Codes, Standards and Reality

Theresa Weston
Westford Symposium
July 31, 2012

"*Reality is merely an illusion, albeit a very persistent one.*" -Albert Einstein

"*Hollywood always wanted me to be pretty, but I fought for realism.*" - Bette Davis

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Agenda

Background on the Codes and Standards
- Where do codes, standards and test methods come from?
- Can you actually use testing to predict performance? Do you know what a test result really means?

Special considerations:
- Innovation and new technology?
- Durability:

Manufactured Housing & Code Opportunities– Mike Lubliner

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Codes:
Do we care? and why?

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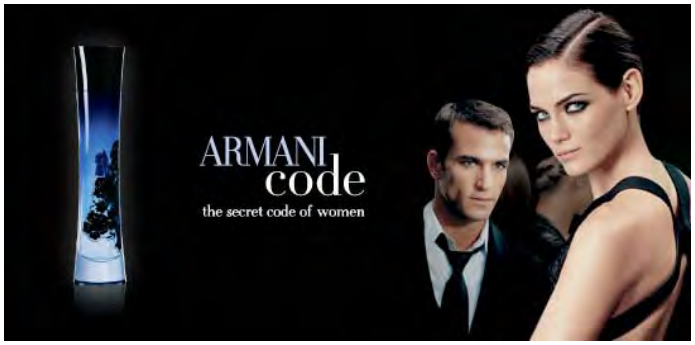

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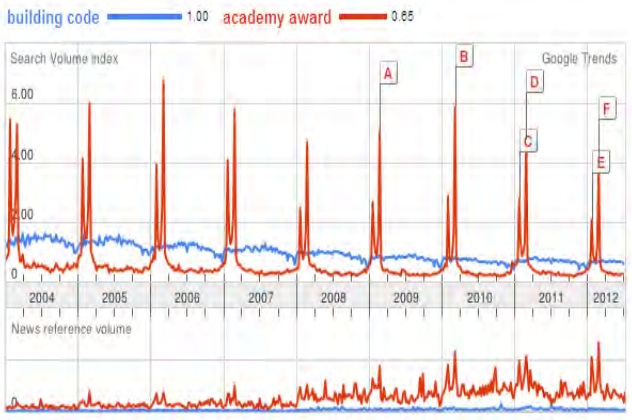

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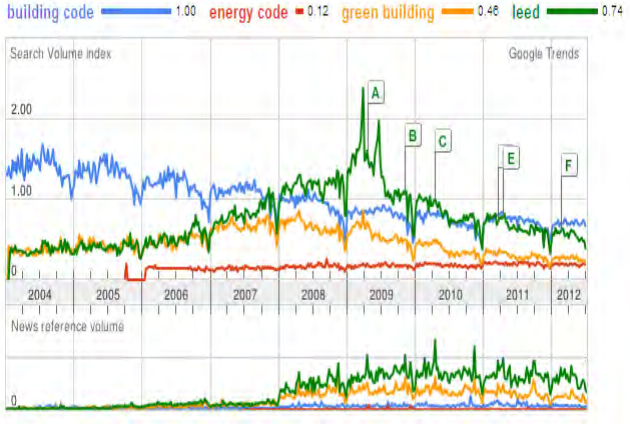

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Legislation

The Energy Policy Act of 1992 (EPAct) required that all states certify the status of residential and commercial codes

- **Residential:** required states to determine if they should upgrade their energy codes to meet or exceed the Council of American Building Officials' 1992 **Model Energy Code** (now IECC or IRC Energy Chapter)
- **Commercial:** required states to meet or exceed **ASHRAE 90.1** -1989

American Recovery and Reinvestment Act of 2009

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Building Code Effectiveness Grading Schedule – Insurance Services Office

"The concept is simple: municipalities with well-enforced, up-to-date codes should demonstrate better loss experience, and insurance rates can reflect that."

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Select criteria	Community points earned		Maximum BCEGS points available		% of points earned by sample department
Training	11	26.5	13	33.5	85
Certification	9		12		75
Experience and qualifications of building officials	6.5		8.5		76
Plan review staffing	6		9		67
Inspection staffing	8		9		89
Plan review details	9		11.5		78
Natural hazard mitigation	1		2		50
Building-code adoption	4.8		8		60
Building-code amendments	0		4		0

Building Code Effectiveness Grading Schedule – Insurance Services Office

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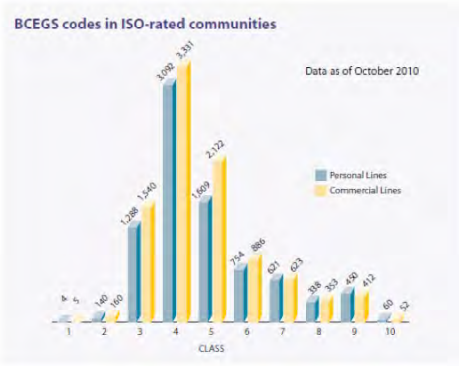

Building Code Effectiveness Grading Schedule – Insurance Services Office

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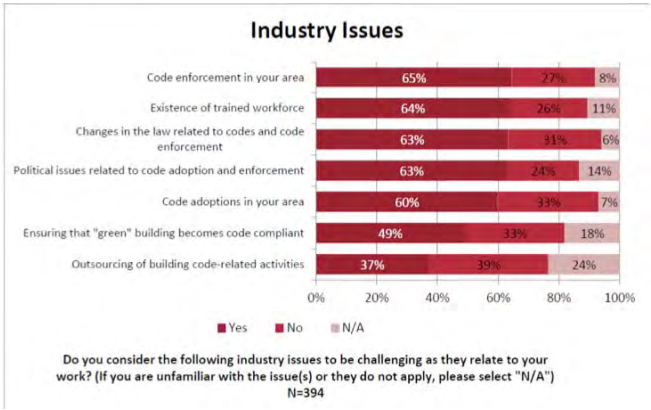

Source: McKinley Advisors, IAC Member Survey, November 2011

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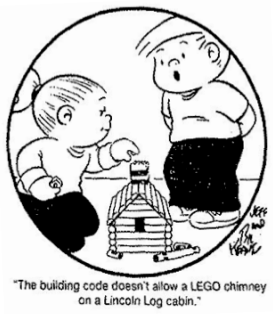
Codes Identified as Barriers to Innovation



"The building code doesn't allow a LEGO chimney on a Lincoln Log cabin."

IBC 104.1 General. *The building official is hereby authorized and directed to enforce the provisions of this code.* ***The building official shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions.*** *Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code*

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Building America
U.S. Department of Energy

Building America Summer 2012 Technical Update Meeting

Issue 6;Do Codes and Standards Get in the Way of High Performance?

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"Code officials at the local level have the legal authority to accept or reject the application of any new building product or system innovation. They can be the ultimate showstopper."

-- "*Overcoming Barriers to Innovation in the Home Building Industry*", Report for US HUD PD& R PATH, April 2005)

from Oster and Quigley, "Regulatory Barriers to the Diffusion of Innovation: Some Evidence from Building Codes", The Bell Journal of Economics, Vol. 8, No. 2 (Autumn, 1977), pp 361-377.

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The **National Commission on Urban Problems (1968)** found that unnecessary housing costs are inherent in building codes that

- delay construction,
- prevent the use of modern materials,
- mandate antiquated and outdated provisions,
- inhibit mass production,
- prevent large-scale conventional construction, and
- are questionably administered.

Many communities, even those nominally adhering to model codes, prohibited cost-saving materials and technologies that, generally, were allowed by the model codes. These communities added prohibitions of their own, or did not adopt the latest version of the model codes, etc.

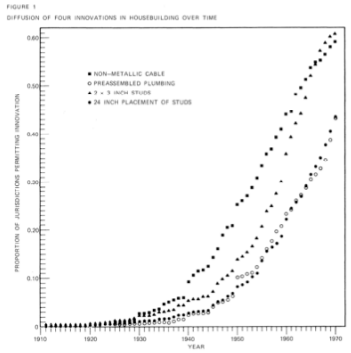

Figure from Oster and Quigley, "Regulatory Barriers to the Diffusion of Innovation: Some Evidence from Building Codes", The Bell Journal of Economics, Vol. 8, No. 2 (Autumn, 1977), pp 361-377. Additional data for Listokin and Hattis

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"*Ideally, construction standards would be a codification of performance specifications for newly constructed dwellings. In practice, however, standards are typically stated in terms of input requirements. To judge the acceptability of an innovation, then, the local building official must first evaluate the results of performance tests conducted by a wide variety of other agencies…on particular materials and designs. Based upon these evaluations, specific standards or input requirements are proposed and promulgated. Thus it appears that the progressiveness of local building codes should be directly related to the professional attributes of the local officials: the amount and type of their professional contact, their backgrounds, and their education.*"

- *Oster and Quigley, "Regulatory Barriers to the Diffusion of Innovation: Some Evidence from Building Codes", The Bell Journal of Economics, Vol. 8, No. 2 (Autumn, 1977), pp 361-377.*

***"Building codes**—and additional national, regional, or municipal regulations affecting the physical production of houses—prohibit innovation either by explicitly specifying only certain materials and methods, not providing speedy and impartial acceptance in the code where that explicit prohibition does not exist, or by being unfairly interpreted during permitting and inspections -*

- *Martín, **PATH Program Review & Strategy, Performance Metrics& Operating Plan,** US Department of Housing and Urban Development - PATH Draft*

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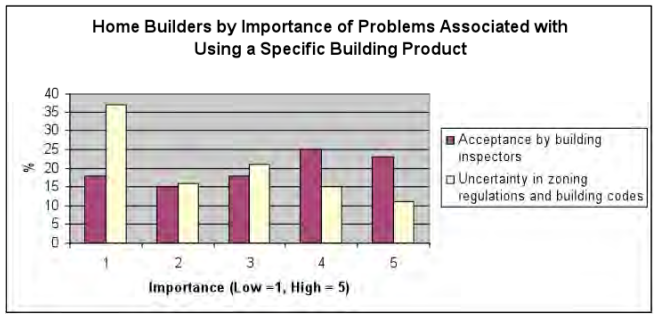

Data from Koebel, et. a., *The Diffusion of Innovation in the Residential Building Industry,* **Report** prepared for the U.S. Department of Housing and Urban Development Office of Policy Development and Research, January 2004

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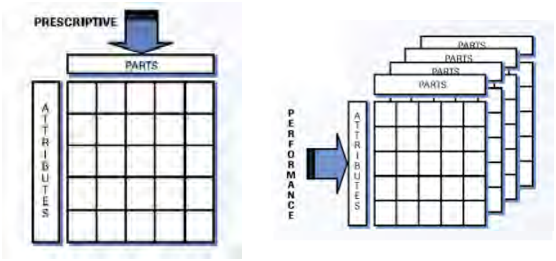
Lack of performance based codes and standards are cited as a hurdle to innovation



from Follette, "Developments in Performance-Based Building Codes and Standard", FOREST PRODUCTS JOURNAL Vol. 50, No. 7/8 JULY/AUGUST 2000

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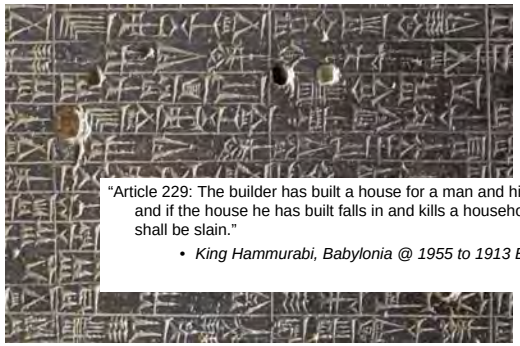
Codes originally were performance-based



"Article 229: The builder has built a house for a man and his work is not strong and if the house he has built falls in and kills a householder, that builder shall be slain."

