



LARGE BUILDING AIR TIGHTNESS TESTING

Challenges and Opportunities



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WHAT IS LARGE BUILDING AIR TIGHTNESS TESTING

- *Method of calculating and / or measuring of air leakage in and out of a building under controlled conditions.*
- *Similar to the testing we have done for years for various OBC part 9 residential building efficiency programs*



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Individual suite testing - Required for “odour” control
Whole building testing - Energy and pressure management

RESIDENTIAL HIGH RISE



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New or Retrofit publicly funded buildings can require air tightness testing for quality control and HVAC sizing.

SCHOOLS / GOVERNMENT



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Air tight owner occupied buildings can reduce the HVAC size, improve comfort, and save annual energy costs.

COMMERCIAL AND INDUSTRIAL



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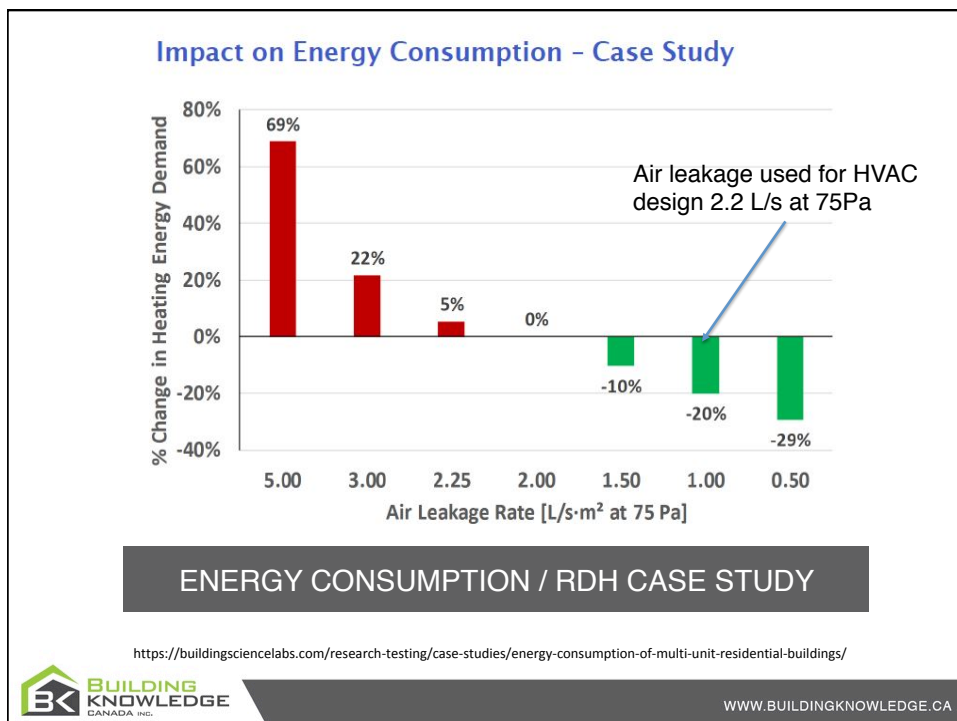
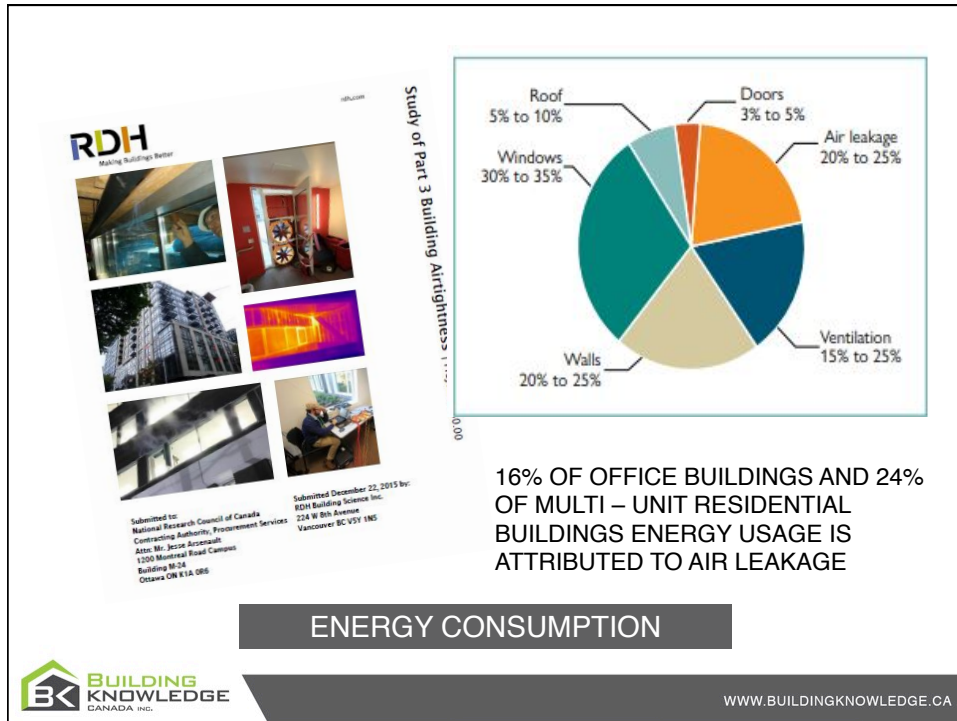
WHY AIR TEST ?

