Interaction Between the Building Envelope and Fenestration Products

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Introduction

Who is UL - CLEB?

- Global independent safety science company
- May - 2017, UL & CLEB combined Building Envelope experience and expertise
- Over 120 years in developing product standards and conducting evaluations of a wide range of building components, materials and systems

Our Mission…"Working for a Safer World"

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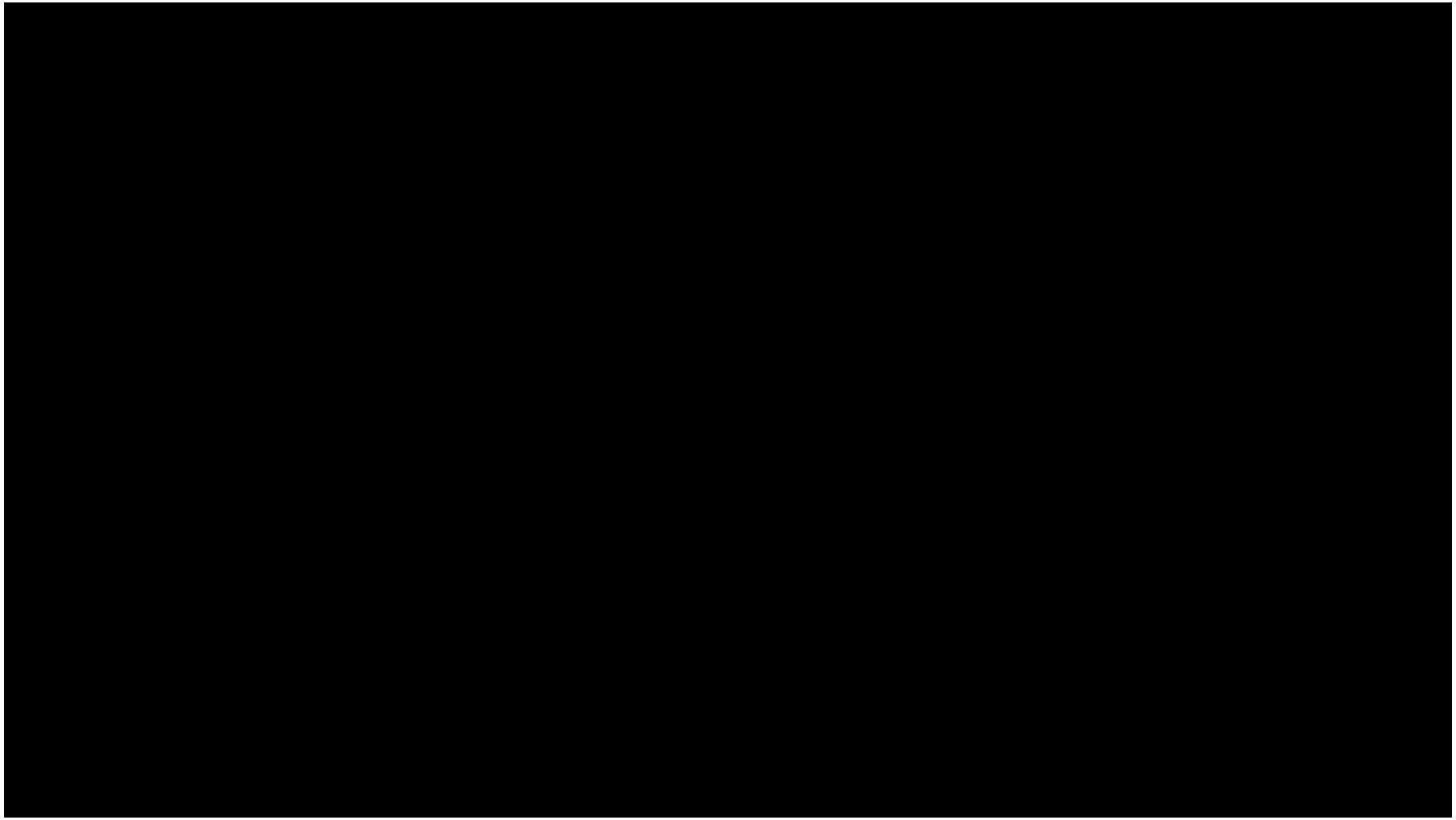
UL CLEB

UL Enterprise View



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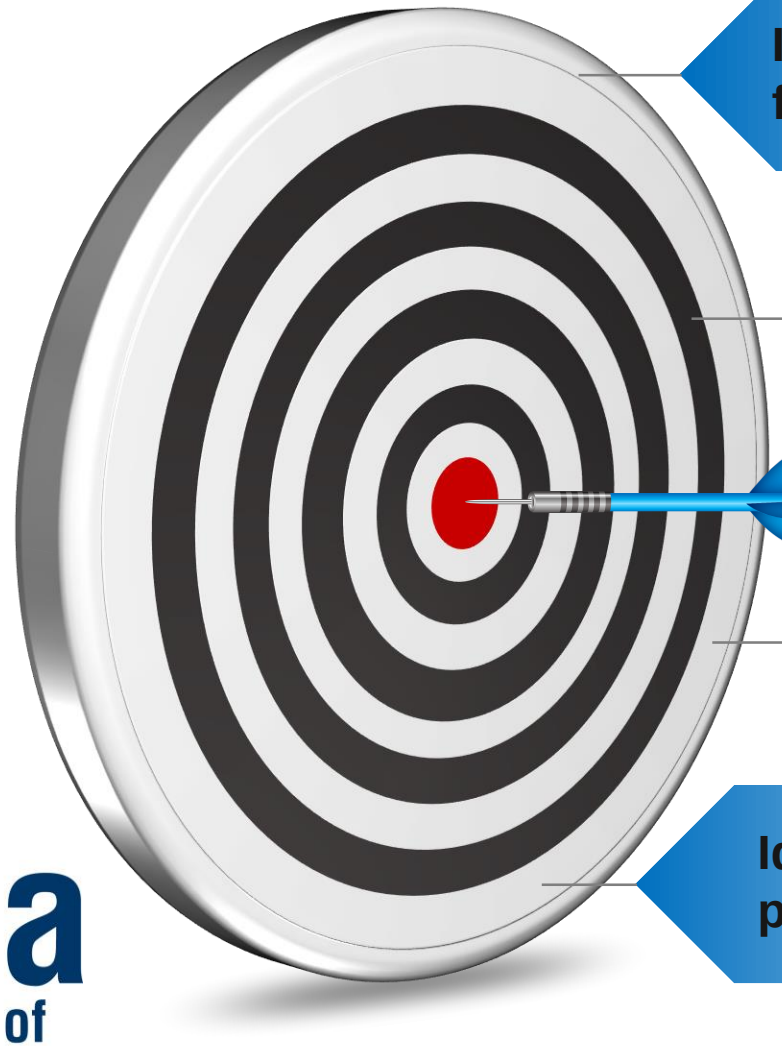
Course Objectives

Upon completion of this course, participants should be able to:



- Identify U.S. and Canadian model code requirements for Building Envelope and Fenestration Products
- Discuss the code relationships and importance of interaction between these types of products
- Explain the performance criteria, and how the model codes handle these types of designs
- Identify potential areas of concern when these products are installed together

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Agenda

- Review of U.S. and Canadian Codes Specific to Building Envelope
- Performance Requirements
- Interaction and Importance of Proper Installation
- Third Party Certification
- Question & Answer

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External Walls

Why the focus:

- Durability
- Climate
- Energy Efficiency
- Performance
- Aesthetics

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Unique External Walls

Shard (London)

Gherkin (London)

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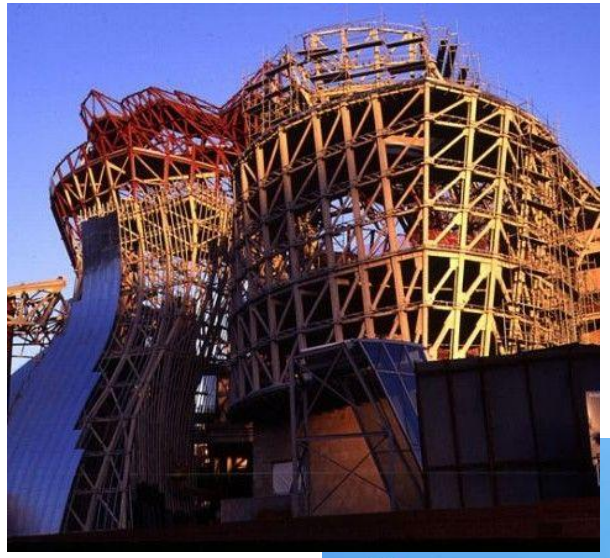
Unique Exterior Walls

Guggenheim Museums



Bilbao, Spain
Frank Gehry

New York City
Frank Lloyd Wright

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External Wall Types

Major Factors when choosing Products?

- Application – residential or commercial?
- Intended Use – keep out weather, wind-borne debris protection, storm shelters, others?
- Integration / Installation – how will it interact with other building envelope materials or products?
- Ensuring proper performance – what codes are driving requirements (local codes or International)?

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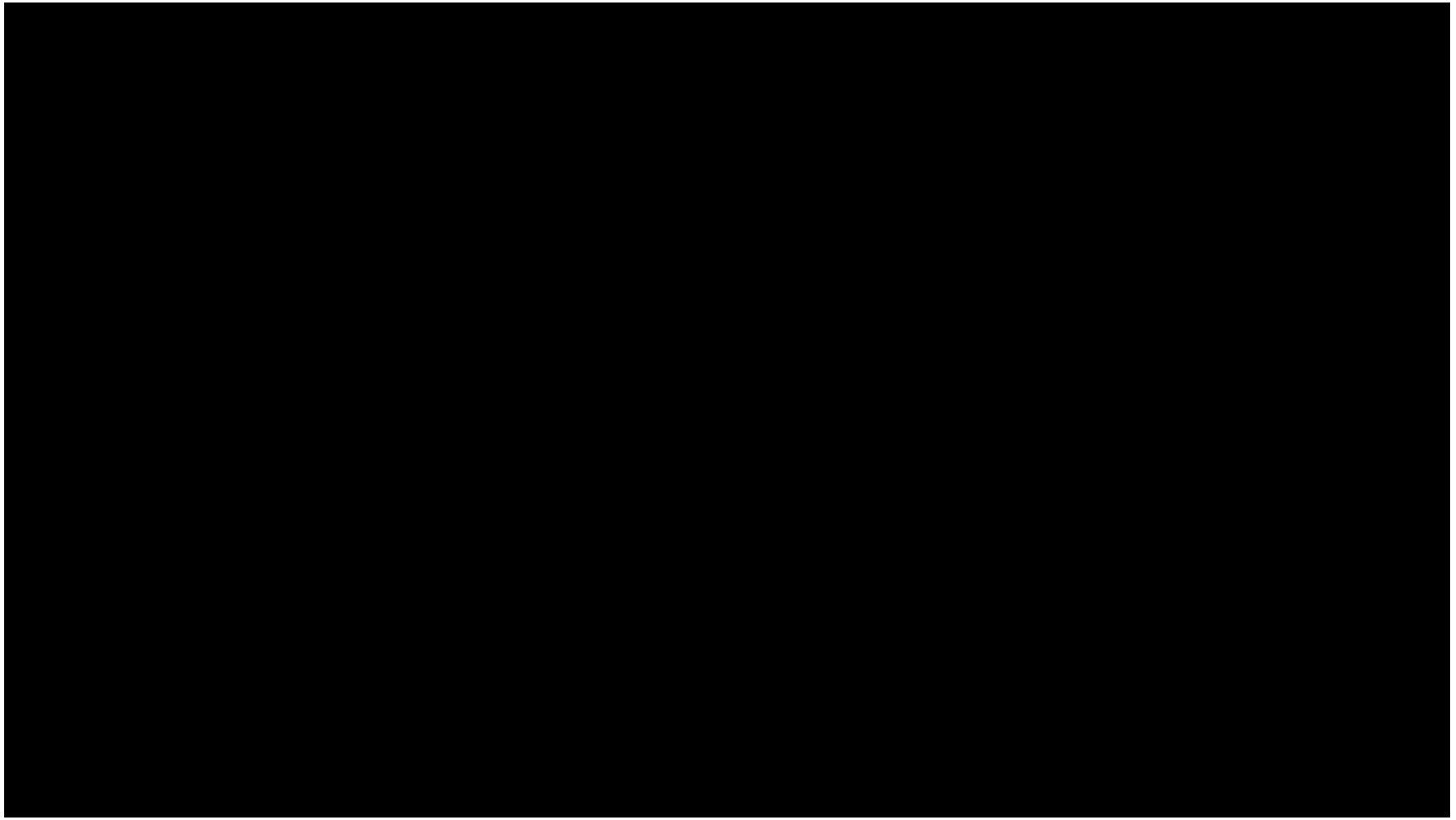
Intended Use Example:
ICC-500 Tornado Impact Testing



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External Wall Types

Wall types can include:

- Masonry
- Curtain walls
- Window Walls
- Fenestration
- Storefront
- EIFS
- Combination
- Etc.

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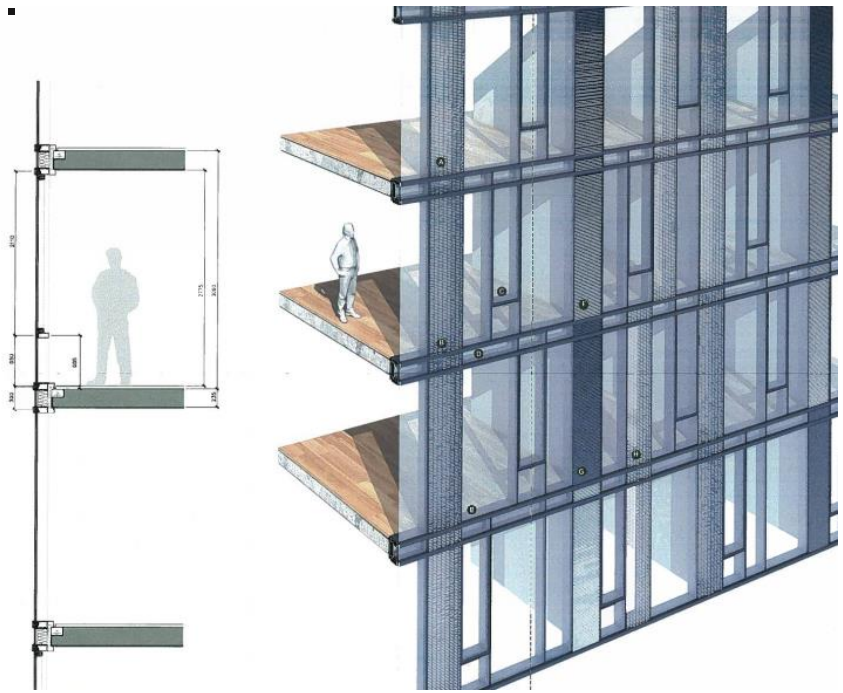
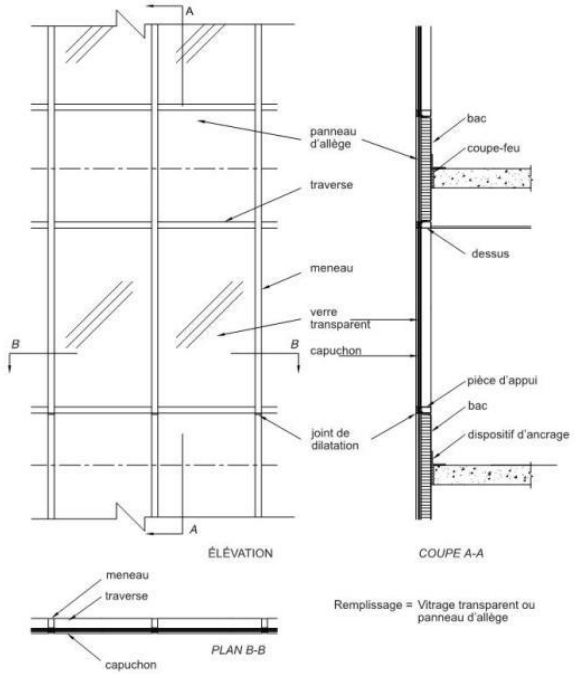
Curtain Wall

A non-load-bearing exterior wall cladding that is hung to the exterior of the building, usually spanning from floor to floor. Curtain wall vertical framing members run past the face of floor slabs, and provision for anchorage is typically made at vertical framing members only.