- *King Hammurabi, Babylonia @ 1955 to 1913 B.C.*

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SECTION 902 EXTERNAL MOISTURE

902.1 Objective. To safeguard people from injury and property from damage that could result from external moisture entering the building.

902.2 Functional statement. Buildings shall be constructed to provide adequate resistance to penetration by, and the accumulation of, moisture from the outside.

902.3 Performance requirements.

902.3.1 Water penetration. Roofs and exterior walls shall prevent the penetration of water that could cause damage to building elements.

902.3.2 Building elements in contact with the ground.

Walls, floors and structural elements in contact with the ground shall not absorb or transmit moisture in quantities that could cause damage to building elements.

902.3.3 Concealed spaces and cavities. Concealed spaces and cavities in buildings shall be constructed in a way that prevents external moisture from causing degradation of building elements.

902.3.4 Moisture during construction. Excess moisture present at the completion of construction shall be capable of being dissipated without permanent damage to building elements.

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IRC-2012

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.

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IECC 2012: C402.4.1.2 Air barrier compliance options…

C402.4.1.2.1 Materials. Materials with an air permeability no greater than 0.004 cfm/ft2 (0.02 L/s · m2) under a pressure differential of 0.3 inches water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E 2178 shall comply with this section. Materials in Items 1 through 15 shall be deemed to comply with this section provided joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than 3/8 inch (10 mm).
2. Oriented strand board having a thickness of not less than 3/8 inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than 1/2 inch (12 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than 1/2 inch (12 mm).
5. Closed cell spray foam a minimum density of 1.5 pcf (2.4 kg/m3) having a thickness of not less than 11/2 inches (36 mm).
6. Open cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than 1/2 inch (12 mm).
8. Cement board having a thickness of not less than 1/2 inch (12 mm).
9. Built up roofing membrane.
10. Modified bituminous roof membrane.
11. Fully adhered single-ply roof membrane.
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8 inch (16 mm).
13. Cast-in-place and precast concrete.
14. Fully grouted concrete block masonry.
15. Sheet steel or aluminum.

C402.4.1.2.2 Assemblies. Assemblies of materials and components with an average air leakage not to exceed 0.04 cfm/ft2 (0.2 L/s · m2) under a pressure differential of 0.3 inches of water gauge (w.g.)(75Pa) when tested in accordance with ASTM E 2357, ASTM E 1677 or ASTM E 283 shall comply with this section. Assemblies listed in Items 1 and 2 shall be deemed to comply provided joints are sealed and requirements of Section C402.4.1.1 are met.

1. Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating;
2. A Portland cement/sand parge, stucco or plaster minimum 1/2 inch (12 mm) in thickness.

C402.4.1.2.3 Building test. The completed building shall be tested and the air leakage rate of the *building envelope* shall not exceed 0.40 cfm/ft2 at a pressure differential of 0.3 inches water gauge (2.0 L/s · m2 at 75 Pa) in accordance with ASTM E 779 or an equivalent method approved by the code official.

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			Code Structure	Compliance	Innovation
Performance Codes	**Describes the required performance:** States goals and objectives to be achieved and describes methods that can be used to demonstrate whether or not products and services meet the specified goals and objectives.	**Pro**	**Simplicity Efficiency** – The development and maintenance of performance based standards ultimately requires less effort after initial establishment. **Transparency** – clearly stated goals andobjectives answer the question of what is to be achieved.	**Flexibility:**The code official has the freedom to define the criteria and methoddology to acheive the defined objectives.	**Open to new technologies:** Performance based standards allow earlier use of new technology. The users of these standards are free to implement new technology as soon as it is demonstrated, without waiting for standards development committees to modify standards to explicitly permit use of new technology **Barriers to Trade:**Performance based standards permit the use of new or nontraditional parts and methods when their use meets the performance criteria. This widens the marketplace, no longer limiting the acceptable suppliers to those manufacturers or countries with specific resources.
		Con	**Requires systemic change**: initially more difficult to establish goals and objectives	**May be difficult to define quantitative criteria.:** The degree to which a standard can be effectively performance based rather than prescriptive depends on the ease of judging whether or not products or services meet the performance objectives. **Education Dependent:** Training might be needed, especially during first phases of implementation. **Cost:** May require costly and complicated testing procedures	
Prescriptive Codes	**Describes acceptable solution:** Prescribes materials, design and construction methods frequently without stating goals and objectives.	**Pro**	**Current State:** does not require systemic change	**Only requires direct interpretation of requirements:**Prescriptive criteria are straightforward for a builder or designer to follow, easy for a third party to check, and relatively easy for building regulators to enforce.	
		Con	**Complex:** Results in "exception" and "deemed to comply" lists. **Lack of Transparancy:** Goals and objectives are implied at best and unknown at worst. For many rules in prescriptive standards, we cannot answer with certainty the question of what end function	**No flexibilty in terms of requirements completion**	**Retardation of technology adoption:** Improved and/or cheaper products may be developed, yet their use might not be allowed if construction is governed by prescriptive codes and standards Another problem is that it makes it very difficult to cost-optimize buildingconstruction.

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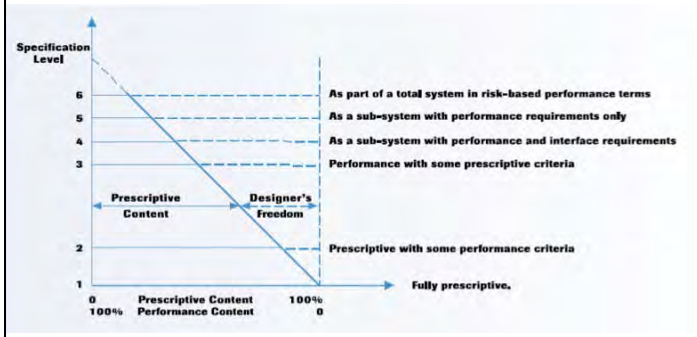

from Follette, "Developments in Performance-Based Building Codes and Standard", FOREST PRODUCTS JOURNAL Vol. 50, No. 7/8 JULY/AUGUST 2000

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Welcome to Code-World

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Building Code Purpose

Sets forth requirements to protect public health, safety and general welfare as they relate to construction and the occupancy of a building. These codes include specific requirements for building materials, fire protection, weather protection (moisture, wind), structural design, light and ventilation, heating and cooling, sanitary facilities and energy conservation.

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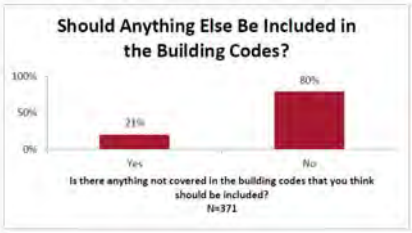

Respondents answering "yes" were asked to share what should be included in building codes that is not already covered. Below is a sample of their responses:

- A clearer scope for the IFC & IRC
- Early-warning detection of fires
- Have an appendix that explains the purpose and derivation of each technical code requirement
- Development and use of ES reports should be more specifically discussed and regulated
- Real world performance criteria not just lab (R-value) results.

Source: McKinley Advisors, IAC Member Survey, November 2011

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Development

Model code language and requirements are written.

Adoption

Codes become law by being adopted by state or local agencies

Implementation

Codes are enforced by local code officials

- Code Interpretation
- Training

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US DOE Building Energy Codes Program Goals

Goals by FY	Baseline	2010	2011	2012	2013	2014	2015	2016	2017
IECC Code Improvement	IECC 2006	IECC 2009 (17%)		IECC 2012 (30%)			IECC 2015 (50%)		
ASHRAE 90.1 Code Improvement	90.1-2004		90.1-2010 (30%)			90.1-2013 (50%)			
Adoption Rate for IECC 2009 (or equivalent)									80%
Compliance Rate with IECC 2009	Unknown								90%

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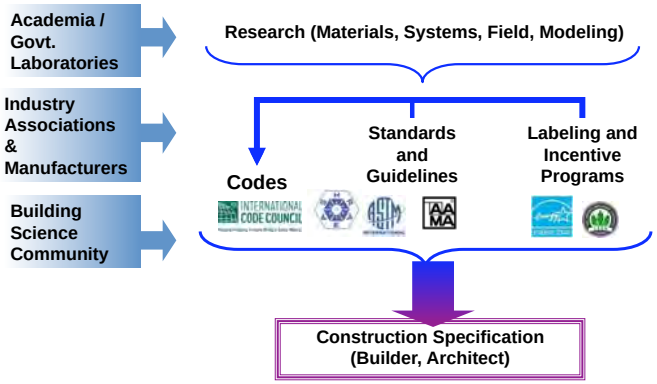
Building Science Influence on Codes and Regulatory Arena



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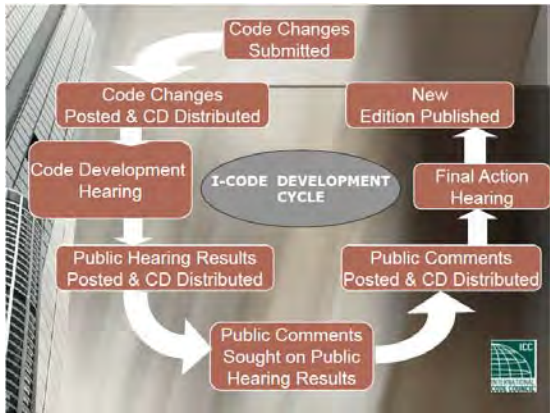

From "ICC Code Development Process", www.iccsafe.org

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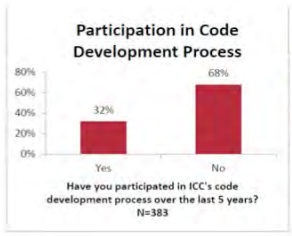

If yes, please indicate your involvement:	
Sample Size	122
Attended initial action code development hearings	58%
Submitted public comments on code change proposals	57%
Attended final action hearings	57%
Submitted code change proposals	53%
Other[1]	13%

Occupations with most participation:
- Association Representatives (80%)

Occupations with least participation:
- Governmental representatives (20%)
- Architects (22%)