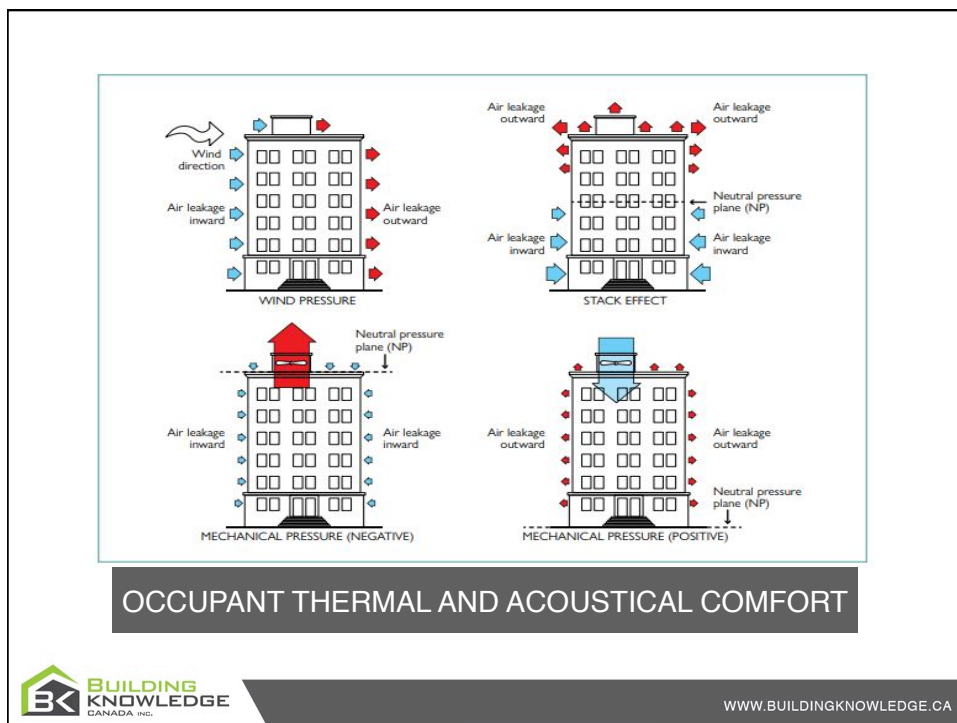
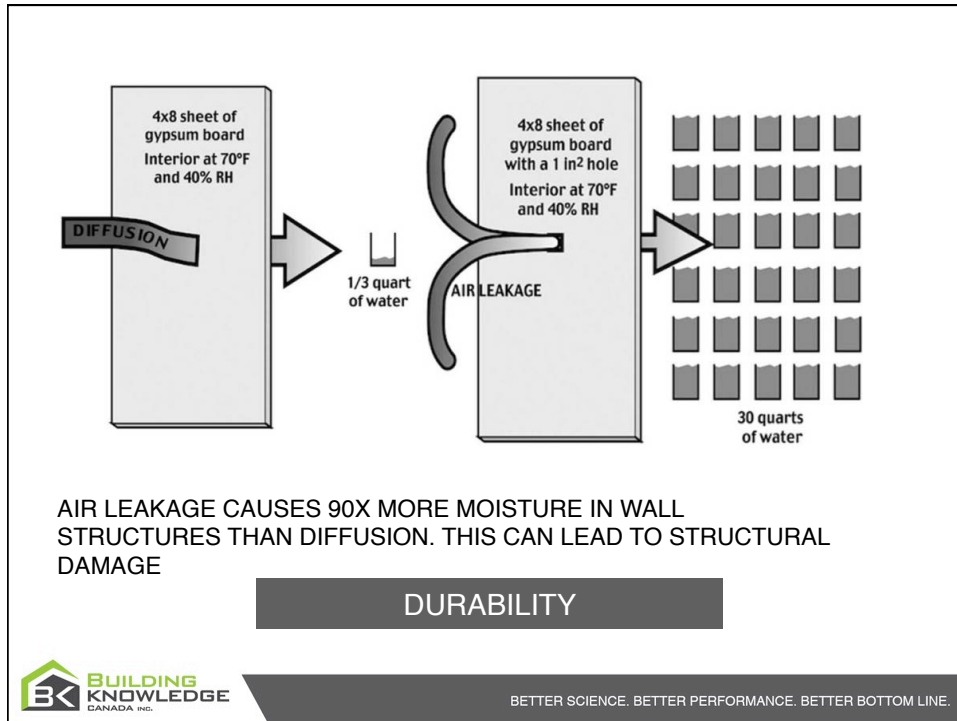
“Air leakage into and out of buildings affects building durability, occupant thermal and acoustical comfort, indoor air quality, and energy consumption.