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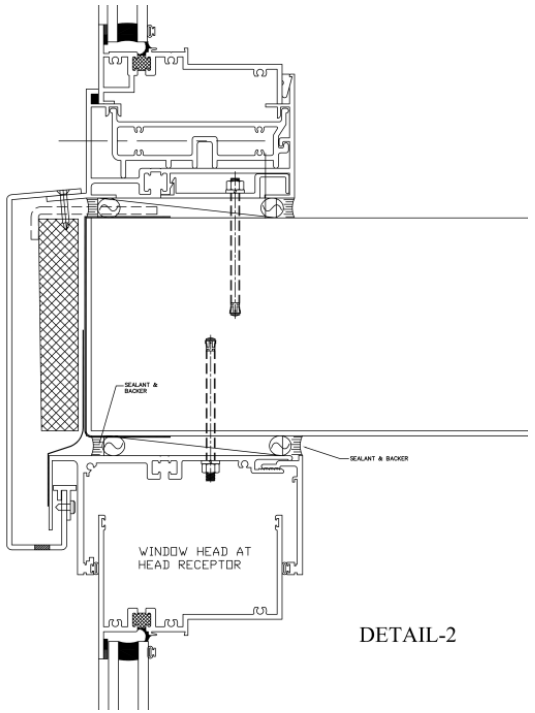
Window Wall

A non-load-bearing fenestration system provided in combination assemblies and composite units, including transparent vision panels and/or opaque glass or metal panels, which span from the top of a floor slab to the underside of the next higher floor slab.



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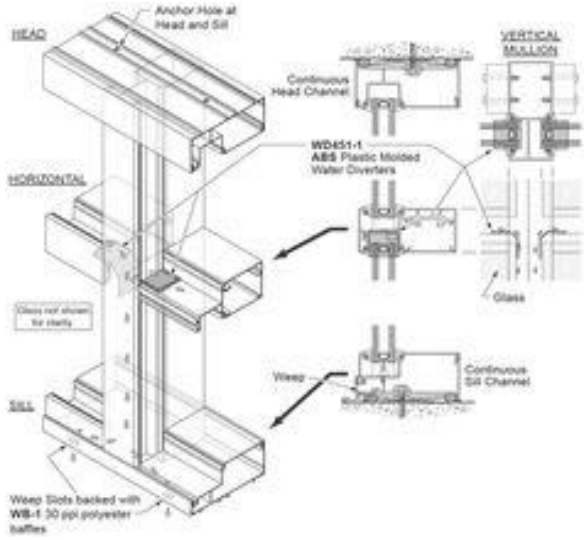
StoreFront

A non-residential, non-load-bearing assembly of commercial entrance systems and windows usually spanning between the floor and the structure above, designed for high use/abuse and strength.



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What is Fenestration?

Consumers don't know!

"Openings in or on the building envelope, such as windows, doors, secondary storm products (SSPs), curtain walls, storefronts, roof windows, tubular daylighting devices (TDDs), sloped glazing, and skylights, designed to permit the passage of air, light, or people."

AG-13 AAMA Glossary

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Agenda

- **Review of U.S. and Canadian Codes Specific to Building Envelope & Fenestration**
- Performance Requirements
- Interaction and Importance of Proper Installation
- Third Party Certification
- Question & Answer

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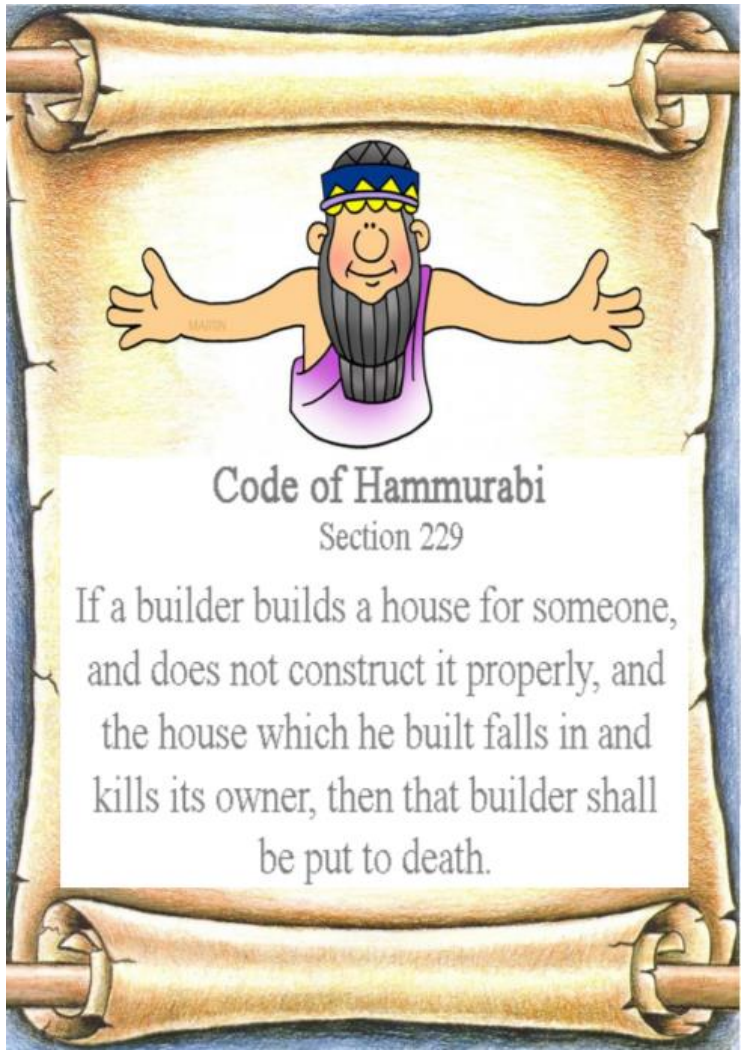
Codes have come a long way…

The Code of Hammurabi
(1800 B.C)
The world's first Building Code



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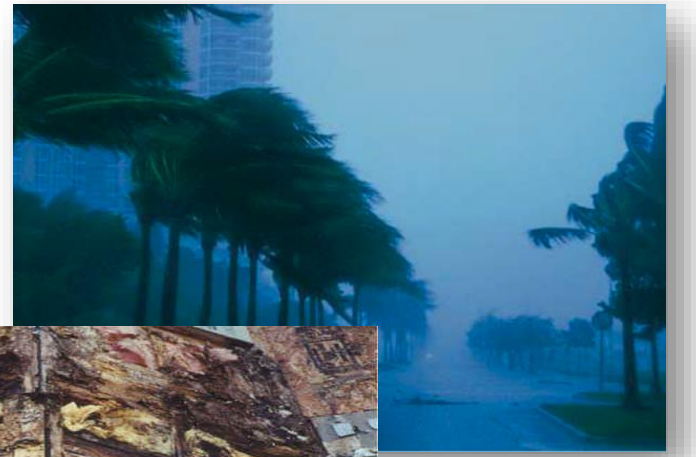
Why Do We Need Building Codes?

Dramatic Events that drive Building Envelope Testing

- **Stronger Storms** (Hurricanes, Tornados, Floods)
- **Insurance Tactics** (Hiring Inspectors)
- Mold
- **Litigations**
- PE Validations
- Code Changes
- State Addendums
- **Impact Requirements**
- Wind-Driven Rain Standards
- **Product Misrepresentation**
- And the list goes on……..



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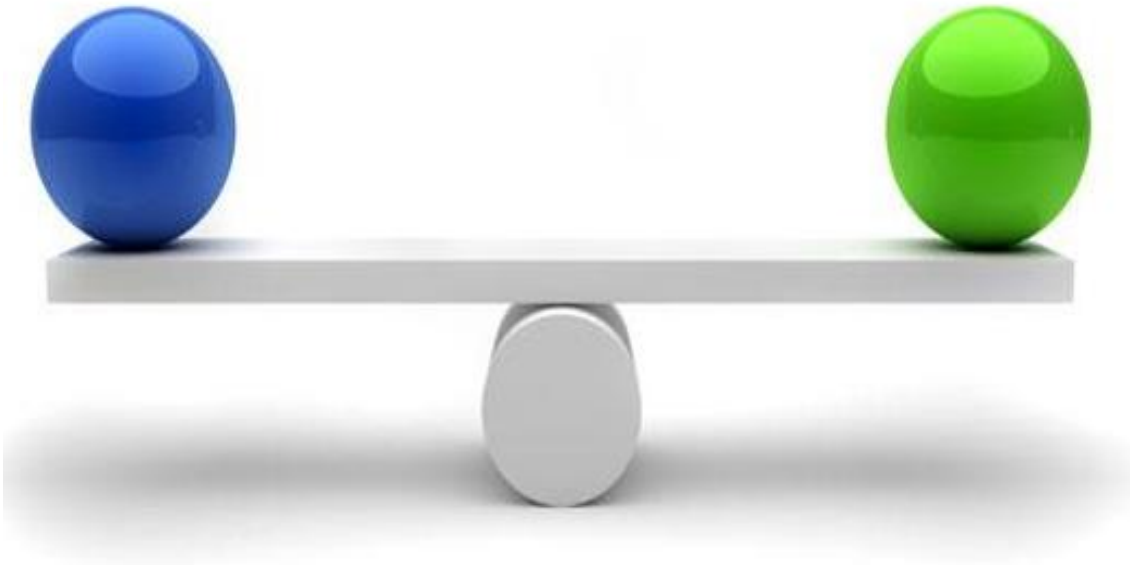
Balance

Building Envelope Performance

Traditional Fire Testing



U.S. Codes

Canadian Codes

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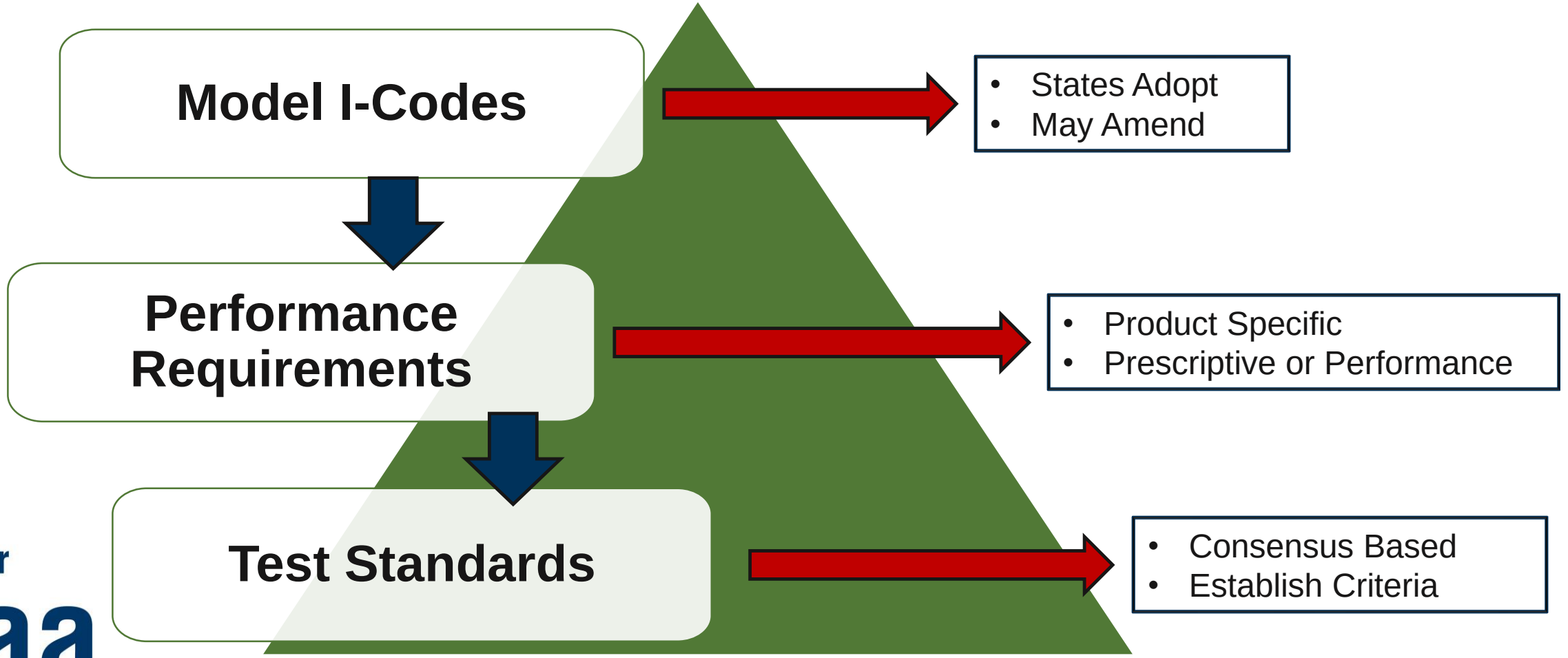
International Codes



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Test Standards Writing Organizations

ANSI

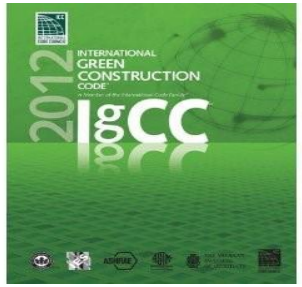
ASHRAE

American Architectural Manufacturers Association

ASME
SETTING THE STANDARD

UL

U.S. GREEN BUILDING COUNCIL



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ASTM INTERNATIONAL
Standards Worldwide

INTERNATIONAL CODE COUNCIL
ICC ES
ICC EVALUATION SERVICE

NFPA®

U.S. and the International Codes

15 Model Codes (IBC, IRC, IECC, Plumbing, Energy, Green, Existing, more)

- Complete set for building safety and fire prevention
- Benefits public safety and supports the industry's need for one set of codes without regional limitations