Source: McKinley Advisors, IAC Member Survey, November 2011

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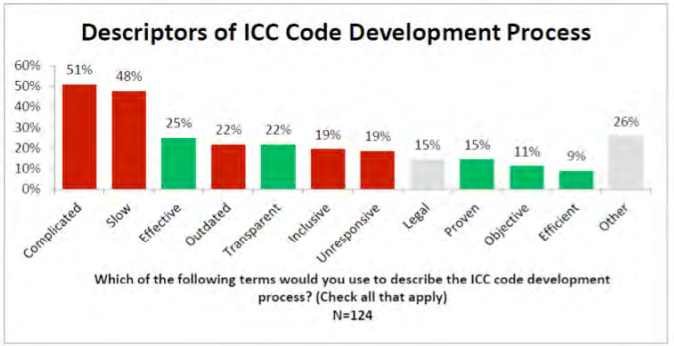

Source: McKinley Advisors, IAC Member Survey, November 2011

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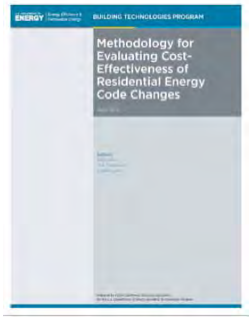
Code Development Participation

Submit Proposal
- Proposed change
- New reference standards
- Reason statement
- Cost impact



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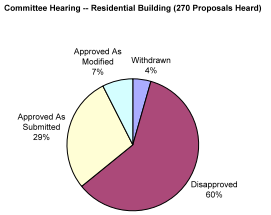
Code Development Participation

Submit Proposal
- Proposed change
- New reference standards
- Reason statement
- Cost impact

Testify at Committee Hearing
- Floor modification



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Code Development Participation

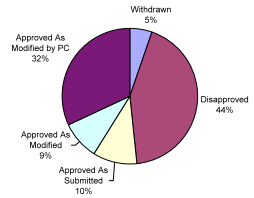
Submit Proposal
- Proposed change
- New reference standards
- Reason statement
- Cost impact

Testify at Committee Hearing
- Floor modification

Submit Public Comment
- Public comment modification

Testify at Final Hearing

Final Hearing - Residential Building 09/10 (36% Proposals with Public Comment)



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Goal: Achieving Consensus

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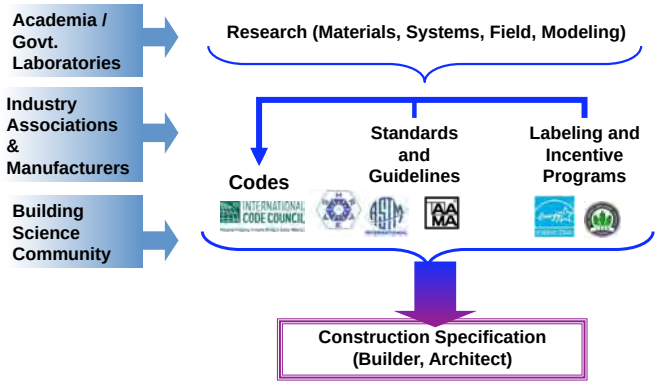
Building Science Influence on Codes and Regulatory Arena



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Referenced Standards in Codes – Example Gypsum in IBC

2506.2 Standards. Gypsum board materials shall conform to the appropriate standards listed in Table 2506.2 and Chapter 35 and, where required for fire protection, shall conform tothe provisions of Chapter 7.

TABLE 2506.2
GYPSUM BOARD MATERIALS AND ACCESSORIES

MATERIAL	STANDARD
Accessories for gypsum board	ASTM C 1047
Adhesives for fastening gypsum wallboard	ASTM C 557
Elastomeric joint sealants	ASTM C 920
Fiber-reinforced gypsum panels	ASTM C 1278
Glass mat gypsum backing panel	ASTM C 1178
Glass mat gypsum panel	ASTM C 1658
Glass mat gypsum substrate	ASTM C 1177
Joint reinforcing tape and compound	ASTM C 474; C 475
Nails FOR gypsum boards	ASTM C 514, F 547, F 1667
Steel screws	ASTM C 954; C 1002
Steel studs, load-bearing	ASTM C 955
Steel studs, nonload-bearing	ASTM C 645
Standard specification for gypsum board	ASTM C 1396
Testing gypsum and gypsum products	ASTM C 22; C 472; C 473

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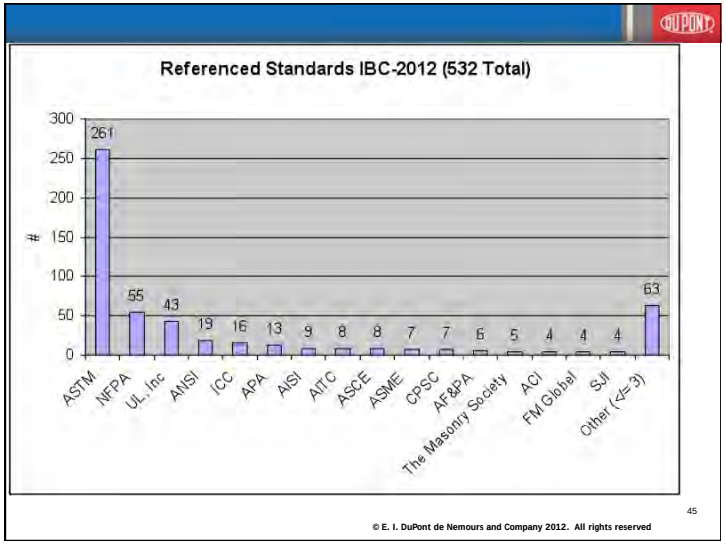

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Types of Standards

Terminology standard

Classification

Guide

Test Method.

Specification

Practice

Source: ASTM Manual of Form and Style

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Terminology & Classifications

terminology standard, *n*— a document comprising definitions of terms; explanations of symbols,abbreviations, or acronyms.

- *E631-06 Standard Terminology of Building Constructions*

classification, *n*— a systematic arrangement or division of materials, products, systems, or services into groups based on similar characteristics such as origin, composition, properties, or use.

Often contained within other standards

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Barrier v. Retarder

"Some recent recommendations have been made to substitute retarder as a preferred term for the subject sense of barrier. This new term has not been broadly accepted, does not have a sound lexicographic basis. It introduces certain grammatical problems, and requires the use a three word term (e.g. diffusional, transport, etc., to become technically correct. Barrier has been and remains the preferred term in technical terminologies and is supported by governmental regulations and usage. Retarder does not decrease potential ambiguities and is not a more accurate term."

Letter from Richard A. Strehlow responding to request of ASTM E06.41 on usage of terms barrier and retarder, March 19, 2001

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ASTM E1677: Two Air Barrier Classifications

Performance Properties	AB Classifications	
	Type I	Type II
Air leakage As tested by E283	< .06 cfm/ft² @ 75 Pa	
Structural Integrity As tested by E330	2 in. H_20 or 500 Pa (65 mph) for 1 hr in each direction	
Water Resistance As tested by E331	No penetration for 15 min of simulated wind driven rain @ 0.11 H_2O or 27 Pa (15 mph)	Not Required
Water Vapor Permeance As tested by E96A	Measured	

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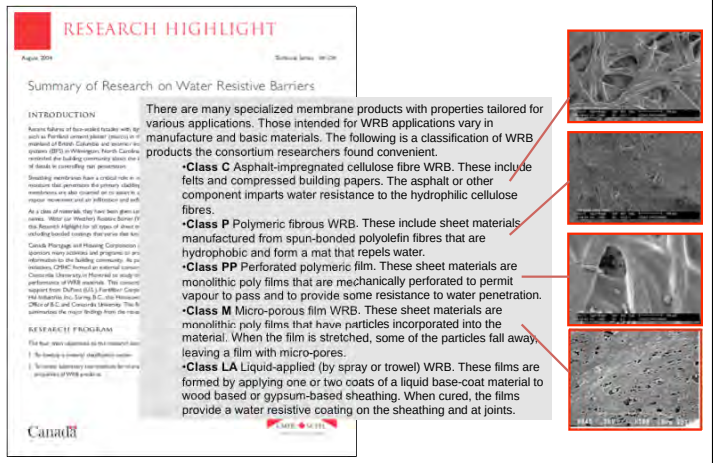

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Guides and Practices

guide, *n*— a compendium of information or series of options that does not recommend a specific course of action

practice, *n*—a definitive set of instructions for performing one or more specific operations that does not produce a test result..

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Speaking of the Pirate Code

"the code is more of what you call guidelines than actual rules"

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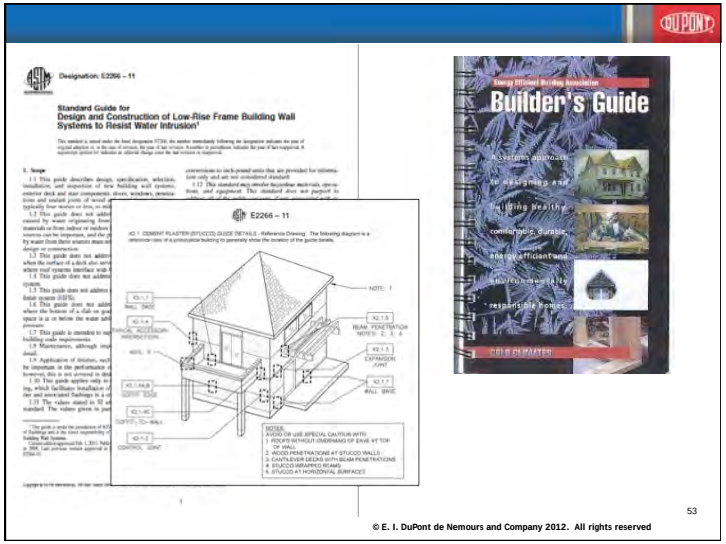

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ASTM E2128 – 01a **Standard Guide for Evaluating Water Leakage of Building Walls**	This guide is intended to provide building professionals with a comprehensive methodology for evaluating water leakage through walls. It addresses the performance expectations and service history of a wall, the various components of a wall, and the interaction between these components and adjacent construction. It is not intended as a construction quality control procedure, nor as a preconstruction qualification procedure. It is intended for evaluating buildings that exhibit water leakage.
ASTM E1825 – 06 **Standard Guide for Evaluation of Exterior Building Wall Materials, Products, and Systems**	This guide may be used by design professionals and others in the building construction industry to provide factual support for professional judgment of materials, products, or systems during the design development of new and remedial exterior building wall construction.

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Document	Fenestration	Wall System
FMA / AAMA 100-07	Flanged or Mounting Fins (Wood, Al, or Vinyl)	Wood Frame
FMA / AAMA 200--09	Frontal Flanged (Aluminum and Vinyl)	Surface Barrier CMU
FMA / WDMA 250-10	Non-frontal flanged (Wood)	Surface Barrier CMU
FMA / AAMA / WDMA 300	Exterior Doors with mounting fins, brick mold, and box frame	Wood Frame
FMA / AAMA / WDMA 400	Exterior Doors with mounting fins, brick mold, and box frame	Surface Barrier CMU

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Test Methods & Specifications

Designation: E2556/E2556M – 10

Standard Specification for
Vapor Permeable Flexible Sheet Water-Resistive Barriers
Intended for Mechanical Attachment

test method, *n*— a definitive procedure that produces a test result.