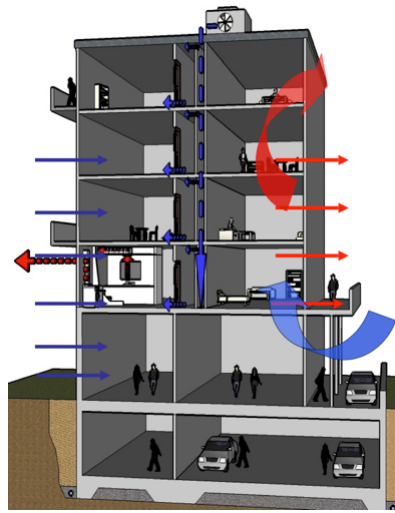
In response to increasing societal concern regarding these building performance characteristics, and in particular energy consumption, improving building enclosure airtightness to reduce air leakage is receiving increased attention.

In various North American jurisdictions and worldwide, this has led to a shift in the way the industry designs, specifies, builds, and measures airtightness”

Lorne Ricketts, MASC, PEng







Wind pressures – up to 300 Pa.

Stack pressures – up to 120 Pa.

Mechanical pressures +/- 75 Pa.

Impact on:

Energy costs

Air conditioning effectiveness

Water intrusion

AIR AND PRESSURE CHALLENGES

$$\Delta P = C a h \left(\frac{1}{T_o} - \frac{1}{T_i} \right)$$

SI units:

where:

