

An Evaluation Guide for Performance Assessment of Air Barrier Systems

William C. Brown
MEMBER ASHRAE

Bruno Di Lenardo, P.Eng.

Gilles F. Poirier, P.Eng.

Mark D. Lawton, P.Eng.
Member ASHRAE

ABSTRACT

The National Building Code of Canada (NBC) requires that an "effective" air barrier system be incorporated within the building envelope. Although the NBC addresses the performance characteristics to be considered to demonstrate that an effective air barrier system has been achieved, the NBC does not prescribe any specific test protocols with acceptance criteria to verify compliance of proprietary air barrier systems. This paper outlines the developmental aspects of producing an evaluation guide for use by the Canadian Construction Materials Centre (CCMC) for the evaluation of proprietary air barrier systems. The development of the protocol and the acceptance criteria focus on the five main features of any air barrier system; specifically, an air barrier system must (1) have an acceptable air leakage rate, (2) be continuous throughout the building envelope, (3) withstand structural wind loading expected during its service life, (4) be durable, and (5) be buildable or reproducible in the field.

INTRODUCTION

The National Building Code of Canada (NBC) (1995) contains requirements for air barrier systems that reflect the industry's knowledge, experience, and practice. Important changes in the air barrier system requirements have been incorporated into the 1995 NBC to correspond to the evolution of thought since the previous edition. The NBC is acknowledging that air movement is a dominant factor in the transport of moisture through building envelope assemblies. It is also an important component of heat transfer, and, as a result, the importance of an air barrier system is also reflected in the Model National Energy Code of Canada for Buildings (1997). Many problems concerning inadequate building envelope performance and deterioration can be attributed to inadequate or failed air barrier systems. This can also be attributed to the fact that no specific test protocol with acceptance criteria was available to verify compliance of air barrier systems.

There was a definite need to develop a process to validate air barrier systems for the marketplace in a fashion akin to window testing. The protocol for validation had to be a universal performance-based approach for evaluating an air barrier system. The NBC Committee expressed a need for a document

that could be referenced to verify compliance to the Code, and, at the same time, proponents of proprietary air barrier systems were seeking evaluation by the Canadian Construction Materials Centre (CCMC), Canada's national evaluation service, to demonstrate compliance to the Code. This led to the development of CCMC's Evaluation Guide (1997) for the assessment of air barrier systems.

NBC AIR BARRIER SYSTEM REQUIREMENTS

Background

The NBC performance requirements are largely based on research that was initiated some 30 years ago by Hutcheon (1963) who listed the principal requirements of an exterior wall. From that initiative it is known that the air barrier system is fundamental to the requirements concerning the control of air, heat, and water vapor flows. It also plays an important role in the control of rain penetration and external noise transmission.

To meet these requirements, the air barrier system of an exterior wall must be:

William C. Brown is a senior research officer in the Building Envelope and Structure Program and **Gilles F. Poirier** and **Bruno Di Lenardo** are evaluation officers at the Canadian Construction Materials Centre, Institute for Research in Construction, National Research Council of Canada. **Mark Lawton** is director of building science at Morrison Hershfield Ltd., Ottawa, Ontario, Canada.

- constructed of materials that are adequately airtight;
- continuous through the building envelope;
- strong enough to resist the air pressure loads imposed on it, transfer these loads to the building structure, and have enough rigidity or support so that deflection under load is accommodated in the specific wall design;
- durable enough to provide the necessary performance in the service environment anticipated;
- buildable.

Material Requirements

Consistent with the first principal requirements listed above, the NBC specifies that the “material” that provides the principal resistance to air leakage within the air barrier system is required to have an average leakage characteristic not greater than $0.02 \text{ L/(s}\cdot\text{m}^2)$ at 75 pascals (Pa) pressure difference. (This represents the leakage rate, for example, through a 12.7 mm sheet of unpainted gypsum wallboard.) This air leakage rate at 75 Pa is not intended to represent typical leakage of the material in situ, since pressure differences across the building envelope are often much different than 75 Pa. The reference pressure difference of 75 Pa is merely used to characterize a material property. The NBC allows materials of lower airtightness, i.e., leakage greater than $0.02 \text{ L/(s}\cdot\text{m}^2)$, if it can be shown that this will not have adverse effects on the health or safety of the users of the building. Again, consistent with the principal requirements, the NBC specifies that the air barrier system must also be continuous across construction joints, across control and expansion joints, at penetrations through an assembly, and at junctions with other assemblies.