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Building Codes

Fenestration and Building Products…
3 Main Areas around Performance

1. Air/Water/Structural
2. Thermal
3. Impact/Cycling

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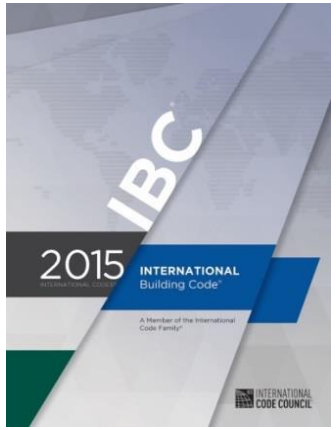
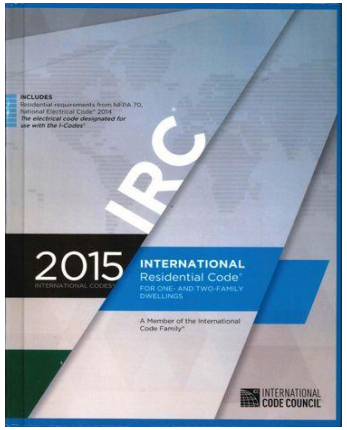
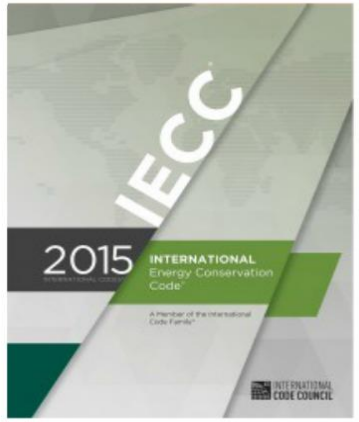
ICC – Model Codes

Model Codes define performance for exterior building envelope products

- IBC and IRC establishes **weather protection performance** (weather barriers)
- IECC establishes **thermal performance** (air barriers)







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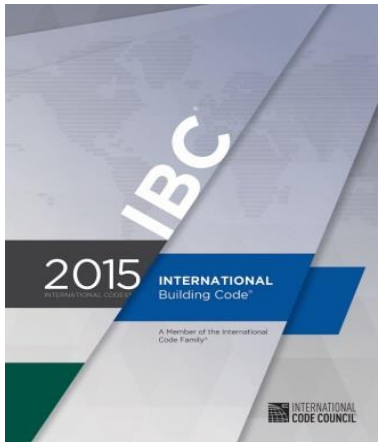
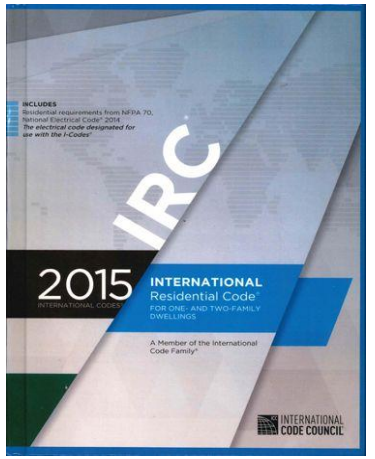
Weather Resistive Construction

First – let's review weather protection performance within IBC & IRC!

Requirements for Building Envelope Weather Protection



Identical reqmt's!



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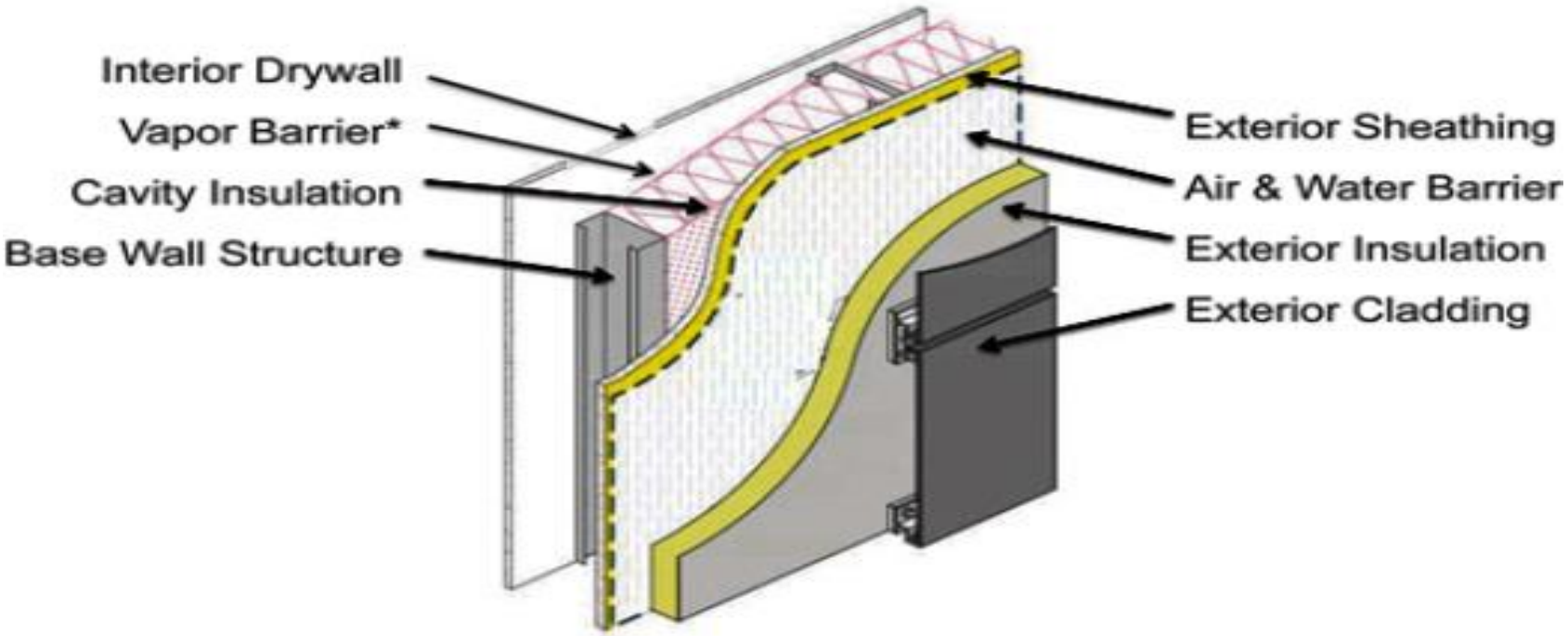
IBC & IRC Definitions

Exterior Wall Envelope. system or assembly of *exterior wall* components that provides protection of building structural members from the detrimental effects of the exterior environment



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IBC & IRC Definitions

***Exterior Wall Covering*.** material or assembly of materials on the exterior side of *exterior walls* for providing a weather-resisting barrier

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IBC & IRC Definitions

***Water-Resistive Barrier*.** material behind an *exterior wall covering* intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the *exterior wall* assembly.

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IBC - Chapter 14
Performance Requirements Exterior Wall Envelope

Must be designed and constructed to:

- Control moisture accumulation
- Control humidity – prevent mold and sick buildings
- Control air leakage
- Maintain indoor comfort
- Conserve energy
- Deter or alleviate water leakage
- Prevent fire spread

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IBC Chapter 14 Requirements

Exterior Wall Envelope

Must be designed and constructed to prevent damage from:

- Rain
- Wind
- Snow
- Other weather events
- Fire

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IBC contains prescriptive and performance requirements for the Building Envelope

Building Envelope Weather Protection

The IBC and IRC take a systematic approach to building envelope weather protection:

1. **Passive Protection**
   - Design and Engineering
   - Plan Review

2. **Active Protection**
   - Lab Testing
   - Mock-up Testing
   - Field Testing

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Passive Protection

(IBC & IRC: Code Sections 1403.2 and R703.1)

Exterior walls shall provide the building with a weather-resistant *exterior wall envelope*.

- *Envelope* shall include flashing
- Be designed and constructed to prevent accumulation of water within the wall assembly by providing a *water resistive barrier* behind the exterior veneer, and means for draining water that enters

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Passive Protection within IBC & IRC!

Passive Protection

(IBC & IRC: Code Sections 1403.2 and R703.1)

2 Exceptions for requiring weather-resistant exterior wall envelope:

1. *Exterior wall envelope* not required over concrete or masonry walls

2. *Exterior wall envelope* tested in accordance with ASTM E331 under **4 conditions**

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Passive Protection

(IBC & IRC: Code Sections 1403.2 and R703.1)

2 Exceptions for requiring weather-resistant exterior wall envelope:

1. *Exterior wall envelope* not required over concrete or masonry walls

2. *Exterior wall envelope* tested in accordance with ASTM E331 under **4 conditions**

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Active Protection within IBC & IRC!

Testing to ASTM E331 – **4 Conditions**

✓***Condition 1:***

- Test specimen to have minimum 1 opening, control joint, wall/eave & wall/sill interface
- Openings/penetrations must represent intended end use

✓ ***Condition 2:***

- Test size = minimum 4’ x 8’

✓ ***Condition 3:***

- Minimum pressure differential of 6.24 psf (Typical test is 2.86 psf)

✓ ***Condition 4:***

- Minimum test exposure = 2 hours (Typical test is 15 minutes)

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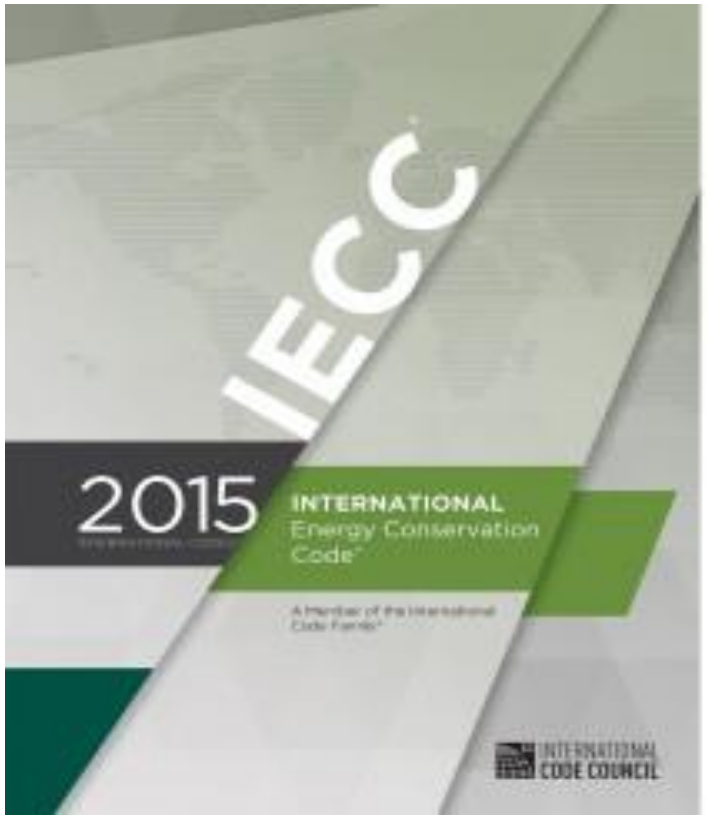
International Energy Conservation Code

Model Code - Requirements for Building **Thermal** Envelope Protection…



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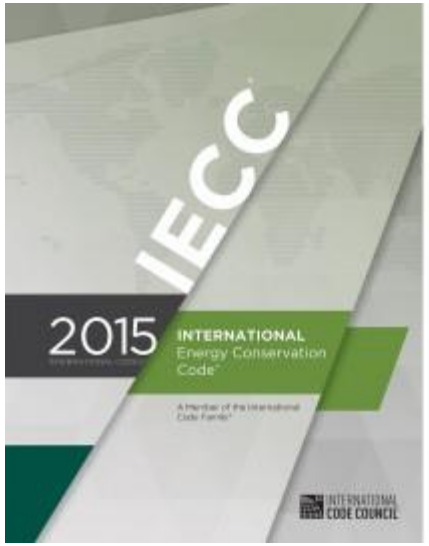
Thermal Protection – Energy Conservation

Thermal protection performance within IECC!

IECC has 2 main sections/provisions

Commercial & Residential



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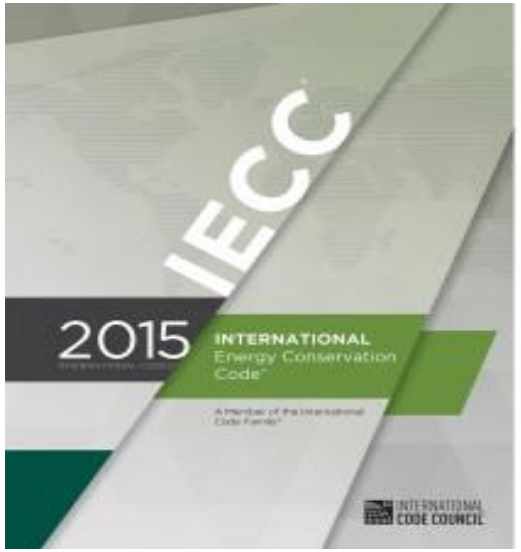
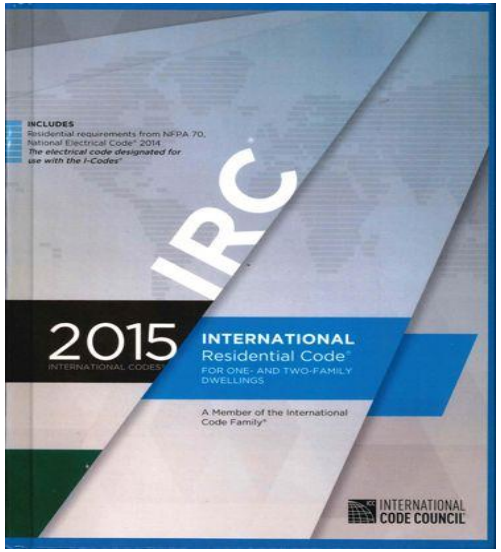
IECC - Residential Provisions

First - Residential Provisions (Section R402.4)

Residential Provisions of IECC are consistent with the IRC



Consistent



(Chapter 11)

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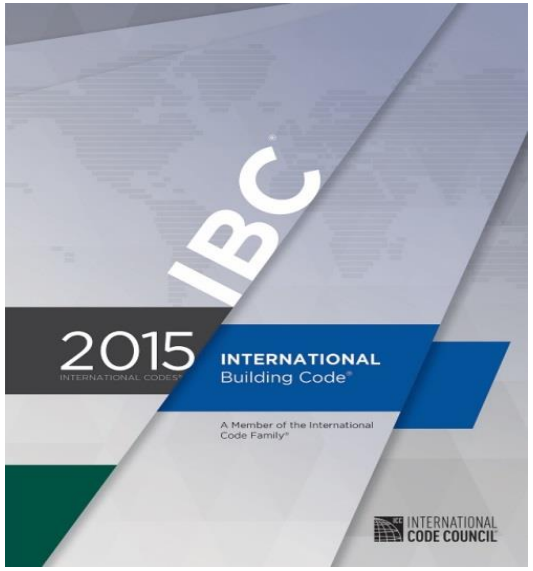
IECC - Commercial Provisions

IBC directly refers use of the Commercial Provisions within the IECC!



