TORO ALUMINUM
MOCK-UP
TEST REPORT

SCOPE OF WORK
PERFORMANCE MOCK-UP TESTING ON A WINDOW WALL SYSTEM

REPORT NUMBER
H2698.01-120-32

TEST DATES
11/29/17 - 01/10/18

ISSUE DATE
04/12/18

RECORD RETENTION END DATE
01/10/22

PAGES
48

DOCUMENT CONTROL NUMBER
ATI 00301 (02/06/18)
RT-R-AMER-Test-2744
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EXECUTIVE SUMMARY

This report contains the results of a testing program designed to evaluate the performance of the materials and systems comprising the Project. The test results presented in this report represent the performance of the materials and systems as tested and shall not be construed as a guarantee of performance in the field or as a guarantee of performance of the Project as a whole.

For INTERTEK B&C:

Ryan D. Weir
Project Technician – Project Testing

Date: 04/12/18

Daniel J. Detzel
Manager – Project/Curtain Wall Testing

Date: 04/12/18

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TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

SECTION 1
SCOPE

Intertek Building & Construction (B&C) was contracted by Toro Aluminum to perform performance testing on a curtain wall mock-up for the above referenced project at the Intertek test facility in York, Pennsylvania. Results obtained are tested values and were secured in accordance with the attached Test Procedure dated November 29, 2017. This report includes complete written and photographic documentation of all testing performed and a copy of "As-Built" mock-up drawings.

The client’s scope for the test was to evaluate gasketed seals (dry seals) at the bypass detail for both seismic and non-seismic zones as well as the design for the light duty head receivers and jamb receivers for the seismic zone applications. Additionally, various types of vent operators were introduced as new prototype designs to evaluate their behavior under exposure to the test conditions.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. This report and related test records that are retained such as "As-Built" mock-up drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be serviced by Intertek B&C for the entire test record retention period. At the end of this retention period, such materials shall be discarded without notice and the service life of this report by Intertek B&C will expire.

SECTION 2
TEST METHODS

Mock-up testing was performed in accordance with referenced test methods as specified in the bid documents.

**Air Infiltration:** ASTM E283-04(2012), *Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen*. Testing was conducted at 6.24 psf positive static air pressure difference.

**Static Pressure Water Resistance:** ASTM E331-00(2016), *Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference*. Testing was conducted at 15.0 psf positive static air pressure difference for a 15-minute duration. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.
TEST METHODS (Continued)

**Dynamic Pressure Water Resistance:** AAMA 501.1-05, *Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure*. Testing was conducted with a dynamic pressure equivalent of 15.0 psf for a 15-minute duration. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.

**Structural Performance:** ASTM E330/E330M-14, *Standard Test Method for Structural Performance of Exterior Windows, Door, Skylights and Curtain Walls by Uniform Static Air Pressure Difference*. Testing was conducted at positive and negative loads as described in the Test Procedure and listed in the Test Results.

**Thermal Cycling:** AAMA 501.5-07, *Test Method for Thermal Cycling of Exterior Walls*. Reference should be made to Test No. 5 in the attached Test Procedure and to the Test Results. The mock-up was inspected prior to and after the test.

**Interstory Vertical Displacement Test:** AAMA 501.7-11, *Recommended Static Test Method for Evaluating Windows, Window Wall, Curtain Wall and Storefront Systems Subjected to Vertical Inter-Story Movements*. Three complete cycles shall be performed in the vertical direction at the floor simulation. Testing was conducted at design displacement as described in the Test Procedure Test No. 12 and listed in the Test Results. The mock-up was inspected prior to and after the test.

**Interstory Horizontal Displacement Test:** AAMA 501.4-09, *Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*. Three complete cycles shall be performed in the horizontal direction at the floor simulation. Testing was conducted at design displacement as described in the Test Procedure Test No. 15 and listed in the Test Results. The mock-up was inspected prior to and after the test.