System Requirements

However, the code committee responsible for air barrier system requirements recognized that, ideally, the maximum air leakage rate of the air barrier system (including materials and joints) should be specified. At the time of the writing of the 1995 NBC, this was not viewed as a practical approach because there are relatively few published data about leakage of the air barrier system as a whole and there was an absence of a standard evaluation protocol. To assist designers, the Appendix to the NBC provides a list of recommended maximum air leakage rates suitable for most climates in Canada (Table 1). These air leakage rates were first suggested in the Institute for Research in Construction (IRC) *Building Science Insight* 86 (1986). They were based on the perceived need to provide higher levels of airtightness than required at the time by the American Architectural Manufacturers Association (AAMA) (1983) standard for metal and glass curtain walls. Measured tightness of assemblies performing well at the corresponding humidities has since supported the validity of the recommended rates listed in Table 1.

The system air leakage rates are the leakage through the opaque insulated portion of the envelope, which is not to be confused with the overall air leakage rate of a building as

TABLE 1
Previously Recommended Maximum System
Air Leakage Rates

Warm Side (% Relative Humidity at 21°C)	Recommended Air Leakage Rate, $\text{L/(s}\cdot\text{m}^2)$ at 75 Pa
< 27	0.15
27 to 55	0.10
> 55	0.05

measured by whole-building air leakage tests. These whole-building air leakage rates do not take into consideration the location of the air barrier system within the wall assembly, its water vapor permeance, or the water vapor permeance of materials outboard of the system.

EVALUATION GUIDE FOR PERFORMANCE ASSESSMENT OF AIR BARRIER SYSTEMS

Objective

In the development of the Evaluation Guide for air barrier systems, a research team was charged to identify the necessary test procedures and protocols and to determine acceptance criteria. First, the air leakage rates that were previously published as proposed values (i.e., Table 1) had to be verified for various locations in Canada and for various wall configurations. The wall configurations to be considered involved varying the location of the air barrier system within the wall assembly and varying the properties of the air barrier material and of other components within the wall system.

Once permissible air leakage rates were set as the definitive criteria, a consistent approach for the measurement of the air leakage rate of air barrier systems had to be formalized in a test procedure. This test procedure would be used to establish the air leakage “rating” of the system at the standard reference pressure of 75 Pa.

For structural assessment, the air barrier system would have to resist the wind loads to which it may be exposed during its service life. A research team needed to characterize the anticipated wind loads within a test procedure, and deflection measurements were also necessary as prescribed by the NBC.

Once an air barrier system was deemed acceptable by surviving the prescribed structural wind loading and maintaining an acceptable air leakage rating, it had to be confirmed that the materials of the system were durable. A protocol had to be established to account for UV degradation during construction and aging mechanisms that occur within the wall assembly during the life of the building. The air barrier system components and accessories had to maintain their strength properties as well as the air permeance properties.

Finally, since the air barrier system is a site-built system that has to be buildable in the field, it was determined that the

test specimens had to be representative of the field situation. The test specimens would have to be constructed in accordance with the field delivery system intended by the proponent of the system. Air barrier systems that would be sold as "commodity-type" components to be erected by any third party would have test specimens constructed by a third party with no prior knowledge of the system. Systems conceived and developed to be delivered by trained and licensed installers would have these trained personnel constructing the specimen. This approach was intended to capture as much system variability as possible within a laboratory environment.

To accomplish the task of developing this Evaluation Guide, CCMC relied on a network of experts within the IRC. The research team included experts in heat and mass transfer and computer modeling, experts in structural wind loading to produce a wind-loading schedule that would be representative of the Canadian climate, as well as polymer chemists to help assess the durability of the materials proposed as components of the air barrier system.

Permissible Air Leakage Rates

It is now generally accepted that the leakage of moist, heated interior air into cold spaces of building envelope assemblies is a far more significant cause of problems resulting from condensation than the diffusion of water vapor. The most important function of a wall air barrier system is to control the flow of air into and through a wall, so that

- condensation is rare or the quantities of water accumulated are small and
- drying is rapid enough to avoid the deterioration of materials or the growth of molds and fungi, which are not only health concerns but also agents of deterioration.

Determining the relationship between air leakage and moisture accumulation requires complex mathematical analysis. One of the key research projects carried out during the development of the Evaluation Guide investigated this relationship by computer simulation. A study was carried out by IRC and the Technical Research Centre (VTT) in Finland, using a jointly developed computer model, to evaluate the effect of various parameters (air leakage, water vapor permeability, weather, insulation levels, and location) on the amount of condensation that is likely to occur inside a typical wood-frame wall assembly (Ojanen et. al 1996).

