioration of materials is very high. The choice of appropriate materials and assemblies for building envelopes is therefore extremely important in Vancouver.

Consistent application of basic water management principles; deflection, drainage, drying and durability of materials throughout the design and construction process is critical for a successful building envelope assembly in Vancouver's climate. Although excess moisture in an envelope assembly can come from construction sources, exterior sources such as rainwater, or interior humidity sources, it has been shown that most performance problems in Vancouver have resulted from a failure to control exterior sources. In Vancouver, the first consideration in envelope design should be the deflection of incident rain with elements such as roof overhangs and the use of flashings with drip edges to direct water away from a building face. The ability to effectively drain water, which does penetrate through the cladding, should be the next consideration for successful envelope assemblies. Since many materials used in the construction of building envelope assemblies are susceptible to deterioration or decay if they remain wet, the ability of the assembly to allow for drying should be considered in the design. However, as the potential for drying in this climate is relatively limited, it should not be relied upon as the primary mechanism, and it should be ensured that materials placed in an exterior envelope assembly do not contain excess moisture before the assembly is enclosed. Lastly, where the probability exists that materials may be exposed to moisture sources, it is critical to choose materials which are durable enough to withstand the moisture until it is dissipated.

Selection and specification of performance criteria for components such as windows should ensure that the components are also capable of meeting the overall envelope performance requirements. In addition, the integration of components into the overall envelope assembly should be carefully considered in the drafting of design documents and throughout the construction process, particularly at the interfaces between components such as windows and the adjacent wall system. All envelope details should be clearly shown in the construction documents, using a progressive series of three dimensional details where correct layering and overlapping of materials needs to be clarified. For critical building envelope assembly details or new and unique assemblies, full-scale mock-ups and testing on site are extremely valuable in confirming the performance of an assembly and in establishing construction standards for the balance of the envelope construction.

The requirements in Part 5 outline a performance standard for the building envelopes, but good design practice should go beyond the requirements in these regulations. Issues such as the quality of detailing, the compatibility of materials used in assemblies, and a design that allows for the simplicity of on-going maintenance are concerns that a professional designer should take into account in the design of a successful building envelope assembly.

Guidance with respect to building science principles and envelope assembly performance for maritime climates is available from a variety of sources. The Canadian Building Digest series and many other publications from the National Research Council (NRC) and in particular from the Institute for Research in Construction (IRC) are valuable resources. Canada Mortgage and Housing Corporation (CMHC) has also published a wide variety of documents which are useful in understanding building science principles and the application of these principles to residential design and construction. Locally, courses in building envelope basics, offered as the educational component towards a Building Envelope Professional accreditation, are administered by the Architectural Institute of BC. Regular seminars on building envelope issues are also offered on an industry wide basis by the BC Building Envelope Council.

A-5.1.2.1.(1) Application. Subsection 1.3.3. of Division A specifies that Part 5 applies to all buildings except those within the scope of Part 9 but not including all Group C multi-family buildings and Artist Live/Work Studios that are more than 2 storeys in building height or more than 600 m² in building area excluding firewalls or the scope of the National Farm Building Code of Canada. Because of their intended use, many buildings need only provide a limited degree of separation from the outdoor environment, the ground, or between interior spaces. The provisions in Part 5 are written to allow exemptions for these buildings.

Part 5 applies to building elements that separate dissimilar environments and to site conditions that may affect environmental loading on the building envelope.

The provisions address

- the design and construction, or selection, of building components, such as windows and doors,
- the design and construction of building assemblies, such as walls, floors and roofs,
- the design and construction of the interfaces between the above-mentioned elements, and
- the design or selection, and installation, of site materials, components and assemblies, such as backfill and drainage, and grading.

Part 5 applies not only to building elements that separate indoor space from outdoor space, but also to those elements that separate indoor space from the ground and that separate adjacent indoor spaces having significantly different environments.

Indoor spaces that require separation include interior conditioned spaces adjacent to indoor unconditioned spaces, and adjacent interior conditioned spaces that are intended to provide different environments. An extreme example of the last would be a wall that separates an indoor ice rink from a swimming pool.

Some building elements are exposed to exterior environmental loads but do not separate dissimilar environments. Solid guards on exterior walkways are one example. Such constructions are subject to the application of Part 5.

A-5.1.2.1.(2) Exemptions. This sentence is intended to allow for the exemption of the application of Part 5 to buildings or parts of buildings where it can be shown that due to the intended use of a building, the full provisions of Part 5 are not necessary. As an example, buildings such as open parking garages, stadia, and certain park buildings intended for summer use would only require a limited degree of separation from the exterior environment. Any proposed exemptions should be discussed with the City of Vancouver prior to implementation.

A-5.1.2.2.(1) Building Envelope Professional Reviews Scope of Application and Letters of Commitment and Completion. The specific areas of focus for which a Building Envelope Professional is required to perform reviews are Sections 5.4., 5.5. and 5.6. The duties are described as Building Envelope Professional design review and enhanced field review. The design review is required to be completed by a Building Envelope Professional. This review is intended to ascertain that the design for which they will be giving a commitment of responsibility for review in the field substantially complies with Part 5 with respect to Sections 5.4., 5.5. and 5.6.

The term enhanced field review is used to differentiate the level of review for which a Building Envelope Professional is responsible, from that which a registered professional signing for architectural items in Schedules B would be responsible. The requirements in Part 5 outline a minimum performance standard, but these requirements cannot address the specific detail concerns which experience has shown are the primary source of problems which have resulted in the deterioration of building envelopes. Building Envelope Professional enhanced field review is intended to address this concern. It requires that the professional performs field reviews at a sufficient frequency and reviews a substantial number of the details, which could be potential problem sources, in order to ascertain that the performance requirements of Part 5 are satisfied. While a professional may not be able to see all of the details, the level of duty intended for this enhanced field review is to review as many details as possible rather than just a representative sampling.

An additional duty of the Building Envelope Professional involves the review of moisture content present in envelope assemblies prior to enclosure. Exterior walls, in buildings of structural light framing systems, should not be enclosed when there is sufficient moisture present to initiate deterioration. While wood may have been delivered to a construction site kiln dried, exposure to rain during construction may raise the moisture content to an unacceptable level (above 19 per cent). Water may also have collected in elements of wall assemblies, such as steel stud tracks, and may lead to deterioration if not dried out prior to the wall assembly being enclosed.

The Building Envelope Professional is required to assure that all wood framing, structural members, and sheathing do not exceed 19% moisture content, and all other materials are dry, prior to the wall assembly being enclosed.

The Articles in Section 5.4 do not define the air tightness limits of a completed assembly, but only that of the components in an assembly. Therefore, it is a critical responsibility of the Building Envelope Professional to conduct sufficient design and field review work in order to be able to ascertain that the continuity of the air barrier system meets the performance requirements of this Part.

The Building Envelope Professional is required to perform sufficient design and field review work to ascertain that the installed vapour barrier system meets the performance requirements of Part 5. The Building Envelope Professional is required to confirm adequate completeness of the system in order to ensure that vapour diffusion is retarded at an appropriate wall location and that all inappropriate barriers to diffusion are eliminated.

Preventing inappropriate barriers to diffusion requires careful attention to detail. While it is often unintended, envelope assemblies may end up with more than one functional vapour barrier. As it can never be ensured that an exterior envelope assembly will always

be free of moisture, the drying mechanism must not be blocked, or the trapped moisture may lead to deterioration of moisture sensitive materials. Drying potential in the system requires that vapour, driven by a vapour pressure differential (i.e. from high interior vapour pressure to low exterior vapour pressure) be allowed to pass to a location in the assembly which is open to exterior air (such as a cavity) where drying may occur. Plywood sheathing for instance has sufficiently low permeance that care must be taken in the design of an assembly to ensure that vapour is allowed to pass the sheathing if it is not intended to act as a vapour barrier. Caution may also be needed with the over use of impermeable sheet membrane materials at details such as windows. If the application is too extensive, the potential for moisture diffusion out of the assembly may be locally impeded, with a resultant increase in the likelihood of deterioration.

