# RESEARCH HIGHLIGHT

Technical Series 01-125

# A Commissionable Air Barrier System for the Building Envelope

## INTRODUCTION

Air leakage can be linked directly or indirectly to the most prevalent building envelope performance and durability problems. Current thinking, that field-testing of the building envelope for airtightness performance will improve the quality of performance of the air barrier, is not realistic because test results, although needed for research and development, do not have enforceable consequences. It has been suggested that commissioning the air barrier system could improve the performance and durability of the air barrier system.

Commissioning is normally associated with mechanical and electrical systems in a building. It is the process of verifying the performance of HVAC systems to determine if the construction complies with the design documents and the specified performance ratings. The complication for commissioning the air barrier system is that, with the exception of curtain walls and windows, there are no measurable design performance requirements for maximum air leakage rate, structural support, material qualities or durability. A broader approach is needed, whereby performance requirements are identified from the beginning of a project, the design of the air barrier system is engineered and tested if necessary, and the construction is certified through compliance testing and review.

To improve the housing industry's ability to predict the performance and durability of the air barrier system, a methodology is needed to encourage designers and builders to advance air barrier system design and construction from an art to a science. The research objective is to formulate a proposed methodology for the development of a commissionable air barrier system.

## RESEARCH PROGRAM

Canada Mortgage and Housing Corporation (CMHC), through various research and development projects, has already made significant advances towards this objective. For example, a recent study examined the air leakage resistance of the building envelopes of high-rise apartments throughout Canada. Another study examined maximum acceptable air leakage rates through exterior walls from a moisture accumulation standpoint. CMHC has also undertaken several studies to determine the air permeability and strength of various construction materials and details.

Much of the report information was taken from these previous studies. Additional information was gathered during a workshop on commissioning attended by representatives of the Canadian Home Builders' Association, Natural Resources Canada, the Institute for Research in Construction, a testing laboratory, an engineering firm, an architecture firm, an energy management firm and a contractor.

## RESULTS

The development of a commissionable air barrier system must begin with the project brief. The project brief is a document that contains the character, the attributes and the constraints governing the design and construction of the building project. It is recommended that the owner retain a specialist to assist and guide the design brief and design process. It is at this time that the owner, with the guidance of the specialist and the designer, declares the intention to commission the performance of the air barrier system.

The project brief should describe the performance requirements of the air barrier system for the building as a whole and any limits that may apply to individual assemblies of the envelope-the roof area and walls in particular. The instructions for the development of an air barrier system could read as follows:

"The air barrier system of the building envelope of this building is to be designed and constructed to provide a continuous, structurally supported plane of materials to contain the indoor air (exfiltration) and to prevent outdoor air from entering the building (infiltration) in accordance with the following requirements:

1. The envelope will incorporate a continuous air barrier system, as per the 1990 National Building Code, Article 5.3.1.
2. The maximum air leakage through the air barrier system within the roof area and associated penthouse envelope components is not to exceed 0.15 L/s·m$^2$ @ 75 Pa.
3. The maximum air leakage through the air barrier system within the areas of the exterior walls in brick veneer steel stud backup from the roof to grade (excluding windows, patio doors, etc.) is not to exceed 0.75 L/s·m$^2$ @ 75 Pa.
4. The maximum air leakage through the fire floor between the parking garage and the main lobby of the apartment is not to exceed 0.10 L/s·m$^2$ @ 75 Pa.
5. The maximum air leakage through the windows and patio doors is not to exceed the prescribed limits of the CSA A440 standard for windows.
6. The maximum air leakage through joints between the air barrier components of various assemblies is not to exceed 0.20 L/s·m$^2$ @ 75 Pa.
7. The air barrier system in all parts of the envelope is to be designed to support maximum wind loads, 30-year return.

The next phase of the commissioning process is to implement the design brief requirements in the design. The task of designing a commissionable air barrier is divided into two parts: an accounting part and a technical part.

