



# Air Barrier Field Testing of Various Air Barrier Materials during construction process

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# LEARNING OBJECTIVES

- Define key test methods used during the construction process for various air barrier materials utilizing site photo's
- Through the use of testing equipment, demonstrate adhesion, density and thickness testing procedures for a variety of air barrier materials.

# LEARNING OBJECTIVES

- Through use of actual project site photo's and video, demonstrate the process to conduct a whole building airtightness test
- Determine key visual items to review through the use of photo's during the construction process to ensure proper substrate preparation and installation of air barrier material

# AIR BARRIERS

FIELD TESTING AND INSPECTION

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# FIELD TESTING / INSPECTION

## Pre-Construction

- Mock-up
- ASTM E783, ASTM E1186

## During Construction

- Adhesion ASTM D4541
- Air Leakage ASTM E783, ASTM E-1186
- Visual - all
- Thickness (SPF/FL)
- Density
- Cohesion

## Post Construction

- Whole Building Airtightness Testing
- ASTM 779
- Thermography



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Pre-Construction

During Construction

ASTM E783-02

Standard test method for field measurement of air leakage through installed windows and doors

- Completed on mock-up or during construction process



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM 783

Why ?

- Ability to test details and intersections
- Provides air leakage rate
- Determine failure points
- Set standard for installation
- Hard to visually see leakage





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM 783



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# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM 783





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

### During Construction

- Adhesion ASTM D4541
- Air Leakage ASTM E783, ASTM E-1186
- Visual
- Thickness
- Density (SPF)
- Cohesion



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

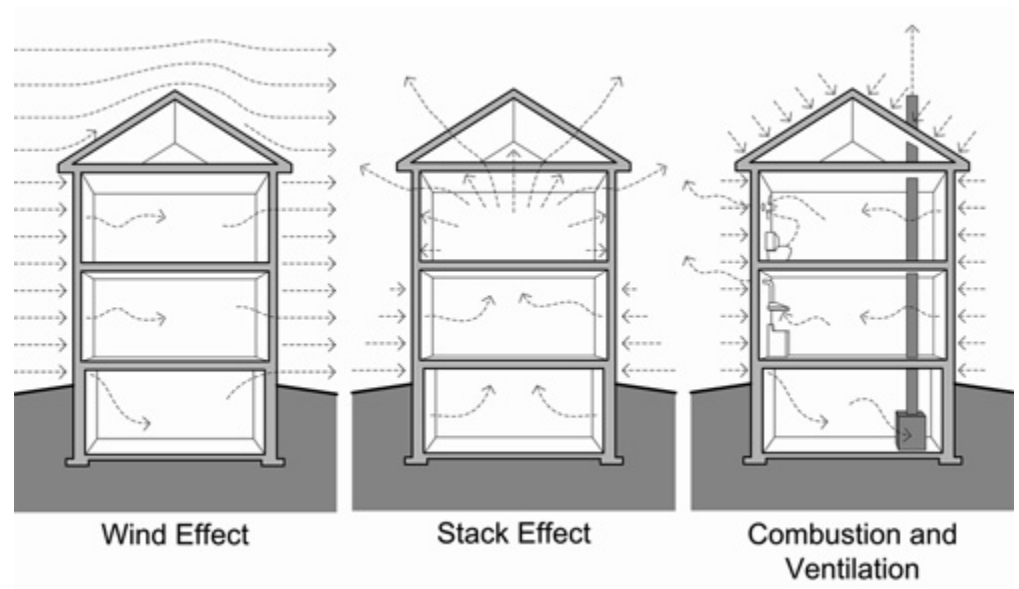
Adhesion ASTM D4541

Why ?

### 5.4.3.1.1 Air Barrier Design

The air barrier shall be designed and noted in the following manner:

d. The continuous air barrier shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation.



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Modified test method

Cut specimen from surrounding material (clause 6.7)

Declare failure mode (substrate releases)

Destructive test, repair required



Designation: D4541 – 09<sup>1</sup>

#### Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers<sup>1</sup>

This standard is issued under the fixed designation D4541; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last revision or reapproval.

<sup>1</sup> Note—Practice D3980 was deleted from Section 2 in August 2010.