**Seismic Movement:** AAMA 501.4-09, *Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*. Testing was conducted at design displacement as described in the Test Procedure Test No. 20 and listed in the Test Results. The mock-up was inspected prior to and after the test.
SECTION 3
LIST OF OFFICIAL OBSERVERS

<table>
<thead>
<tr>
<th>NAME</th>
<th>COMPANY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygmunt Zuchelkowski</td>
<td>Toro Aluminum</td>
</tr>
<tr>
<td>John Barkovich</td>
<td>Toro Aluminum</td>
</tr>
<tr>
<td>Fraser Gooderham</td>
<td>Toro Aluminum</td>
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<tr>
<td>Michael Swart</td>
<td>Intertek B&amp;C</td>
</tr>
<tr>
<td>Zach Mohar</td>
<td>Intertek B&amp;C</td>
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<tr>
<td>Tom Lawlor</td>
<td>Intertek B&amp;C</td>
</tr>
<tr>
<td>Ryan Weir</td>
<td>Intertek B&amp;C</td>
</tr>
</tbody>
</table>

SECTION 4
GENERAL MOCK-UP DESCRIPTION

Project Type
Toro Aluminum 258T Series Window Wall system consisting of two corner conditions, spanning three stories, and consisting of the following components:

1. Fixed vision units and spandrel sections
2. Gasketed seismic by-pass with light-duty head receiver and seismic jamb receivers
3. Gasketed bypass and curb with strap anchors at the window wall head
4. 8000 Series swing door (vent A) prototype of operable insert
5. 8000 Series awning window (vent B) prototype of operable insert
6. 8000 Series hopper window (vent C) prototype of operable insert
7. 8000 Series casement window (vent A) prototype of operable insert

Mock-Up Size

Window Wall-Front: 16' 11-1/8" wide by 27' 10" high

Operable Vent/Door: (A) 3' 6" wide by 7' 9-5/8" high
(B) 3' 5-1/4" wide by 5' 6-1/4" high
(C) 3' 8-1/8" wide by 5' 9" high
(D) 2' 7-1/4" wide by 5' 6-1/4" high

Material Source/Installation
The mock-up materials/components were supplied by Toro Aluminum. The installation of the mock-up was completed by Toro Aluminum.
## SECTION 5
### SUMMARY OF TESTS

The following table is a summary of tests completed and the performance levels reached per mock-up component based on accepted criteria as outlined in the test procedure (see Section 8). For full documentation of the test results and all remedial work performed, see Section 6.

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEST STANDARD</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ASTM E283 @ 6.24 psf</td>
<td>AAMA 501.5 Thermal Cycling</td>
<td>ASTM E331</td>
<td>AAMA 501.1</td>
<td>ASTM E330 Deflection/Overload</td>
<td>AAMA 501.7 Vertical Displacement</td>
</tr>
<tr>
<td></td>
<td>(cfm/ft²)</td>
<td>(°F)</td>
<td>(psf)</td>
<td>(mph)</td>
<td>(psf)</td>
<td>(in)</td>
</tr>
<tr>
<td>Fixed Window Wall &amp; Spandrel 258T Series</td>
<td>&lt;0.05</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Seismic By-pass w/Light-duty Head Receiver &amp; Gasketed By-pass Sill</td>
<td>&lt;0.05</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Non-seismic By-pass Straps and Caulk at Head, Gasketed By-pass Sill &amp; Gasketed Curb</td>
<td>&lt;0.05</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Swing Door (Open In) 8000 Series w/Butt Hinges (See Notes 1, 2, 3, 4)</td>
<td>&lt;0.08</td>
<td>Excluded</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Vent B Awning - 8000 Series (See Notes 2, 3)</td>
<td>&lt;0.07</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Vent C Hopper - 8000 Series (See Notes 2, 3, 5)</td>
<td>&lt;0.05</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
<tr>
<td>Vent D Casement - 8000 Series (See Notes 2, 3)</td>
<td>&lt;0.06</td>
<td>0 to +180</td>
<td>15.0</td>
<td>77</td>
<td>DP ±40.0</td>
<td>±1.00</td>
</tr>
</tbody>
</table>

Notes:
1. Hardware option with butt hinge was introduced for the door
2. Interior perimeter bead at insert frame transition to window wall opening was resealed
3. Additional vent holes in the operable sash stiles were drilled to have total of two 3/8" diameter holes
4. Two drain holes were introduced at the bottom rail of the swing door, 6\" from the ends
5. The outer lite of glass cracked during the thermal cycling
## SECTION 6
### FINAL TEST RESULTS