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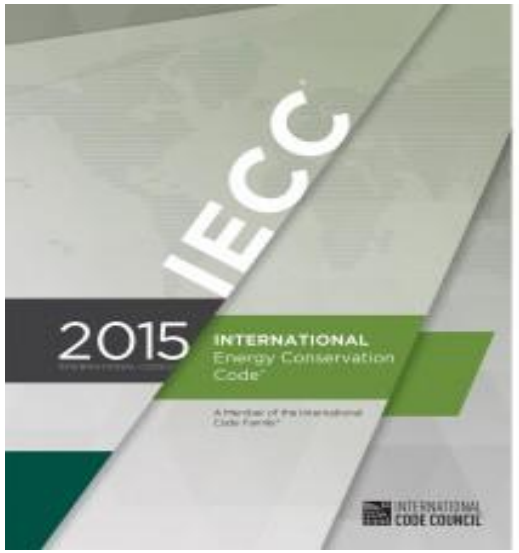
Directs to IECC



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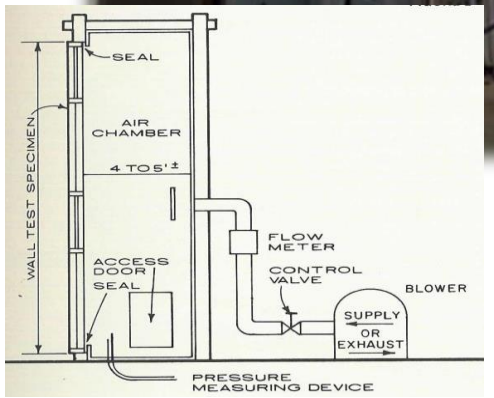
IECC – Commercial Provisions

Now – review Commercial Provisions of IECC (Section C402)

Prescriptive Building Thermal Envelope Requirements:

- ✓ Insulation – walls, floors and roof
- ✓ Fenestration – maximum area
- ✓ **Air leakage – thermal envelope/air barriers**
- ✓ Air leakage of fenestration



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Canadian Building Codes

4 Model Codes (NBC building, NPC plumbing, NFC fire, NECB energy)

- NBC is divided in different parts that cover large buildings and small buildings separately;
- Parts 3, 4 and 5 large building and part 9 housing and small buildings. (3 stories and 600 m^2 (6000 ft^2));
- Adopted or modified by provinces.

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Canadian Building Codes

In Canada:

- Codes are not divided by usage, like commercial and residential, neither by occupancy, but rather by size;
- Parts 3, 4 and 5 «large buildings» cover all type of occupancy including medium to high-rise residential
- Part 9 «housing and small buildings » which is some times referred as residential also includes small commercial buildings

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Canadian Codes for Building Envelope

Building Envelope requirements are found:

- In NBC Part 5 «Environmental Separation» which covers:
  - ✓ Heat transfer (control of condensation)
  - ✓ Air leakage
  - ✓ Protection from precipitation
  - ✓ Vapour diffusion
  - ✓ Windows, Doors and Skylights
  - ✓ Other Fenestration
- In NECB Part 3 Building Envelope (heat transfer and air tightness)
- In NBC Part 9 «Housing and Small Buildings », more specifically:
  - ✓ Section 9.7 Windows, Doors and Skylights
  - ✓ Section 9.25 Heat Transfer, Air Leakage and Condensation Control

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Canadian Codes Building Envelope Requirements for the Air Barrier

NBC Part 5 «Environmental Separation»:

- Requires that the materials intended to provide the principal resistance to air leakage shall have an air leakage characteristic not greater than 0,02 L/s-m^2 , measured at an air pressure difference of 75 Pa. (section 5.4.1.2), when tested in accordance to ASTM E2178, ”Standard Test Method for Air Permeance of Building Materials.”, or;
- Conform to CAN/ULC-S741, "Air Barrier Materials – Specification“.
- Materials with multiple functions: Where building materials, components or assemblies perform more than one function, they shall satisfy the requirements of all of those functions.
- No specific requirements for systems, apart from recommendations in Appendix

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Canadian Codes Building Envelope Requirements for the Air Barrier

NBC Part 5 «Environmental Separation»: Appendix A

- Recommends that air barrier systems have a maximum air leakage rate as a function of the hygrometric conditions maintained in the building.
  (see table A-5.4.1.2 1)

Table A-5.4.1.2. 1) and 2)
Recommended Maximum Air Leakage Rates

Warm Side Relative Humidity at 21 °C	Recommended Maximum System Air Leakage Rate, L/ (s . m^2) at 75 Pa
< 27 %	0,15
27 à 55 %	0,10
> 55 %	0,05

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Canadian Codes Building Envelope Requirements for the Air Barrier

NECB Part 3, Section 3.2.4. Air Tightness (prescriptive)

- Requires that the opaque portions of the building envelope shall include an air barrier system;
- Which conforms to CAN/ULC-S742, "Air Barrier Assemblies – Specification".
- With an air leakage characteristic not greater than 0,2 L/s-m^2 , measured at an air pressure difference of 75 Pa.
- The air barrier assembly could also be tested as per ASTM E 2357 for Determining Air Leakage of Air Barrier Assemblies, as long as wind pressures are below 0,65 kPa and installed on the warm side of the building envelope

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Canadian Codes Building Envelope Requirements for the Air Barrier

NBC Part 9 «Small Buildings»:

- Air Barrier required for walls, ceilings and floors between conditioned space and unconditioned space;
- To control moisture condensation, insure comfort and minimize soil gas ingress;
- No values set for leakage limits;
- Emphasis on continuity:
  - ✓ Joints and intersections in wall, ceilings and floors
  - ✓ Penetration details (windows, doors, conduits etc.)

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National Air Barrier Association (NABA)

The testing of an air barrier material for air leakage is completed in accordance with ASTM E2178 '*Standard Test Method for Air Permeance of Building Materials*' or CAN/ULC-S741 '*Standard for Air Barrier Materials - Specification*'. Air barrier materials (ie. self-adhered sheet air barriers, liquid applied membranes, medium density sprayed polyurethane foam, mechanically fastened commercial building wraps and boardstock air barriers) are defined by their air permeance and the amount of air that passes through them. NABA defines an air barrier material as one that has been tested and has an air permeance less than 0.02 L/(s • m^2) @ 75 Pa (0.004 cfm/ft^2 @ 1.57 lb/ft^2). Keep in mind that air permeance is the amount of air that migrates through a material, whereas air leakage is the air that passes through holes or gaps.

To determine the air permeance of a material, a one metre by one metre piece of exposed air barrier specimen is tested in one of the two following apparatuses:

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Testing of Air Barrier Assemblies

The testing of an air barrier assembly for air leakage is completed in accordance with ASTM E2357 '*Standard Test Method for Determining Air Leakage of Air Barrier Assemblies*' or CAN/ULC-S742 '*Standard for Air Barrier Assemblies - Specification*'. NABA defines an air barrier assembly as one that has a air leakage rate less than 0.2 L/(s•m^2) @ 75 Pa (0.04 cfm/ft^2 @ 1.57 lb/ft^2). Specimen one of the test is a 8' x 8' wall with exterior panel-type material. The joints are sealed and the air barrier is applied to form a continuous assembly. The second specimen is a 8' x 8' wall with exterior panel-type material, a 24" x 48" window rough opening, masonry ties, junction boxes, galvanized duct and a PVC pipe. The panel joints and penetration joints are sealed and the air barrier material then applied. The cumulative results of this test specimen will include the air permeance of the material, accessories, air barrier components (window and services elements) and the air leakage that results from joining those three parts together. See the image below for the specimens tested as per ASTM E2357 or CAN/ULC-S742.

ULC and ASTM STANDARDS

- CAN/ULC-S741-08 «Air Barrier Materials»;
- CAN/ULC-S742-10 «Standard for Air Barrier Assemblies»;
- ASTM E2178 - 11 «Standard Test Method for Air Permeance of Building Materials»;
- ASTM E2357 - 11 «Standard Test Method for Determining Air Leakage of Air Barrier Assemblies».

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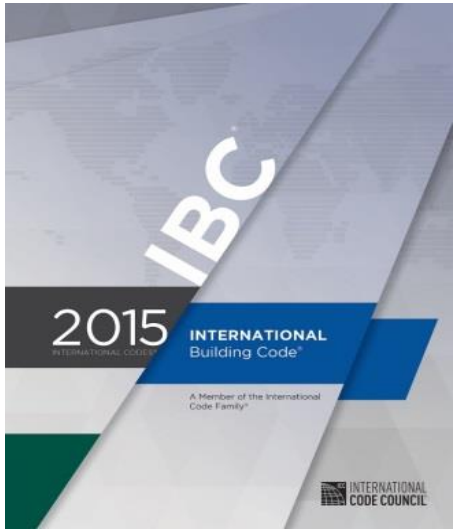
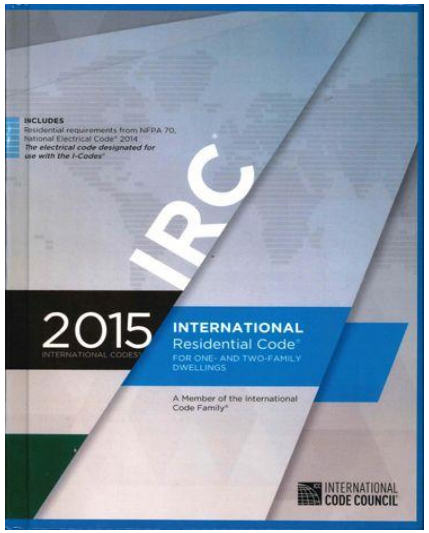
US Model Codes and Fenestration

Section 1709.5 Exterior window and door assemblies



Similar Reqmt's!



Section R609: Exterior Windows and Doors

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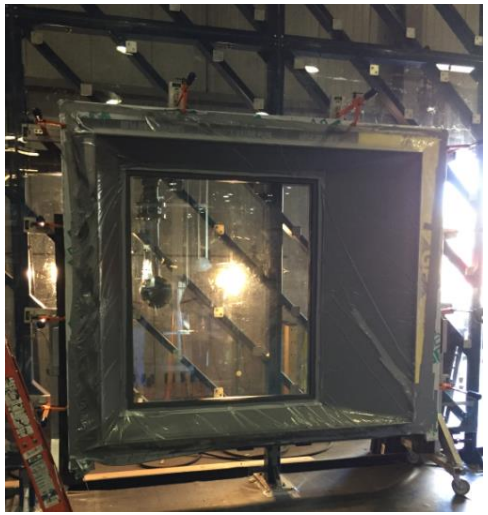
Lab Fenestration Testing Procedures

Fenestration product testing as per:

North American Fenestration Standard (NAFS) AAMA/WDMA/CSA 101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights

Code compliance:
Section 1709.5.1 of the IBC and
Section R609.3 of the IRC



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IBC Chapter 17 Requirements

SECTION 1709
PRECONSTRUCTION LOAD TESTS

Section 1709.4 Load-bearing wall and partition assemblies with and without window framing

Section 1709.5.1 Exterior windows and doors tested and labeled to AAMA/WDMA/CSA 101/I.S.2A440 *OR*

Section 1709.5.2 Exterior windows and door not covered by 1709.5.1 shall be tested in accordance with ASTM E330 or ANSI/DASMA 108

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IBC Chapter 17 Requirements

1709.7 Test specimens

- Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice.
- The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representative samples of the materials used to construct the load test assembly.
- Required tests shall be conducted or witnessed by an *approved agency*.

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Canadian Codes and Fenestration

NBC Part 5 «Environmental Separation»:

- Requires that Windows, Doors and Skylights shall conform to the requirements in

  a) AAMA/WDMA/CSA101/1.S.2/A440, “NAFS - North American Fenestration Standard /Specification for Windows, Doors , and Skylights" ***and***

  b) CSA A440Sl, “Canadian Supplement to NAFS - North American Fenestration Standard /Specification for Windows , Doors, and Skylights.“

- There is no installation requirements in Part 5 of the NBC, other than the air barrier continuity requirement around penetrations through the building assembly.

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Canadian Codes and Fenestration

NBC Part 5 «Environmental Separation»:

For other fenestration products not covered by NAFS the air leakages shall be limited to:

a) 0.2 L/(s·m^2) for fixed portions, including any opaque portions, ***and***

b) 1.5 L/(s·m^2) for operable portions

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Canadian Codes and Fenestration

NECB Part 3, Section 3.2.4. Air Tightness (prescriptive)

- Requires that the curtain wall shall have air leakage characteristic not greater than 0,2 L/s-m^2 , measured at an air pressure difference of 75 Pa under ASTM E283;

- Requires that the fixed windows and fixed skylights shall have air leakage characteristic not greater than 0,2 L/s-m^2 , measured at an air pressure difference of 75 Pa when tested to NAFS;

- Requires that the operable windows and operable skylights shall have air leakage characteristic not greater than 0,5 L/s-m^2 , measured at an air pressure difference of 75 Pa when tested to NAFS.

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Canadian Codes and Fenestration

NBC Part 9 «Small Buildings»:

- Requires that Windows, Doors and Skylights shall conform to the requirements in

  a) AAMA/WDMA/CSA101/1.S.2/A440, “NAFS - North American Fenestration Standard /Specification for Windows, Doors , and Skylights" ***and***

  b) CSA A440Sl, “Canadian Supplement to NAFS - North American Fenestration Standard /Specification for Windows, Doors, and Skylights.“

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Canadian Codes and Fenestration

NBC Part 9 «Small Buildings» (continued):

- Requires that Windows, Doors and Skylights shall be installed in accordance with CAN/CSA A440.4 which covers: Materials used, General principles, Opening preparation and mounting procedures, Insulation (thermal barrier), Air leakage control (air barrier), Vapor diffusion (vapor barrier) and Precipitation ingress control (water barrier)

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Summary of US vs Canadian Codes

US

- Weather Protection Performance
  - ✓ IBC and IRC (usage and occupancy)
- Thermal
  - ✓ IECC (Commercial and Residential)
- Building Envelope
  - ✓ Similar requirements for materials and systems (IECC)
- Fenestration
  - ✓ NAFS certification required (IBC and IRC)

CANADA

- Weather Protection Performance
  - ✓ NBC Part 5 and Part 9 (size)
- Thermal
  - ✓ NECB (Commercial)
- Building Envelope
  - ✓ Similar requirements for materials (NBC Part 5) for systems (NECB)
  - ✓ Part 9 no specific requirements
- Fenestration
  - ✓ NAFS only testing is required (NBC Part 5 and Part 9)

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Agenda

- Review of U.S. and Canadian Codes Specific to Building Envelope
- **Performance Requirements**
- Interaction and Importance of Proper Installation
- Third Party Certification
- Question & Answer

