

GREEN BUILDING PROGRAM

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**Airtightness and Water Penetration Testing for
Residential Buildings**



GREEN BUILDING PROGRAM GUIDELINES

The Green Building Program (GBP) Guideline for Airtightness and Water Penetration Testing for Residential Buildings was developed for the Green Building Co-ordination Team (GBCT) by the Building Envelope Technology Access Centre (Red River College) and Manitoba Housing.

GBCT wishes to acknowledge the contributing authors of the Airtightness and Water Penetration Testing Guideline: Kevin Knight (Building Envelope Technology Access Centre), Gary Proskiw (Proskiw Engineering Ltd.), Harry Schroeder (Manitoba Hydro) and Chris Buzunis (Manitoba Housing).

The guideline is intended to assist building owners, government organizations and project teams interpret and apply the green building criteria.

The guideline supplements other resources and should not be considered the primary source of information on the subject. Information in the guideline is only intended to provide background, resource and guidance to support implementation of green building criteria.

AIRTIGHTNESS AND WATER PENETRATION TESTING FOR RESIDENTIAL BUILDINGS

Why is testing necessary?

Excessive air leakage is responsible for heat loss, poor indoor air quality, low occupant comfort, noise pollution, and enhanced risk of moisture damage which seriously compromises the building ability to achieve the owner's expectations of efficiency, affordability and occupant comfort.

Testing validates the quality of workmanship and proves the designers and contractors delivered a building that meets design specifications and building code requirements.

Testing is performed at critical stages of construction to identify design or assembly issues and ensure they are resolved affordably in a timely fashion.

Manitoba's Green Building Program (GBP) establishes minimum testing requirements for GRE owned and funded residential buildings to verify the building is air tight and resistant to water penetration.

How is testing requested?

Testing requirements are specified in the Owner's Project Requirements (OPR). This will ensure the requirements are communicated to the project team.

The testing standards are copyright protected and must be administered by authorized testing agencies. Contractors and commissioning professionals can source the agencies that conduct testing in Manitoba, most agencies are listed on the Manitoba Green Building Services Directory at:

<http://greenbuildingservicesmb.ca/services-home/>

What are the testing requirements under the Green Building Program?

The testing requirements, standards and protocols for residential buildings (Part 3 and Part 9) are summarized in the table below. Supporting explanations are described in the indicated section.

GBP Air tightness & Water Penetration Testing Requirements	PART 3: Residential Buildings Testing standard & Protocol	PART 9: Residential Buildings Testing standard & Protocol
Test Fenestration (window, doors, skylights, curtain walls) for air tightness and water penetration	Section 1	Section 1
Test opaque wall for air tightness and water penetration	Section 2	Section 2
Test building air tightness (overall)	Section 3	Section 3

Testing Requirements & Protocols for Residential Buildings

Section 1: Fenestration Field Testing

Purpose: Water and air infiltration testing of fenestration units (windows, doors, skylights, curtain walls etc.) are a critical part of quality control in obtaining a well constructed building. Testing a sample of new units being installed ensures the products and assemblies meet design specifications and the installations were completed in a detailed manner to prevent air and water leakage.

Application at mock-up and prior to project close-out (*choose applicable application*).

- 1. 1 Installation of 20 or more windows (new building construction or window replacement project).
- 1.2: Installations of less than 20 windows.

Fenestration Field Testing At mock-up and project close-out	PART 3: Residential Buildings Testing standard & Protocol	PART 9: Residential Buildings Testing standard & Protocol
ASTM E783- Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors	Application 1.1	Application 1.2
ASTM E1105 – Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference Dynamic Water Penetration	Application 1.1	Application 1.2
ASTM E1186 – Practices for Air Leakage Site Detection in Building Envelopes and Air Barriers	Application 1.1	Application 1.2
AAMA 501.1- Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure	Application 1.1	Application 1.1
AAMA 501.2 – Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems	<i>If applicable</i> Application 1.1	No

Application 1.1: (installation of 20 or more windows)

Test the fenestration units and their installation. A mock-up and test of each type of fenestration must be performed at start of work, when a mock-up has been completed and again after the final fenestration unit is installed (prior to project close-out).

At site mock-up - test each type of fenestration being installed for air leakage and water penetration. If any unit or assembly fail ASTM or AAMA tests, make corrections to the unit or assembly and re-test at the contractor's expense. The correction procedure must be approved by the owner and consultant before any repairs are made. Where approved corrective actions lead to additional testing failures, contractor to discard failing fenestrations and provide newly manufactured fenestrations. A passing grade on both tests is required before proceeding with any additional unit installations beyond mock-up.