**General Note:** Unless otherwise stated, all comments relative to location are as viewed from the interior.

<table>
<thead>
<tr>
<th>DATE:</th>
<th>November 29, 2017</th>
<th>TEMP:</th>
<th>56.1°F</th>
<th>BP:</th>
<th>29.60 inHg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TITLE OF TEST</strong></td>
<td><strong>MEASURED</strong></td>
<td><strong>ALLOWED</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preload @ + 30.0 psf</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static Pressure Air Infiltration @ 6.24 psf</td>
<td>PASSED</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td>0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent B</td>
<td>0.10 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent C</td>
<td>0.02 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent D</td>
<td>0.03 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note #1:** The leakage rate on the door was above the allowable. It was cycled and checked to make sure all gaskets were properly seated before testing again.

### Dynamic Pressure Water Resistance @ 15.0 psf (Door A excluded)

- **Measured:** No uncontrolled leakage
- **Allowed:** No uncontrolled leakage

**Note #2:** The leakage rate on the door was, again, above the allowable rate. The hinge that was installed did not have a three-way adjustment, so the seal could not be tightened with the available hardware. Duct tape was applied around the door perimeter on both the interior and exterior to remove it from subsequent tests. The hardware would be replaced later in the test sequence.
**DATE through DATE:** December 6, 2017, through December 8, 2017

<table>
<thead>
<tr>
<th>TITLE OF TEST</th>
<th>MEASURED</th>
<th>ALLOWED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Cycling</td>
<td>See Note #3</td>
<td></td>
</tr>
<tr>
<td>0°F – 180°F (3 Cycles)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note #3:* The outer glass lite on Vent C cracked during the thermal cycling test (See Photo No. 4). It is unknown during which cycle the crack occurred. The single crack line measured approximately 36 inches and extended from (as viewed from the exterior) the bottom right corner to about midway up the right vertical sash. There was no fallout; all glass remained in the frame.

**Remedial Work performed by Representatives of Toro Aluminum:** The crack was covered with a line of silicone sealant from the exterior. The client chose to proceed with the test sequence.

<table>
<thead>
<tr>
<th>DATE:</th>
<th>TEMP: 54.4°F</th>
<th>BP: 29.41 inHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE OF TEST</td>
<td>MEASURED</td>
<td>ALLOWED</td>
</tr>
<tr>
<td>Repeat Static Pressure Air Infiltration @ 6.24 psf</td>
<td>PASSED</td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td>0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
</tr>
<tr>
<td>Door A</td>
<td>0.03 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent B</td>
<td>0.04 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent C</td>
<td>0.02 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent D</td>
<td>0.03 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
</tbody>
</table>

**Repeat Static Pressure Water Resistance @ 15.0 psf**

FAILING

See Note #4 and Sketch #2

*Note #4:* There was 1 area of leakage noted as follows:

- **Leak #1:** Water came in through the frame joint below the sash on Door A (See Photo No. 1). The leak started near the end of the test and entered through several points along the joint's length. The water pooled on the frame surface and spilled over to adjacent surfaces.

**Remedial Work performed by Representatives of Toro Aluminum:** After the test, the door was opened, and there was water present in the outside track that did not appear to be draining. Two 3/8" drain holes were drilled into the bottom rail of the door sash 6" from each end. Beads of sealant were also applied on the interior and exterior below the door frame at the adapter.
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Date: 04/12/18

FINAL TEST RESULTS (Continued)

| DATE: | December 20, 2017 |
| TEMP: | 54.4°F |
| BP: | 29.41 inHg |

<table>
<thead>
<tr>
<th>TITLE OF TEST</th>
<th>MEASURED</th>
<th>ALLOWED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat Static Pressure Water Resistance @ 15.0 psf</td>
<td>FAILED</td>
<td>See Note #5 and Sketch #2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No uncontrolled leakage</td>
</tr>
</tbody>
</table>

**Note #5:** There was 1 area of leakage noted as follows:
- Leak #2: Water entered through the frame adapter joint below the Vent B sash (See Photo No. 6). The leak was similar to leak #1 as it appeared near the end of the test and entered at multiple points along the length of the joint.