The Building Envelope Professional is required to perform sufficient design and field review work to ascertain that the installed exterior cladding system meets the performance requirements of Part 5. The Building Envelope Professional is required to confirm that the cladding system will provide continuous precipitation protection, the drainage paths are complete and the flashings as installed over the complete exterior envelope will function properly.

A-5.1.4.1. Application of Structural Design to Other Building Elements. Part 4, as currently written, applies primarily to buildings as a whole and to structural members. Requirements defining structural loads and design to accommodate or resist those loads, however, apply not only to buildings as a whole and components that are traditionally recognized as structural members, but also apply to other elements of the building that are subject to structural loading. This is addressed to some extent in Part 4 by the requirements that pertain, for example, to wind loads on cladding. A range of structural loads and effects, as defined in Subsection 4.1.2., may be imposed on non-loadbearing elements such as backing walls, roofing, interior partitions and their connections. These must generally be addressed using the same load determination and structural design procedures as used for structural members.

Responsibility for the structural design of buildings as a whole and their structural members is commonly assigned to the engineer of record. The application of Part 4 reflects this, and as such, “non-structural” elements are not explicitly identified in the Part 4 provisions. Rather the application of Part 4 to these elements is specified in cross-references from other Parts of the By-law, e.g. Part 5, which recognizes the fact that the structural design of these elements is often carried out by engineers other than the engineer of record.

Part 4 does not generally apply to the structural design of building services, such as heating, ventilating, air-conditioning, plumbing, electrical, electronic or fire safety systems, though these may be subject to structural loads. It does, however, apply to the design of the connections of building services to address earthquake loads (See Article 4.1.8.18.).

A-5.1.4.1.(2) Materials, Components and Assemblies with Multiple Functions. Where materials, components or assemblies are used to fulfill multiple functions, the designer may have to take into account their function with regard to structural loads, heat transfer, air leakage, vapour diffusion, and protection from precipitation, surface and ground water, and sound transmission. Materials should be selected taking into account the environmental loads to which they will be subjected, their physical and chemical characteristics, and their installation. Design and construction details should satisfy all intended functions and ensure continuity within and between assemblies, without adversely impacting adjacent materials, components or assemblies. The designer should also anticipate unintended consequences when materials that may fulfill multiple functions are used. For example, building membranes consisting of modified bitumen compounds, which are commonly used to control both water ingress and air leakage, also typically have low vapour transmission characteristics. Similarly, extruded polystyrene boards, which are used as thermal insulation, may also act as a component of an air barrier assembly, thus requiring wind loads to be considered.

An increasing number of manufactured systems are being used to serve more than one (and sometimes all) of the functions of an environmental separator: examples include pre-engineered building systems, exterior insulation finish systems, insulated metal panel systems, windows, other fenestration assemblies, and insulated precast concrete wall panels. These systems consist of combinations of pre-manufactured and/or site-built components, which are supposed to be assembled in a prescribed manner.

Ensuring compliance with one Section of Part 5 may impact compliance with other Sections of Part 5: for example, air barriers that are integral to some systems may also act as vapour barriers and impact condensation control. By extension, ensuring compliance with the requirements of Part 5 may impact compliance with other Parts of the By-law: for example, increasing the thickness of the insulation to improve an assembly’s thermal performance may impact its compliance with Part 3 with regard to fire resistance.

Compliance with a standard listed in Section 5.9. does not ensure that a system is appropriate for the intended application.

The designer should consider all relevant criteria, beyond the standard tests, when selecting an appropriate product for a project.

A-5.1.4.1.(5) Past Performance as Basis for Compliance with Respect to Structural Loads. As discussed in Note A-5.1.4.1., a range of structural loads and effects can be imposed on materials, components and assemblies in environmental separators and assemblies exposed to the exterior. In many instances, compliance with Sentence 5.1.4.1.(1) for structural loads must be determined based on the loads and calculation methods described in Part 4 as specified in Sentence 5.1.4.1.(3) and the referenced

Subsection 5.2.2., e.g. for cladding. In practice, compliance for some materials, components or assemblies of environmental separators and assemblies exposed to the exterior is determined by relying on provisions governing the use of alternative solutions (such as Clause 1.2.1.1.(1)(b) of Division A).

For some very common building elements and installations, however, there is a very large body of evidence of proven performance over a long period of time. In these cases, imposing the degree of analysis, or documentation of performance, required by Part 4 or Section 2.3. of Division C would be unnecessary and onerous. Clause 5.1.4.1.(5)(b) is intended to address these particular cases. Because the constructions are so widely accepted throughout the industry and the body of evidence is so substantial (though not necessarily documented in an organized fashion), there should be no question that detailed analysis or documentation is unnecessary.

Whether compliance of a particular material, component or assembly may be determined based on past performance depends not only on the type of material, component or assembly, but also on its intended function, the particular loads to which it will be subject and the magnitude of those loads. Because the possible combinations and permutations are infinite, only guidelines can be provided as to when past performance is a reasonable basis for determining compliance.

In determining compliance based on past performance, the period of past performance considered should be a substantial number of years. For example, 30 years is often used to do life-cycle cost analysis of the viability of investments in building improvements. This period is more than long enough for most deficiencies to show up. There should be no question as to the structural adequacy of a material, component or assembly that has been successfully used in a given application for such a period.

The determination of compliance may be based on past performance only where the function of the material, component or assembly is identical to that of the materials, components or assemblies used as a reference, and where the expected loads do not exceed those imposed on the reference materials, components or assemblies. For example, the acceptance of gypsum board, and its fastening, to serve as part of the backing wall supporting cladding cannot be based on the performance of gypsum board that has served only as an interior finish.

The determination of compliance may be based on past performance only where the properties of the material, component or assembly are identical or superior to those of the materials, components or assemblies used as a reference. For example, where a component of a certain gauge of a particular metal has provided acceptable performance, the same component made of the same metal or a stronger one would be acceptable.

Compliance with respect to various loads may be determined individually. A particular material may have to be designed to Part 4 to establish acceptable resistance to wind or earthquake loads, for example, but past performance may be adequate to determine that the material and normal fastening will support the material's dead load and will resist loads imposed by thermal and moisture-related expansion and contraction.

Past performance is a reasonable basis for determining compliance for lighter materials, components or assemblies not subject to wind load; for example, semi-rigid thermal insulation installed in wall assemblies where other materials, components or assemblies are installed to resist air pressure loads.

Past performance is an appropriate basis for determining compliance for some smaller elements that will be subject to wind loads but are continually supported or fastened behind elements that are designed for wind loads, for example, standard flashing over wall penetrations.

It should be noted that this particular approach to demonstrating compliance pertains only to the resistance or accommodation of structural loads described in Part 4. The resistance or accommodation of environmental loads, resistance to deterioration, and material compatibility must still be addressed in accordance with Part 5.

A-5.1.4.1.(6)(b) and (c) Accommodating Movement. It is well understood that the deflection of the backing assembly in a wall can have significant effects on the performance of the cladding. For example, CSA S304, "Design of Masonry Structures," specifies the maximum deflection criteria for backing assemblies to masonry veneer. Clauses 5.1.4.1.(6)(b) and (c) are written in very general terms in recognition of the fact that not only can the deflection of cladding affect the performance of the backing assembly, but that the excessive deflection of any element has the potential to adversely affect the performance of any adjacent element. Similarly, inter-storey drift has the potential to adversely affect the performance of components and assemblies of environmental separators. CSA O86, "Engineering Design in Wood," specifies a method for calculating building movement due to changes in moisture content. The effects of movement should be avoided or accommodated.