Prior to project close-out – additional testing to be performed on two of each type of fenestration installed. If a unit fails a test, an additional 2 randomly selected fenestrations of the type tested will be chosen by the owner and consultant and will be tested at the contractors expense: *if any additional units fail*, a meeting of the owner, consultant, the window installers and manufacturer should be convened to identify the issue; *if no additional units fail*, the single failure will be treated as an isolated case and should be corrected and retested until a passing grade is achieved at the contractor’s expense.

Application 1.2 (installation of less than 20 windows) & Part 9 Buildings

At mock-up – visually inspect each type of fenestration being installed.

Prior to project close-out. Conduct a blower door test. If the results are acceptable with a visual inspection using a smoke pencil, full testing in accordance with ASTM E783 and ASTM 1105 will not be required unless specified by the building owner. If the results are not acceptable full testing in accordance with ASTM E783 and ASTM 1105 is required.

NOTE: Windows with an AC tray may not pass the tests since they are not designed to meet ASTM air and water tightness levels. In these situations, isolate the AC tray and perform the tests on the remainder of the window.

Section 2: Opaque wall air tightness and water penetration testing

Purpose: Air infiltration into a building increases energy consumption, reduces occupant comfort and causes condensation that will lead to moisture problems. Fan pressurization tests determine the quality of the building envelope by measuring air leakage. In addition, air leakage rates can be used to determine the amount of mechanical ventilation needed for proper indoor air quality.

Opaque Wall Airtightness & Water Penetration Testing When air barrier is complete	PART 3: Residential Buildings Testing standard & Protocol	PART 9: Residential Buildings Testing standard & Protocol
ASTM E1186 – Practices for Air Leakage Site Detection in Building Envelopes and Air Barriers	Application 2.1	Application 2.1
ASTM D4551 – Test Method for Pull-off Strength for Coatings Using Portable Adhesion Testers	Application 2.1	Application 2.1
Air leakage testing protocol Part 3: Residential Buildings: *USACE Air Leakage Test Protocol For Building Envelopes version 3. *This will be superseded by ASTM WK35913 Standard Test Method for Determining the Air Leakage Rate of Large or Multi Zone Buildings upon publication.	Application 2.1	NA
Air leakage testing protocol Part 9: Residential Buildings CGSB 149.10 Determination of the Air tightness of Building Envelopes by the Fan Depressurization Method	NA	Application 2.1

Application once air barrier is complete (choose applicable application):

2.1 Testing of new construction (Part 3 and Part 9 Residential Buildings).

2.2 Testing of major renovations when building envelop is part of the scope.

2.3 Test major renovation when only windows are changed.

Application 2.1 Test new building construction

Perform an air leakage test as soon as possible; at earliest when the building's air barrier is complete. Testing early will help identify deficiencies before they are fully covered up by finish materials allowing for quicker and cheaper repairs. Testing is performed by installing a large fan(s) at the main door of the building. The fan is used to pressurize and depressurize the building. The volume of air the fan moves to maintain a specific pressure difference across the building's envelop is measured and represents the air leakage. The leakage is referenced against the area of the building's envelope or the building's volume to indicate the amount of air leaked. The test must be administered for Part 3: Residential Buildings in accordance with USACE Air Leakage Test Protocol For Building Envelopes version 3 or in accordance with CGSB 149.10 for Part 9: Residential Buildings. Each protocol outlines the testing procedures and the pass/fail requirements for the air leakage test. In addition to the reported values from the test, the air leakage must be reported in air changes per hour at 50 Pa (ACH50). Results must be reported to the project team immediately after testing.

Application 2.2: Test major renovations (building envelope is in scope)

Conduct a pre-test prior to the renovation to quantify the amount of air leakage and identify the sources of leakage, which ensures a solution will be incorporated into the renovation design specifications. Conduct the pre-test for Part 3: Residential Buildings using the USACE Air Leakage Test Protocol For Building Envelopes version 3 and use CGSB 149.10 for Part 9: Residential Buildings. The pass/fail requirement outlined in the protocol is the target for air tightness in the building; however the target might not be achievable with the approved scope of work. The alternate pass/fail criteria are for the building test to achieve a decrease in air leakage of at least 16% over the baseline test conducted pre-construction. This target is based on an average decrease determined by the experience of Manitoba Housing. In addition to the reported values from the test, the air leakage must be reported in air changes per hour at 50 Pa (ASH50). Test results must be provided to the project team immediately after testing.

Application 2.3: Test major renovations (only windows are being replaced)

Refer to Section 1, use Application 1.1 or 1.2 as applicable – based on the number of window installations. Results must be reported to the project team immediately after testing.