Test Result:

- Relationship: equation or curve
- Number
- Pass/Fail

specification, *n*— an explicit set of requirements to be satisfied by a material, product, system, or service.

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The Answer to the Ultimate Question of Life, The Universe, and Everything

from the supercomputer, Deep Thought, specially built for this purpose. It takes Deep Thought 7½ million years to compute and check the answer,

Douglas Adams -- Hitch-hikers Guide to the Galaxy

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Property	Test Method	Maximum Requirement
Section 5.1		
Tensile Strength- Rubber and Thermoplastic	ASTM D 412, Method A, Die C	980 kPa (140 psi) minimum
Tensile Strength- Polymer Modified Bitumen	ASTM D 1970, Section 7.3	980 kPa (140 psi) minimum
Tensile Strength- Woven/Nonwoven Textile Fabrics	ASTM D 5034	0.5 kN/mm (2.9 lbs/in) minimum
Section 5.2		
Water Penetration Around Nails:		
-After 24 hours @ 23°C ± 1°C (73°F ± 2°F) & 50% RH	ASTM D 1970, Section 7.9, modified per 5.2.1.	Must Pass 51 mm (1.2 in) of water
-After thermal cycling (10 cycles)		Must Pass
Water Penetration Around Nails (Alt):		
-After 24 hours @ 23°C ± 1°C (73°F ± 2°F) & 50% RH -After thermal cycling (10 cycles)	ASTM E 331/E 547, or modified test per Annex 1	Must Pass Must Pass
Section 5.3		
90° Peel Adhesion (Initial)		
After 24 hours @ 23°C ± 1°C (73°F ± 2°F) & 50% RH	ASTM D 3330, Method F	0.263 N/mm (1.5 lbs/in) minimum
All Substrate Substrates		
Section 5.4		
Accelerated UV Aging (14 days) 90° Peel Adhesion	ASTM G 154, UVA cycle 1 ASTM D 3330, Method F	0.263 N/mm (1.5 lbs/in) minimum *NOTE 1: change from original appearance*
Appearance	Visual	
Section 5.5		
Elevated Temperature Exposure Level 1 - 50°C (122°F) 7 days Level 2 - 65°C (149°F) 7 days Level 3 - 80°C (176°F) 7 days	ASTM D 3330, Method F	0.263 N/mm (1.5 lbs/in) minimum *NOTE 2: change from original appearance*
Appearance	Visual	
Section 5.6		
Thermal Cycling (10 cycles) 90° Peel Adhesion (See Section 5.6 for temperature)	AAMA (TIR)9, Section 5.5 ASTM D 3330, Method F, Section 16	0.263 N/mm (1.5 lbs/in) minimum *NOTE 3: change from original appearance*
Appearance	Visual	
Section 5.7		
Cold Temperature Flexibility	ASTM C 765	Must Pass -18°C (0°F)
Section 5.8		
Adhesion after water immersion	AAMA 800, Section 2.4.3.1.1/2.4.1.4.3 Test B	0.263 N/mm (1.5 lbs/in) minimum
Section 5.9		
Resistance to Peel	Annex 2	Report Only

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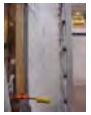
	 Material Property Testing	 Product Testing	 Assembly Testing	 Controlled Field Testing	 Whole Building Testing
Objective	Mechanistic understanding of material performance	Product functional performance	Installed performance – short term / accelerated aging	Installed performance – longer term, real weather conditions	As Built and / or In-Service Performance
Use & Consideratons	➢Material characterization: ➢Input to modeling ➢can be time intensive	➢Product property reporting ➢Quality Control ➢Needs to repeatable and quick	➢Installation method development ➢Compatibility with other products ➢System performance reporting	➢Longer duration installation and compatibility effects ➢Benchmarking of smaller scale testing and simulation models	➢Validation of smaller scale testing and simulation models ➢Occupancy effects ➢Installation Quality

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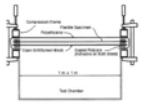
Air Barrier Test Methods and Usage

	Product Testing	Assembly Testing	As-built Testing
	 ASTM E2178	 ASTM E2357	 ASTM E779,
ABAA Certification	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa)	≤ .04 cfm/ft² at .3 in.H_2O (≤ .2 L/(s•m²)@75 Pa)	
IECC(2012) Residential			≤ 5 ACH_{50} (Climate Zones 1&2) ≤ 3 ACH_{50} (Climate Zones 3 - 8)
IECC (2012) Commercial	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa)	≤ .04 cfm/ft² at .3 in.H_2O (≤ .2 L/(s•m²)@75 Pa)	≤ .4 cfm/ft² at .3 in.H_2O
USACE Specification	≤ .004 cfm/ft² at .3 in.H_2O (≤ .02 L/(s•m²) @75 Pa)		≤ .25 cfm/ft² at .3 in.H_2O (modified by USACE protocol)

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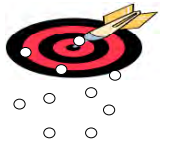
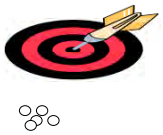
Precision & Bias – Mandatory sections for ASTM Standard Test Methods





Precision

- **Repeatability** - addresses variability between independent test results gathered from within a single laboratory (otherwise known as intralaboratory testing).
- **Reproducibility** - addresses variability among single test results gathered from different laboratories (otherwise known as interlaboratory testing).

Bias is defined as a systematic error that contributes to the difference between the mean of a large number of test results and an accepted reference value.

- if an accepted reference value is not available, then the bias cannot be established.
- if the bias is unknown but the direction or bounds of the bias can be estimated, this information should be included in the bias statement.

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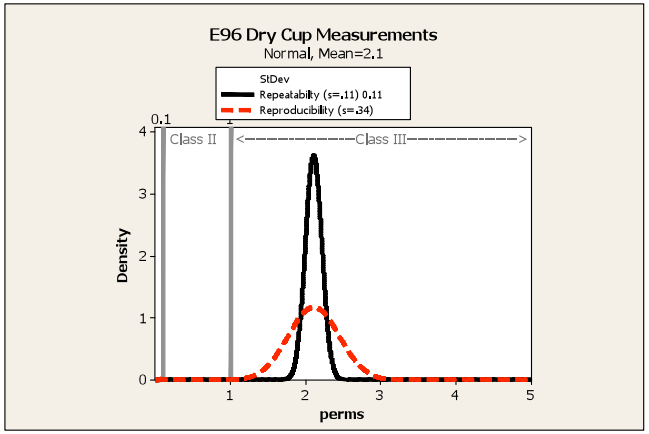

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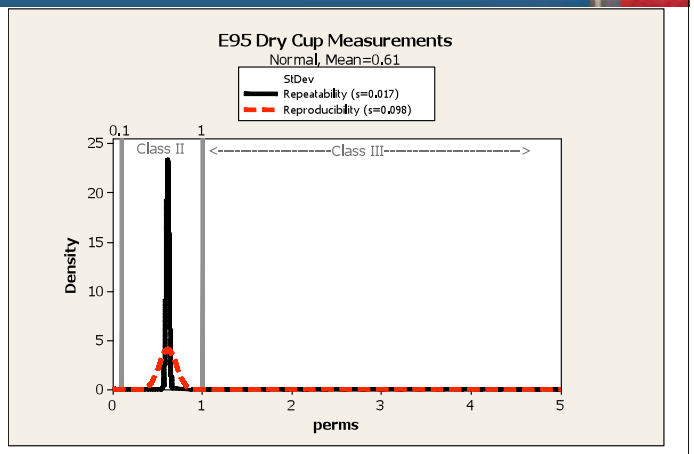

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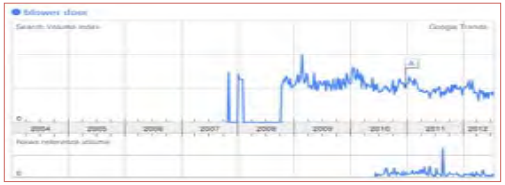
"Gallagher, John" <jgallagh@astm.org>
07/15/2009 11:57 AM

To Theresa A Weston/AE/DuPont@DuPont
cc
bcc
Subject ASTM E 779

History: This message has been forwarded.

Good Morning Theresa,
This is John Gallagher from the ILS department at ASTM International. I wanted to let you know that ASTM E 779 was among our top 100 selling standards in 2008. Congratulations and thank you for producing such a quality method. There are a few items that require attention. Please see the following:

E 779 - No Precision Information (Repeatability/Reproducibility) in Method



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		Type of Test	Test Result	P&B Statement
E283	**Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen**	Lab Assembly	Curve of air leakage vs. pressure	The precision and bias of this test method has not been determined.
E2178	**Standard Test Method for Air Permeance of Building Materials**	Product Performance	Air Leakage @75 Pa Curve of air leakage vs. pressure	The precision and bias of the test method have not been determined
E2357	**Standard Test Method for Determining Air Leakage of Air Barrier Assemblies**	Specified lab assembly subjected to specified preconditioning.	Air Leakage @75 Pa Curve of air leakage vs. pressure	The precision and bias of this practice has not been determined. The precision and bias of the individual test procedures required are given in those methods.
E330	**Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference**	Lab Assembly	pass/fail at specified or max pressure	No statement is made either on the precision or bias of this test method for measuring structural performance, since this method merely states whether or not the test specimen sustained the loads applied and otherwise conformed to the criteria specified for success.
E331	**Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference**	Lab Assembly	pass/fail at specified or max pressure	No statement is made either on the precision or bias of this test method for measuring water penetration since the result merely states whether there is conformance to the criteria specified for success.
E779	**Standard Test Method for Determining Air Leakage Rate by Fan Pressurization1**	Whole Building	Multi-point Air Leakage under infiltration and exfiltration conditions	The confidence limits calculated in 9.7 give an estimate of the precision uncertainty of the test results. The specific precision and bias of this test method is dependent largely on the instrumentation and apparatus used and on the ambient conditions under which the data are taken.
E1827	**Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door1**	Whole Building	Air Leakage under infiltration and exfiltration conditions	11.1 Measurement Uncertainty—The precision and bias of this standard depend on the instrumentation and apparatus used, the test zone envelope, and the ambient conditions under which the data are taken.6 Refer to recommended maximum values for precision and bias in Tables X1.1 and X1.2. These recommendations achieve the following uncertainties when calculated in accordance with Annex A3. 11.2 Single-Point Method—The uncertainty of measured flow at 50 Pa is 10 % using the single-point measurement assumptions for precision and bias and 5 % using the two-point assumptions. 11.3 Two-Point Method—Assuming an exponent of n = 0.65, P1 = 50 Pa (0.2 in. H2O), and P2 = 12.5 Pa (0.05 in. H2O), the uncertainty of extrapolating to measured flow at 4 Pa (0.016 in. H2O) would be 13 % using the two-point assumptions for precision and bias. Estimates of C and n have uncertainties of 10 % and 0.05, respectively, for the two-point assumptions.