A-5.1.4.2. Deterioration. Environmental loads that must be considered include but are not limited to: sound, light and other types of radiation, temperature, moisture, air pressure, acids and alkalis.

Mechanisms of deterioration include:

- structural (impact, air pressure)

- hygrothermal (freeze-thaw, differential movement due to thermal expansion and contraction, ice lensing)
- electrochemical (oxidation, electrolytic action, galvanic action, solar deterioration)
- biochemical (biological attack, intrusion by insects and rodents).

Information on the effects of deformations in building elements can be found in the Commentary entitled *Effects of Deformations in Building Components* in the “User’s Guide – NBC 2015, Structural Commentaries (Part 4 of Division B).”

Resistance to deterioration may be determined based on field performance, accelerated testing or compliance with guidelines provided by evaluation agencies recognized by the authority having jurisdiction. Guidance can be found in CSA S478, “Guideline on Durability in Buildings.”

Building components should be designed with some understanding of the length of time over which they will effectively perform their intended function. Actual service life will depend on the materials used and the environment to which they are exposed. The design should take into consideration these factors, the particular function of the component and the implications of premature failure, the ease of access for maintenance, repair or replacement, and the cost of repair or replacement.

Many buildings are designed such that access for maintenance, repair or replacement is not possible without damaging – or seriously risking damaging – other building elements. This can become a considerable deterrent to proper maintenance thus compromising the performance of the subject materials, components and assemblies, or other elements of the building. In cases where it is known or expected that maintenance, repair or replacement is likely to be required for certain elements before such time as the building undergoes a major retrofit, special consideration should be given to providing easy access to those elements. Anchorage points for maintenance personnel should be considered during the design of multi-storey buildings, including those of wood-frame construction, as adding them post-construction can be difficult.

Where the use of a building or space, or the services for a building or space, are changed significantly, an assessment of the impact of the changes on the environmental separators should be conducted to preclude premature failures that could create hazardous conditions.

A-5.2.1.1.(3) Soil Temperatures. In theory, soil temperatures are needed to determine the conformance of a design to the requirements related to heat transfer and vapour diffusion. In practice, standard construction in a particular area may have proven to perform quite adequately and detailed calculations of soil temperature are unnecessary. (See also Sentence 5.2.1.3.(2).)

A-5.2.1.2.(1) Interior Environmental Loads. The interior environmental conditions required depend on the intended use of the spaces in the building as defined in the building program. Spaces in different types of buildings and different spaces within a single building may impose different loads on the separators between interior and exterior spaces and between adjacent interior spaces. The separators must be designed to withstand the expected loads.

A-5.2.2.1.(2)(c) Determination of Structural Loads and Effects. As regards materials, components and assemblies and their interfaces that are installed in buildings to which Part 5 applies, the effects of earthquake loads on their ability to resist or accommodate environmental loads are generally only taken into account in the design of post-disaster buildings. For all other buildings, damage to building components during seismic events is anticipated and these buildings are not intended to be functional after the event. However, for post-disaster buildings, seismic effects must be taken into account in the design for environmental separation, as these buildings are required to have an adequate degree of functionality after the design event to meet their intended function (See Article 4.1.8.13. for deflections and drift limits for post-disaster buildings).

However, it is important to note that earthquake effects must be taken into account in the seismic design of all building materials, components and assemblies and their interfaces covered by Article 4.1.8.18. to address life safety and the structural protection of buildings.

A-5.2.2.2. Resistance to Wind and Other Air Pressure Loads. The wind load provisions apply to roofing and other materials subject to wind-uplift loads.

Note that, although Article 5.2.2.2. is specifically concerned with wind loads and directly references only one Article from Part 4, Sentence 5.2.2.1.(1) references all of Part 4 and would invoke Article 4.1.7.10. for example, which is concerned with air pressure loads on interior walls and partitions.

A-5.2.2.2.(4) Membrane Roofing Systems. Wind loads for sheet membrane roofing systems must be calculated in accordance with Part 4 (see Note A-1.4.1.1. of Division A concerning roof terminology). The tested uplift resistance and factored load should satisfy the requirements of the Commentary entitled *Limit States Design* in the “Structural Commentaries (User’s Guide – NBC 2020: Part 4 of Division B).”

The test method described in CAN/CSA-A123.21, “Standard test method for the dynamic wind uplift resistance of membrane-roofing systems,” applies only to sheet membrane roofing systems whose components’ resistance to wind uplift is achieved by fasteners or

adhesives. It does not apply to liquid-applied membranes or to membrane roofing systems that use ballasts, such as gravel or pavers, to secure the membrane against wind uplift.

In the case of sheet membrane roofing systems in which the waterproof membrane is attached to the structural deck using mechanical fasteners, the wind-induced forces and the roofing system's response are time- and space-dependent and, thus, dynamic in nature. Further information on the design and evaluation of such systems can be found in "A Guide for the Wind Design of Mechanically Attached Flexible Membrane Roofs," published by NRC.

The wind uplift resistance obtained from the test method in CAN/CSA-A123.21 is limited to configurations with specific fastener or adhesive patterns. To extrapolate the test data to non-tested configurations, refer to ANSI/SPRI WD-1, "Wind Design Standard Practice for Roofing Assemblies," for a rational calculation procedure. However, in using this extrapolation procedure, wind loads should be calculated in accordance with the By-Law. NRC's guide for wind design referenced above provides further guidance and examples of wind load calculations.

Wind resistance of ballasted roofs may be calculated using ANSI/SPRI RP-4, "Wind Design Standard for Ballasted Single-ply Roofing Systems". However, its methods are based on wind speeds, not wind pressures. Conversely, wind pressures, not wind speeds, are used in Appendix C of this By-law. Therefore, a registered professional skilled in the work of Part 4 should use the ANSI/SPRI standard in conjunction with wind speeds listed in Table C-1, applying wind loads calculated in accordance with Subsection 4.1.7. of Division B (see the commentary on Wind Effects in Appendix C of Division B). Where ballast is used to resist other structural loads in a building, a registered professional is responsible to review these, particularly in replacement roofing.

Technical Bulletin Volume 40 "Design of Loose-Laid Gravel Stone Ballasted Roofs" published by the Canadian Roofing Contractors Association (CRCA) provides some guidance for using the ANSI/SPRI standard to determine ballast requirements. Note that the exposure categories are different from those used in this By-law. A registered professional may select the appropriate ballast size and weight guidelines based on roof zones and zone dimensions.

The ballast values published in CRCA Technical Bulletin Volume 40 are minimum values that will address many roof designs where the roof deck is air-impermeable. If the roof deck is air-permeable, or if flow control drains are present (these may retain water on the roof, thereby introducing added buoyancy), the design may require higher ballast weights (and correspondingly higher volumes). A registered professional should ensure that the structural design of the building can accommodate the necessary ballast weight, together with anticipated live loads including those loads imposed on the building during construction.

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While gravel ballast is commonly used on protected membrane roof systems, wind scour can dislodge rocks from the roof, rendering them a public safety hazard. Consequently, a roof may need to be designed with higher parapets or with a different ballast material, such as concrete pavers. See also CRCA Technical Bulletin Volume 35 "Ballast For Protected Membrane Roofing" on ballast design requirements for protected membrane roofs.