Note: The term "airtightness testing" is used to describe a quantitative, airtightness test performed on a larger building (typically a Part 3 structure); this generally requires multiple blower doors to complete. "Blower door testing" refers to a quantitative, airtightness test performed on a house or other small building (i.e. Part 9) and normally requires only a single blower door to complete.

Section 3: Air & Water tightness (overall)

Purpose: Fan pressurization tests measure the amount of air leakage across the building's envelope. Air leakage rates are used to determine the required amount of mechanical ventilation for proper indoor air quality.

Air & Water Tightness Testing (Overall) When project is complete	PART 3: Residential Buildings Testing standard & Protocol	PART 9: Residential Buildings Testing standard & Protocol
*USACE Air Leakage Test Protocol For Building Envelopes version 3. *This will be superseded by ASTM WK35913 Standard Test Method for Determining the Air Leakage Rate of Large or Multi Zone Buildings upon publication.	Application 3.1	NA
CGSB 149.10 – Determination of the Air tightness of Building Envelopes by the Fan Depressurization Method	NA	Application 3.1
AAMA 501.1- Standard Test Method for Water Penetration of Windows, Curtain Walls, and Doors Using Dynamic Pressure	Application 3.1	Application 3.1

Application when project is complete (choose the applicable criteria):

3.1 Testing of new construction (Part 3 and Part 9 Residential Buildings).

3.2 Testing of major renovations when building envelope is part of the scope.

3.3 Test major renovation when only windows are changed.

Application 3.1 Test new building construction at completion.

Refer to Section 2 use Application 2.1 and apply protocol for AAMA 501.1 at completion. Results must be reported to the project team immediately after testing.

Determine if the information following application 3.3 is applicable to the testing of the building.

Application 3.2 Test building when renovations are complete.

Refer to Section 2, use Application 2.2 Results must be reported to the project team immediately after testing.

Application 3.3 Test building after window installation.

Refer to Section 1, use Application 1.1 or 1.2 as applicable – based on the number of window installations. Results must be reported to the project team immediately after testing.

Whole Building Air tightness Targets for various types of Part 3 buildings.

Review the following table to establish additional requirements for the whole building airtightness test for various types of Part 3 buildings. These are based upon the current National Building Code of Canada (NBCC), Part 5, Appendix recommendations for air leakage rates under different humidity levels. It uses a multiplier of x2 for Enhanced and x5 for Fundamental whole building airtightness rates. All of these rates are based upon tests conducted with the buildings intentional openings (HVAC, etc.) sealed/closed.

A second test to evaluate the building true operational performance shall also be conducted with the building's intentional openings open. There are no prescribed airtightness rates but the results from this test shall be reported to the commissioning agent and/or consultant to help with the energy use.

	NBCC, Part 5, Appendix Recommendations	Enhanced Life Service ≥ 50 Years	Fundamental Life Service < 50 Years
Warm side relative humidity at 21 C	Recommended maximum system air leakage rate, L/(s • m ²) at 75 Pa	Recommended maximum Whole Building Airtightness. L/(s • m ²) at 75 Pa	Recommended maximum Whole Building Airtightness, L/(s • m ²) at 75 Pa
Class 1 RH $< 27\%$	0.15 L/s/m ²	x 5 = 0.75 L/(s • m ²)	x 10 = 1.50 L/(s • m ²)
Class 2 RH 27-55%	0.10 L/s/m ²	x 5 = 0.50 L/(s • m ²)	x 10 = 1.00 L/(s • m ²)
Class 3 RH $> 55\%$	0.05 L/s/m ²	x 5 = 0.25 L/(s • m ²)	x 10 = 0.50 L/(s • m ²)

Resources:

Air Leakage Within Multi-Unit Residential Buildings: Testing and Implications for Building Performance, Finch, Straube and Genge, 12th Canadian Conference on Building Science and Technology, Montreal Quebec – 2009, pages 529-544

Building Science Corporation, BSD-040: Air tightness Testing in Large Buildings, John Straube, March 2014

ASTM E2813 12 Standard Practice for Building Enclosure Commissioning

ASTM E2947-14 Standard Guide for Building Enclosure Commissioning

AAMA 502 – Voluntary Specification for Field Testing of Newly Installed Fenestration Products

AAMA 503 – Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems

CSA Z320/11 Building Commissioning

Manitoba Hydro: An Investigation of Air tightness in Manitoba's Commercial Building Sector Applied Research and Commercialization, Red River College of Applied Arts, Science and Technology and Proskiw Engineering Ltd.