#### 1. Scope<sup>2</sup>

1.1 This test method covers a procedure for evaluating the pull-off strength (commonly referred to as adhesion) of a coating system from metal substrates. Pull-off strength of coatings from concrete is described in Test Method D7234. The test determines either the greatest perpendicular force (in tension) that a surface area can bear before a plug of material is detached, or whether the surface remains intact at a prescribed force (push/fall). Failure will occur along the weakest plane within the system comprised of the test fixture, adhesive, coating system, and substrate, and will be exposed by the fracture surface. This test method maximizes tensile stress as compared to the shear stress applied by other methods, such as scratch or knife adhesion, and results may not be comparable.

Note 1—The procedure in this standard was developed for metal substrates, but may be appropriate for other rigid substrates such as plastic and wood. Factors such as loading rate and flexibility of the substrate must be addressed by the user/specifier.

1.2 Pull-off strength measurements depend upon both material and instrumental parameters. Results obtained by each test method may give different results. Results should only be assessed for each test method and not be compared with other instruments. There are five instrument types, identified as Test Methods B-F. It is imperative to identify the test method used when reporting results.

Note 2—Method A, which appeared in previous versions of this standard, has been eliminated as its main use is for testing on concrete substrates (see Test Method D7234).

1.3 This test method uses a class of apparatus known as portable pull-off adhesion testers.<sup>3</sup> They are capable of applying a concentric load and counter load to a single surface so that coatings can be tested even though only one side is

accessible. Measurements are limited by the strength of adhesion bonds between the loading fixture and the specimen surface or the cohesive strengths of the adhesive, coating layers, and substrate.

1.4 This test can be destructive and spot repairs may be necessary.

1.5 The values stated in MPa (inch-pound) units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

#### 2. Referenced Documents

##### 2.1 ASTM Standards:<sup>4</sup>

D2651 Guide for Preparation of Metal Surfaces for Adhesive Bonding

D3933 Guide for Preparation of Aluminum Surfaces for Structural Adhesive Bonding (Phosphoric Acid Anodizing)

D7234 Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

##### 2.2 ANSI Standard:

NS12 Protective Coatings (Paints) for the Nuclear Industry<sup>5</sup>

##### 2.3 ISO Standard:

ISO 4624 Paints and Varnish—Pull-Off Test for Adhesion<sup>6</sup>

#### 3. Summary of Test Method

3.1 The general pull-off test is performed by securing a loading fixture (dolly, stud) normal (perpendicular) to the

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D03 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D03.40 on Industrial Protective Coatings.

Current edition approved Feb. 1, 2009. Published April 2009. Originally approved in 1993. Last previous edition approved in 2002 as D4541 – 02. DOI: 10.1533/D4541-09003.

<sup>2</sup> The term adhesion tester may be interpreted of a number, but its adoption by two manufacturers and at least five patents indicate continued usage.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>5</sup> A Summary of Changes section appears at the end of this standard.

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# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Step-by-Step Process

- Choose area that is relatively flat
- Choose area that has cured material
- Adhere test disks to area with adhesive (epoxy or other adhesive)
- Curing time depends on RH and temperature, recommended adhered the day before test





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Step-by-Step Process



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Step-by-Step Process



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Step-by-Step Process





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Adhesion ASTM D4541

How ?

### Step-by-Step Process

- Document Results:
  - Disc Size
  - Mode of Failure
  - Reading on force gauge
  - Convert to PSI, if needed
  - Document in ABAA daily work report



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM E1186

ASTM E1186

Standard practices for air leakage site detection in building envelopes and air barrier systems

**Method 4.1.6:** chamber depressurization (pressurization) with smoke tracers

**Method 4.1.7** Chamber depressurization and leak detection liquids



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM E1186

Why ?