In deciding what modeling assumptions it should work with, the project team relied on previous research findings to define common construction features that would make a wall system more susceptible to condensation. These features included the following:

- The wall would be well insulated. High insulation levels keep the outer portions of the wall colder.
- The most airtight surface would be at the outer sheathing layer. (This situation could easily occur when low-

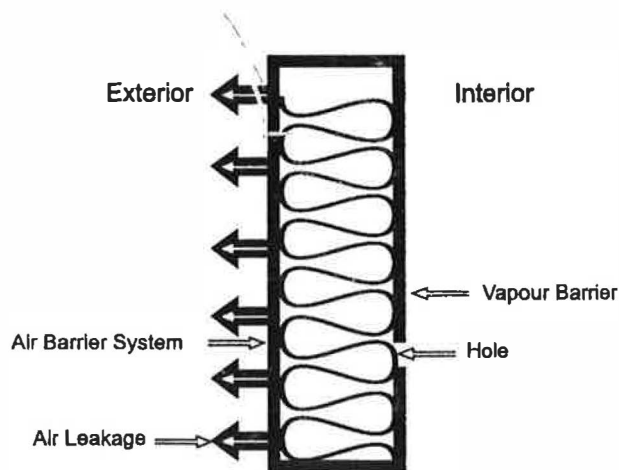


Figure 1 Composition of simulated stud cavity.

permeability sheathings are used in conjunction with penetrations of the interior sheathing or when the air barrier system is located on the cold side.)

- The entry of exfiltrating air into a particular wall cavity would be at a single leakage point.
- The wall would operate under a slight exfiltrating pressure. (This pressure is commonly created by stack forces or mechanical ventilation. In addition, there are exfiltrating and infiltrating pressures that are created by wind.)

The composition of the simulated stud cavity is illustrated in Figure 1. An air barrier system is located on the exterior of the assembly. Air leakage is simulated through a hole, such as an electrical outlet in the interior finish. Air leakage through this single hole then exfiltrates through the exterior air barrier system in a uniformly distributed fashion. The climates of Edmonton, Halifax, and Ottawa were simulated for temperature, wind pressure, wind direction, and vapor pressure, while a positive baseline air-pressure difference of 10 Pa was simulated across the wall.

The mathematical modeling included the following:

- temperature
- air pressure
- water vapor pressure
- thermal insulation
- leakage rate of air barrier system
- water vapor permeance of air barrier system
- added insulation outside air barrier system
- water vapor permeance of the vapor barrier

The modeling of the relationship between air leakage rates and moisture accumulation showed the complexity of the hygrothermal mechanism. Curve A in Figure 2 shows how moisture accumulation varies with leakage rate for one set of assumptions related to temperatures, humidity, insulation, and air barrier permeability. Note how moisture accumulation increases with leakage up to a certain point and then decreases as the increased heat from the leaking air warms the air surface

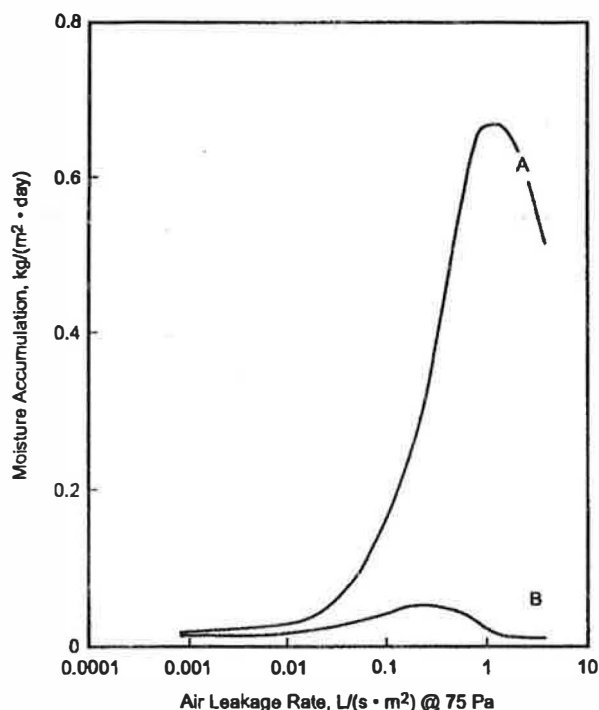


Figure 2 Moisture accumulation vs. air leakage rate and the effect of insulation.

to a temperature above condensing. Very airtight or very leaky walls will not have a problem, whereas one with an intermediate level of airtightness may. The location of the crest for this moisture accumulation varies with the assumed temperature, humidity, and insulation level. The accumulation rate and location of the “hump” changes dramatically, for example, if the air barrier is kept warmer by placing some insulation outside the air barrier. Curve B in Figure 2 shows the effect of adding insulation with a thermal resistance of $0.75 \text{ K} \cdot \text{m}^2 \cdot \text{W}^{-1}$ (R4.3) outside the air barrier modeled in Curve A.