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New Standard Test Method by ABAA & ASTM E06.41: Standard Method for Building Enclosure Air Tightness Compliance Testing

Draft Scope

- *This standard test method provides a quantitative field-test procedure and calculation method for assessing compliance of a building enclosure with an air tightness specification using fan- induced pressure differences.*
- *Building setup conditions appropriate for testing the enclosure's air tightness are defined in this standard.*
- *Guidelines to identify the air barrier boundaries of the building enclosure to be tested are provided in this standard.*
- *This test method applies to all building types and portions thereof.*
- *This test method is applicable to typical indoor-outdoor temperature differentials and low to moderate wind pressure conditions.*
- *This standard defines two test procedures: multipoint regression and repeated single point pressure testing.*
- *This standard allows for testing compliance with pressurization only, depressurization only or a combination.*

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ASTM Inter-laboratory studies (Jan 10, 2012 email)

Dear Theresa,

ASTM's Interlaboratory Study Program would like to lend you a hand! According to our records, we see that ASTM WK35913…needs Repeatability and Reproducibility cited in the precision and bias section.

ASTM's Form and Style Manual requires test methods contain a statement (1) regarding within-laboratory precision of the test results (repeatability) when approved, and (2) regarding the precision of test results obtained in different laboratories (reproducibility) within 5 years. …

Precision and bias statements validate the methodology of your standard, and greatly benefit the user. The ILS Program is designed to support the committees in their efforts to produce precision statements for their test methods and is available to assist in the following areas:

- Designing an interlaboratory study
- Identifying potential samples
- Soliciting volunteer laboratories
- Finding available suppliers
- Contracting with distributors
- Reviewing laboratory instructions
- Collecting and analyzing data
- Producing a draft precision statement
- Compiling information for the research report
- Giving recognition to participating laboratories

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Whole Building Testing "Interlab" Studies

We are in the planning process.

- Review past work – identify sources for lack of repeatability and/or reproducibility
- Working with ASTM ILS
- Looking for "test specimen buildings"
- Opportunity for your input

Photo source: ASHRAE RP-1478 Testing, Orlando FL

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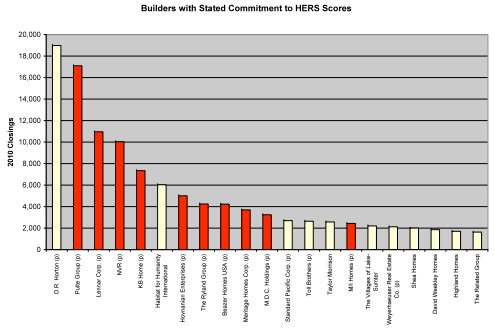
Increasingly Builders are Committing to HERS Rating All Houses



Data from ProSales and RESNET

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Test Huts – Test Replication

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Wall Assemblies Evaluated

Wall #	Exposure	Cladding	Water-Resistive Barrier	Sheathing
1	E and W	Fiber Cement	WRB B	OSB
2	E and W	Fiber Cement	WRB C	OSB
3	**E and W**	**Fiber Cement**	**WRB A**	**OSB**
4	**E and W**	**Vinyl**	**WRB A**	**OSB**
5	E and W	Vinyl	WRB C	OSB
6	E and W	Stucco	Paper-backed Lath + WRB B	OSB
7	E and W	Stucco	Paper-backed Lath + WRB C	OSB
8	E and W	Stucco	Paper-backed Lath + WRB A	OSB
9	E and W	Brick	WRB A	OSB
10	E and W	Brick	WRB B	OSB
11	E and W	Brick	WRB C	OSB
12	**E and W**	**Vinyl**	**WRB A**	**OSB**
13	E and W	Vinyl	WRB B	OSB
14	**E and W**	**Fiber Cement**	**WRB A**	**OSB**
15	E and W	Fiber Cement	WRB D	OSB
16	E and W	Fiber Cement	WRB A	none

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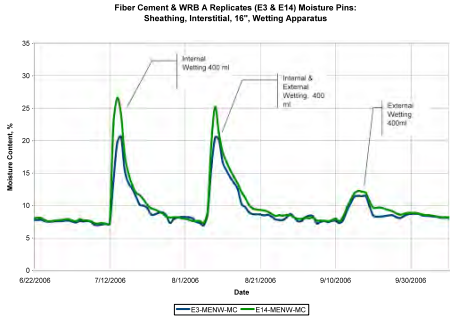
Moisture content at water injection system - July '06, August '06 and September '06 wetting events

(Fiber-cement siding and WRB A)



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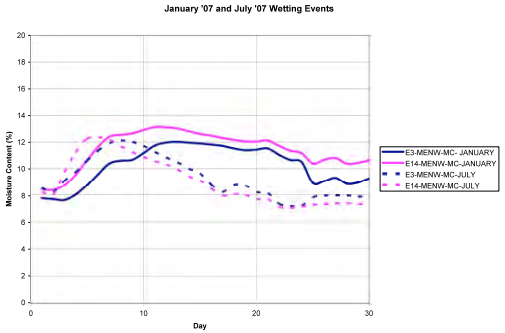
Moisture content at water injection system --January and July wetting events

(Fiber-cement siding and WRB A)



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Summary of repeatability of replicate walls

Sensors	Vinyl and WRB A Std Dev		Fiber Cement and WRB A Std Dev
East - MENW	**0.907**		**1.071**
East - MENM	**0.169**		**0.225**
East – MAEM	**0.337**		**0.735**
West - MENW	**1.28**		**0.955**
West - MENM	**1.191**		**0.457**
West - MAEM	**0.858**	-	**0.355**

MENM = OSB at 48"; MENW = OSB behind the water injection system; MAEM = gypsum-board wafer

Modified Gage R&R analysis was conducted on each of the daily averages of each sensor.

Absolute per cent study variation is statistically confounded since the measured variation and differences come from a combination of the wall and sensor inputs.

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Innovation & New Technology

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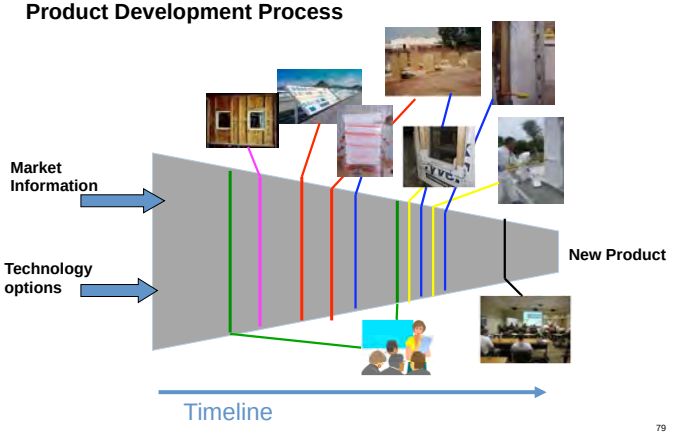
Product Development Process



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Code and standard planning critical to innovation deployment

"For an **innovation to be accepted by the regulatory system**, at a minimum it must be tested, certified, and evaluated. Once an evaluation report is prepared, these early steps may seem easy relative to educating code officials throughout the country about the product. Similarly, **changing the model code (and ultimately state and local codes) so that it explicitly allows an innovation** can be an even more difficult task. Although each of these steps can be expensive individually, they become more so the longer they are put off because of lack of understanding or bad planning."

- *Hassel et. al., "Building Better Homes, Prepared for the U.S. Department of Housing and Urban Development (HUD) Office of Policy Development and Research and the Partnership for Advancing Technology in Housing (PATH), 2003*

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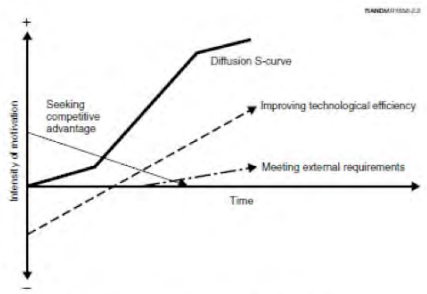

SOURCE: Adapted from Mitropoulos and Tatum (1995, p. 22).

Figure 2.3—Forces for Adoption and Diffusion over Time

From Hassel et. al., "Building Better Homes, Prepared for the U.S. Department of Housing and Urban Development (HUD) Office of Policy Development and Research and the Partnership for Advancing Technology in Housing (PATH), 2003

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IBC 104.11 Alternative materials, design and methods of construction and equipment.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, ***at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.***

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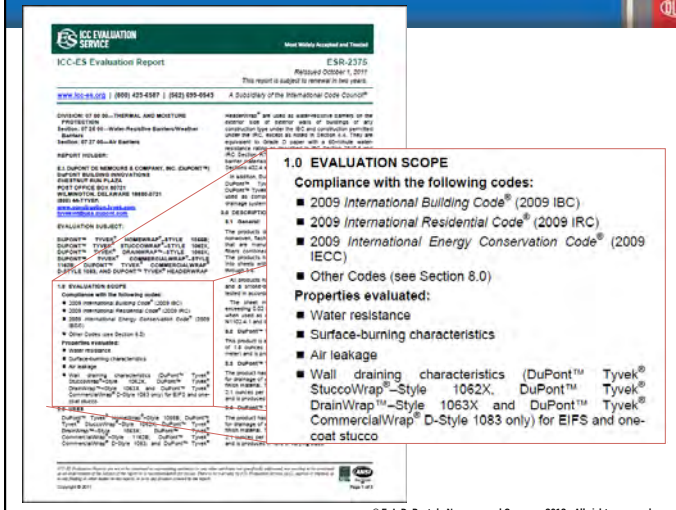
ICC EVALUATION SERVICE

ICC-ES Evaluation Report ESR-2375

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009 *International Building Code*® (2009 IBC)
- 2009 *International Residential Code*® (2009 IRC)
- 2009 *International Energy Conservation Code*® (2009 IECC)
- Other Codes (see Section 8.0)

Properties evaluated:

- Water resistance
- Surface-burning characteristics
- Air leakage
- Wall draining characteristics (DuPont™ Tyvek® StuccoWrap®–Style 1062X, DuPont™ Tyvek® DrainWrap™–Style 1063X and DuPont™ Tyvek® CommercialWrap® D-Style 1083 only) for EIFS and one-coat stucco

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Code Officials' Reasons for Denial of Green Product, Material, System, or Design Application

Reason	*N*	Percent
Insufficient supporting information to satisfy safety concerns	40	71.4
Insufficient knowledge or technical expertise with the product, material, system, or design	30	53.6
Clear conflict with the intent of the code	28	50.0
Insufficient time in the building department to conduct sufficient research to understand the product, material, system, or design	18	32.1
General unfamiliarity with the product, material, system, or design	15	26.8
Personal experience with failure of the product, material, system, or design	9	16.1
Other	7	12.5
Inability of building department to meet tight schedule of applicant	6	10.7
Knowledge of problem of the approach in other jurisdictions	6	10.7

From Eisenberg, et al., Breaking Down the Barriers: Challenges and Solutions to Code Approval of Green Building, Development Center for Appropriate Technology Report, 2002.