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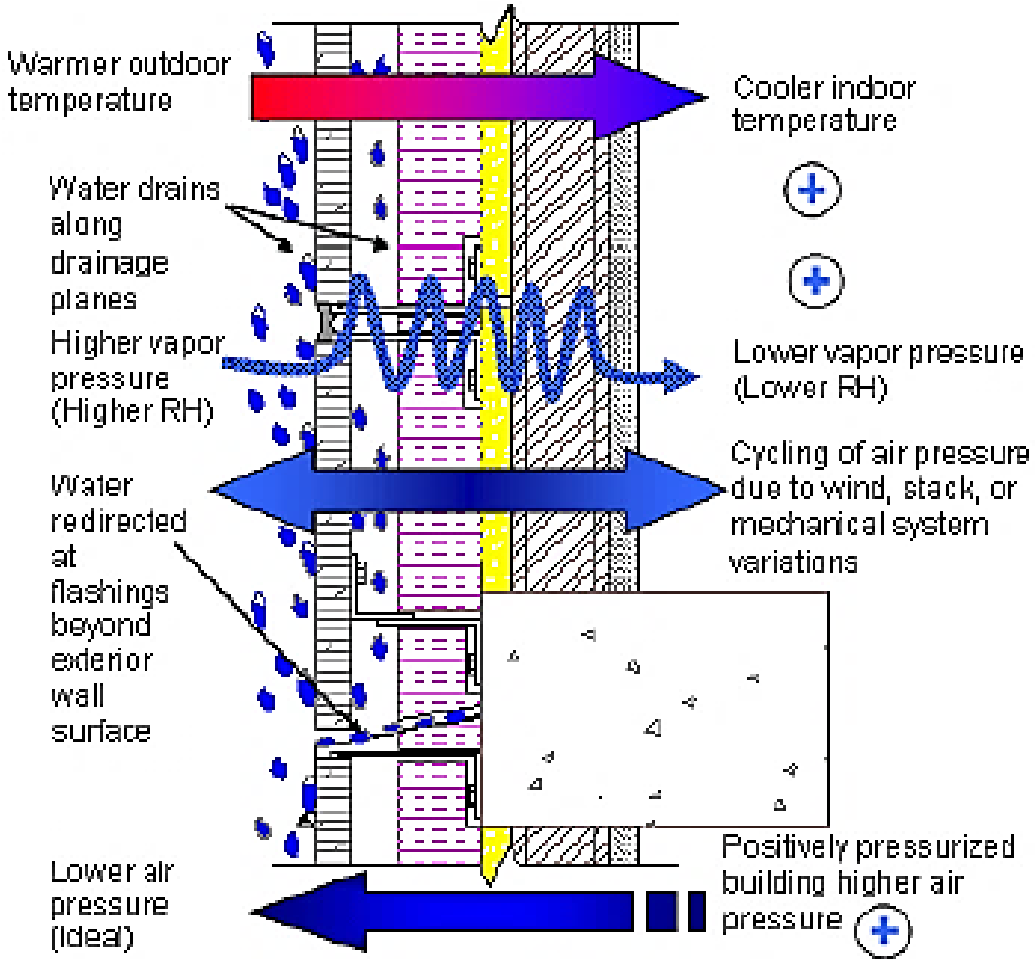
REQUIREMENTS AND SELECTION CRITERIA

Criteria for performance

- Resistance to structural loads
- Watertightness
- Airtightness
- Humidity transfer control
- Energetic efficiency
- Fire resistance
- Soundproofing

- Compatibility of materials
- Flexibility - resistance of materials
- Durability of components
- Component Recovery



TRANSFER DIAGRAM (HOT-HUMIDE CLIMATE)
Source: National Institute of Building Science

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Window Requirements in Project Specifications

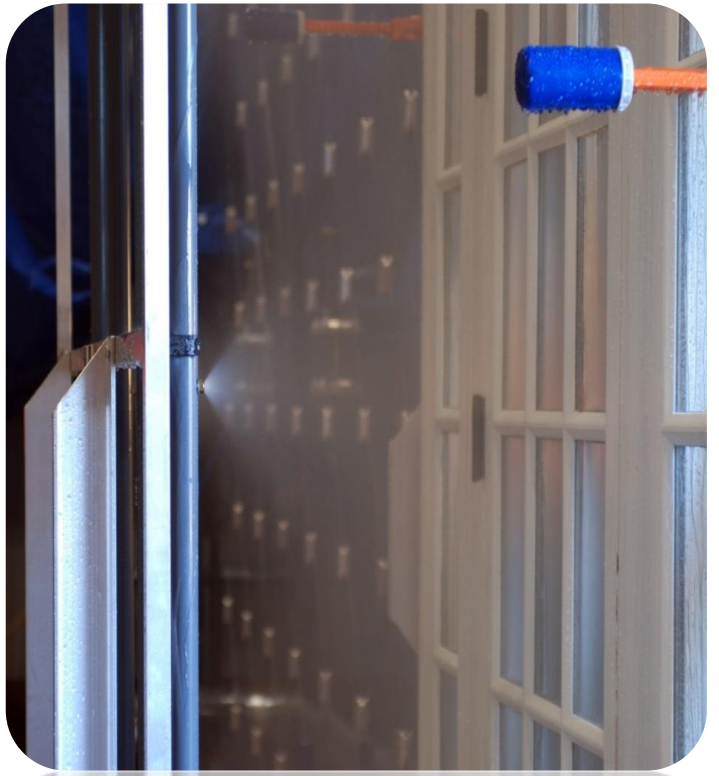
Specifications require windows to be tested and labeled to the NAFS standard under laboratory conditions as required by the IBC and IRC.

Standard: North American Fenestration Standard (NAFS)

AAMA/WDMA/CSA101/I.S.2/A440-(02,05,08 or11)

Testing required:

- Air infiltration - ASTM E283
- Water penetration – ASTM E331
- Structural performance – ASTM E330
- Forced entry – ASTM F588
- Operational force testing – ASTM E2068
- Operational cycling performance
- Many other tests dependent on Class



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Typical Label on windows:

Thermal Performance Requirements

The IECC requires windows, doors and curtain walls to meet thermal performance requirements established by the NFRC (National Fenestration Rating Council)

Performance Requirements:

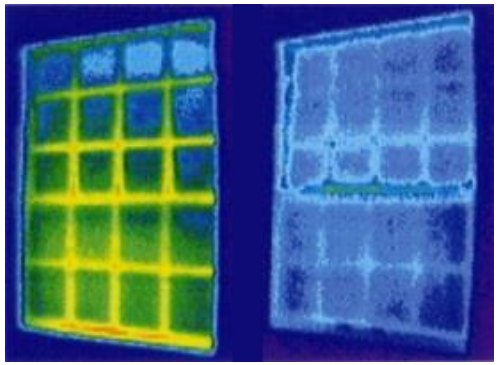
- U-Factor
- SHGC – Solar Heat Gain Coefficient
- VT – Visible Transmittance
- Condensation (optional)

Standards:

- NFRC 100
- NFRC 102
- NFRC 500

Testing required:

- Thermal simulation testing
- Thermal Performance testing to validate simulation results



Typical Label:

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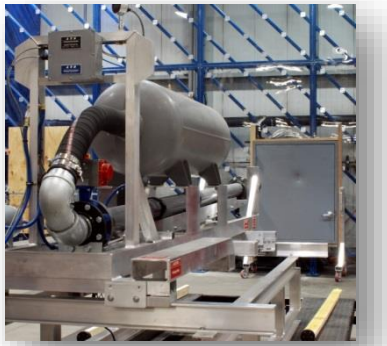
Windstorm Resistance Requirements

FBC, Miami-Dade, Texas (TDI), ICC, FEMA and others require windstorm rated products and assemblies

Performance Requirements: Structural integrity from impact and high velocity wind pressures

Standards:

- ASTM E330
- ASTM E1886
- ASTM E1996
- TAS 201/202/203 (Miami-Dade)
- FEMA Publication 320 and 361 (safe rooms)
- ICC 500 (storm shelters)



Testing required:

- Static Structural Loads
- Large & small missile impact testing
- Cyclic Pressure testing

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Typical Label:

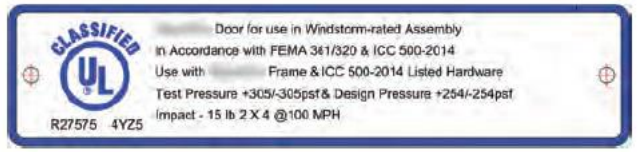

Figure B1-7. Example door label for a product that has been tested to safe room criteria

Agenda

- Review of U.S. and Canadian Codes Specific to Building Envelope
- Performance Requirements
- **Interaction and Importance of Proper Installation**
- Third Party Certification
- Question & Answer

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Fenestration

Integration & Installation

Solid walls typically don't leak… it's when they're interrupted that problems are introduced!

Proper Installation is one of <u>THE</u> most critical aspect of incorporating fenestration products into the building envelope!

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Lab & Field Testing Prevents & Identifies Problems

Testing identifies water and air leakage issues for prevention and mitigation

✓ ***Water Leakage through the window or wall cavity results in mold, mildew and air quality concerns***

✓ ***Water Leakage into the wall cavity results in electrical shorting and fire concerns***

✓ ***Water damage on exterior façade caused by water leakage resulting in deterioration***

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Fenestration and Barrier Interaction

2012 IRC Reference to Flashing

R612.1 General. This section prescribes performance and construction requirements for exterior window and doors installed in wall. Windows and doors shall be installed and flashed in accordance with the fenestration manufacturer's written installation instructions. Window and door openings shall be flashed in accordance with Section R703.8. Written installation instructions shall be provide by the fenestration manufacturer for each window and door.

R703.8 Flashing. *Approved* corrosion-resistant flashing shall be applied shingle-fashion in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. The flashing shall extend to the surface of the exterior wall finish. *Approved* corrosion-resistant flashings shall be installed at all of the following locations:

1. Exterior window and door openings. Flashing at exterior window and door openings shall extend to the surface of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Flashing at exterior window and door openings shall be installed in accordance with one or more of the following:

   1.1. The fenestration manufacturer's installation and flashing instructions, or for applications not addressed in the fenestration manufacturer's instructions, in accordance with the flashing manufacturer's instructions. Where flashing instructions or details are not provided, pan flashing shall be installed at the sill of exterior window and door openings. Pan flashing shall be sealed or sloped in such a manner as to direct water to the surface of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Openings using pan flashing shall also incorporate flashing or protection at the head and sides.

   1.2. In accordance with the flashing design or method of a registered design professional.

   1.3. In accordance with other approved methods.

Section R612.1 states that the fenestration manufacturer is primarily responsible for providing installation instructions and flashed as referenced in R703.8

Requires that the flashing direct water to the exterior finish or be integrated with the WRB drainage plane

Requires use of pan flashing if installation instructions not available

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Fenestration and Barrier Interaction

Key Installation / Flashing Codes & Standards

WINDOW / DOOR INSTALLATION STANDARDS:

- ASTM E2112 – standard flanged windows, very comprehensive & hard for installer
- FMA/AAMA 100 – wood frame construction subject to “extreme exposure”
- FMA/AAMA 200 & FMA/WDMA 250 – surface barrier CMU systems, the “Florida wall”
- FMA 300/400 – door installation in wood frame and CMU walls in “extreme exposure”
- AAMA 2400-10 – open stud construction, the “southwest wall”
- AAMA 2410-13 – flush finned window over existing frame (replacement)

FLASHING MATERIAL STANDARDS:

- AAMA 711-07(13): Self-Adhered Flashing Products – referenced in 2009 IRC
- AAMA 712-11: Mechanically Attached Flashing – to be referenced in 2015 IRC
- AAMA 714-11: Liquid Applied Flashing – to be referenced in 2015 IRC

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FLASHING CODES

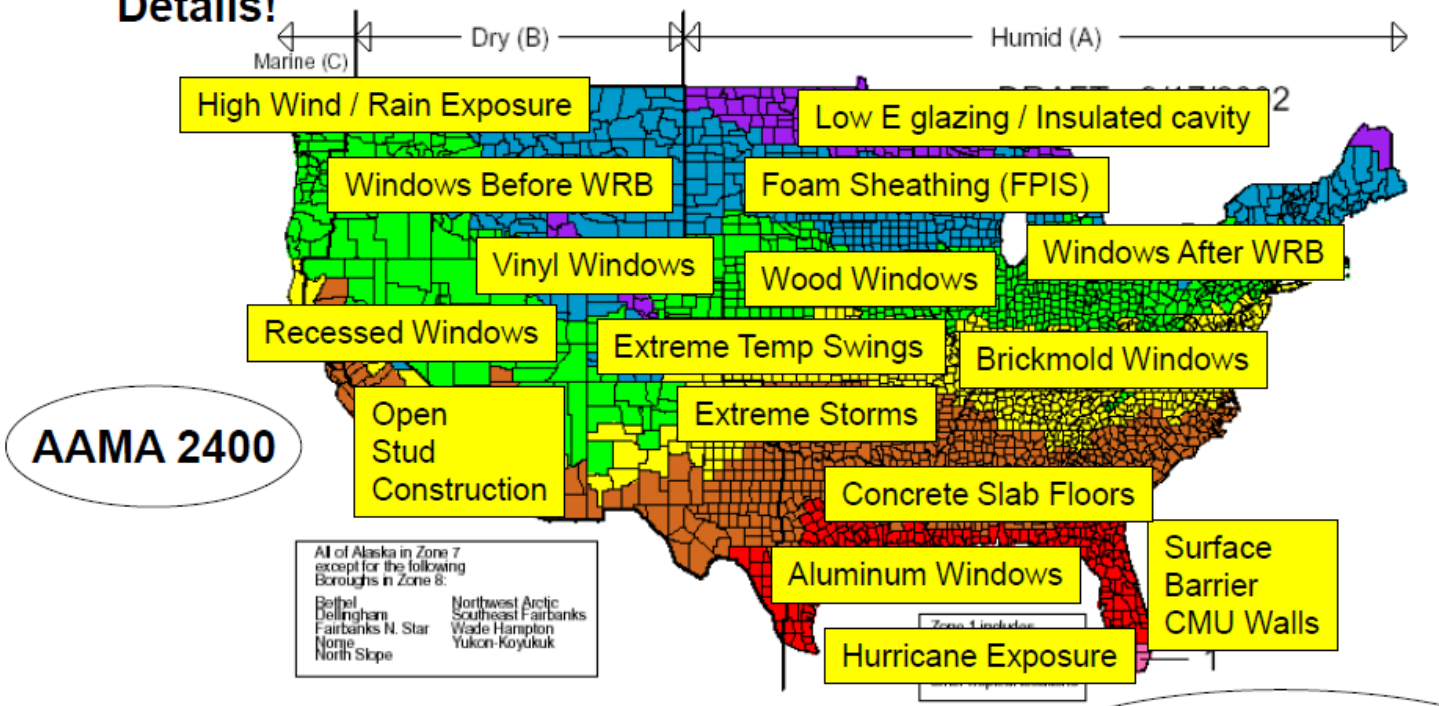
- IRC R703.8 – describes basic flashing principles (must be applied with correct shingling, drainage to WRB or to exterior), references other “approved guidelines”
- IRC R613.1 – designates responsibility to window manufacturer to provide written flashing and installation instructions for each window, flashing per R703.8
- FBC – references FMA/AAMA 100, 200 and FMA/AAMA/WDMA 300 as ‘approved method”

Fenestration and Barrier Interaction

Challenges for Installation of Windows & Doors…

These highly variable fenestrations are installed a wide variety of climates, exposures and regional practices…

….that Desperately Need Regionally Specific Installation Details!