The simulation also indicated whether water would condense and be retained until the arrival of warm periods of the year, when mold and fungi are likely to grow. Figure 3 shows an example of a yearly moisture collection curve from the study. The largest accumulation of moisture occurred when

- the air barrier system was outside the insulation,
- the assembly outside the insulation had a low water vapor permeance, and
- the indoor relative humidity level was high.

Small differences were noted in moisture accumulation for the buildings modeled in the three cities at the end of the one-year cycle. The Halifax simulation indicated only a slightly lower moisture accumulation than that of Edmonton. This stems from the fact that, although the Edmonton winter is colder than that in Halifax, the drying potential to reduce cavity moisture is more limited in the Maritimes than in the Prairies.

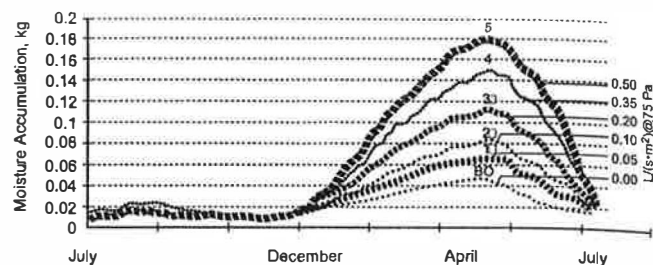


Figure 3 Mathematical modeling of moisture accumulation in a stud cavity. Total mass of moisture in the exterior 15 mm of insulation at the condensing surface with different air permeances of the air barrier layer and $60 \text{ ng}/(\text{Pa} \cdot \text{s} \cdot \text{m}^2)$ vapor permeance. For more information on the modeling conducted, see Ojanen and Kumaran (1996).

Even if the arrangement of materials is such that air leakage does not result in moisture accumulation, a maximum air leakage rate for air barrier systems should be defined to control energy flow through the wall. The study showed that at an air leakage rate of $0.2 \text{ L}/(\text{s} \cdot \text{m}^2)$ at 75 Pa, the heat loss due to air leakage was approximately 15% of the conductive heat transfer through a simulated RSI 3.6 (R20) wall system. This rate of heat loss was accepted to be commensurate with the maximum allowable air leakage rate. The CCMC evaluation criteria consider both moisture collection potential and energy conservation to define the maximum allowable air leakage rate. Modeling with an external air barrier system and typical indoor humidity levels of up to 35% at 21°C resulted in the maximum system air leakage rates shown in Table 2.

The assessment of the maximum air leakage rate is based on total system leakage, including anticipated joints, connections, and penetrations. Table 2, developed for the Evaluation Guide, lists the maximum allowable leakage rates for a building with indoor relative humidity levels up to 35% at 21°C . Note that the allowable leakage depends on the water vapor permeance (WVP) of the outermost (nonvented) layer of the wall assembly.

As indicated in the notes to Table 2, where insulation has been placed outside the air barrier system, a higher air leakage rate is possible without condensation. The CCMC evaluation criteria increase the allowable air leakage rate by $0.05 \text{ L}/(\text{s} \cdot \text{m}^2)$ at 75 Pa when the ratio of the insulation value of the wall outside the inner surface of the air barrier system is adequate (Table 3). This ratio varies with geographic location. The permissible air leakage rates were developed based on the wall assembly having a vapor barrier of at least $60 \text{ ng}/(\text{Pa} \cdot \text{s} \cdot \text{m}^2)$ on the warm side of the insulation.

Air Leakage Test Procedure

The air leakage rates reported for full-scale test assemblies under the evaluation procedure are not merely those rates recorded during a single test at 75 Pa pressure difference. A

TABLE 2
Permissible Wall Air Barrier System Air Leakage
Rates and Respective Water Vapor

Water Vapor Permeance of Outermost (Nonvented) Layer of Wall Assembly ^{1, 2} Ng/(Pa·s·m ²)	Maximum Permissible Air Leakage Rates ³ L/(s·m ²) at 75 Pa
15 < WVP < 60	0.05
60 < WVP < 170	0.10
170 < WVP < 800	0.15
> 800	0.20

¹ For an air barrier system installed on the cold side, adjacent to a vented space, this value would be the WVP of the most water vapor impermeable material of the air barrier system. For air barrier systems located within the wall assembly (i.e., toward the warm side, within the insulation), this value would apply to the material with the lowest WVP outboard of the air barrier system and inboard of any vented space.