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Strategies Used to Gain Approval of Green Product, Material, System, or Design Application

	Sample			
	Code Official		Code User	
Strategy	*N*	Percent	*N*	Percent
Providing adequate supporting information	43	76.8	126	64.0
Starting the approval process early to allow time to work with the building department	33	55.4	108	54.8
Involving the building department staff early in the design process	31	55.4	103	52.3
Providing precedents of code approval of similar approach in other jurisdictions	19	33.9	68	34.5
Providing contact information for building officials in other jurisdictions with experience in the green approach	18	32.1	60	30.5
Using outside experts	16	28.6	60	30.5
Persistence/patience	10	17.9	100	50.8
Other	7	12.5	20	10.2

From Eisenberg, et al., Breaking Down the Barriers: Challenges and Solutions to Code Approval of Green Building, Development Center for Appropriate Technology Report, 2002.

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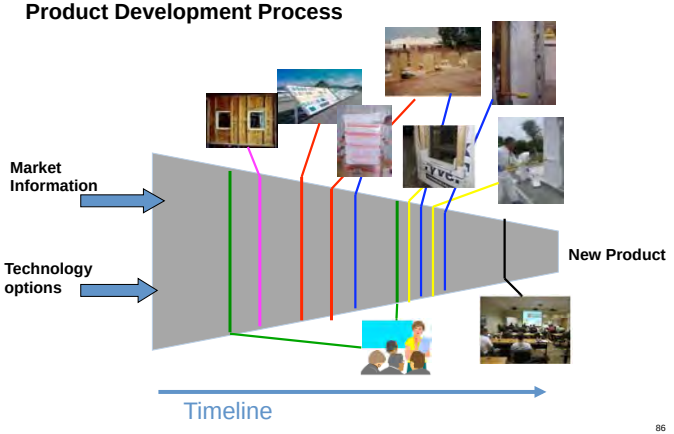
Product Development Process



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User Defined System Needs.
Reduced Water Intrusion
Effective Installation

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User Defined System Needs.	Material Performance Attribute
Reduced Water Intrusion	Resists water penetration
	Resists air leakage
	Allows drying through diffusion
	Allows drainage
	Tear /rip resistant
	Durable to repeated exposure to water
Effective Installation	Durable during construction
	No extra installation steps
	Interfacable with other components

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User Defined System Needs.	Material Performance Attribute	Water Barrier Property Target	Test Method
Reduced Water Intrusion	Resists water penetration	Water Resistant (>180 cm)	Hydrostatic Head (AATCC-127)
		Does not absorb water	Visual observations
	Resists air leakage	<= .3 L/m2/hr @ 75 Pa	Air-Ins Air Leakage Test
	Allows drying through diffusion	Vapor permeability (>/= 20 perms)	ASTM E96 (Method A)
	Allows drainage	Drainage behind flat sheet (>/=800 ml/hr/cm)	Proprietary test method
	Tear /rip resistant	Tear strength > 5 lb/in	ASTM D1117
	Durable to repeated exposure to water	No substantial change in material integrity after repeated wetting	Visual observations, Tensile strength (ASTM D882)
Effective Installation	Durable during construction	Tensile strength > 20 lbs	ASTM D882
		Tear strength > 5 lb/in	ASTM D1117
		UV resistant to 120 days	Proprietary test method
	No extra installation steps	Drainage behind flat sheet – Second product is not needed to provide drainage	
	Interfacable with other components	Compatible with flashings	
		Compatible with tapes and caulks	

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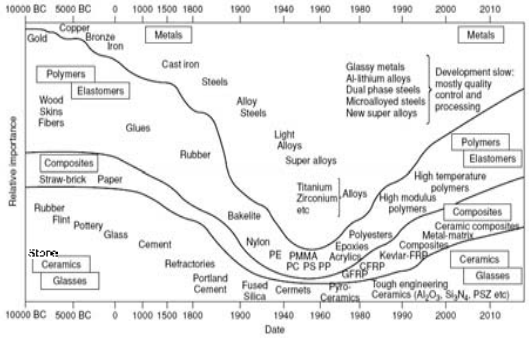
Material Substitution



M.F. Ashby, Materials Selection in Mechanical Design, 1992

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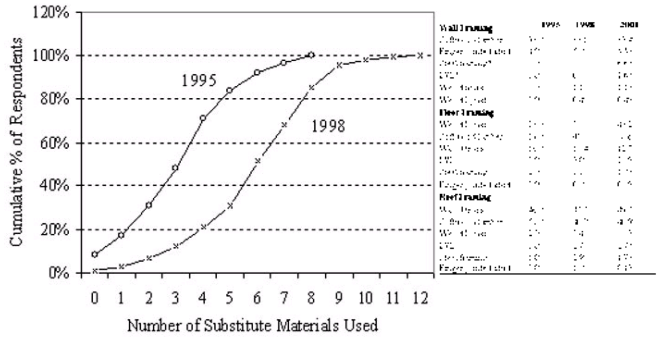
Material Substitution



CINTRAFOR, 2001

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Dodge Construction News

'Piece of paper' is latest new hot construction product here

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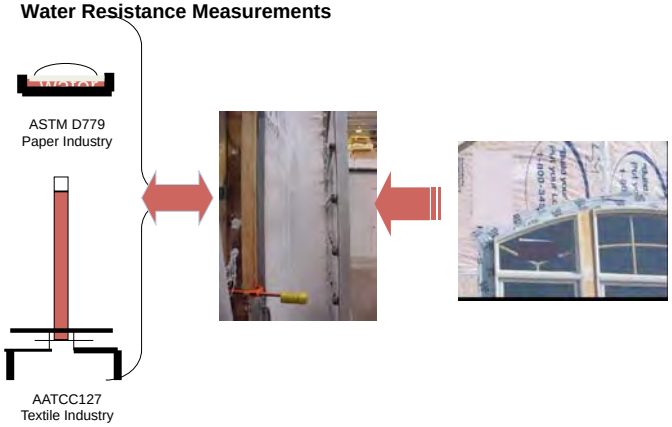
Water Resistance Measurements



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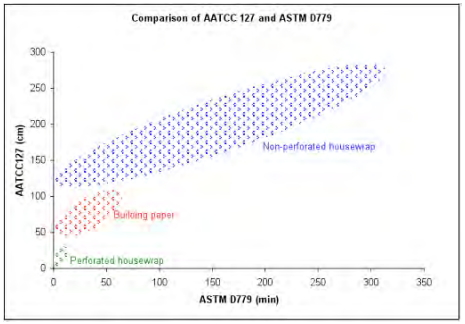
"Repeatability within a single laboratory appears to vary as a function of the water resistance level of the material. Other aspects of material composition and uniformity can also impact test repeatability."



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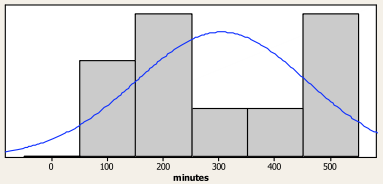
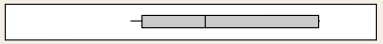
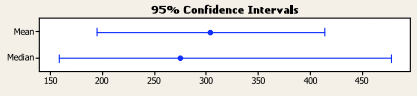
D779 (min) Measurements of SBPO

(SBPO 28perms, 270cm hydrohead)







Anderson-Darling Normality Test	
A-Squared	0.84
P-Value	0.020
Mean	303.93
StDev	152.69
Variance	23314.50
Skewness	0.14679
Kurtosis	-2.23595
N	10
Minimum	141.50
1st Quartile	160.46
Median	274.63
3rd Quartile	477.00
Maximum	480.00
95% Confidence Interval for Mean	
194.70	413.16
95% Confidence Interval for Median	
158.41	477.37
95% Confidence Interval for StDev	
105.03	278.75

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E2556/E2556M – 09

TABLE 1 Requirements for Water Resistive Barriers

Test Requirement	Specimen Type	Test Method	Minimum Performance Requirements	
			Type I	Type II
Dry tensile strength or dry breaking force (choose 1)	(1) as manufactured and (2) aged in accordance with A1.2	Test Method D828 for paper and felt materials, or Test Methods D882 for polymeric materials, or Test Method D5034 (Grab Method)	3500 N/m (20 lb/in.) minimum (machine and cross direction)	3500 N/m (20 lb/in.) minimum (machine and cross direction)
			178 N (40 lbf) minimum (machine direction) 156 N (35 lbf) minimum (cross direction)	
Water resistance test (choose 1)	(1) as manufactured and (2) aged in accordance with A1.2	Test Method D779, or	10 min minimum	60 min minimum
		Water Resistance Ponding Test (A1.1), or	No water shall transmit through the membrane in 120 min	not applicable
		AATCC Test Method 127 except that the specimens shall be held at a hydrostatic head of 55 cm (21.6 in.)	not applicable	No leakage is permitted to the underside of any specimen in 300 min
Water vapor transmission test	as received	Test Method E96/E96M (Dessicant Method)	290 ng/(Pa · s · m²) (5 perms) minimum	
Pliability test	as received	see A1.3	The material shall not crack when bent over a 1.6 mm (1/16-in.) diameter mandrel at a temperature of 0°C (32°F)	

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ASTM WK19510 - New Test Method for Water Resistance of Water-Resistive Barriers

1. Scope

Means of evaluating the water-resistance of water-resistive barriers used on above grade walls. Current standard methods are applicable only to specific materials of composition. No current test method allows evaluation across materials types.

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Durability

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The Concept of Durability Raises a lot of questions?

How to define?

- On what scale
- For how long -- premature deterioration, service life.
- Durability vs. maintenance free

How to validate?

- If validating with testing - How to measure?
  - Loss of function vs. attribute change
  - Final state or rate
  - How to benchmark?

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Durability

"…the stakes of building science –comfort, health, durability, and energy bills-"

- "The Trouble with Building Science", *Fine Homebuilding*, Spring/Summer 2012.

Part of Green Construction:

International Green Construction Code (IgCC)

- **Chapter 5 Material Resource Conservation and Efficiency.** Chapter 5 addresses material resource conservation and efficiency by means of provisions related to material selection, recycling, reuse, renewability, toxicity and durability, including resistance to damage caused by moisture.

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"Durability and cost were seen as the key factors in choosing green products by respondents to the BD&C White Paper Survey."

Green-product attributes
(rated by importance to user)

Ability to last the life of the building	4.38
Cost vs. equivalent conventional product	4.27
Availability of product to job site	4.16
Use of renewable resources	4.01

From Building Design & Construction White Paper on Sustainability, November 2003

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Durability is the ability to endure

-- Wikopedia

Durable – *Resistant to wear and decay*. (New Zealand Building Code)

Durability *– the ability of a building or any of it components to perform its required functions in its service environment over a period of time without unforeseen cost for maintenance or repair* (CSA S478-95 Guideline on Durability in Buildings)

ASTM has 54 definitions for durability, some modified with descriptors -- Chemical, exposure, etc. and are specific for individual materials and end-uses.