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Fenestration and Barrier Interaction

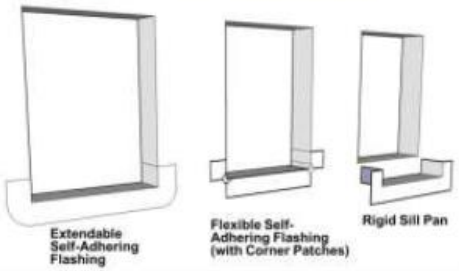
Types of Flashing Used in Window and Door Applications

- Flexible – Self-Adhered

- Flexible – Mechanically Attached

- Liquid Applied Flashing

- Sill Pan Flashing (rigid or flexible)



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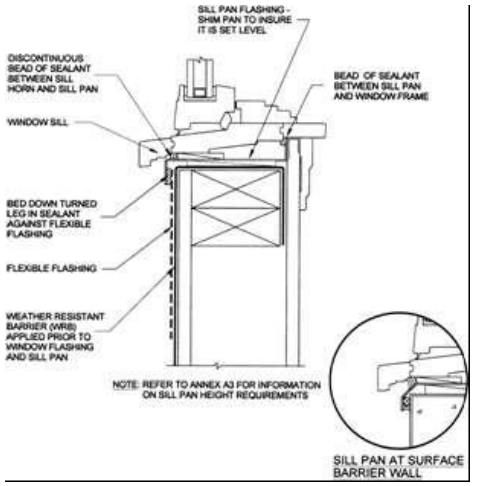
Sill Pan Flashing

- Key component to drainable installations / extreme exposure conditions
- Mandated by FMA/AAMA-100 & 300, recommended by ASTM E2112
- Protects the most vulnerable area of the rough opening – where water collects
- Interior air/water seal essential feature – often adds to complexity of installation (shims, anchors, etc)
- No Industry Standard has been developed



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Mock-Up Testing

Building mockups are specific to a project with an average six month to one year lead time before the start of building construction.

“Typically, architects request a mockup for large, commercial projects,” says Mario Goncalves, global business leader, UL CLEB building science. “The mockup gives an architect the opportunity to evaluate the visual aspects of the design and assess the performance of the assembly via a three-dimensional representation.”

Think of it as a rehearsal for the big show, a chance to make sure everything ebbs and flows together, literally.

“We test to the worst conditions by testing the whole installation,” explains Goncalves, “but, we are most concerned about air and water getting through the building envelope.”

The building envelope is what keeps the weather out, and the occupants tucked safely inside the building. Architects carefully consider requirements such as building movement, wind loads, thermal expansion and thermal efficiency when they plan for its construction.

“Any form of excessive air leakage or poor thermal performance could result in discomfort to the building occupants, plus lead to the formation of excessive, interior condensation or the formation of icicles on the building’s exterior in cold climates, while temperature and humidity control could be problematic in warm climates. This would be unacceptable to any building owner or occupant,” says Goncalves.

Performance requirements are established for each project on a case by case basis to account for building height, geographic location, design parameters and the expected occupancy of the building.

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Exterior Wall System Mock-Up Test Sample

A pre-construction exterior wall system constructed to evaluate air and water resistance, structural, thermal & seismic performance

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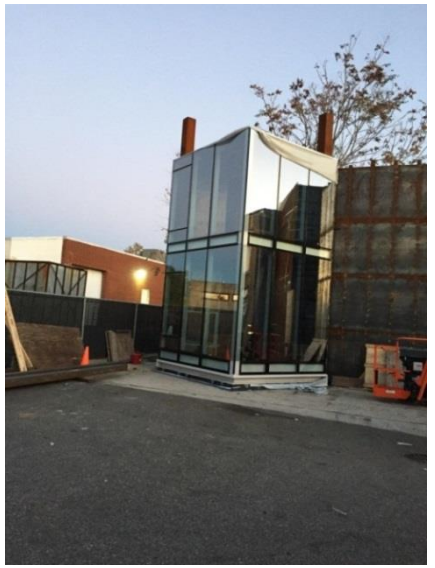
Mock-Up Test Sequence

Mock-up testing sequence typically required:

- ✓ Air Infiltration as per ASTM E283
- ✓ Water Penetration under Static Pressure as per ASTM E331
- ✓ Dynamic Resistance Test as per AAMA 501.1
- ✓ Inter-story Vertical Displacement as per AAMA 501.7
- ✓ Structural Performance as per ASTM E330
- ✓ Inter-story Horizontal Displacement as per AAMA 501.4
- ✓ Thermal Cycling as per AAMA 501.5
- ✓ Condensation Resistance Testing
- ✓ Seismic Displacement Testing
- ✓ Anchor Bolt Testing
- ✓ Washer Bolt Testing



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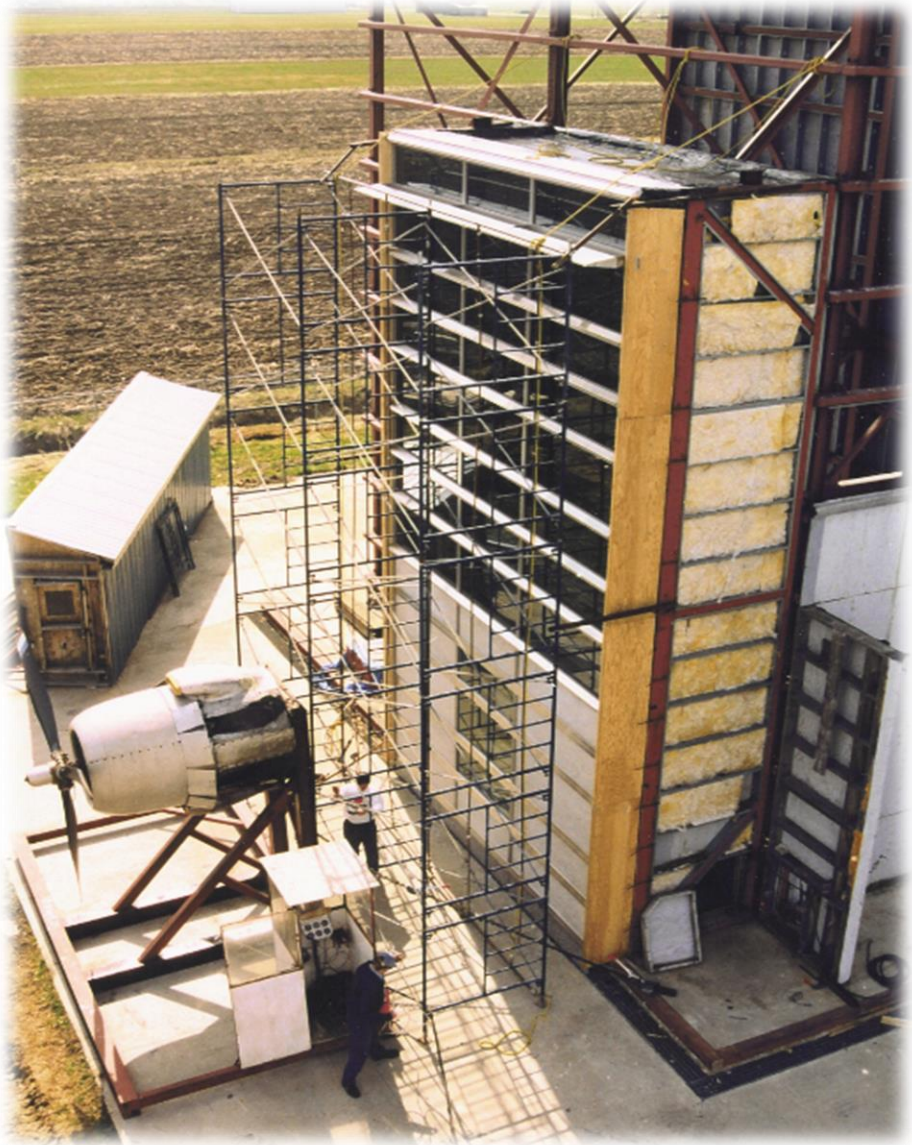

Lab Testing Results

Typical issues or challenges identified in Mock-up samples:

- ✓ **Incompatibility of materials**
- ✓ **Materials don’t meet the performance requirements of the project**
- ✓ **Sealants or gaskets missing or needed**
- ✓ **Sealants or gaskets incompatible with substrates**
- ✓ **Lack of installation instructions**
- ✓ **Incomplete installation instructions**
- ✓ **Materials difficult or time consuming to install in the field**

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Laboratory Testing

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Lab Testing at UL Facility

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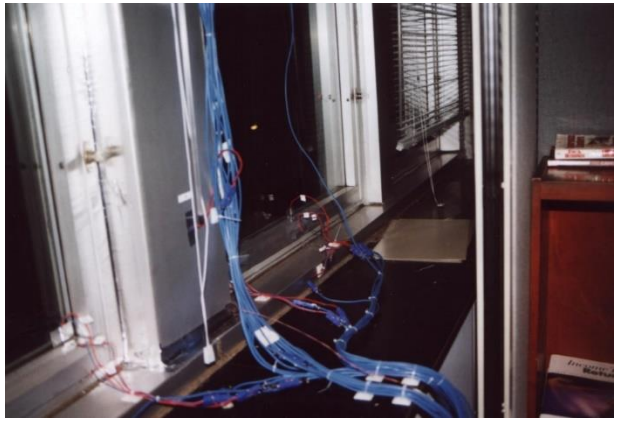
Field Testing



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Field Testing

Ensure quality of installation, the performance of installed products, verify compliance with specifications

Field testing of installed windows, doors, skylights, curtain-walls and storefronts to evaluate air infiltration, air barriers, water penetration, structural, acoustical, condensation, anchor pull-out test performance, etc., of installed products.

- New construction
- Existing construction

Test methods:

- **ASTM E783**
- **ASTM E1105**
- **AAMA 502**

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Field Testing Prevents & Identifies Problems

- ✓*Water Leakage through the window or wall cavity results in mold, mildew and air quality concerns*
- ✓*Water Leakage into the wall cavity results in electrical shorting and fire concerns*
- ✓*Water damage on the exterior façade caused by water leakage results in deterioration of the facade*

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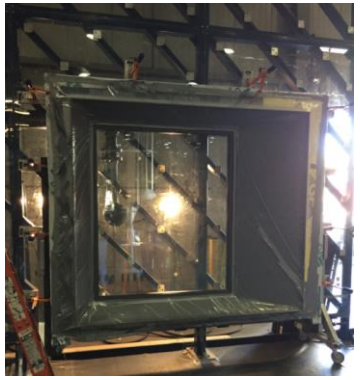
Air and Water Field Testing Case Studies

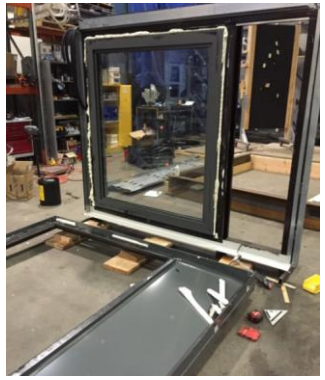
European window system for commercial high-rise

- Testing: AAMA/WDMA/CSA101/I.S.2/A440 (NAFS)

Issues:

- Lack of coordination between architect, consultant, window system supplier, window broker and window manufacturer.
- Lack of detailed installation instructions
- Window system was installed out of square resulting in primary seal not performing its function





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Agenda

- Review of U.S. and Canadian Codes Specific to Building Envelope
- Performance Requirements
- Interaction and Importance of Proper Installation
- **Third Party Certification**
- Question & Answer

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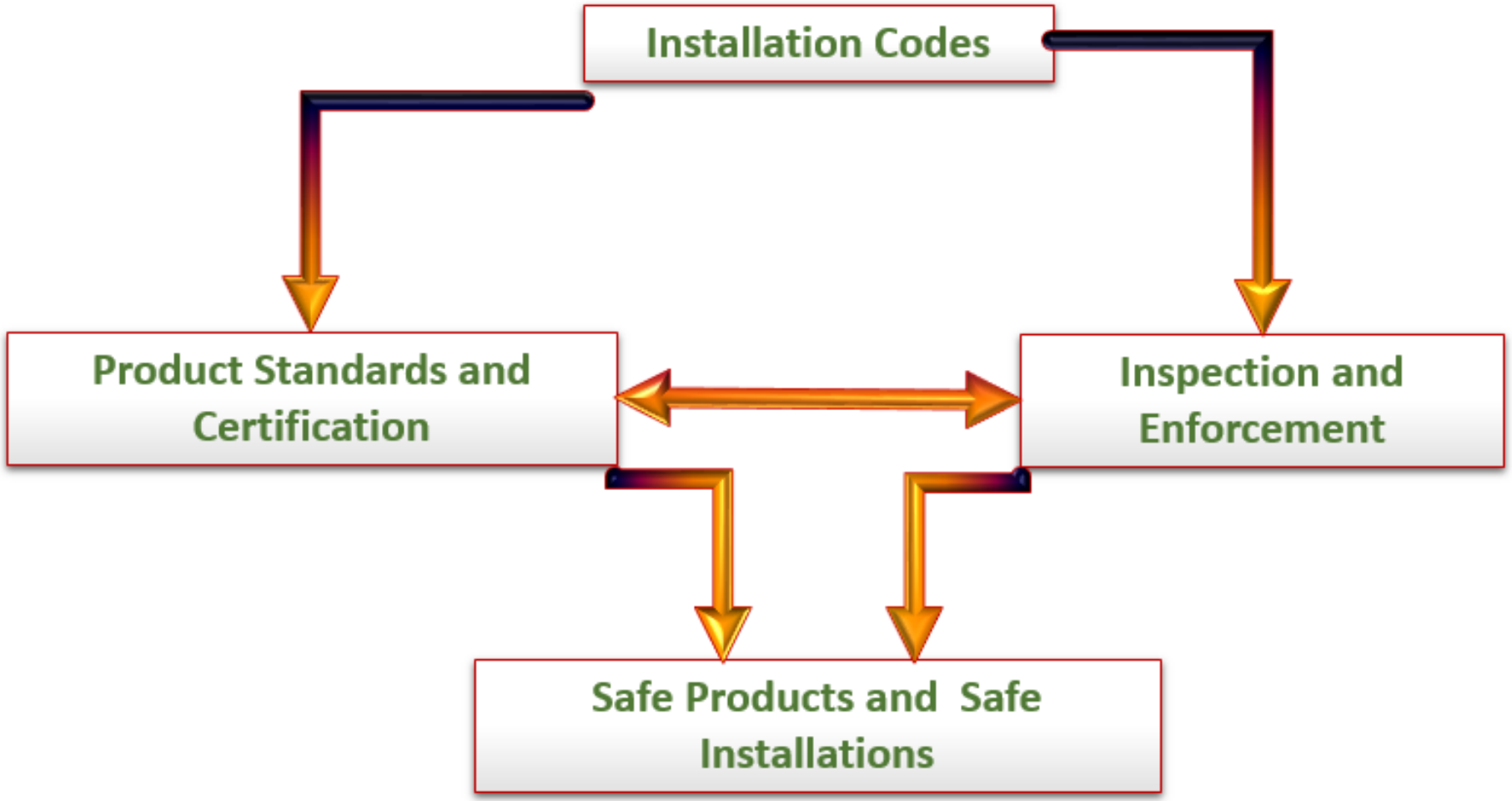
Inspection of Building Envelope



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Significance of Third Party Certification

- Many municipalities' laws, codes and regulations require building products be tested, listed and/or labeled before the products can be installed (Section 26 of IBC)

- Code Officials rely on Testing and Certification Organizations to conduct an evaluation – evidence of compliance
  - ✓ Knowledge and expertise
  - ✓ Test equipment
  - ✓ Time

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- Some manufacturers make it a company policy to obtain UL certification - minimizes the possibility of non-acceptance by AHJs.