² The CCMC evaluation report will state that where the designated air barrier system is located within the wall assembly, there must be no material installed outboard of the air barrier system that has a lower WVP for the respective air leakage rating.

³ The maximum permissible air leakage rate for an air barrier system within any of the first three categories of WVP ranges may be increased by 0.05 L/(s·m²) at 75 Pa to a maximum of 0.2 L/(s·m²) at 75 Pa if the air barrier system is insulated in accordance with Table 3 for the respective geographical locations. The maximum permissible air leakage rate of 0.2 L/(s·m²) at 75 Pa is the cutoff point based on acceptable heat loss into the wall assembly. For proponents of an air barrier system in buildings operating at relative humidities greater than 35%, CCMC will establish the permissible air leakage rate case by case.

TABLE 3
Ratio of Outboard to Inboard
Thermal Resistance¹

Heating Degree-Days at Building Location (Celsius degree-days)	Minimum Ratio
Up to 4999	0.20
5000 to 5999	0.30
6000 to 6999	0.35
7000 to 7999	0.40
8000 to 8999	0.50
9000 to 9999	0.55
10000 to 10999	0.60
11000 to 11999	0.65
12000 or higher	0.75

¹ The ratio is the total thermal resistance outboard of a material's inner surface to the total thermal resistance inboard of the material's inner surface.

particular test sequence is specified for three test specimens. The air leakage tests are conducted over a spectrum of loadings up to 500 Pa. Air leakage data derived from the opaque wall tests (see Figure 4), conducted after structural loading tests as discussed below, are then shown in a graph plotting air leakage versus pressure, and the value at 75 Pa is only accepted if the air barrier assembly has also provided good

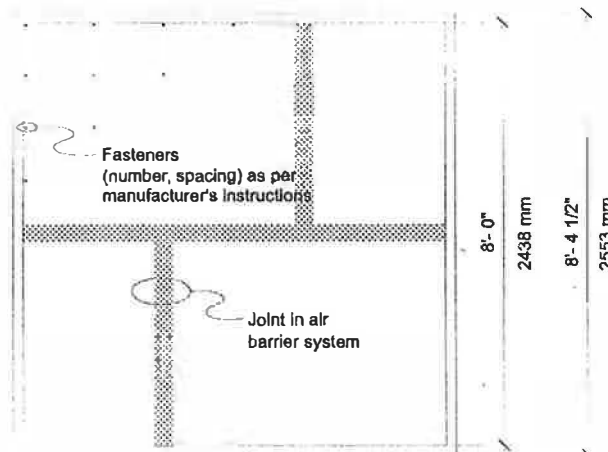


Figure 4 Opaque wall specimen used to obtain base air leakage data.

performance at higher pressures. This means that during the tests the air leakage rate of the specimen would perform linearly across the range of pressures. This is established by the testing agency using standard mathematical data fitting procedures. In addition, the air leakage of those test specimens with penetrations through or connections to other elements (see Figures 5 and 6) must not exceed the air leakage of the opaque wall by more than 10%. Thus, appropriate air leakage behavior for all three specimens with no more than 10% variability constitutes the CCMC acceptance criteria if the air leakage rate falls within the permissible rates of Table 2.

In addition, as air barrier systems are site-built systems, the test specimens 4 to 6 must be constructed in a fashion that is representative of how they will be constructed in the field.

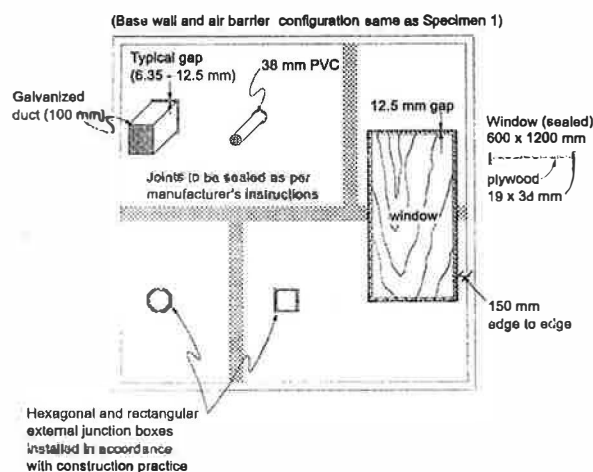


Figure 5 Test specimen(s) with penetrations through the air barrier system. (Note: window, duct, outlets, and pipe are sealed; only interface with penetrations and opaque portion factor into the air leakage measurement.)