A-5.2.2.2.(6) Vegetated Roof Assemblies When a vegetated system is added on the top of a membrane roofing assembly, a *vegetated roof assembly* is formed. The test methods described in CAN/CSA-A123.24, "Standard test method for wind resistance of vegetated roof assembly," determine both the wind uplift resistance and the wind flow resistance of the *vegetated roof assembly*. If the wind uplift resistance of the membrane roofing assembly used in the *vegetated roof assembly* has already been determined in accordance with the requirements of CAN/CSAA123.21, "Standard test method for the dynamic wind uplift resistance of membrane-roofing systems," as required by Sentence 5.2.2.2.(4), then this resistance can be used as an acceptable conservative wind uplift resistance of the *vegetated roof assembly*; in such cases, only the wind flow resistance of the *vegetated roof assembly* has to be determined in accordance with CAN/CSAA123.24. If, however, any variations in the components or methods of construction of the membrane roofing assembly used in the *vegetated roof assembly* are made after the wind uplift resistance was determined in accordance with the requirements of CAN/CSA-A123.21, then the wind uplift resistance of the *vegetated roof assembly* must be determined in accordance with CAN/CSAA123.24.

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A-5.3. Heat Transfer. In addressing issues related to health and safety, Section 5.3. calls up levels of thermal resistance needed to minimize condensation on or within environmental separators, and to ensure thermal conditions appropriate for the building use. Energy regulations, where they exist, specify levels of thermal resistance required for energy efficiency or call up energy performance levels, which relate to levels of thermal resistance. Where Part 5 calls for levels of thermal resistance higher than those required by the energy regulations, the requirements of Part 5 take precedence.

A-5.3.1.1. Required Resistance to Heat Transfer. The control of heat flow is required wherever there is an intended temperature difference across the building assembly. The use of the term "intended" is important since, whenever interior space is separated from exterior space, temperature differences will occur.

The interior of an unheated warehouse, for example, will often be at a different temperature from the exterior due to solar radiation, radiation from the building to the night sky and the time lag in temperature change due to the thermal mass of the building and its contents. If this temperature difference is not "intended," no special consideration need be given to the control of heat flow. If the

warehouse is heated or cooled, thus making the temperature difference “intended,” some consideration would have to be given to the control of heat flow.

It should be noted, however, that in many cases, such as with adjacent interior spaces, there will be an intended temperature difference but the difference will not be great. In these cases, the provisions to control heat flow may be little or no more than would be provided by any standard interior separator. That is, materials typically used in the construction of partitions may provide the separation needed to meet the requirements of Section 5.3. without adding what are generally considered to be “insulating” materials.

A-5.3.1.2. Material and Component Properties and Condensation. Total prevention of condensation is generally unnecessary and its achievement is rarely a certainty at design conditions. Part 5, therefore, requires that condensation be minimized. The occurrence of condensation should be sufficiently rare, or the quantities accumulated should be sufficiently small and dry rapidly enough, to avoid material deterioration and the growth of mould and fungi.

The Harmonized North American Fenestration Standard, AAMA/WDMA/CSA 101/I.S.2/A440, “NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,” identifies procedures to determine the condensation resistance and thermal transmittance of windows, doors and skylights though testing for condensation resistance is presented as optional in the standard. As such, a fenestration product that meets the standard’s requirements on air leakage, water penetration, uniform load and other performance requirements may not meet the condensation resistance performance level needed for a given application. Only the physical test procedure presented in CSA A440.2, “Fenestration Energy Performance,” can be used to establish the temperature index (I) value, which denotes condensation resistance performance evaluation criteria. It is recommended that designers specify I values for a given application to minimize the potential for condensation. Further guidance on the selection of the correct I value is provided in CSA A440.3, “User Guide to CSA A440.2-14, Fenestration Energy Performance.”

The scope of AAMA/WDMA/CSA 101/I.S.2/A440, which is referenced in Subsection 5.9.2., includes skylights and tubular daylighting devices (TDD). Where skylights and TDDs pass through unconditioned space, their wells and shafts may become the environmental separator and would therefore have to comply with the requirements of Part 5.

A-5.3.1.2.(1) Use of Thermal Insulation or Mechanical Systems for Environmental Control. The level of thermal resistance required to avoid condensation on the warm side of an assembly or within an assembly (at the vapour barrier), and to permit the maintenance of indoor conditions appropriate for the occupancy depends on

- the occupancy
- the exterior design air temperature
- the interior design air temperature and relative humidity
- the capacity of the heating system, and
- the means of delivering heat.

To control condensation on the interior surface of an exterior wall, for example, the interior surface must not fall below the dew point of the interior air. If, for instance, the interior air is 20°C and 35% RH, the dew point will be 4°C. If the interior air is 20°C and 55% RH, the dew point will be 11°C.

Where the exterior design temperature is mild, such as in the City of Vancouver, the interior RH during the heating season may well be around 55%. With an exterior temperature of -7°C, the materials in the environmental separator would have to provide a mere RSI 0.082 to avoid condensation on the interior surface. Depending on the specific properties of the material, this RSI might be provided by 10-mm plywood. Therefore, materials generally recognized as thermal insulation would not be required only to limit condensation on the warmer side of the building envelope.

In certain areas, design conditions may be different. In these cases, maintaining temperatures inboard of the vapour barrier above the dew point will require insulation or increased heat delivery to the environmental separator. Direct delivery of heat over the entire surface of the environmental separator is generally impractical. Indirect heat delivery may not be possible without raising the interior air temperatures above the comfort level. In any case, increased heat delivery would often entail excessive energy costs.

In addition to controlling condensation, interior surface temperatures must be warm enough to avoid occupant discomfort due to excessive heat loss by radiation. Depending on the occupancy of the subject spaces, this may require the installation of insulation even where it is not needed to control condensation.

A-5.3.1.3.(2) Position of Materials Providing Thermal Resistance. For a material providing thermal resistance to be effective, it must not be short-circuited by convective airflow through or around the material. The material must therefore be either

- the component of the air barrier system providing principal resistance to air leakage, or
- installed in full and continuous contact with a continuous low air permeance component.

A-5.4.1.1. Resistance to Air Leakage. An air barrier system in above-grade building components and assemblies separating conditioned space from the exterior will reduce the likelihood of condensation due to air leakage, discomfort from drafts, the infiltration of dust and other pollutants, and interference in the performance of building services, such as HVAC and plumbing. These problems can all lead to serious health or safety hazards.

Currently, the most obvious and significant problems are due to moisture-related material deterioration, such as rot and corrosion, which can lead to the failure of component connections. The infiltration of dust and other pollutants can lead to a wide range of health problems. Where the separator is subject to high moisture levels, the pollutants may include fungus spores. Interference with the performance of building services can lead to unhealthy conditions and potentially hazardous conditions during the heating season in many regions of the province.

There are few buildings intended for human occupancy where the interior space is conditioned but where an air barrier system is not required. Some industrial buildings, for example, may be exempt. This would depend, however, on the particular levels of interior conditioning provided, ventilation levels, protection provided for the workers, and the tolerance of the building's construction to the accumulation of condensation and potential precipitation ingress.

Some industrial buildings are provided with only limited conditioning, for example radiant heating, and ventilation levels are sufficient to reduce relative humidity to a level at which condensation will not accumulate to a degree that is problematic. Conversely, some industrial buildings, due to the processes they contain, operate at very high temperatures and high ventilation levels. In these cases, the building envelope will be maintained at temperatures that will avoid condensation. In both examples above, either the ventilation rates or protective gear required in the work environment would protect the occupants from unacceptable levels of pollutants.

Where adjacent interior environments are sufficiently different, controlling airflow between those spaces is necessary to maintain conditions. Referring again to the industrial building examples above, assemblies separating office space from the work floor would likely require an air barrier system.

The word “minimize” is used in Clause 5.4.1.1.(1)(c) because not all moisture accumulation in an assembly need be of concern. Incidental condensation is normal but should be sufficiently rare and in sufficiently limited quantities and should dry rapidly enough to avoid material deterioration and the growth of mould or fungi.