**Remedial Work performed by Representatives of Toro Aluminum:**
A thin bead of sealant was added along the joint.

<table>
<thead>
<tr>
<th>TITLE OF TEST</th>
<th>MEASURED</th>
<th>ALLOWED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat Static Pressure Water Resistance @ 15.0 psf</td>
<td>FAILED</td>
<td>See Note #6 and Sketch #2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No uncontrolled leakage</td>
</tr>
</tbody>
</table>

**Note #6:** There was 1 area of leakage noted as follows:
- Leak #3: Similar to leaks #1 and #2, water entered through the adapter joint below the Vent C sash (See Photo No. 7).

**Remedial Work performed by Representatives of Toro Aluminum:** Like the previous fixes, a thin bead of sealant was added to the frame adapter below Vent C. Also, although no leaks had occurred there, a bead was added below Vent D since it is a similar condition to the others. Additional vent holes were also added on the jambs of the vents and door just below the existing vent holes to help water weep more freely.

<table>
<thead>
<tr>
<th>TITLE OF TEST</th>
<th>MEASURED</th>
<th>ALLOWED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeat Static Pressure Water Resistance @ 15.0 psf</td>
<td>PASSED</td>
<td>No uncontrolled leakage</td>
</tr>
<tr>
<td>Repeat Dynamic Pressure Water Resistance @ 15.0 psf</td>
<td>PASSED</td>
<td>No uncontrolled leakage</td>
</tr>
<tr>
<td>Uniform Load Deflection</td>
<td>PASSED</td>
<td></td>
</tr>
<tr>
<td>@ +30.0 psf (Preload)</td>
<td>See Table #1 and Sketch #1</td>
<td></td>
</tr>
<tr>
<td>@ +60.0 psf (Design Load)</td>
<td>See Note #7 and #8</td>
<td></td>
</tr>
<tr>
<td>@ -20.0 psf (Preload)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ -40.0 psf (Design Load)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note #7:** The structural design load test was initially run at 60.0 psf (in the positive direction only) before it was determined that the system should be tested at 40.0 psf. Several system components were not designed for 60.0 psf. The system was then tested at a negative load of 40.0 psf, and after a successful test, it was retested at negative 60.0 psf.

**Note #8:** Additional damage occurred to the outer lite on Vent C during the design loads (See Photo No. 14). Several cracks emanated from the previous cracks that had been covered in silicone. The new cracks were not covered before proceeding.
# FINAL TEST RESULTS (Continued)

<table>
<thead>
<tr>
<th>DATE:</th>
<th>December 20, 2017</th>
<th>TEMP:</th>
<th>54.4°F</th>
<th>BP:</th>
<th>29.41 inHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE OF TEST</td>
<td>Repeat Static Pressure Air Infiltration @ 6.24 psf</td>
<td>FAILED</td>
<td>0.01 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>0.05 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Door A</td>
<td>0.08 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vent B</td>
<td>0.02 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vent C</td>
<td>0.06 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vent D</td>
<td>0.08 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TITLE OF TEST</td>
<td>Repeat Static Pressure Water Resistance @ 15.0 psf</td>
<td>ACCEPTED</td>
<td>See Note #9 and Sketch #2</td>
<td>No uncontrolled leakage</td>
<td></td>
</tr>
</tbody>
</table>

**Note #9:** There was 1 area of leakage noted as follows:
- **Leak #4:** Water came in through the miter joint at the bottom right corner of Vent C (See Photo No. 15). Intermittent drips occurred throughout the duration of the test. Water visibly entered through the cracked exterior lite in the vent and was believed to be the cause of the leak at the miter. After the test, water remained between the vent lites.

**Remedial Work performed by Representatives of Toro Aluminum:**
The cracked exterior glass was covered with 3M tape to seal from additional water getting in.