Specimen 3 - Foundation Interface and opaque wall (with modifications)

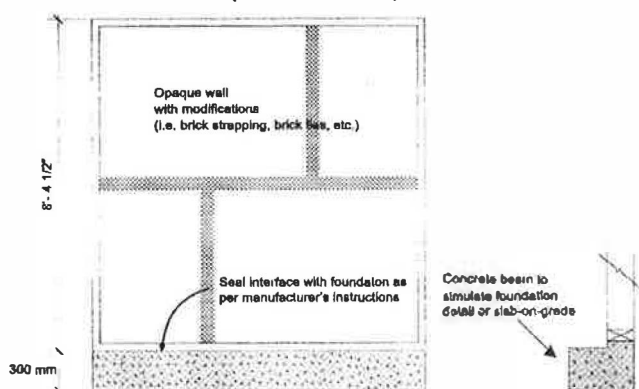


Figure 6 Test specimen(s) with connections to other elements through air barrier system.

Proponents of a proprietary air barrier system intending to specify certified installers may have their specimens constructed by said certified installers, while proponents of a system that is marketed as a commodity-type system to be constructed by any third party shall have their specimens fabricated by a third party with no special knowledge of the system, thus attempting to capture the variability that may occur as part of the delivery system to the field.

Structural Capacity

The structural capacity of the air barrier system is determined by using procedures that test the air barrier system to the design wind pressure experienced by low-rise wall systems in most climates in Canada. In addition, the deflection at 150% of the wind pressure is measured and reported because the information is important to designers.

A wall system is subjected to lateral air pressure loads created by stack forces, mechanical forces, and wind. Stack forces and mechanical forces can be characterized as being relatively low in magnitude but long in duration; whereas wind forces, and particularly those associated with gusts, may be temporary but are much higher in magnitude.

Because the air barrier system is by definition the most airtight plane in the wall, it will carry most of the air pressure loads. The designer has to assume that the air barrier system must be able to resist and transfer the full wind pressure to the building structure without damage to the air barrier system or other components of the wall system.

Structural Loading Requirements

To evaluate the structural capacity of the air barrier system specimens in relation to expected wind loads, the specimens are tested for sustained, cyclic, and gust loadings. The pressures for these tests, shown in Table 4, are established in accordance with the one-in-ten-year return wind pressure for the geographical area in which the wall will be situated. These

TABLE 4

Wind Pressures Established in Accordance with the 1-in-10 Year Return Wind Load for the Geographical Area

For geographical areas where wind design value is (kPa)	P_1, P_1' Sustained for 1 hour (Pa)	P_2, P_2' 2000 cycles ¹ (Pa)	P_3, P_3' Gust Wind (Pa)
$Q_{10} < 0.40$	400	530	800
$Q_{10} < 0.60$	600	800	1200

¹ The 2000 cyclic loads could be applied in four stages of 500 cycles, reversing from positive to negative pressures, or in two stages of 1000 cycles, reversing from positive to negative. See Figure 7 for reference to $P_1, P_1', P_2, P_2', P_3, P_3'$.

design load levels are consistent with wind loading for the structural design of glass for windows in the NBC, since windows are part of the air barrier system for the building. The one-in-ten-year return wind was also considered more appropriate when considering the specified wind loads on a building according to the structural requirements of the NBC. The one-in-ten-year return wind is specified for cladding with a gust factor of 2.5, while the design of structural members is based on the one-in-thirty-year return wind with a gust factor of 2.0. Since the air barrier system is within the wall assembly, it was rationalized that it should be subjected to the wind design value of the cladding with a gust factor representative of what the structure may experience.

The wind loads are applied according to Figure 7, and the test pressures and cycles are thought to be representative of the wind pressures and fatigue on the air barrier associated with two or three major storms that any building would likely experience during a ten-year period.

The material providing the principal plane of airtightness of the air barrier system need not rely on its own strength to resist these structural loads. A flexible membrane can be supported by another material or a framing system that is more air permeable but has the necessary structural strength and rigidity. Any proprietary air barrier system must identify both the plane of airtightness component and its structural components, such as substrates and fastenings, which are part of the system.