Significance of Third Party Certification

Being UL Certified Means:

- Product has been evaluated and complies with UL's requirements
- Manufactured under UL's Follow-Up Service Program - **not just tested by UL**

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UL Online Search Tools

- UL Certifications Directory
- Product Spec ™
- Code Link

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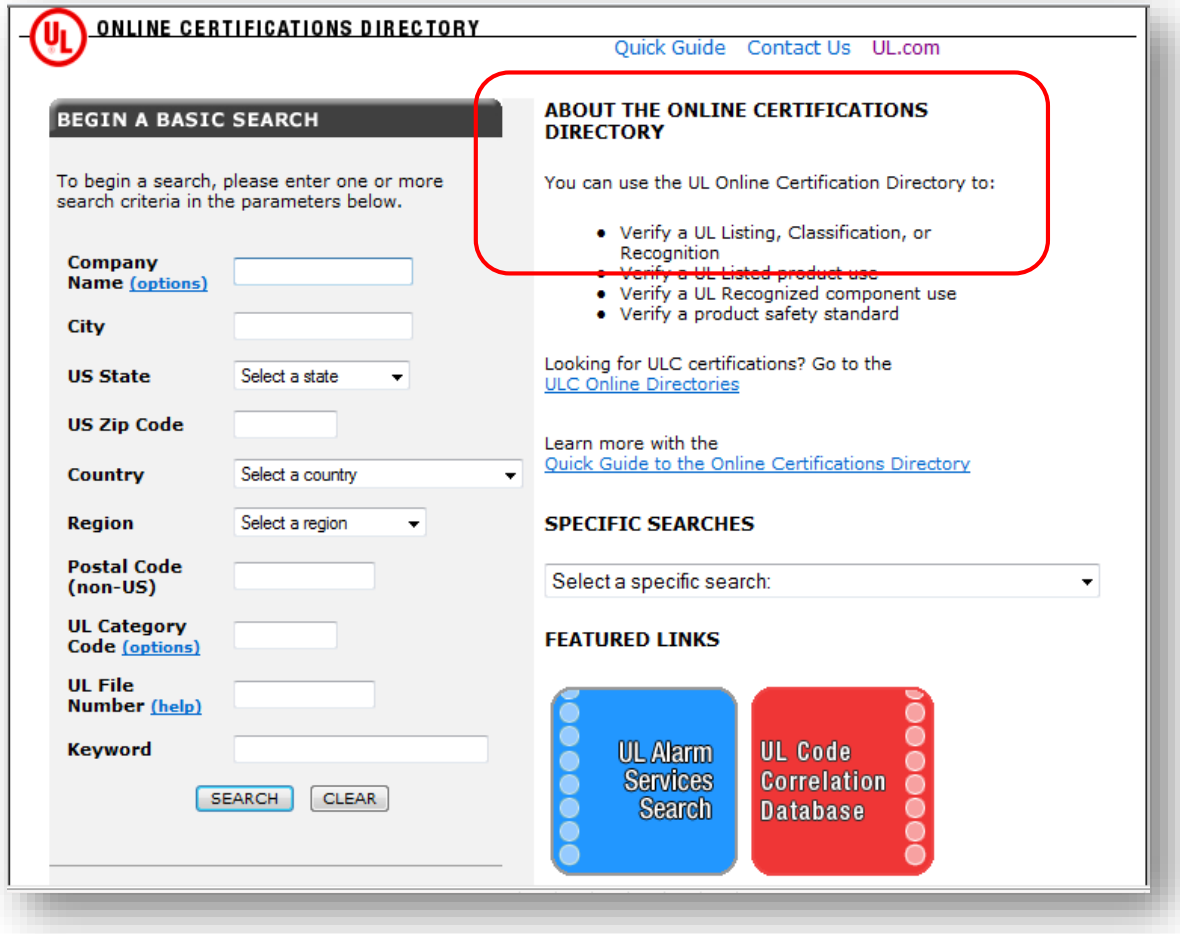

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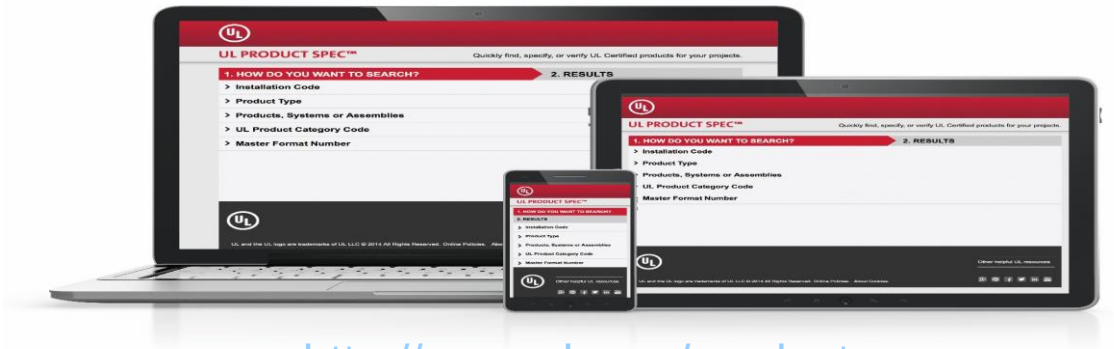

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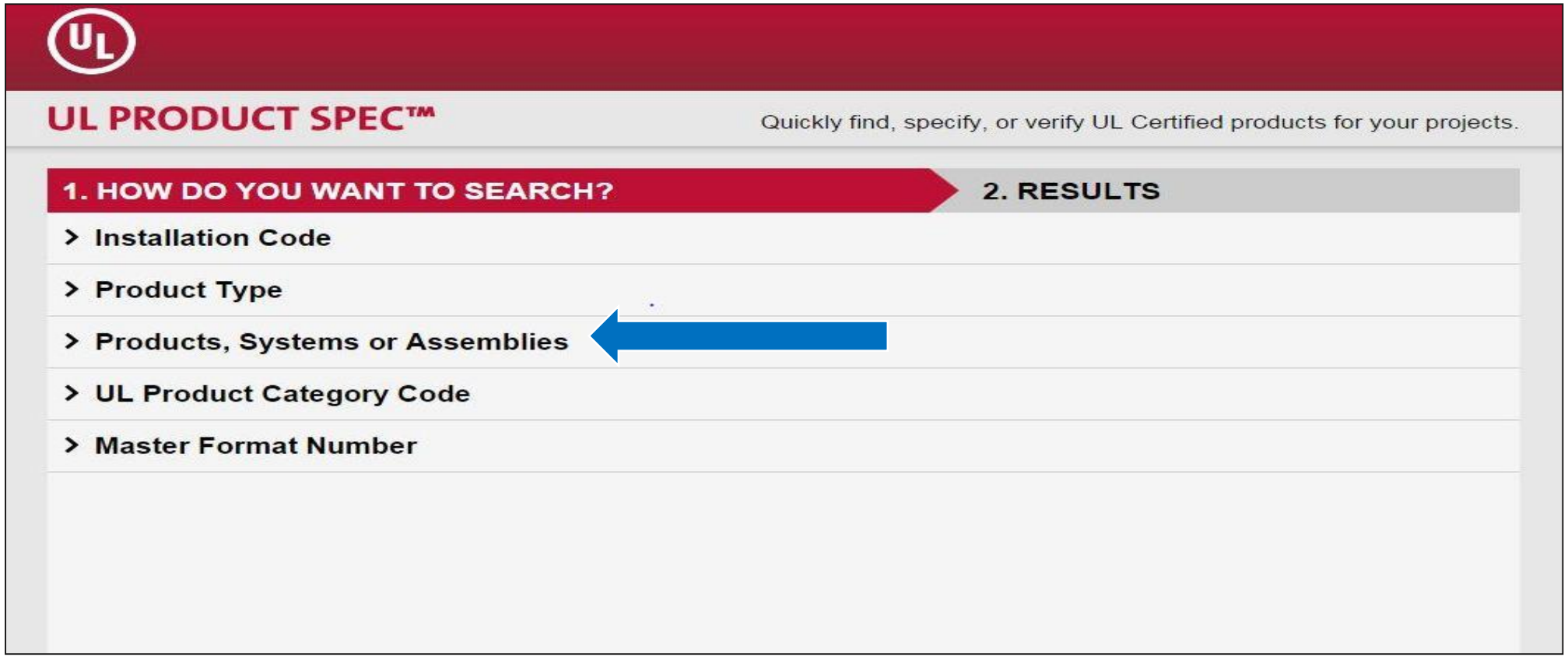

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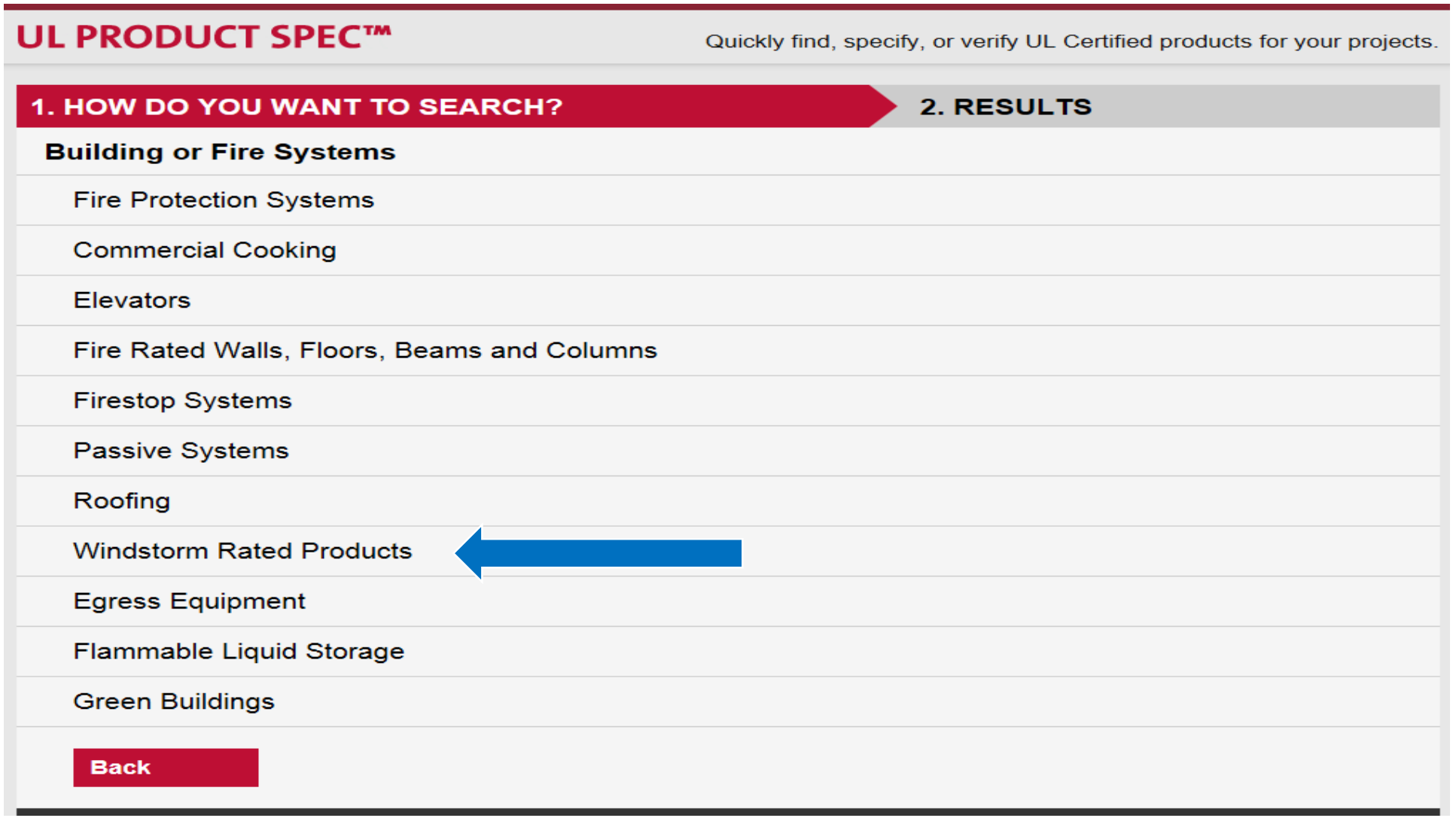

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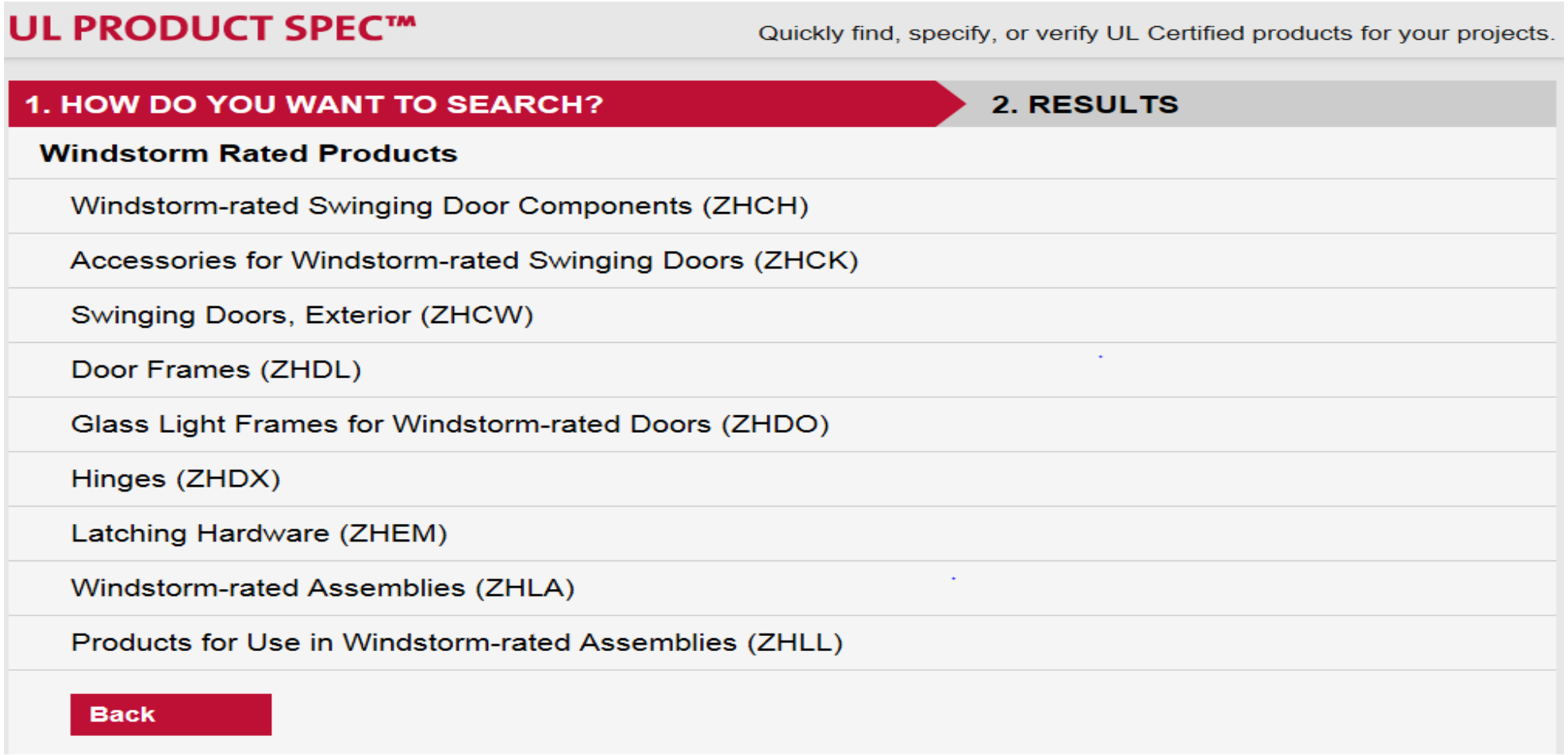
UL Product Spec™