<table>
<thead>
<tr>
<th>DATE:</th>
<th>December 21, 2017</th>
<th>TEMP:</th>
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<th>BP:</th>
<th>29.65 inHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE OF TEST</td>
<td>Interstory Vertical Displacement @ ±1.00&quot; (3 cycles)</td>
<td>PASSED</td>
<td>No visible damage</td>
<td>No visible damage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repeat Static Pressure Air Infiltration @ 6.24 psf</td>
<td>Total Leakage</td>
<td>63.0 cfm</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Repeat Static Pressure Water Resistance @ 15.0 psf</td>
<td>ACCEPTED</td>
<td>See Note #10 and Sketch #2</td>
<td>No uncontrolled leakage</td>
<td></td>
</tr>
</tbody>
</table>

**Note #10:** There was 1 area of reoccurring leakage noted as follows:
- **Leak #4:** Water again entered through the corner miter of Vent C and was still visibly entering between the lites and sitting inside.
## FINAL TEST RESULTS (Continued)

<table>
<thead>
<tr>
<th>DATE:</th>
<th>04/12/18</th>
</tr>
</thead>
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### TEST REPORT FOR TORO ALUMINUM

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<thead>
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<th>DATE:</th>
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<td><strong>ALLOWED</strong></td>
</tr>
<tr>
<td>Repeat Static Pressure Air Infiltration @ 6.24 psf</td>
<td>PASSED</td>
<td></td>
</tr>
<tr>
<td>Fixed</td>
<td>0.05 cfm/ft²</td>
<td>0.06 cfm/ft² max.</td>
</tr>
<tr>
<td>Door A</td>
<td>0.08 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent B</td>
<td>0.07 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent C</td>
<td>0.05 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
<tr>
<td>Vent D</td>
<td>0.06 cfm/ft²</td>
<td>0.10 cfm/ft² max.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE:</th>
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<th>BP: 29.63 inHg</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TITLE OF TEST</strong></td>
<td><strong>MEASURED</strong></td>
<td><strong>ALLOWED</strong></td>
</tr>
<tr>
<td>Uniform Structural Overloads</td>
<td>PASSED</td>
<td></td>
</tr>
<tr>
<td>@ +30.0 psf (Preload)</td>
<td>See Table #2 and Sketch #1</td>
<td>See Table #2 and Sketch #1</td>
</tr>
<tr>
<td>@ +60.0 psf (Overload)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ -30.0 psf (Preload)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ -60.0 psf (Overload)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note #11:** During the positive load, the top units on the main face disengaged from the head receptor at the system center, and the fixed lites on the ends blew out as a result. The system failed at approximately 75.0 psf. The negative overload was not performed.

**Remedial Work performed by Representatives of Toro Aluminum:** The top units were reset back into the receptor, and all glass was removed from the broken glazing units.
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

FINAL TEST RESULTS (Continued)

<table>
<thead>
<tr>
<th>DATE</th>
<th>TEMP</th>
<th>BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 10, 2017</td>
<td>49.6°F</td>
<td>29.89 inHg</td>
</tr>
</tbody>
</table>

**Note #12:** It was agreed to test seismic movement without replacing the broken glass lites on the top units since the 3% seismic movement amount was based off of the middle span.

<table>
<thead>
<tr>
<th>Seismic Horizontal Displacement @ ±3.375&quot; (3 cycles)</th>
<th>PASSED</th>
<th>ALLOWED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No visible damage</td>
<td>No visible damage</td>
</tr>
</tbody>
</table>

SECTION 7
CONCLUSION

The mock-up met the specified performance requirements with the exception of Door A being excluded during thermal testing.

Regarding the glass tested, no conclusions of any kind regarding the adequacy or inadequacy of the glass in the test specimen are to be drawn from the test. Tape or film, or both were used to seal against air leakage; this did not influence the results of the testing.
SECTION 8
TEST PROCEDURE
Mock-Up Test Procedure

Rendered to:

Toro Aluminum

Project: 2000 Series Window Wall

Mock-up testing for Toro Aluminum 2000 Series Window Wall shall be performed in accordance with referenced test methods as specified in the bid documents. Mock-up testing shall be observed by the Engineer and/or the Owner, Architect and their consultants during construction and testing. All pretesting shall be documented and included in the comprehensive test report.