Deflection Requirements

Deflection of the air barrier system is measured at the loads shown in Table 5 and is considered important because deflection of the air barrier system under load can

- place wind loads on surfaces that were not designed to support them,
- displace other materials in the wall system, and
- result in tension loads in the membrane (or joints) and affect its long-term service life.

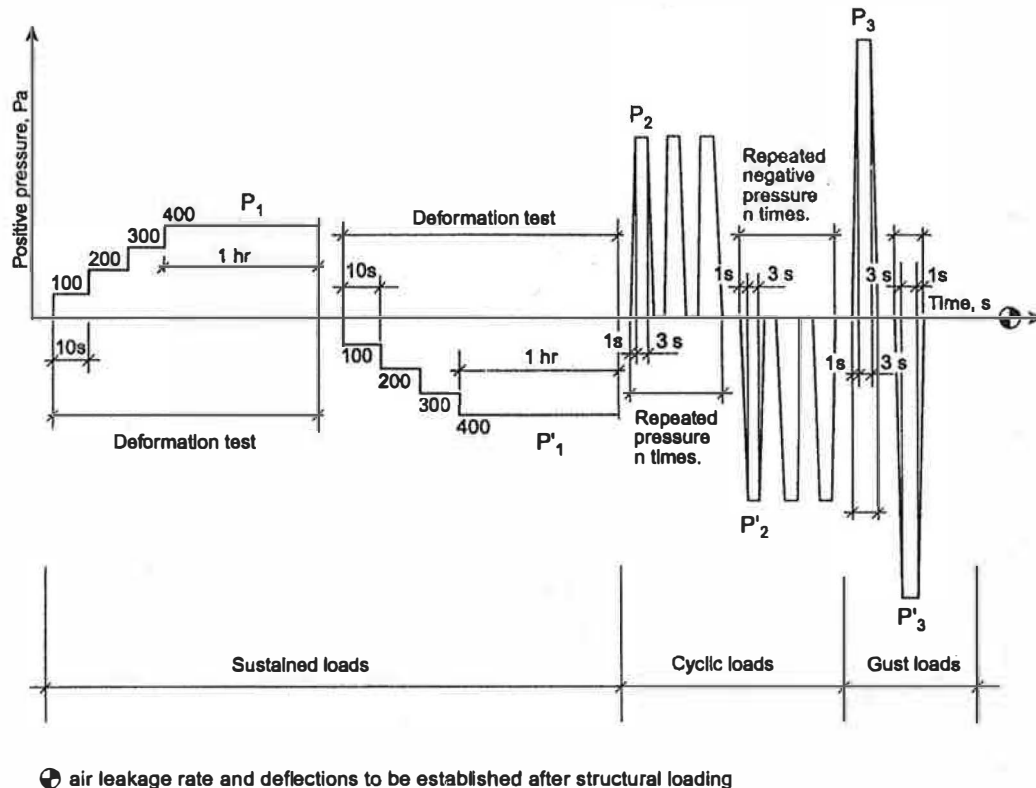


Figure 7 Structural (wind) loading schedule.

The wall design must accommodate the deflection of the air barrier under full load and it must also allow some margin for construction tolerance. The CCMC evaluation criteria and the NBC are based on the premise that the design should accommodate the degree of air barrier system deflection that would occur if 1.5 times the design wind load were placed on it. With the CCMC evaluation procedure, this level of deflection is measured and reported.

It should be noted that with a flexible membrane supported on a framing system, the ability to resist lateral loads depends on the ability of the membrane and joints to resist tensile forces. This requires that joints in the membrane and to adjacent construction be detailed to provide the required strength. This is usually done by clamping the joints between rigid members.

Air barrier system rigidity also affects the performance of rainscreen walls. If the air barrier deflects, it allows more of the dynamic pressure load to be borne by the exterior cladding. This can increase the level of rain penetration.

Continuity of the Air Barrier System

The continuity within the air barrier system is addressed by requiring testing of specimens that contain fasteners, joints, and connectors to adjacent construction, as shown in Figures 4 to 6. It is also addressed by determining the air leakage rate

of the specimens after they have been exposed to the structural loading test. The air leakage test results on these specimens after structural loading must not vary by more than 10% from the opaque wall system air barrier (Figure 4) to meet the requirements for continuity.