The accounting part consists of a procedure to audit all areas of the envelope, all joints between the areas, the maximum air leakage rates for each, and the method of design validation to certify limits of performance. To facilitate this accounting, the construction of a table is recommended, as shown in Table 1, which lists all primary envelope assemblies along the top and down the left side of the table.

| Certification Method | Maximum Air Leakage From.....(l/s) | | | | |
|---|---|---|---|---|---|
| | Envelope | Roof | North Wall | Windows North Wall | → |
| Envelope | 190 A | | | | |
| Roof | | 12 B | 6 | | |
| North Wall | | E | 36 C | 10 | |
| Window North Wall | | | E | 5 D | |
| ↓ | | | | | |

Table 1 Sample summary of air leakage and certification method requirements

The maximum air leakage rates are computed for each assembly based on the rates defined by the project brief and the area of the assembly. The calculated rates are entered in the diagonal row of squares. The remaining squares identify the joints between each area. The maximum air leakage for each area and joint is inserted in the upper right side of each cell.

The second part of the accounting consists of documenting the sources of validation for the design detail to obtain validation of the air barrier system and its components. The proof-of-design performance may take many forms, but is likely to be one of the following:

A. Building overall air leakage test.

B. Certified by previous testing in another project.

C. Certified performance as determined by CMHC, detail testing.

D. To be certified by window test according to CSA A440.

E. Certified by field mock-up test.

The source of validation would also be entered in the matrix (see Table 1). Similarly, the designer would construct a table that establishes the structural loads to be supported by each part of the air barrier and each joint.

The technical part of the air barrier design is the design of the sections and details required to meet the performance requirements listed in the table developed as described above. The designer can refer to tested (certified) detail designs to aid in the design of the air barrier system. If such rated details do not exist, the details of the proposed method should be tested in a laboratory or by mock-ups on-site. No design detail for the air barrier should be specified unless proof of performance can be established. As the design of the air barrier

progresses, the designer, with the assistance of the specialist, must also develop and prepare field verification procedures for inclusion in the tender documents.

During construction, the process of assembling the air barrier system and certifying its performance must be planned carefully and systematically with the full knowledge of those involved. For small buildings, the performance of the air barrier system may be determined all at once using a blower door fan, or it may be determined progressively. For larger buildings, the process should be undertaken in a progressive manner, through the construction of on-site mock-ups to test the quality of assemblies, or by testing wall areas as typical floors are enclosed.

As the building nears completion, the overall performance of the air barrier system may now be commissioned. Commissioning the air barrier system consists of testing its performance attributes. The final performance test to be undertaken must determine the maximum air leakage rate through the envelope as a whole and the ability of the air barrier system to withstand a structural load, also as prescribed by the tender documents.

To ensure that the air barrier system performs its function adequately for a long period of time, a program of monitoring and testing may ensure durability. Monitoring can be direct or indirect. Indirect monitoring could consist of visual observations of symptoms indicative of air leakage or by monitoring changes in energy usage that might signal increased air leakage. Direct monitoring involves the use of instrumentation and equipment installed at strategic locations to monitor air pressure differences, temperature and humidity in the building envelope cavities. As this approach is localized in nature, it should be supplemented by other direct methods, such as tracer gas testing, fan pressurization or thermography.

## IMPLICATIONS FOR THE HOUSING INDUSTRY

It has been estimated that the cost of an air barrier system adds between five per cent and 10 per cent to the building envelope costs. When the construction costs and the consulting fees for development and review are combined, it is estimated that the development of a commissionable air barrier system would increase the cost of the building between one and two per cent, depending on the scale, complexity, geographic location and occupancy type. However, the concept of a commissionable air barrier system is attractive and definitely needed by the industry to facilitate improvement in building envelope air leakage performance.

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**Housing Research at CMHC**

Under Part IX of the ***National Housing Act***, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

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