The final test procedure shall be as follows:

1. **PRELOAD (ASTM E330)**

   To set the specimen for testing, a positive differential (inward acting) of **20.0 psf**, held for a minimum of ten (10) seconds, and then released. The wall and anchoring will be inspected for any failure.

   **Allowable**

   No visible signs of failure shall be allowed.

2. **STATIC AIR INFILTRATION TEST (ASTM E283)**

   The mock-up exterior face will be covered with polyethylene (plastic sheeting). The mock-up will then be subjected to a positive static pressure differential of **6.24 psf**. The air infiltration required to maintain the air pressure differential is measured. This air infiltration reading represents the chamber tare. The polyethylene will be removed and the mock-up specimen will again be subjected to a positive static pressure differential of **6.24 psf**. Air infiltration will be measured. The total air infiltration reading represents the amount of air through the specimen including chamber tare. Subtracting the chamber tare from the latter total reading yields the net amount of air infiltration through the mock-up. Dividing the mock-up air leakages by the mock-up area yields the air infiltration rate.

   **Allowable**

   Air infiltration shall not exceed **0.06 cfm** per square foot of fixed wall area.

   Air infiltration shall not exceed **0.10 cfm** per square foot of operable area.
3. **STATIC WATER PENETRATION TEST (ASTM E331)**

A fifteen (15) minute water penetration test will be conducted on the wall system with a water application rate of 5 gal/hr/ft\(^2\) at a pressure differential of **15.0 psf**. No uncontrolled water penetration is allowed.

**Allowable**

No uncontrolled water leakage.

*Note: Water penetration is defined as the appearance of uncontrolled water on the indoor face of any part of the work. "Controlled" water or condensation is that which is demonstrably drained harmlessly to the exterior of the work without endangering or wetting adjacent surfaces or insulation, and not visible in the final construction. This definition and conditions are relevant to all water tests, both static and dynamic, throughout this procedure.*

4. **DYNAMIC WATER PENETRATION (AAMA 501.1)**

A fifteen (15) minute water penetration test will be conducted on the system with a water application rate of 5 gal/hr/ft\(^2\) and dynamic air stream equivalent to static pressure of **15.0 psf**.

**Allowable**

No uncontrolled water leakage.

5. **THERMAL CYCLES (AAMA 501.5)**

The entire mock-up shall be subjected to **three (3)** thermal cycles. Each cycle shall be maintained for two hours after establishing the following temperatures and consist of:

1. **Thermal Cycle Requirements (AAMA 501.5)**
   a. Low exterior temperature of **0 °F** for two hours after establishing temperature.
   b. High exterior ambient temperature of **180 °F** for two hours after establishing temperature.
   c. Interior temperature shall be maintained between **60 °F** and **80 °F**. Components used within the system shall withstand thermal movements without buckling, distortion, cracking, failure of glass, and failure of joint seals or undue stress on the finished surfaces, materials, or fixing assemblies.
6. **REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)**

The mock-up specimen will be subjected to a positive static pressure differential of **6.24 psf**. Air infiltration will be measured.

**Allowable**

Air infiltration shall not exceed **0.06 cfm** per square foot of fixed wall area.
Air infiltration shall not exceed **0.10 cfm** per square foot of operable area.

7. **REPEAT STATIC WATER PENETRATION TEST (ASTM E331)**

Repeat Test No. 3 as stated above.

8. **REPEAT DYNAMIC WATER PENETRATION (AAMA 501.1)**

Repeat Test No. 4 as stated above.

9. **UNIFORM STRUCTURAL DESIGN LOAD TEST (ASTM E330)**

Deflection of the system shall be measured and recorded at design pressure when held for **ten (10)** seconds and evaluated using the following allowable criteria:

Each load shall be held as follows:

- **+20.0 psf** - 50% Positive Design Load (10 seconds)
- **+40.0 psf** - 100% Positive Design Load (10 seconds)
- **-20.0 psf** - 50% Negative Design Load (10 seconds)
- **-40.0 psf** - 100% Negative Design Load (10 seconds)

**Allowable Criteria**

- Deflection Normal to Wall Plane: L/175 or 3/4" max for spans up to 13'-6".
- Deflection Normal to Wall Plane: L/240+1/4" for spans greater than 13'-6".