ΔP = available pressure difference, in **Pa**

$C = 0.0342$

a = atmospheric pressure, in **Pa**

h = height or distance, in **m**

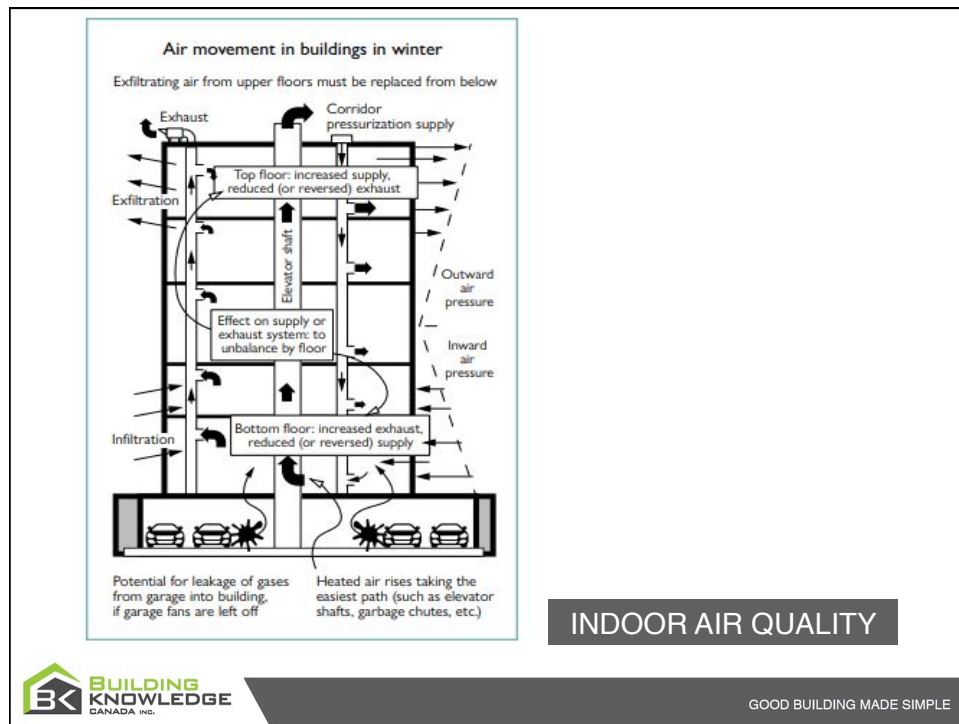
T_o = absolute outside temperature, in **K**

T_i = absolute inside temperature, in **K**

On design day in Ontario
= 4-5 Pa per story



STACK PRESSURES



Combinations of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air

DEFINITION OF AN AIR BARRIER ASSEMBLY

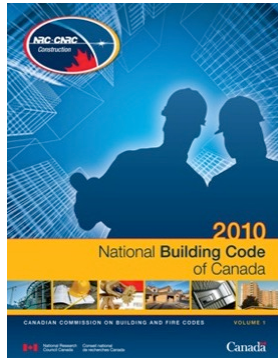
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Part 9 – 9.25.3 Air Barrier Systems
 9.25.3.1(1) Thermally insulated wall, ceiling and floor assemblies **shall** be constructed so as to include an air barrier system that will provide a continuous barrier to air leakage.

Part 3 – 5.4.1 Air Barrier Systems
 Summary - an air barrier system **shall** be installed to provide the principal resistance to air leakage, **except** where it can be shown that uncontrolled air leakage will not adversely effect the health and safety of the building users, the intended use of the building, or the operation of building services.

AIR BARRIERS IN THE ONTARIO BUILDING CODE

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Division B Part 5 – 5.4.1 Air Barrier Systems

- 5.4.1.1(1) Where a building component or assembly separates interior conditioned space from exterior space, interior space from the ground, or environmentally dissimilar interior spaces, the properties and position of the materials and components in those components or assemblies **shall** be such that they control air leakage or permit venting to the exterior as to
- Provide acceptable conditions for the building occupants,
 - Maintain appropriate conditions for the intended use of the building,
 - Minimize the accumulation of condensation in and the penetration of precipitation into the building component or assembly....

5.4.1.1(3) an air barrier system **shall** be installed to provide the principal resistance to air leakage.