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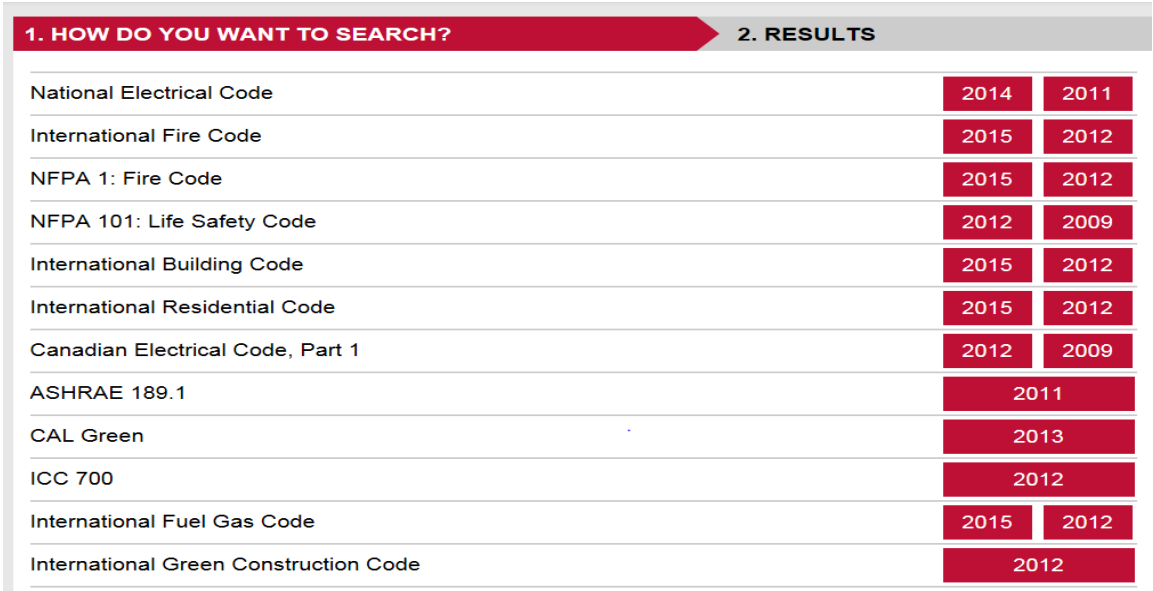
Code Link

- Correlates model code sections to UL product categories
- Covers many model codes and editions (IBC, IRC, IgCC, ICC-700, etc.)
- Flexible search capabilities
- Powerful tool to locate appropriate Listings
- www.ul.com/codelink



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Code Link

1. HOW DO YOU WANT TO SEARCH?	2. RESULTS	
National Electrical Code	2014	2011
International Fire Code	2015	2012
NFPA 1: Fire Code	2015	2012
NFPA 101: Life Safety Code	2012	2009
International Building Code	2015	2012
International Residential Code	2015	2012
Canadian Electrical Code, Part 1	2012	2009
ASHRAE 189.1	2011	
CAL Green	2013	
ICC 700	2012	
International Fuel Gas Code	2015	2012
International Green Construction Code	2012	

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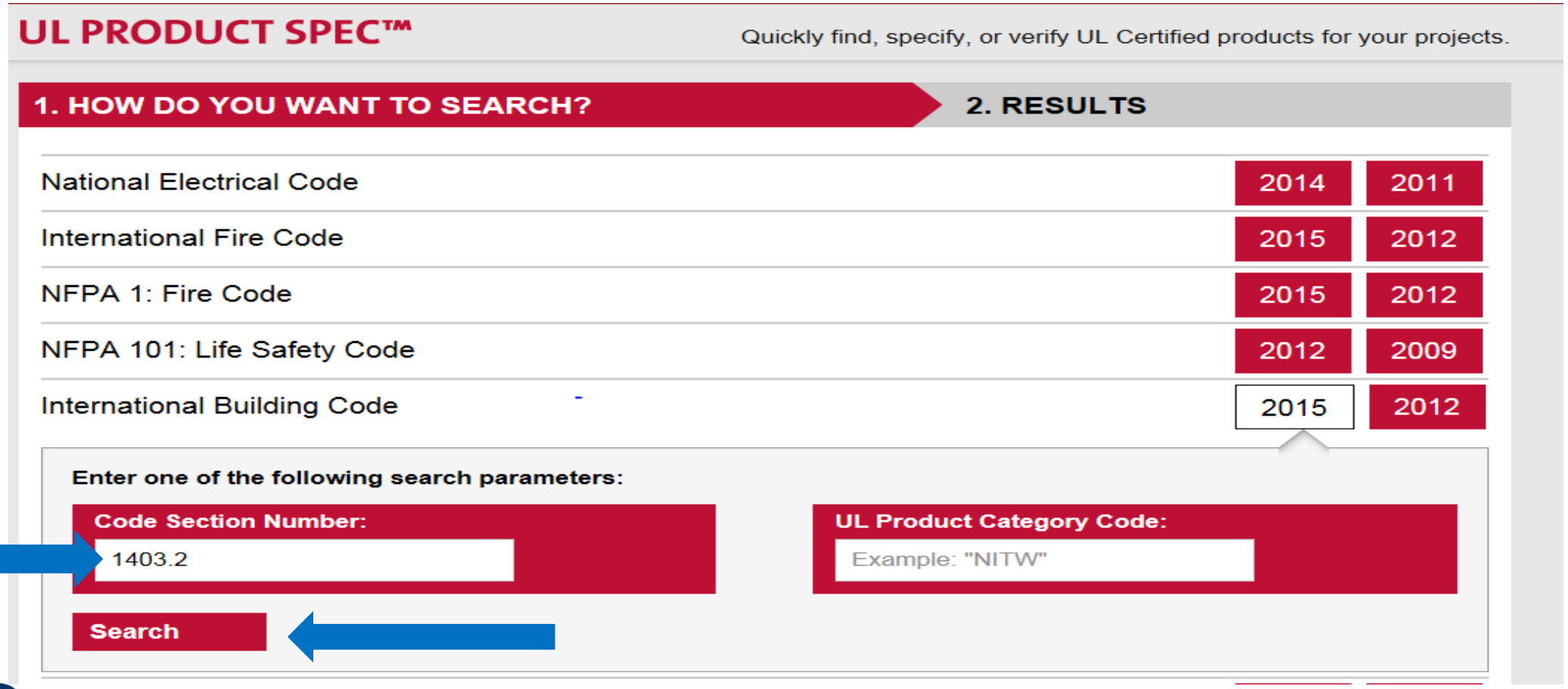
Code Link



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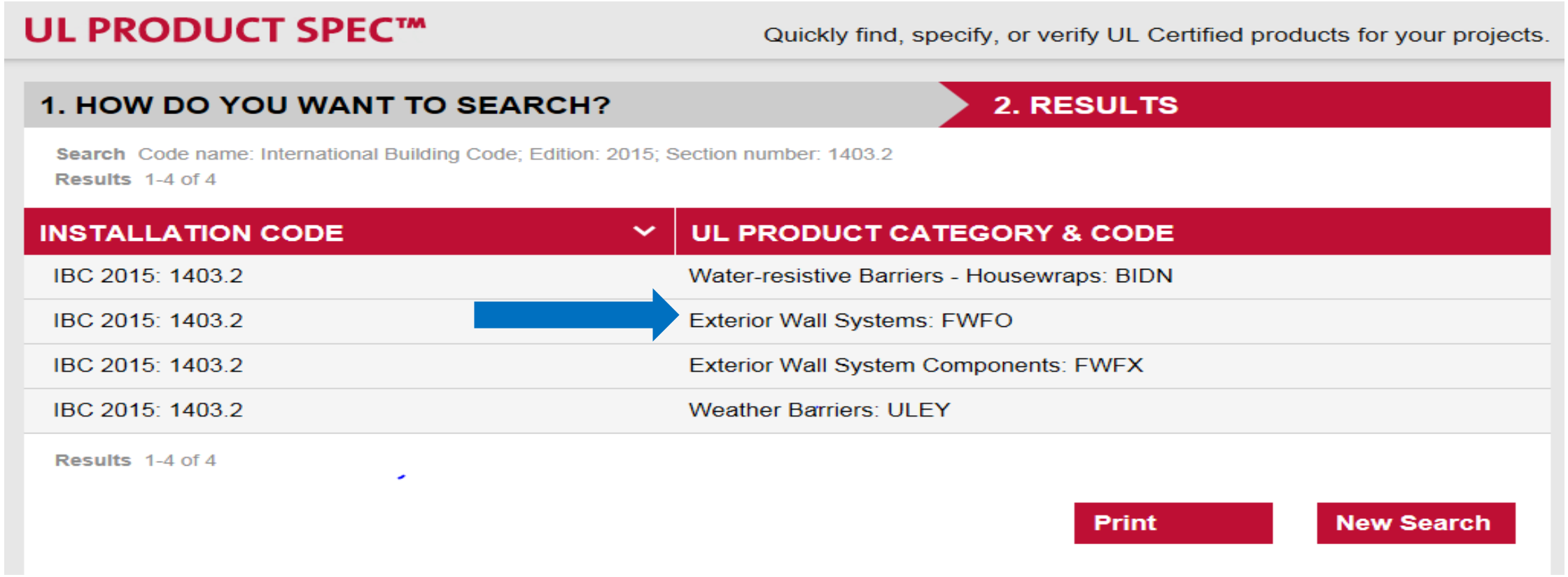
Code Link



UL PRODUCT SPEC™

Quickly find, specify, or verify UL Certified products for your projects.

1. HOW DO YOU WANT TO SEARCH?

2. RESULTS

Search Code name: International Building Code; Edition: 2015; Section number: 1403.2

Results 1-4 of 4

INSTALLATION CODE	UL PRODUCT CATEGORY & CODE
IBC 2015: 1403.2	Water-resistive Barriers - Housewraps: BIDN
IBC 2015: 1403.2	Exterior Wall Systems: FWFO
IBC 2015: 1403.2	Exterior Wall System Components: FWFX
IBC 2015: 1403.2	Weather Barriers: ULEY

Results 1-4 of 4

Print

New Search

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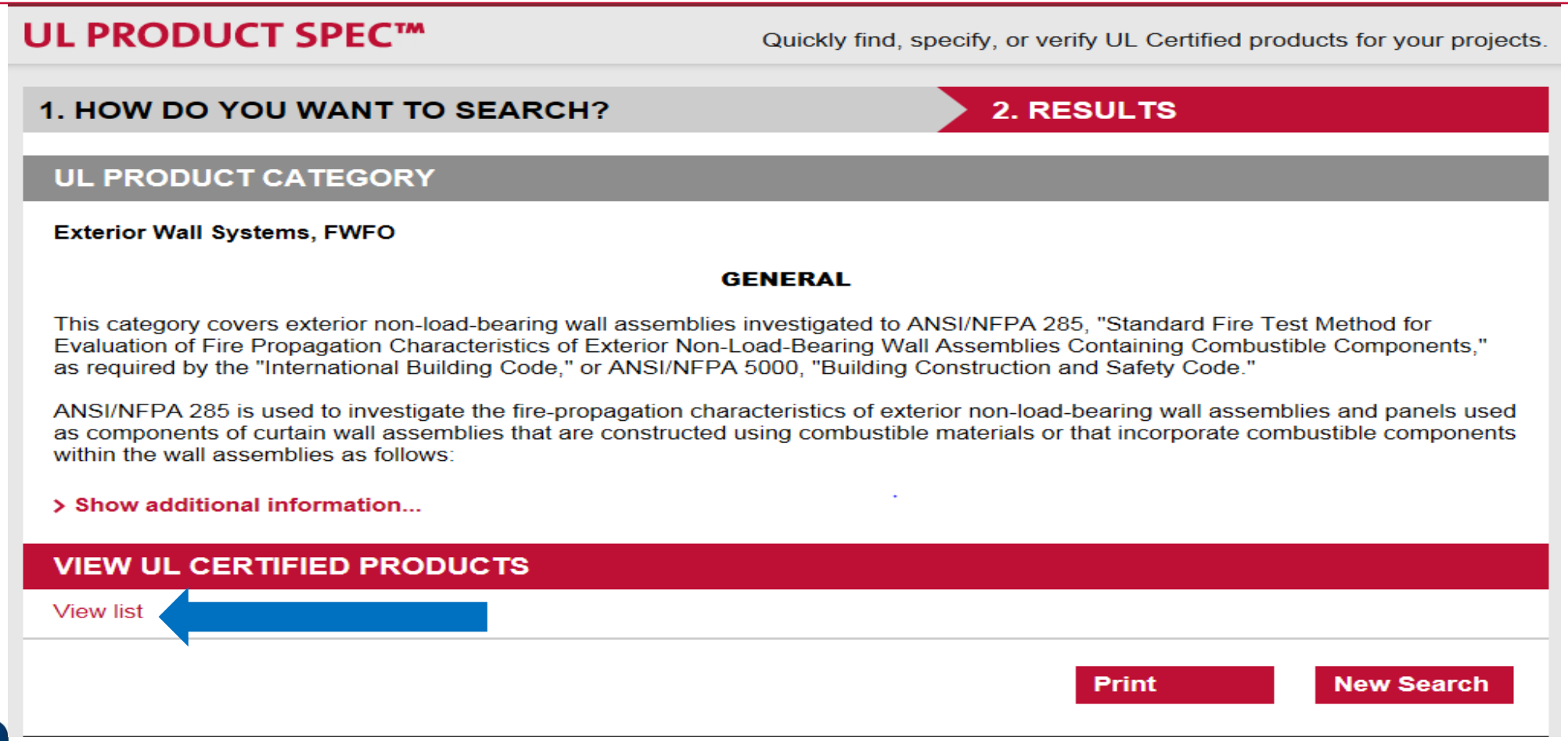
Code Link



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Learning Objectives - Review

We hope that each of you has gained further knowledge of the following:

- Identify U.S. and Canadian model code requirements for Building Envelope and Fenestration Products
- Explain the performance criteria regarding performance, and how the model codes handle these types of designs
- Discuss the code relationships and importance of interaction between these types of products
- Identify potential areas of concern when these products are installed together

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Agenda

- Review of U.S. and Canadian Codes Specific to Building Envelope
- Performance Requirements
- Interaction and Importance of Proper Installation
- Third Party Certification
- **Question & Answer**

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