10. **REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)**

Repeat Test No. 6 as stated above.

11. **REPEAT STATIC WATER PENETRATION TEST (ASTM E331)**

Repeat Test No. 3 as stated above.
12. INTER-STORY DIFFERENTIAL VERTICAL MOVEMENT TEST (AAMA 501.7)

Three (3) complete cycles shall be performed uniformly in the vertical direction at the supplied columns. Vertical movement will be \(1.00\)" down, then back to zero, \(1.00\)" up, and then back to zero (one cycle).

**Allowable**

There shall be no failure or gross permanent distortion of anchors, frame, glass, or panels. Structural silicone shall not experience adhesive or cohesive failure along any glass, frame or panel edge. Glazing gaskets may not disengage and weather seals may not fail.

13. REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)

Repeat Test No. 6 as stated above.

14. REPEAT STATIC WATER PENETRATION TEST (ASTM E331)

Repeat Test No. 3 as stated above.

15. INTER-STORY DIFFERENTIAL HORIZONTAL MOVEMENT TEST (AAMA 501.4)

Three (3) complete cycles shall be performed in the horizontal direction parallel to the main elevation at the intermediate simulation. Parallel horizontal movement will be \(2.12\)" to the left, then back to zero, \(2.12\)" to the right, and then back to zero (one cycle).

**Allowable**

There shall be no failure or gross permanent distortion of anchors, frame, glass, or panels. Structural silicone shall not experience adhesive or cohesive failure along any glass, frame or panel edge. Glazing gaskets may not disengage and weather seals may not fail.

16. REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)

Repeat Test No. 6 as stated above.

17. REPEAT STATIC WATER PENETRATION TEST (ASTM E331)

Repeat Test No. 3 as stated above.
18. **REPEAT DYNAMIC WATER PENETRATION (AAMA 501.1)**

Repeat Test No. 4 as stated above.

19. **UNIFORM STRUCTURAL OVER LOAD TEST (ASTM E330)**

Permanent deformation of the system shall be measured and recorded at 1.5 x design pressure when held for ten (10) seconds and evaluated using the following allowable criteria:

Each load shall be held as follows:

- **+30.0 psf** - 75% Positive Design Load
- **+60.0 psf** - 150% Positive Design Load
- **-30.0 psf** - 75% Negative Design Load
- **-60.0 psf** - 150% Negative Design Load

**Allowable**

The net permanent set shall not exceed **0.2%** of the clear span.

20. **SEISMIC MOVEMENT DISPLACEMENT TEST (AAMA 501.4)**

**Three (3)** complete cycles shall be performed in the horizontal direction parallel to the main elevation at the **intermediate** simulation. Parallel horizontal movement will be **3.375"** left, back to zero, **3.375"** right and back to zero (one cycle).

**Allowable**

At the conclusion of this test there shall be no glass breakage, permanent damage to frame members, or anchors.

**END OF TESTING**

This Test Procedure dated November 29, 2017, and revised for the test report for the 2000 Series Window Wall mock-up is approved as written.

RDW:abo
cc: H2698.01-120-32
SECTION 9
SKETCHES
INTERIOR VIEW
## SECTION 10

### TABLES

#### TABLE #1A - Uniform Load Deflection (Deflection in inches)

<table>
<thead>
<tr>
<th>INDICATOR LOCATION</th>
<th>POSITIVE 60.0 psf</th>
<th>NET DEFLECTION</th>
<th>NEGATIVE 40.0 psf</th>
<th>NET DEFLECTION</th>
<th>ALLOWED*</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0.040</td>
<td>0.040</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>0.420</td>
<td>0.325</td>
<td>0.300</td>
<td>0.220</td>
<td>0.614</td>
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<tr>
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<td>0.120</td>
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<td></td>
<td></td>
</tr>
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<td>4</td>
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<tr>
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<td>0.080</td>
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<td>0.300</td>
<td>0.150</td>
<td>0.110</td>
<td>0.060</td>
<td>0.614</td>
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<td>15</td>
<td>0.300</td>
<td>0.090</td>
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</table>

