WB7-3 Observations Regarding Window Testing and Failures

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Window Testing

• Architect identifies a sampling of windows to be tested.
  – Representative sampling of each window type on the job
• Windows Leak Tested
  – Independent testing agency
  – ASTM E1105 or AAMA 502
• Windows Leak
• Window sub-contractor tunes up windows
• Windows retested and pass
• Windows and their installation are accepted once the sample windows meet requirements of the test.
Leak Test

• ASTM E1105 or AAMA 502

• Pressure differential across window
  – Interior negative or
  – Exterior positive

• Spray water to form a continuous film of water on surface
  – Does not attempt to mimic kinetic energy of wind blown rain
From ASTM E1105

FIG. 1 General Arrangement of Water Penetration Test Apparatus
Installer Tune-up

- Sealants at butt (mitered) joints in gaskets in corners,
- Cam locks, shimmed or adjusted to apply more pressure to gaskets
  - “dollar bill” test
- Sealant at fixed joints between aluminum extrusions
  - Corners of frames and sashes
  - Fasteners
End Result

• All windows are adjusted during “Tune Up”
• Testing of exemplar windows is a proper test of the window system
• Windows don’t leak when tester and contractor leave site
Problems with Testing

• May not include doors
• Testing normally performed after interior finishes in place
  – Hides wall leaks
  – May hide leaks within frame perimeter
Problems with End Result

• Great that windows are tested – how about the rest of the wall
• Windows may not leak at time of test but how about several years later
• Windstorms
Then Time Happens

• Sealants harden, shrink and crack
• Gaskets shrink and harden
  – End joints open up
  – Gaskets relax so air and water pass through gasketed joints at an increasing rate over time
• Buildings settle differentially twisting assemblies
• Users damage windows
• Fixed joints aren’t really fixed
Then Wind Happens

- Wind pressures during wind driven rain exceed those in leak test
- Pressures during a hurricane event drastically exceed test pressures
- Window must have some sort of pressure relieve feature to prevent water passage
  - Pressure balanced seals
  - Drainage subsills
Wind Creates Pressure Differentials
Wind Speed Increases with Height
Stack Effect – Warm Climate
Stack Effect – Cold Climate
Combined Effect – HVAC, Stack and Wind
# Pressure Differentials

<table>
<thead>
<tr>
<th>Pressure Differential</th>
<th>PSF</th>
<th>Inches Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Pressure</td>
<td>9</td>
<td>1.73</td>
</tr>
<tr>
<td>Wind Pressure - High</td>
<td>86</td>
<td>17</td>
</tr>
<tr>
<td>Wind Pressure - Low</td>
<td>56</td>
<td>11</td>
</tr>
</tbody>
</table>
Paradigm Shift

• Good Old Days – Stupid & Simple
  – Huge water storage, inorganic materials, simple materials and assemblies

• Now – Smart & Sophisticated
  – High tech materials
  – Complex assemblies
  – High performing
  – Sustainable
  – Water sensitive
Good Old Day

- PLASTER
- 4" BRICK
- 2" AIR CAVITY
- FACE BRICK
- DAMP-PROOFING
- WEEP HOLE
- FLASHING
- SHELF ANGLE
Now
Current State of the Construction Industry

• Sophisticated High tech materials and systems
• Rapid product development
• Increasing specialization
  – Manufacturers
  – Contractors
• Increase in magnitude of natural forces affecting materials and assemblies
  – Insulation
  – Membranes
Case Study - Florida

- Windows in Florida
- Hurricanes
- General Guidance
  - ASTM E2112 – Standard Practice for Installation of Exterior Windows Doors and Skylights
- Specific Regional Guidance
  - Fenestration Manufacturers Association Standards
CSI Sections

- Division 03
  - Concrete,
- Division 04
  - Brick
  - Stone
  - Concrete Block
- Division 06
  - Wood framing
- Division 07
  - Flashing
  - Sealants
- Division 08
  - Windows
- Division 09
  - Painting
Manufacturers

- Window
- Flashing
- Sealants
- Brick
- Precast sill
- Concrete block

- Mortar
- Wood blocking
- Fasteners
- Metal furring
- Gypsum drywall
- Paint
Contractors

- Window
- Masonry
- Carpentry
- Drywall
- Painting
- Caulking
<table>
<thead>
<tr>
<th>FMA/AAMA</th>
<th>Type</th>
<th>Frame/Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Flanged</td>
<td>Wood Frame</td>
</tr>
<tr>
<td>200</td>
<td>Frontal Flanged</td>
<td>Surface Barrier CMU</td>
</tr>
<tr>
<td>250</td>
<td>Non-Frontal Flange (wood)</td>
<td>Surface Barrier CMU</td>
</tr>
<tr>
<td>300</td>
<td>Sliding Glass Door</td>
<td>Wood Frame</td>
</tr>
<tr>
<td>400</td>
<td>Sliding Glass Door</td>
<td>Surface Barrier CMU</td>
</tr>
</tbody>
</table>
Fenestration Manufacturer’s Association

- Drainable sill pan
- Recommended section for a precast sill that provides drainage
- Use of liquid applied sealants to form perimeter flashing continuous with sill pan
Strength of Approach

• Establishes draining subsill as a standard part of window assembly
• Attempts to consolidate critical tasks with one entity
• Written set of instructions
Starting to Appear in Guide Specifications

• Palm Beach County Schools
  – In window section

• Broward County Schools
  – Not yet

• Regional – not in national guide specs
Contractors Involved in Window Installation

- **Mason sub-contractor**
  - Install precast sill
  - prepare the masonry opening
- **Waterproofing sub-contractor**
  - Install the sill pan and perimeter coatings
- **Carpentry sub-contractor**
  - install wood bucks
- **Window sub-contractor**
  - install the window
- **Stucco sub-contractor**
  - stucco over the sill and on jambs and head
- **Painter**
  - sealant between stucco and window
  - paint
- **Drywall sub-contractor**
  - interior finishes
Specification Sections Involved

- Masonry
- Waterproofing
- Window
- Stucco
- Painting
Next Step

• New window specification section
  – consolidates all of the work required by the standard in a single specification section.

• Include in major guide specifications providers
  – NIBS Construction Criteria Base
  – Arcom (AIA) MasterSpec®,
  – CSI Spectext®.
Proposed ASTM E 1105 Changes

- Add Low Pressure Water Test (LPWT)
- Intended to jibe better with end user expectations of the test
Proposed ASTM E 1105 Changes

• **Low Pressure Water Test (LPWT)**
  – less than 75 pascals (1.57 lbf/ft²)
  – No visible water through window

• **High Pressure Water Test (HPWT)**
  – Current definition
  – Water may be visible inside window (except collector sills) - but not past it

• **Water penetration through perimeter frame**
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