Failure – the loss of performance, as defined by the onset of any of the following limit states:

- collapse, as related to human safety or to loss of function of the building;
- Local damage, as related to loss function of the building component or to appearance;
- Displacement, as related to loss of function of the building component or to appearance; or
- Discolouration, as related to appearance of components having an aesthetic function

(CSA S478-95 Guideline on Durability in Buildings)

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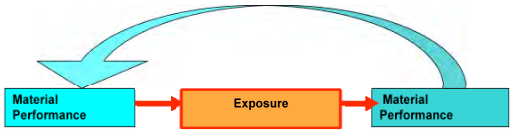
Durability Product Testing



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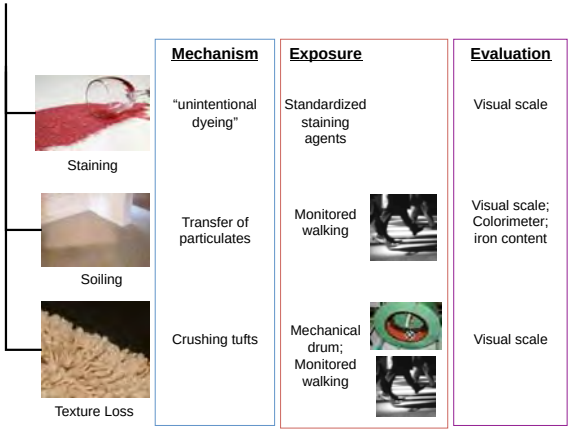
Change in Appearance (Benchmarked against real installations)



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Scale of Durability




Many standards on specific products and materials

CSA S478-95 Guideline on Durability in Buildings

Performance Building Codes (ex. New Zealand Building Code)

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New Zealand Building Code (2004)

OBJECTIVE

- **B2.1** The objective of this provision is to ensure that a *building* will throughout its life continue to satisfy the other objectives of this code.

FUNCTIONAL REQUIREMENT

- **B2.2** *Building* materials, components and *construction* methods shall be sufficiently durable to ensure that the *building*, without reconstruction or major renovation, satisfies the other functional requirements of this code throughout the life of the *building*.

CSA S478-95 Guideline on Durability in Buildings

Basic Durability Requirement

Buildings and their components shall be conceived, designed, constructed, and operated and maintained in such a way that, under foreseeable environmental conditions, they maintain their required performance during their design service lives.

The predicted service life of buildings and building components and assemblies should meet or exceed their design service life

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Service Life

Table 2
Categories of Design Service Life for Buildings
(See Clauses 5.2.3 and 6.2.)

Category	Design service life for building	Examples
Temporary	Up to ten years	• non-permanent construction buildings, sales offices, bunkhouses • temporary exhibition buildings
Medium life	25 to 49 years	• most industrial buildings • most parking structures*
Long life	50 to 99 years	• most residential, commercial, and office buildings • health and educational buildings • parking structures below buildings designed for long life category*
Permanent	Minimum period, 100 years	• monumental buildings (eg, national museums, art galleries, archives) • heritage† buildings

From CSA S478-95 Guideline on Durability in Buildings

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From NZ Code

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ANSI/ASHRAE Standard 160-2009

ASHRAE STANDARD

Criteria for Moisture-Control Design Analysis in Buildings

Approved by the ASHRAE Standards Committee on January 24, 2009, by the ASHRAE Board of Directors on January 29, 2009, and by the American National Standards Institute on January 30, 2009.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

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ISSN 1041-2336

ANSI

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

2.5 This standard does not address the design of building components or envelopes to resist liquid water leakage from sources such as rainwater, ground water, flooding, or ice dams.[B-1]

INFORMATIVE ANNEX B
COMMENTARY ON STANDARD 160

[B-1] Although this standard applies to all parts of all buildings, additional information may be needed for the proper design of foundations and ventilated cavities, such as crawl spaces and attics. This standard assumes that appropriate measures have been taken to limit bulk water entry into the building and building envelope. For information and guidance on selection and installation of materials and systems to avoid water damage, the following documents may be helpful. See Annex C, "Bibliography," for complete references.

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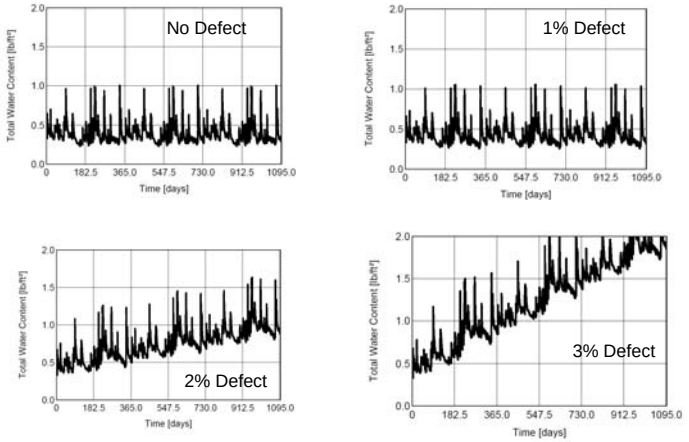

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Scale of Durability

Many standards on specific products and materials

CSA S478-95 Guideline on Durability in Buildings

Performance Building Codes (ex. New Zealand Building Code)

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Methods to verify durability of components (building elements)

- In service history / demonstrated effectiveness
- Modeling
- Testing (Lab, assembly, field)

Benchmarking

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System Performance Testing

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AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION

AAMA 504-05
Voluntary Laboratory Test Method to Qualify Fenestration Installation Procedures

Test Assembly: fenestration product, fasteners, sealant, flashing components and weather resistant barrier shall be included. Exterior cladding, interior perimeter cavity insulation and expanding foam shall not be applied to the test mockup for this evaluation.

The completed mockup shall be preloaded prior to testing using 10 positive cycles of 480 Pa (10 psf) followed by 10 negative cycles of 480 Pa (10 psf).

Test for air leakage in accordance with ASTM E 283 at a pressure differential of 75 Pa (1.57 psf).

Test for water penetration resistance in accordance with ASTM E 331 at a minimum test pressure of 150 Pa (3.0 psf) for 60 minutes.

The entire mockup shall be subjected to 14 twelve hour durability cycles in accordance with ASTM E 2264 Method A, Level 1:
- *Exterior Temperature Exposure*
  - **Level 1 49°C (120 °F)**
  - Level 2 3°C (150 °F)
  - Level 3 82°C (180 6°F)

Exterior Low Ambient Air Temperature: –30°C (–22°F)

Following cycling, the mockup shall again be tested for air leakage and water penetration resistance

The entire mockup shall be tested for structural loads in accordance with ASTM E 330 at a minimum test pressure of 1440 Pa (30 psf) positive and negative.

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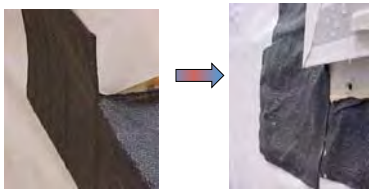
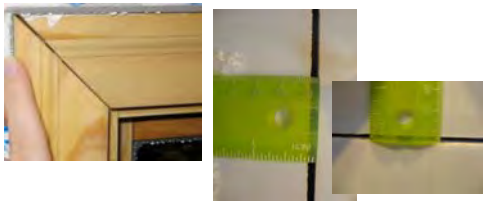
Material deformation and loss of adhesion



Joints open



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6.3 Components

6.3.1 Determination of Component Design Service Life

The appropriate *design service life* of each *component* of a building should be determined considering
(a) exposure conditions (see Appendix C);
(b) difficulty and expense of *maintenance*;
(c) the consequences of *failure* of the *component* in terms of costs of *repair*, disruption in operation, and hazard to building users (see Table 3);
(d) current and future availability of suitable *components*;
(e) the *design service life* of the building (see Appendix A); and
(f) technical or functional obsolescence.

From CSA S478-95 Guideline on Durability in Buildings

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Table C1
Environmental Agents That Can Affect Service Life
(See Clause C2.)

Agent	Type	Clause No.
Moisture	solid (ice, snow), liquid (rain, condensation), gas (water vapour, humidity)	C2.1
Air constituents	O_2, CO_2	C2.2
Air contaminants	oxides, particulates, sea spray	C2.3
Ground constituents	sulphates and other salts, acids (from decomposition of organic matter)	C2.4
Ground contaminants	chemicals from spills and leaks, chlorides from road salt, induced electrical currents	C2.4
Biological *agents*	microorganisms, insects, other animals, plants	C2.5
Temperature		C2.6
Solar radiation	UV (ultraviolet) radiation	C2.7
Incompatible chemicals		C2.8
Differential movements	between *components* (shrinkage and swelling), within massive materials (temperature gradient response), creep/flow	
Use or exposure	loading, abrasion, overloading	

From CSA S478-95 Guideline on Durability in Buildings

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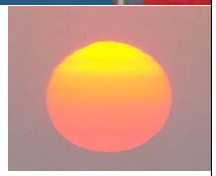
Real Time and Accelerated Exposure



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Accelerated Exposure

The goal is to be able to predict material or component change in a reasonable amount of time.

Benchmarking is always a concern.

Acceleration by intensification of exposure without changing the chemical and physical deterioration mechanisms, i.e. time-temperature superposition.

Combined exposures – serial or parallel

NIST-Patented 2-meter SPHERE

(Simulated Photodegradation via High Energy Radiant Exposure)

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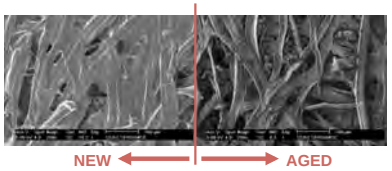
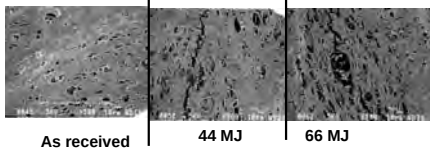
Deterioration mechanism examples

Volatilization



Polymer degradation (embrittlement & micro-cracking)



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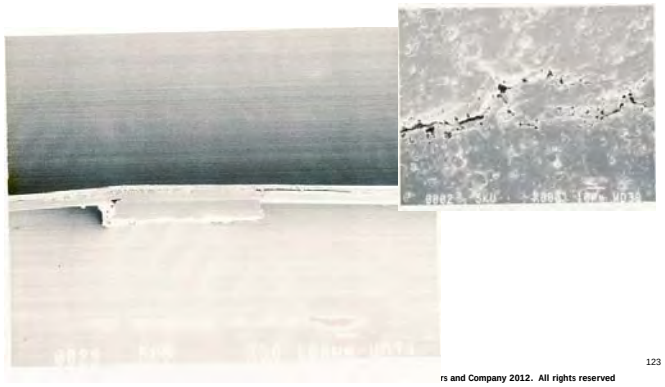
Delamanation – material mis-match

Laminate Stretched to 50% Break Elongation



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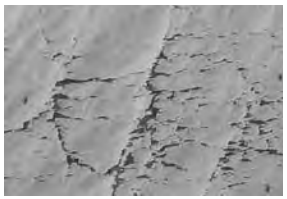

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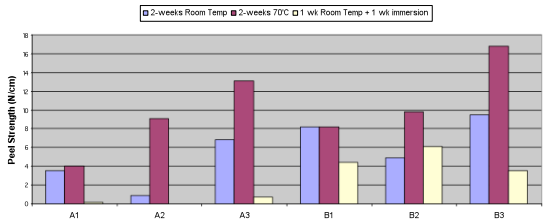
Adhesion Loss - adhesive vs. cohesive failure



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E06.22.09 Durability Task-Group on Air and Water Retarders for Above Grade Walls

Scope:

This task-group will develop standard test methods and specifications pertaining to the of durability air and water barriers. These materials are a component of an exterior wall assembly providing control of air and bulk water leakage into building structures. In this capacity these materials must maintain performance through long term exposure to UV radiation, thermal cycling, mechanical cycling and in some cases specific chemical environments. Materials include but are not restricted to housewraps, building papers and felts, sheathing materials and the interfaces of other materials with them (adhesives, sealants, mechanical fasteners, etc.)