The test specimens have to be constructed in accordance with the field delivery system intended by the proponent of the system. Air barrier systems that would be sold as commodity-type components to be erected by any third party would have test specimens constructed by a third party with no prior knowledge of the system, while systems conceived and devel-

TABLE 5
Deflection of the Air Barrier System
at Specified Loads

Wind design values (kPa)	Record maximum deflection(s) after completion of wind pressure loading ¹
$Q_{10} < 0.40$	$D_{0.40}$ @ 640 Pa
$Q_{10} < 0.60$	$D_{0.60}$ @ 960 Pa

¹ The wind pressure loading shall be maintained for a minimum of 10 seconds and the maximum deflection, at any point on the specimen, from the supporting member of the air barrier system shall be determined for both positive and negative pressures. The loadings are 1.6 times Q_{10} from adjustments for exposure in urban areas.

oped to be delivered by trained and licensed installers would have these trained personnel construct the specimen.

The continuity within the air barrier system is also addressed by the requirement of an installation manual with detailed drawings. The construction process, the material requirements, and how the continuity of the plane of airtightness is maintained within the system must be clearly identified in the manual. The installation requirements must also be coupled with the identification of a quality assurance plan.

Durability

Durability can be defined as the ability of a building component to perform its required functions over a period of time in the environment to which it is exposed.

The durability of an air barrier system depends on compatibility with adjacent materials and the loads to which it is subjected over its service life. The factors in the local environment that can play a role include temperature, moisture, solar radiation, electrochemical factors, and biologically active material. The required durability of any material or system depends on how long it is intended to perform and whether it can be maintained or economically repaired. Some air barrier systems are accessible for maintenance, but many are not because they are incorporated within the wall construction. The NBC implies that inaccessible air barrier systems be considerably more durable than accessible and repairable ones.

The Evaluation Guide has defined durability criteria based on the accessibility of the air barrier system and the specific materials used. Currently, criteria have been developed for spray-in-place foam plastic insulation, rigid insulation, exterior non-paper-faced gypsum board, polyethylene- and polypropylene-based membranes, flexible PVC sheets, and modified-bitumen membranes.

The evaluation criteria address durability by evaluating each material according to standard tests that simulate aging, climate, and repeated use. (The tests were developed by ASTM, CGSB, and other standards-writing organizations.) In addition, accelerated-aging protocols for UV and heat aging have been produced for the Evaluation Guide, and acceptance criteria have been set based on 85% residual strength for the strength parameters and no more than 10% increase in air permeance after accelerated aging for the materials forming the principal plane of airtightness.

CONCLUSIONS

There was a definite need in the building product approval process for a method to verify and validate air barrier systems. The CCMC Evaluation Guide, along with the CCMC staff

review contained within their published CCMC evaluation reports, have accomplished this objective. The CCMC Evaluation Guide is now an in-house CCMC document used as a basis for evaluation of air barrier systems and becomes available upon submission to CCMC for product evaluation.

CCMC's Evaluation Guide was developed to assess the entire air barrier system as a product that can be composed of a number of materials, accessories, or assemblies. Air barrier systems that have been evaluated by CCMC in accordance with the requirements of the guide can be deemed to meet the requirements of the NBC if all materials used in the system have been installed properly in the field so that they perform as evaluated. The system is to be installed in accordance with the evaluated installation manual, and the application must be within any limitations defined by the CCMC evaluation. For example, a site inspection of installations over the first year after evaluation may be required in some cases. The field delivery system of the air barrier system, a site-built system, is addressed within the CCMC Evaluation Report for each proprietary air barrier system.

REFERENCES

- AAMA Standard 501-83. 1983. The methods of test for metal curtain walls. American Architectural Manufacturer's Association (AAMA).
- Air barrier systems for walls of low-rise buildings: performance and assessment. Institute for Research in Construction, National Research Council of Canada, Ottawa, 1963.
- Hutcheon, N.B. 1963. Requirements for exterior walls. *Canadian Building Digest* (CBD) 48. Ottawa: Division of Building Research, National Research Council.
- Lux, M.E. and W.C. Brown. 1989. An air barrier for the building envelope. *Proceedings of Building Science Insight '86*. Institute for Research in Construction. National Research Council of Canada, Ottawa. NRCC 29943.
- Model National Energy Code of Canada for Buildings 1997. Canadian Commission on Building and Fire Codes. National Research Council of Canada, Ottawa. NRCC 40635.
- National Building Code of Canada 1995. Canadian Commission on Building and Fire Codes, National Research Council of Canada, Ottawa. NRCC 38726.
- Ojanen, T., and K. Kumaran. 1996. Effect of exfiltration on the hygrothermal behaviour of a residential wall assembly. *Journal of Thermal Insulation and Building Envelopes*, Vol. 19, January.