An air barrier system is required in components and assemblies in contact with the ground to control the ingress of radon, and may be required to control the ingress of other soil gases such as methane.

In addition to an air barrier system, other measures may be required to reduce the radon concentration to a level below the guideline specified by Health Canada. Further information on protection from radon ingress can be found in:

- “Radon: A Guide for Canadian Homeowners” (CMHC/HC),
- “Guide for Radon Measurements in Public Buildings (Schools, Hospitals, Care Facilities, Detention Centres)” (HC), and
- EPA 625/R-92/016, “Radon Prevention in the Design and Construction of Schools and Other Large Buildings.”

A-5.4.1.2.(1) Air Leakage through the Air Barrier System. The current requirements specify only a maximum air leakage rate for the material in the air barrier system that provides the principal resistance to air leakage.

Research and in-situ testing of installed air barrier systems have shown that the bulk of air leakage occurs through joints (between air barrier materials) and junctions (between air barrier components).

Ideally, a maximum air leakage rate for the complete air barrier system would be specified. The maximum acceptable rate will ultimately depend on warm and cold side temperatures and humidity conditions, and on the susceptibility of the environmental separator to moisture-related deterioration. Recommended maximum leakage rates for the air barrier system in an exterior envelope in most locations in Canada are shown in Table A-5.4.1.2.(1). These values are for air barrier systems in opaque, insulated portions of the building envelope. They are not for whole buildings, as windows, doors and other openings are not included. The Table is provided for guidance when testing air barrier systems as portions of an envelope.

Table A-5.4.1.2.(1)
Recommended Maximum Air Leakage Rates
Forming Part of Note A-5.4.1.2.(1)

Warm Side Relative Humidity at 21°C	Recommended Maximum System Air Leakage Rate, L/(s·m ²) at 75 Pa
< 27%	0.15
27% to 55%	0.10
> 55%	0.05

Determining the leakage rate of a particular assembly, however, is problematic. There is little information available on the airtightness

of the many air barrier systems used in building construction, and testing requires specialized equipment and expertise. Depending on the type of test,

- testing may not represent the performance of the complete installed system,
- the location of deficiencies may be difficult to identify, and
- rectification of deficiencies may not be feasible.

Despite the difficulties, when using a system whose performance is not known, it is recommended that tests be conducted. Testing options include:

- laboratory tests of small sections of the air barrier system, including the joints and intersections of different assemblies
- laboratory tests of large wall sections
- in-situ tests of characteristic envelope areas.

A-5.5.1.1. Required Resistance to Vapour Diffusion. Resistance to vapour diffusion is required to reduce the likelihood of condensation within building assemblies, and the consequent potential for material deterioration and fungal growth. Deterioration such as rot and corrosion can lead to the failure of building components and connections, and interfere with the performance of building services. Some fungi can have very serious effects on health.

In Canada, relatively few buildings that are subject to temperature and vapour pressure differences would be constructed or operated in such a manner that the control of vapour diffusion would not need to be addressed in their design. Assemblies enclosing certain industrial spaces, as described in Note A-5.4.1.1. for example, may be exempt.

For residential spaces, and most other spaces that are conditioned for human occupancy, a means of vapour diffusion control is generally agreed to be necessary, even in the milder climates. The questions in those cases pertain to the degree of control needed.

The word “minimize” is used in Sentence 5.5.1.1.(1) because not all moisture accumulation in an assembly need be of concern. Incidental condensation is normal but should be sufficiently rare and in sufficiently limited quantities, and should dry rapidly enough, to avoid material deterioration and the growth of mould or fungi. Here are some references regarding the effects of fungi on health:

- “Fungal Contamination in Public Buildings: Health Effects and Investigation Methods,” Health Canada
- “Guidelines on Assessment and Remediation of Fungi in Indoor Environments,” New York City Department of Health and Mental Hygiene (NYCDH)

A-5.5.1.2.(1) Vapour Barrier Materials and Installation. In the summer, many buildings are subject to conditions where the interior temperature is lower than the exterior temperature. Vapour transfer during these periods is from the exterior to the interior. In general, in Canada, the duration of these periods is sufficiently short, the driving forces are sufficiently low, and assemblies are constructed such that any accumulated moisture will dissipate before deterioration will occur.

Buildings such as freezer plants, however, may operate for much of the year at temperatures that are below the ambient exterior temperature. In these cases, the “warm” side of the assembly would be the exterior and a detailed analysis on an annual basis is required.

Steady state heat transfer and vapour diffusion calculations may be used to determine acceptable permeance levels for the vapour barrier and to identify appropriate positions for the vapour barrier within the building assembly.

A-5.6.1.1. Required Protection from Precipitation. Windows, cast-in-place concrete walls, and metal and glass curtain wall systems are examples of components and assemblies that, when properly designed and constructed, are expected to prevent the ingress of precipitation into a building. Assemblies such as roofs and veneer walls consist of materials specifically intended to screen precipitation.

Components and assemblies separating interior conditioned space from the exterior are generally required to provide protection from the ingress of precipitation. Components and assemblies separating interior unconditioned space from the exterior may or may not be required to provide protection from the ingress of precipitation. Buildings such as stadia, parking garages and some seasonally occupied buildings, for example, may not require complete protection from the ingress of precipitation. The degree of protection will depend to a large extent on the materials selected for the building elements that will be exposed to precipitation.

The word “minimize” is used in Sentence 5.6.1.1.(1) because not all moisture ingress or accumulation in an assembly need be of concern. The penetration of wind-driven rain past the cladding may not affect the long-term performance of the assembly, provided the moisture dries out or is drained away before it initiates any deterioration of building materials. When the design service life of a material or component is longer than the design service life of the overall assembly, taking into account the expected exposure to moisture, initiating deterioration of the material should not be of concern. That is to say, provided the material or component continues to provide the necessary level of performance for its intended service life and does not adversely affect the service life of the assembly of which it is a part, the deterioration of the material or component is not an issue.

A-5.6.1.2. Protective Material.**Draining Moisture with Protective Materials**

The City of Vancouver's past experience has shown that it is virtually impossible to make face sealed walls work in the Vancouver climate, in anything beyond a very low exposure condition. The intent of Section 5.6. is to illustrate to the designer that a rainscreen design is the minimum acceptable option for vertical exterior envelope assemblies in Part 5 buildings. Where there is a slope in any element of the envelope, it should be considered a roof and treated accordingly.

Where the system is a mass wall construction type, and does not include a cladding, all joints between panels (and junctions to other elements such as windows) are required to be two-stage or rainscreen joints with an appropriate means to drain any accumulated moisture to the exterior.

Exterior Cladding over Structural Light Framing

Exterior cladding shall be installed over a cavity with all the necessary through wall flashings designed to drain accumulated moisture to the exterior, where the wall system incorporates exterior cladding over structural light wood or steel framing systems. This cavity, a water shedding plane on the interior side of the cavity and a complete air barrier system to achieve pressure moderation, constitute the primary elements of a required rainscreen design. Compartmentalization of the cavity, in particular at corners, is required to achieve effective pressure moderation. Where the cladding material is stiffer than the supporting light frame structure, such as in a stucco application, the compartmentalization should include through wall flashing at each floor. The design of the cavity should minimize the potential for water to bridge across this gap and maximize the free air space.