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Scale of Damage

Product / Material Properties

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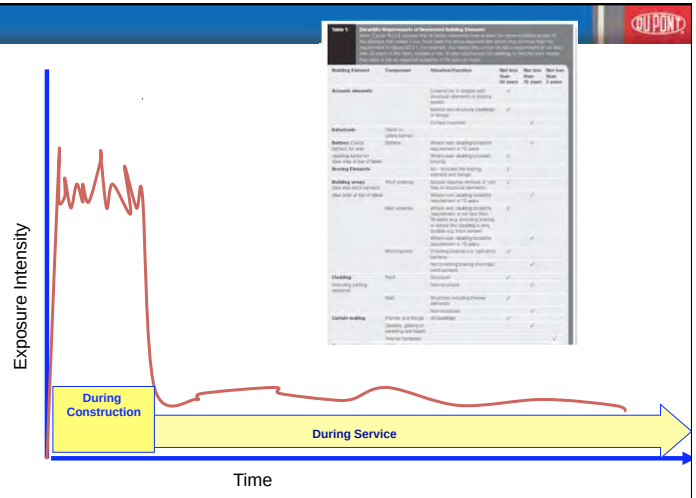

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RESEARCH REPORT

INCOMPATIBLE BUILDING MATERIALS

	Problem	Reporting Source	Solution
Housewrap/Surfactants	There are reports of changes in the properties of spunbonded polyolefins due to surfactants. The surfactants can originate from a) certain types of wood species b) additives mixed with the stucco to improve workability during installation. The primary function of a housewrap or sheathing membrane is moisture control. Therefore, any breakdown of the moisture penetration control barrier offers the possibility of water entry into the building envelope. Certain chemicals can cause the loss of water repellency of spunbonded polyolefin housewraps. These chemicals, called surfactants, are typically ingredients in soap.Surfactants can reduce the water repelling capability of housewrap by changing the viscosity of water. The tannins that make species such as cedar and redwood durable can also act as surfactants that cause housewrap to become more permeable to water. In addition, certain additives that improve the workability of stucco can also act as surfactants and lower the effectiveness of housewrap moisture barriers.	Building science researchers, builders	For wood species with high tannin content, install the cladding over strapping so that the cladding is not in direct contact with the housewrap. Another solution (probably less reliable) is to backprime the siding. For stucco, a building system that separates the stucco from the housewrap should always be used.
Exterior membranes/Sunlight	Problem: Building paper and housewraps are installed in wall assemblies to prevent rain penetration. Any breakdown of the rain penetration control barrier offers the possibility of water entry into the building envelope. Building papers and housewraps are not designed to withstand long-term exposure to ultraviolet radiation (sunlight). Therefore, the planning of construction should ensure that building paper or housewrap membrane be covered with cladding in the period of time recommended by the membrane manufacturer. In addition, prolonged exposure increases the potential of tears from wind and construction activity.	Product evaluation reports	All Canadian Construction Material Centre (CCMC) product evaluation reports verify sheathing membrane performance based on a 60-day exposure. However, because the durability of exposed housewrap varies with climate and exposure, it is good practice to cover the membrane soon after installation and to check the manufacturer's recommendations

Canada CMHC SCHL

June 2003

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Peel-and-stick membranes/Vinyl windows	Certain asphalt-based peel-and-stick membranes used to seal sheathing membranes to vinyl doors and windows may react with the vinyl. The reaction results in the asphaltic membrane running and staining exterior surfaces. The asphaltic material is a first generation peel-and-stick product (4-in.-100-mm and 6-in.-150-mm rolls). In addition to staining the vinyl, it is likely the reaction also damages the window or door frame. Staining shows itself within one year of installation. It is not known if or when failure of the joint will occur.	B.C. architect	Use new generation peel-and-stick products or use rubber products and check with the window manufacturer for compatibility.




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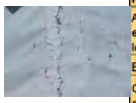
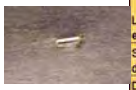
Durability Issues Listed in ASTM Task-Group Survey

Field Durability Concern	Exposure	Construction Period	In Service
Asphalt leaching causing embrittlement and water saturation / leakage	cyclic moisture loading (wet/dry cycle)	X	X
Embrittlement	UV	X	
Cracking at corner bends (inside and outside)	Cyclic bending with or without accelerated aging	X	X
Leakage / lack of sealing at fasteners; elongation of fastener holes	Accelerated aging; thermal/moisture expansion, contraction or wrinkling; wind forces	X	X
Seepage of water (absorption vs. drainage capability)	Water on both sides; with or without accelerated aging	X	X
Decrease in water resistance or degradation due to chemical incompatibility	Exposure to: wood chemicals, paints, sealants / primers, etc.	X	X
Uneven surface (wrinkling) causing variation in stucco depth	UV; wet/dry cycles; thermal and humidity cycles	X	

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Scale of Damage



Product / Material Properties

Gross Tearing/Ripping
Extremely Installation dependent
Affected by material properties, but will not change material properties

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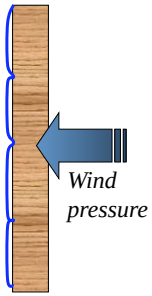
Wind Load Durability Testing (ASTM E330)



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Wind Load Durability Testing (ASTM E330)

Negative Wind Load Resistance (ASTM E330)*

Fastner	Fastner Spacing	Tyvek(R) HomeWrap(R) Max load (psf)	Tyvek(R) HomeWrap(R) Max load (mph)	Tyvek(R) CommercialWrap(R) Max load (psf)	Tyvek(R) CommercialWrap(R) Max load (mph)
0.5" Crown Staples	6"	27 psf	105 mph	33 psf	115 mph
1" Crown Staples	6"	38 psf	125 mph	45 psf	135 mph
1" Cap Nails	6"	60 psf	155 mph	77 psf	175 mph
2" Cap Nails	6"	95 psf	195 mph	86 psf	185 mph
0.5" Crown Staples	12"	14 psf	75 mph	27 psf	105 mph
1" Crown Staples	12"	14 psf	75 mph	27 psf	105 mph
1" Cap Nails	12"	33 psf	115 mph	38 psf	125 mph
2" Cap Nails	12"	45 psf	135 mph	60 psf	155 mph
0.5" Crown Staples	18"	10 psf	65 mph	18 psf	85 mph
1" Crown Staples	18"	14 psf	75 mph	14 psf	75 mph
1" Cap Nails	18"	22 psf	95 mph	27 psf	105 mph
2" Cap Nails	18"	38 psf	125 mph	45 psf	135 mph

* Open Stud wall construction (30" W x 32 " L) Wood framing, 16" o.c, no siding. Values presented are maximum load, and an appropriate factor of safety must be incorporated in design.

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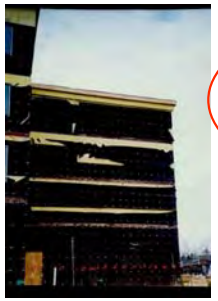
Scale of Damage



Product / Material Properties

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WK17179 Standard Guide for Assessing the Durability of Air and Water-Resistive Barriers

Scope

- This guide describes the selection of test methods and criteria to be used to simulate the aging of concealed air and water-resistive barrier materials used in above grade walls.
  - The sequence of test methods selected is desired to simulate exposure during the construction process followed by aging that occurs during the service life of the barrier.
- This guide does not provide for a conclusion within itself but is for use in conjunction with appearance or physical property tests to follow accelerated exposure.
- This standard does not address the simulation of extreme natural or man-made events such as hurricanes, blast, etc.
- This standard does not address compatibility with adjacent materials.

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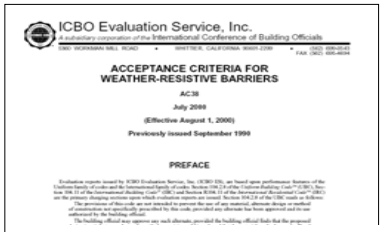
ICBO Evaluation Service, Inc.

ACCEPTANCE CRITERIA FOR WEATHER-RESISTIVE BARRIERS

AC38

July 2000

(Effective August 1, 2000)

Previously issued September 1999

PREFACE

UV/Accelerated Aging only required for polymeric based WRBs

UV sun lamps for a total of 210 hours:
- 10 hours per day for 21 days
- exposure temperature for the between 135 F and 140 F

25 accelerated aging cycles:
- Oven drying at 120 F for 3 hours
- Water immersion in room temperature water for 3 hours
- Air drying for 18 hours at a temperature of 75 F +/- 5 F

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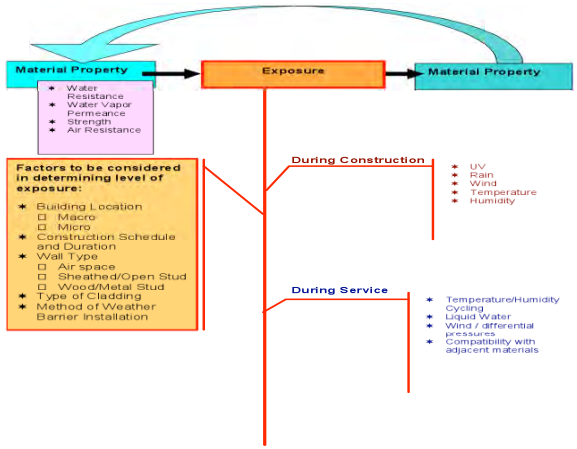

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Final Thoughts

Even though construction codes and standards are not new, the current state is far from perfect and there are many opportunities in our industry

Change will not be made by a single person – we need to work together.

Opportunities:
- Communication with and training of building officials
- Understanding and encouragement of performance codes vs prescriptive codes
- Participate in Codes and Standard development
- Whole Building and large scale testing Participation in Interlaboratory studies, and other research to understand repeatability and reproduceability.

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Per ardua ad astra

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