AIR BARRIERS IN THE NATIONAL BUILDING CODE



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90.1 - 2007

ANSI/ASHRAE/IESNA Standard 90.1-2007
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2004)
Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

5.4.3 Air Leakage

5.4.3.1 Building Envelope Sealing. The following areas of the *building envelope* shall be sealed, caulked, gasketed, or weather-stripped to minimize air leakage:

- joints around *fenestration* and *door* frames
- junctions between *walls* and foundations, between *walls* at building corners, between *walls* and structural *floors* or *roofs*, and between *walls* and *roof* or *wall* panels
- openings at penetrations of utility services through *roofs*, *walls*, and *floors*
- site-built *fenestration* and *doors*
- building assemblies used as ducts or plenums
- joints, seams, and penetrations of vapor retarders
- all other openings in the *building envelope*

CHANGING STANDARDS



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90.1 - 2010

STANDARD

ANSI/ASHRAE/IES Standard 90.1-2010
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2007)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard
for Buildings
Except Low-Rise
Residential Buildings

I-P Edition


5.4.3 Air Leakage


5.4.3.1 Continuous Air Barrier. The entire *building envelope* shall be designed and constructed with a continuous air barrier.

5.4.3.1.1 Air Barrier Design. The air barrier shall be designed and noted in the following manner:

- All air barrier components of each *building envelope* assembly shall be clearly identified or otherwise noted on *construction documents*.
- The joints, interconnections, and penetrations of the air barrier components including lighting *fixtures* shall be detailed or otherwise noted.
- The *continuous air barrier* shall extend over all surfaces of the *building envelope* (at the lowest floor, exterior walls, and ceiling or roof).
- The *continuous air barrier* shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical *ventilation*.

CHANGING STANDARDS


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Flow rate to **surface area** metric at **75 Pa**

Materials: < 0.02 l/s/m² or 0.004 cfm/ft² @75 Pa (ASTM E 2178)

Assemblies: < 0.4 l/s/m² or 0.04 cfm/ft² @75 Pa (ASTM E 2357 or E 1677)

Whole Buildings: 0.4 l/s/m² or cfm/ft² @75 Pa – no limit at this time

AIR TIGHTNESS METRICS


GOOD BUILDING MADE SIMPLE



AIR BARRIERS - INDUSTRY ASSOCIATIONS



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AIR TIGHTNESS TESTING

Tests can be done as one zone, multiple guarded zones, or individual suite testing.



AIR TIGHTNESS TESTING

Building Knowledge has the equipment to test up to 70,000 cfm.

Or 100,000 sq ft @ 4 l/s / m² @ 75pa a zone.



STANDARDS FOR AIR TIGHTNESS TESTING



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ENERGY STAR



Passive House Institute US



CANADA GREEN BUILDING COUNCIL
CONSEIL DU BÂTIMENT DURABLE DU CANADA



IECC



ASHRAE



IGCC
SAFE & SUSTAINABLE BY THE BOOK

PROGRAMS / STANDARDS SPECIFYING AIR TIGHTNESS TESTING AND TARGETS




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British Columbia – Air test required for mandatory Energy Modeling

Washington State
buildings over 5 stories
2.03 l/s/m² @ 75 pa

City of Fort Collins Colorado – commercial buildings testing required 1.25 l/s/m² @ 75pa




United Kingdom : Buildings
>500 M sq - 2.8 l/s / m²

Plan 2022 – all new buildings to be air tested.
2023 all buildings to be tested and pass target TBD

US military – all new buildings
1.27 l/s / m² @ 75 pa

US General Services Administration PNS-P100 all new buildings 2.0 l/s / m² @ 75 pa

JURISDICTIONS REQUIRING AIR TIGHTNESS TESTING



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Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, India, Japan, Lithuania, Latvia, Norway, Qatar, Slovenia, Scotland, Slovakia, Abu Dhabi