While there is agreement on the need for a cavity, current research is not conclusive on the optimal width of a cavity to maximize drying potential, however a conservative approach would suggest that the widest allowable cavity would be prudent in this environment, where drying is an issue. As other Sections of this By-law limit a cavity in a wall to 25 mm before requiring fire blocks, a 19 mm (3/4") cavity is the minimum width recommended which will satisfy this requirement, while still maximizing the drying potential for an assembly with insulation in the stud space. [See Clause 3.1.11.2.(2)(d)]

Where the envelope system employs a full membrane application on the outside of the sheathing and where all of the insulation is installed outboard, then the width of the cavity may be reduced, since the drying potential is not as critical in this configuration. Research has shown that a 10 mm gap is sufficient to prevent liquid water from bridging across a cavity. Therefore, a cavity width of 12 mm (1/2") is the minimum recommended for this configuration, provided that the application of the cladding and the insulation is constructed so that the Building Envelope Professional can assure that this 12 mm (1/2") gap can be maintained.

Exterior columns, beams, walkways, guardrails, or other elements, which do not form a direct continuation of the building enclosure, may not be required to be constructed as rainscreen assemblies. For this approach to be acceptable, these elements must be totally constructed with pressure treated lumber and sheathing (field treated at cuts and boltholes) or other durable materials, with corrosion resistant fasteners and be provided with proper ventilation.

Exterior Insulation Finish Systems

Subject to specific limitations, the required cavities in Exterior Insulation Finish Systems may be reduced in dimension provided they form part of a pressure moderated rainscreen system. This approach would not be acceptable where the application is over wood framing.

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A-5.6.1.2.(1) Ice Damming. Water leakage through **water-shedding** roofs is often due to the formation of ice dams at the eaves, which can be limited by controlling the transfer of heat to the roof through a combination of insulation and venting to dissipate heat. See Clause 5.3.1.2.(1)(d).

A-5.6.1.2.(2) Integrity and Performance of Vegetated Roof Assemblies The integrity of some assemblies installed to provide the required protection from the ingress of precipitation in vegetated roofing systems can be compromised due to an inadequate resistance to the penetration of plant roots and rhizomes. Additional information on vegetated roofing systems and the performance of protective materials can be found in the German Landscape Research, Development and Construction Society's (FLL) "Guidelines for the Planning, Construction and Maintenance of Green Roofing" and in the National Roofing Contractors Association's "The NRCA Vegetative Roof Systems Manual" and in the standards published in the "Roofing Practices Manual" by the Roofing Contractors Association of British Columbia.

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A vegetated roof assembly is intended to both grow and flourish, and is often used to control the rate of rainwater discharged through a **storm drainage system**. Maintenance of a **vegetated roof assembly** is necessary. This includes removal of dead vegetation that does not compost quickly, to reduce fire risk, and regular removal of biomass from around roof drains, to prevent clogging and ponding.

A-5.6.1.2.(3) Flashings, Drips or Overhangs. As the first principle for water management in a building envelope is deflection, the appropriate use of flashings, drips or overhangs is a critical part of any precipitation protection system. The 1996 CMHC survey of envelope failures in B.C. found a striking inverse relationship between the length of overhang, and the percentage of walls which experienced water induced problems. Roof overhangs perform a more complex function than that as a simple ‘umbrella’ shielding the wall below. Studies have shown that a large proportion of the precipitation incident on any building face will be deposited on an overhang at the top of a wall due to wind movement and water deposition patterns. If the overhang includes a means to shed this water, a large portion of the precipitation can be deflected without it ever touching the rest of the building face. Proper detailing and lapping of flashings with other materials is also critical to prevent the ingress of precipitation where there are changes in planes of walls and roofs, changes in cladding material, or window or door heads and sills.

Information on the installation of flashing to drain water to the exterior of roof or wall assemblies may be found in a number of publications including, but not limited to:

- “Roofing Practices Manual,” Roofing Contractors Association of British Columbia
- “Best Practice Guide: Flashings,” Canada Mortgage and Housing Corporation
- “Technical Notes,” Masonry Institute of British Columbia
- “Architectural Sheet Metal Manual,” Sheet Metal and Air-Conditioning Contractors National Association, Inc.

A-5.6.2.1. Sealing and Drainage. Providing a surface-sealed, durable, watertight cover on the outside of a building is difficult. Where there is a likelihood of some penetration by precipitation into a component or assembly, drainage is generally required to direct the moisture to the exterior.

The degree of protection against precipitation ingress needed in any particular case and the approach taken to provide that protection will depend on

- the exterior loads imposed on the assembly
- the materials selected for the backing assembly,
- the use of the enclosed space, and
- the level of maintenance that will be acceptable to the owners.

Where exterior loads are greater, it may be prudent to select a precipitation protection system whose small failures will not be as likely to have an immediate impact on the building or its occupants. For example, drained and vented wall and vented roof assemblies are typical for low-rise residential buildings. More robust drained and vented wall assemblies are recommended for mid- and high-rise buildings where the cost of maintenance and repair could be high.

Where materials with a greater resistance to moisture are used in the assembly, a less rugged precipitation protection system or a less rigorous maintenance schedule may be acceptable. This might be the case, for example, where the wall or backing wall is concrete or masonry.

For spaces that are not intended for ongoing human occupancy, some rainwater leakage may not be of particular concern. This may be the case for certain warehouse spaces for example, depending on how the spaces are used and conditioned.

Information on the installation of flashing to drain water to the exterior of roof and wall assemblies may be found in a number of publications including, but not limited to:

- “Architectural Sheet Metal Manual,” Sheet Metal and Air-Conditioning Contractors National Association, Inc.
- “High-Rise Residential Construction Guide,” Tarion Warranty Corporation (formerly Ontario New Home Warranty Program)
- Technical Notes, National Concrete Masonry Association
- Roofing Specifications, Canadian Roofing Contractors’ Association
- **Standards in the “Roofing Practices Manual,” Roofing Contractors Association of British Columbia**
- “The NRCA Roofing Manual: Membrane Roof Systems” and “The NRCA Waterproofing Manual,” National Roofing Contractors Association
- Technical Notes on Brick Construction, Brick Industry Association

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Environmental separators installed in buildings of wood construction that exceed 4 storeys can be subjected to increased loading due to the height of the building. As such, certain design considerations may require different approaches from the common ones used by industry for buildings of 4 storeys or less. These considerations include, but are not limited to, the following:

- air barrier assemblies,
- fenestration selection,

- protection from precipitation,
- differential movement due to wood shrinkage,
- roofing selection and design, and
- risk of deterioration due to longer exposure of materials to the elements during construction.

Information on environmental separators and the loading to which they are subjected when installed in buildings of wood construction, as well as recommendations on dealing with differential movement, can be found in the following publications, among others:

- “Moisture and Wood-Frame Buildings,” Canadian Wood Council
- “Guide for Designing Energy-Efficient Building Enclosures for Wood-Frame Multi-Unit Residential Buildings in Marine to Cold Climate Zones in North America,” FPIInnovations and RDH Building Engineering Ltd.

A-5.6.2.2.(5) Overflow Outlets. Where a roof or balcony is entirely enclosed by parapet walls there is a likelihood of drains becoming obstructed with materials such as leaves falling during heavy autumn rains. It is recommended that a secondary means of drainage such as scuppers be provided. Overflow outlets should be installed in the parapet walls in sufficient number and at an appropriate height to drain the roof or balcony, to avoid water backing up into moisture sensitive assemblies, and to prevent structural collapse from ponding. Refer also to Division B of Book II (Plumbing Systems), Sentence 2.4.10.4.(2). (For climate resiliency requirements see CAN/CSA-A123.26, “Performance requirements for climate resilience of low slope membrane roofing systems”, together with the Standards published in the “Roofing Practices Manual” by the Roofing Contractors Association of British Columbia.)

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A-5.7. Protection from Interior Sources of Water. Protection similar to that prescribed in Section 5.7. may be required where interior assemblies are in contact with water (such as site-built showers, steam rooms, swimming pool areas) and where adjacent interior spaces need to be protected from the transfer of water through these assemblies.