- Ability to test penetrations and details
- Visually see where leakage is taking place
- Does not provide a numerical value, rather just visual



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM E1186

Method 4.1.6

**Method 4.1.6:** chamber depressurization (pressurization) with smoke tracers





# FIELD TESTING / INSPECTION





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Air Leakage

ASTM E1186

Method 4.1.7

**Method 4.1.7:** chamber depressurization (pressurization) with leak detection liquids



# FIELD TESTING / INSPECTION

DURING CONSTRUCTION

Air Leakage

ASTM E1186

Method 4.1.7

**Method 4.1.7:** chamber depressurization (pressurization) with leak detection liquids



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# FIELD TESTING / INSPECTION



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Thickness Testing

- Liquid/Fluid applied membranes
- Sprayed Polyurethane Foams





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Thickness Testing

- Liquid/Fluid applied membranes
- Wet Mil \_ wet thickness gauge (need solids content of material)
- Dry Mil \_ digital caliper



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Density

- Specific to Sprayed Polyurethane Foams
- Water Displacement Methods



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Density

Why ?

- Good indication of physical properties of material
- Material manufactured on-site, more quality control





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Density

### Step-by-Step Process

- Take Foam Sample from Wall
- Cut to fit into round cylinder
- Ensure weight is at least 5.5 grams
- Weigh sample and record





# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

During  
Construction

Density

### Step-by-Step Process

- Determine volume of water in cylinder
- Submerge foam sample and record the volume of water
- Value is difference between original volume and then volume with foam in it



# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

All Materials

### Visual Inspection

- Various key items should be reviewed for each type of material on an on-going basis
- Many times, you do not need an elaborate test to see if something is wrong !
- Some key items for 6 common air barrier materials: self-adhered, liquid/fluid applied, sprayed polyurethane foam, board stock, commercial building wraps, bonded membranes to sheathing

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Self-Adhered

Substrate	Application	
Dirty, wet, cold	Overlap of joints/seams	Damage by other trades
No primer	Sealant of leading edge	Punctures
Large unsupported gaps	Sealant on penetrations	Proper tie into systems
Protrusions	Proper primer set-up	
Damage	“fish mouths”	
	Un-adhered material	
	UV degradation	

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Liquid/Fluid

Substrate	Application	
Proper joint treatment	Correct thickness	Damage by other trades
CMU struck flush	Slumping of material	Punctures
Imperfections filled	Pin holing	Proper tie into systems
Clean, sound, no moisture	Alligatoring	All self-adhered application items
	UV degradation	
	Un-adhered material	

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Sprayed Foam

Substrate	Application	
Surface and substrate moisture	Coloration (off-ratio)	Equipment settings (temperature/pressure)
Clean, no loose scale	Cell Structure	Material shelf life
Metal primed/adhesive	Pass thickness	adhesion
Oils and bonding agents	Thermal cracking	
Proper adhesion of self-adhered membranes	ambient temperature	
Temperature	PPE/job site safety	

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Board Stock - Cellular

Substrate	Application	
Material is substrate	Joint treatment	Damage
OR	Tie-in to openings (fluid/mesh or self-adhered membrane)	Tie into below grade and roof
Applied to substrate:	Mechanical fastening	Adhesion of joint materials
Protrusions		
Soundness		

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Commercial Building  
Wrap

Substrate	Application	
Protrusions	Overlap of seams	Integration with window/door flashing
Significant gaps	Overlap of joints	Connection to roof/below grade airtightness layer
	Penetrations treated	Reverse laps
	Mechanical fastening	Damage by other trades
	Tears, rips	

# FIELD TESTING / INSPECTION

## DURING CONSTRUCTION

Visual Inspection

Bonded Membrane to  
Sheathing

Substrate	Application	
Material is substrate	Joint treatment	Damage
OR	Tie-in to openings (fluid/mesh or self-adhered membrane)	Tie into below grade and roof
Applied to substrate:	Mechanical fastening	Adhesion of joint materials
Protrusions		
Soundness		



# FIELD TESTING / INSPECTION

## AFTER CONSTRUCTION

### Post Construction

- Whole Building Airtightness Testing
- ASTM 779



# FIELD TESTING / INSPECTION

## AFTER CONSTRUCTION

Introduce Smoke to Find Leaks



# FIELD TESTING / INSPECTION

## AFTER CONSTRUCTION

Introduce Thermography at same time





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se in US office build



Center for Energy  
and Environment



The Energy Conservatory

# Thank you for your time!

## Question and Answer Period

This concludes The American Institute of Architects  
Continuing Education Systems Course

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