COUNTRIES REQUIRING SOME AIR TIGHTNESS TESTING



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BUILDING KNOWLEDGE TESTING

Examples of buildings tested by our office



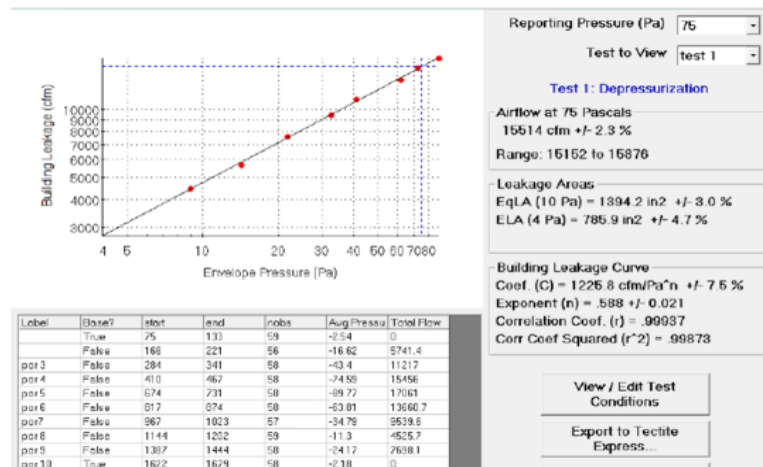
Experience. The Difference.™

SIFTON CENTER AIR TEST



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Analysis in TECLOG3



GOOD BUILDING MADE SIMPLE

Sifton Center:

Air Test Results:

Specific Leakage Rate (Envelope) @ -75 Pa: 0.39 l/s/m²

Specific Leakage Rate (Envelope) @ +75 Pa: 0.49 l/s/m²

Average Specific Leakage Rate @ +75 Pa: 0.44 l/s/m²



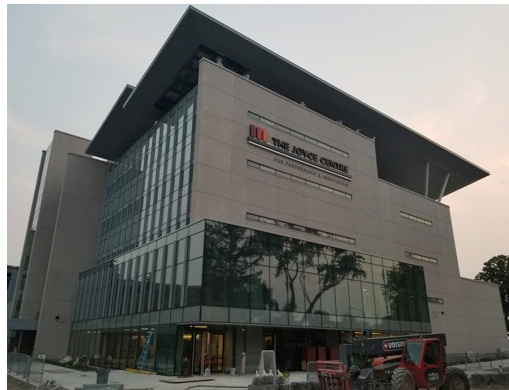
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SIFTON CENTER AIR TEST



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 **MOHAWK**
COLLEGE

RON JOYCE CENTER AIR TEST



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Ron Joyce Center:

Air test to the ISO 9972 standard:

Specific Leakage Rate (Envelope) @ -75 Pa:	0.54 l/s/m ²
Specific Leakage Rate (Envelope) @ +75 Pa	0.55 l/s/m ²
Average Specific Leakage Rate	0.545 l/s/m ²



RON JOYCE CENTER AIR TEST



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The collage includes the following documents:

- RDH Making Buildings Better**: A report featuring images of modern buildings and interior spaces.
- Study of Part 3 Building Airtightness | eno**: A technical report with a focus on building airtightness.
- Illustrated Guide Achieving Airtight Buildings**: A guide published in September 2017, showing a multi-story residential building.
- BC HOUSING**: A report titled "Air Leakage Control in Multi-Unit Residential Buildings" with the subtitle "Development of Testing and Measurement Strategies to Quantify Air Leakage in Houses". It includes images of various residential units.
- Air Leakage Control for Multi-Unit Residential Buildings**: A report by CanaRE, featuring a large image of a modern multi-story building.

CANADIAN STUDY'S AND REPORT'S AVAILABLE



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- Energy Conservatory: Blower Door Applications Guide: Beyond Single Family Residential – v.1.0 2014.04.01
- Building Science Digest 014: Air Flow Control in Buildings – John Straube 2007.10.15
- Canadian Building Digest 23: Air Leakage in Buildings – Wilson, A.G. 1963.12.xx
- CMHC: Controlling Stack Pressure in High-Rise Buildings by Compartmenting the Building – 1996.03.xx
- Canadian Building Digest 72: Control of Air Leakage is Important – Garden, G.K., 1965
- Building Science Digest 040: Airtightness Testing in Large Buildings – John Straube 2014.03.18
- 14th Canadian Conference on Building Science and Technology – 2014.10.28-30
 - Papers for presentations below are available on OBEC website members area
- Building America Report: Field Testing of Compartmentalization Methods for Multifamily Construction – 2015.03

STATE OF TESTING AND RESEARCH – LARGE BUILDING AIR TIGHTNESS TESTING



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THANK YOU

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