A-5.7.1.2.(2) Drainage. Water should be directed away from the building and, ultimately, to a municipal drainage system, drainage ditch, swale, or other acceptable water management means. This can be accomplished by setting the building grade higher than the surrounding grades, by sloping the grade away from the building, by installing a surface water drainage system, or by a combination of these approaches. The chosen approach should follow generally accepted guidelines, such as the Rational Method of Stormwater Design by David B. Thompson, or other design methods acceptable to the Chief Building Official.

A-5.7.3.3.(1)(a) Imperfections. Examples of imperfections include shrinkage cracks, air holes, honeycombing, form-tie cone holes, and form joint ridges.

A-5.7.3.4.(1) Dampproofing. Dampproofing refers to the application of a material or materials to an environmental separation assembly to protect it and the interior space against the transfer of moisture due to the mechanisms of water vapour transmission, capillary action and pressure differences other than hydrostatic pressure.

A dampproofed assembly should be designed such that it can provide short-term resistance to the ingress of water due to occasional hydrostatic pressure from ground water.

A-5.8. Required Protection from Noise. Section 5.8. applies to the separation of dwelling units from other dwelling units and from spaces where noise may be generated with regard to sound transmission irrespective of Clause 5.1.2.1.(1)(b), which deals with the separation of dissimilar environments. It is understood that, at any time, there is the potential for sound levels to be quite different in adjoining dwelling units.

A-5.8.1.2. Using ASTC in lieu of STC. A designer may choose to use an ASTC rating of equal or higher numerical value than the required STC to show compliance where STC ratings are required.

An ASTC measurement or calculation will always yield a value equal to or lower than the STC for the same configuration, as the ASTC includes flanking transmission.

A-5.8.1.4. Methods of Calculating ASTC. The technical concepts, terminology, and calculation procedures relating to the detailed and simplified ASTC calculation methods are discussed in detail, with numerous worked examples, in the NRC publication entitled “Guide to Calculating Airborne Sound Transmission in Buildings.” This Guide includes references to readily-available sources of pertinent data.

For many common constructions, the calculations required by Article 5.8.1.4. can be performed using software tools, such as soundPATHS, which is available on NRC’s Web site.

The simplified calculation method may not always identify the prominent flanking paths. Furthermore, it corresponds more closely

with the results of the detailed calculation method where the separating assembly and the flanking constructions are both constructed according to the same method, i.e. either both are lightweight construction (steel or wood framing) or both are heavyweight construction (masonry or concrete).

A-5.9.1.1.(1) Selection of Materials and Components and Compliance with Referenced Standards. It is important to note that Sentence 5.9.1.1.(1) is stated in such a way that the selection of materials and components is not limited to those traditionally recognized as serving particular functions or those for which a standard is identified in Table 5.9.1.1. This approach permits more flexibility than is provided by similar requirements in Part 9. As long as the selected material meets the performance requirements stated elsewhere in Part 5, the material may be used to serve the required function.

However, where the selected material or component, or its installation, falls within the scope of any of the standards listed in Table 5.9.1.1., the material, component or installation must comply with that standard. For example, if some resistance to heat transfer is required between two interior spaces and standard partition construction will provide the necessary resistance, the installation of one of the “thermal insulation” materials identified in the standard list is not required. If, on the other hand, one decides to install glass fibre insulation, the material must conform to CAN/ULC-S702, “Mineral Fibre Thermal Insulation for Buildings.”

A-Table 5.9.1.1. Selection and Installation of Sealants. Analysis of many sealant joint failures indicates that the majority of failures can be attributed to improper joint preparation and deficient installation of the sealant and various joint components. The following ASTM guidelines describe several aspects that should be considered when applying sealants in unprotected environments to achieve a durable application:

- ASTM C 1193, “Use of Joint Sealants,”
- ASTM C 1299, “Selection of Liquid-Applied Sealants,” and
- ASTM C 1472, “Calculating Movement and Other Effects When Establishing Sealant Joint Width.”

The sealant manufacturer’s literature should always be consulted for recommended procedures and materials.

A-5.9.2.1.(3) Airtightness and Watertightness of Windows, Doors, Skylights, Other Glazed Products and their Components Required to have a Fire-Protection Rating. The airtightness and watertightness requirements are waived for these products when used in such an application, in recognition of the fact that the availability of assemblies that meet both the requirements of the applicable standards and the requirements for fire resistance may be limited. However, control of air and water leakage should not be ignored: measures should be taken to attempt to comply with applicable requirements.

A-5.9.2.2. Design and Construction of Windows, Doors and Skylights.

Design Values

CSA A440S1, “Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440, NAFS – North American Fenestration Standard/ Specification for Windows, Doors, and Skylights,” 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.

Installation and Field Testing of Windows, Doors and Skylights

The installation details of windows, doors, skylights and their components must be appropriately designed and implemented for the building envelope assembly to perform acceptably overall. The proper design of the installation details provides the information necessary to integrate the structure and air, vapour and moisture barrier functions of windows, doors and skylights into the overall design of the building envelope assembly. Construction should be carried out in accordance with these details to achieve an appropriate level of long-term performance. Further guidance on installation detailing can be found in CAN/CSA-A440.4, “Window, Door, and Skylight Installation.”

It is recommended that the performance of installed windows, doors and skylights be field tested early in the envelope construction phase so that any discontinuities can be readily identified and corrected before construction of the building envelope

assembly is completed. Additional field testing during subsequent construction phases to monitor installation consistency is also recommended. Field test procedures should be carried out in accordance with test standards such as ASTM E 783, “Field Measurement of Air Leakage Through Installed Exterior Windows and Doors,” and ASTM E 1105, “Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.” Further guidance can be found in Annex D of CAN/CSA-A440.4, “Window, Door, and Skylight Installation,” however, the performance requirements developed in AAMA/WDMA/CSA 101/I.S.2/A440, “NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,” should be used rather than the industry performance data values listed in CAN/CSA-A440.4.

A-5.9.2.2.(1) Two Compliance Paths. It is intended that any fenestration product that conforms to this Part may choose to comply with either Clause (a) or Clause (b) of Sentence 5.9.2.2.(1). Even if a product is in scope of the standards referenced via Clause (b) (NAFS and the Canadian Supplement to NAFS), the compliance path in Clause (a) may be used. However, it is not intended that the compliance path in Clause (b) be used where fenestration products are not within the scope of the referenced standards.

A-5.9.2.2.(2) Other Glazed Products. Glazed products such as curtain walls or sloped glazing that are not typically considered windows but are installed as part of a separation described in Sentence 5.9.2.1.(1) are not within the scope of the referenced standards and therefore must conform to Subsection 5.1.4. and Sections 5.3., 5.4. and 5.6. The following are considered to be “other glazed products”:

Curtain Wall

A curtain wall is considered to be a continuous wall cladding assembly (which may include fenestration and opaque portions) that is hung away from the edge of the primary floor structure. Curtain wall assemblies do not generally support vertical loads other than their own weight. Anchorage is typically provided by anchors that connect back to the floor structure. Curtain wall assemblies can be either “stick built,” meaning each main unit is assembled on-site, or a “unitized” system, meaning factory-assembled main units are installed and connected together on-site.

Window Wall

A window wall is considered to be a wall cladding assembly (which may include fenestration and opaque portions) that spans from the top of a primary floor structure to the underside of the next higher primary floor structure. Window wall assemblies do not generally support vertical loads other than their own weight. Primary provision for anchorage occurs at head and sill connections with the adjoining floor structure. Window wall assemblies may include separate or integral floor edge covers.

Storefront

A storefront is considered to be a non-residential assembly (which may include fenestration and opaque portions) consisting of one or more elements that could include doors, windows and curtain wall framing. Storefronts do not generally support vertical loads other than their own weight. Storefront profiles are typically narrow, rectilinear framing members that hold a combination of pocket glazing and applied glazing stops to securely retain the infills. Vertical framing members typically span the height of one floor or are retained within a structural punched opening.

Storefront assemblies are designed/selected to take into account the anticipated service and exposure conditions, which may be different than those for other portions of the building.

Glazed Architectural Structures

Glazed architectural structures are considered glazing assemblies that are supported in a non-traditional manner, such as corner-clamped, point-supported, linear-supported and edge-clamped glazing. Structural support systems can include, but are not limited to, tension cables, tension rods, steel and glass. Glazed architectural structures do not generally support vertical loads other than their own weight. These assemblies are designed/selected to take into account the anticipated service and exposure conditions, which may be different than those for other portions of the building.

Skylights that are not covered by AAMA/WDMA/CSA 101/I.S.2/A440, “NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,” are considered glazed architectural structures.

Testing of Other Glazed Products

Although other glazed products are generally not within the scope of the standards referenced in Clause 5.9.2.2.(1)(b), they can be tested using other standards such as:

- AAMA 501, “Test for Exterior Walls,”
- AAMA 501.1, “Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure,”
- AAMA 501.2, “Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and

Sloped Glazing Systems,”

- AAMA 501.4, “Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts,”
- AAMA 501.5, “Thermal Cycling of Exterior Walls,” and
- AAMA 501.6, “Recommended Dynamic Test Method For Determining The Seismic Drift Causing Glass Fallout From A Wall System.”
- ASTM E 283, “Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.”
- ASTM E 330/E 330M, “Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.”
- ASTM E 331, “Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.”
- ASTM E 547, “Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.”
- ASTM E 783, “Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.”
- ASTM E 1105, “Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.”

Water Penetration

Notwithstanding that other glazed products are not covered under the testing scope of CSA A440S1, “Canadian Supplement to AAMA/WDMA/CSA 101/LS.2/A440, NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights,” they may be tested at the driving rain wind pressure calculated in accordance with the procedure described therein.

Resistance to Condensation

Notwithstanding that other glazed products are not fully covered under the testing scope of CSA A440.2, “Fenestration Energy Performance,” the test method described therein can be used to evaluate their resistance to condensation, with technical modifications to accommodate differences in the size and configuration of the specimen. It is also common practice to use one cold cycle of AAMA 501.5, “Thermal Cycling of Exterior Walls,” to assess the potential for condensation. Both methods can be used for mock-ups in laboratory performance evaluations, however, only the test method in CSA A440.2 should be used if a Temperature Index is required. In most cases, the project specification documents establish the hygrothermal conditions (i.e. exterior temperature, interior temperature, interior relative humidity, etc.) for which the potential for condensation should be minimized. Under these conditions, the aforementioned test methods can be used to aid in the selection of the appropriate system performance to minimize the potential for interior surface condensation. In all cases, care should be taken in the construction and configuration of the specimen, as these parameters may have an impact on its thermal performance and resistance to condensation. These parameters may include, without limitation, interior wall construction and finishes, heating systems, ventilation systems, etc., to simulate the actual in-service conditions as closely as practicable.

Air Leakage Rate and Test Pressure

Air leakage rates and/or higher differential test pressure can be selected for specific applications of other glazed products where tight control of airflow is required to prevent interstitial condensation (e.g. in concealed spaces), improve thermal comfort (e.g. in hospitals, seniors’ residences), or prevent the migration of airborne contaminants (e.g. in food and drug research, manufacturing applications, biological laboratories, etc.). It is typical of other glazed products to be used as the sole building envelope component. Where this is the case, a correspondingly higher degree of airtightness may be required.

In addition, higher test pressure differentials can be used to evaluate assemblies with low air leakage, such as non-operable or fixed fenestration systems whose air leakage rates are not easily measurable at the lower standard pressure differentials.

A-5.9.2.2.(3) Loads and Procedures. For windows within the scope of the “Canadian Supplement” referred to in Sentence 5.9.2.2.(1), structural and wind loads are included and may be calculated in accordance with that standard. As an alternative, structural and wind loads from Section 5.2. may be used to select fenestration products that are appropriate for the point of installation. Values derived from the referenced standard, which uses a simplified calculation method, are typically higher than those derived from calculations done in conformance with Section 5.2.

A-5.9.2.4.(3) Heat Transfer through Fire-Rated Glazed Assemblies. Thermal bridging through fire-rated glazed assemblies should not be ignored; measures should be taken to minimize condensation consistent with the intent of Sentence 5.9.2.4.(2).

A-5.9.4.1.(1) Exterior Insulation Finish Systems (EIFS). The reference to CAN/ULC-S716.1, “Exterior Insulation and Finish Systems (EIFS) – Materials and Systems,” in Clause 5.9.4.1.(1)(b) does not preclude the use of other component materials that may also meet the intent of the By-law. For example, using mineral-fibre insulation in lieu of other rigid insulation types, mechanical fastening methods for the insulation component in lieu of adhesive, or a type of water-resistive barrier other than a liquid-applied water-resistive barrier could be acceptable.

The following two companion standards facilitate the application of and conformance with CAN/ULC-S716.1:

- CAN/ULC-S716.2, “Exterior Insulation and Finish Systems (EIFS) – Installation of EIFS Components and Water Resistive Barrier,” and
- CAN/ULC-S716.3, “Exterior Insulation and Finish System (EIFS) – Design Application.”

Additional information on EIFS design and installation can be found in the EIFS Council of Canada’s “EIFS Practice Manual” and the manufacturer’s literature.

EIFS Selection

CAN/ULC-S716.1 provides minimum performance criteria for EIFS materials and systems that are tested under specific laboratory test protocols identified in the standard. However, compliance with this standard does not ensure that a system is appropriate for all projects. When selecting an EIFS product, designers should consider all relevant criteria – not only those covered by the tests in CAN/ULC-S716.1 – including, but not limited to,

- building exposure
- local climate characteristics (wind, precipitation, temperature variations, solar exposure, etc.)
- intended building use
- intended resistance to damage and deterioration
- construction tolerances
- constructability

Design and Construction of EIFS Drainage Cavity

The drainage capacity and thermal performance of the EIFS assembly can be affected by the dimensions and configuration of the EIFS drainage cavity.

EIFS are installed over other building materials such as sheathing and primary structural components, which have various construction installation tolerances. Designers should take into consideration the cumulative effects of construction tolerances and sequencing when specifying the drainage method and the cavity dimensions and configuration in order to ensure adequate drainage.

Designers should also take into account the impact of air movement, which varies depending on cavity size and the extent of venting, on the EIFS’ thermal performance when reviewing the overall thermal performance of the building envelope. ASTM C 1363, “Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus,” presents one method for assessing the thermal performance of assemblies.

Where an Exterior Insulation Finish System (EIFS) is used, design review and enhanced field review is required to be conducted by a Building Envelope Professional who has specialized training and experience with EIFS. The professional is required to review the project specific design, and confirm that the whole system including the required thermal expansion/contraction joints, joints around doors or windows, or any other penetrations of the finish will allow for drainage back to the exterior, without reliance on surface sealing. The professional is also responsible for reviewing the pressure moderating system including compartmentalization, vent location, sizing, and confirming the required stiffness of the substrate, using calculations based on the manufacturer’s data or by testing demonstrating that sufficient pressure equalization has been achieved as defined by the Institute for Research in Construction, Construction Technology Update No. 17; “Pressure Equalization in Rainscreen Wall Systems,” July 1998.

The quality provisions of the CCMC Technical Guide for “Exterior Insulation and Finish Systems (EIFS) Class PB Masterformat Section 07240”, Section 7.0 “Quality Assurance Program” must be adhered to. Buildings are required to be designed incorporating devices such as davit bases or other design elements, so that any required maintenance could be provided without causing undue damage to the EIFS.