*General Note: Allowable amounts are based on L/175 of their clear span for framing members. Refer to Sketch #1 for dial indicator locations and to the Test Procedure for additional information regarding allowable deflections.*

#### TABLE #1B - Uniform Load Deflection (Deflection in inches)

<table>
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<tr>
<th>INDICATOR LOCATION</th>
<th>NEGATIVE 60.0 psf</th>
<th>NET DEFLECTION</th>
<th>ALLOWED*</th>
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<tr>
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<td>0.180</td>
<td>0.160</td>
<td>0.614</td>
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<td>15</td>
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### TABLE #2 - Uniform Structural Overloads (Permanent Set in inches)

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<th>INDICATOR LOCATION</th>
<th>POSITIVE 60.0 psf</th>
<th>NET PERM. SET</th>
<th>NEGATIVE 60.0 psf</th>
<th>NET PERM. SET</th>
<th>ALLOWED*</th>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>0.000</td>
<td>0.015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0.005</td>
<td>0.015</td>
<td>-0.003</td>
<td>0.215</td>
</tr>
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<td>0.020</td>
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</tr>
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<td>0.003</td>
<td>0.092</td>
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<tr>
<td>11</td>
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<td>0.010</td>
<td>0.020</td>
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<td>0.030</td>
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<td>0.030</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*General Note: Allowable amounts are based on 0.2% of their clear span for framing members. Refer to Sketch #1 for dial indicator locations and to the Test Procedure for additional information regarding allowable deflections.*
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

SECTION 11
PHOTOGRAPHS

Photo No. 1
Mock-up with Tare Bag for Chamber Calibration

Photo No. 2
Static Water Penetration Test
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

Photo No. 3
Setup for Dynamic Water Penetration Test

Photo No. 4
Broken Outer Lite on Vent C After Thermal Cycling
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

Photo No. 5
Leak #1 at Door A Frame After Thermal Cycling

Photo No. 6
Leak #2 at Vent B Frame After Thermal Cycling
Photo No. 7
Leak #3 at Vent C Frame After Thermal Cycling

Photo No. 8
Dial Indicators on Frame for Structural Load Test
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
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Photo No. 9
Dial Indicator at Top of Vertical Mullion

Photo No. 10
Dial Indicators on Inside Corner Vertical Mullion
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

Photo No. 11
Dial Indicator at Top of Inside Corner Vertical Mullion

Photo No. 12
Dial Indicators on Outside Corner Vertical Mullion
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

Photo No. 13
Dial Indicator at Top of Inside Corner Vertical Mullion

Photo No. 14
Additional Breakage on Vent C Lite After Structural Load Test
Photo No. 15
Leak #4 from Corner Miter on Vent C Sash After Structural Design Loads

Photo No. 16
Setup for Vertical Deflection at Center Column
TEST REPORT FOR TORO ALUMINUM
Report No.: H2698.01-120-32
Date: 04/12/18

Photo No. 17
Setup for Horizontal Movement Test at Center Column

Photo No. 18
Dynamic Water Test with WOLFs
Photo No. 19
Damage to Top Units After Structural Over Loads @ +90.0 psf

Photo No. 20
Top Units Disengaged from Head Receptor
SECTION 12
DRAWINGS

The "As-Built" drawings for the 2000 Series Window Wall; Sheet Nos. E, S1 through S5, and P1 through P7, and dated August 4, 2017; which follow have been reviewed by Intertek B&C and are representative of the project reported herein. Project construction was verified by Intertek B&C per the drawings included in this report. Any deviations are documented herein or on the drawings.
Project Name: INTERTEK - ATI AMAA 501.4 TESTING

PMU Type: DRY GASKET BYPASS MOCK UP - AS BUILT

Contractor: TORO ALUMINUM

Test Date: 19TH - 22ND DECEMBER, 2017

AS BUILT COMMENTS & ADDITIONS

1. ADD 1" VENT HOLE ON BOTH SIDES 1" BELOW EXISTING VENT HOLE
2. RE-CAULK ADAPTER AT BOTTOM MULLION AND END JOINTS
3. RE-CAULK BREAK IN SEAL AT BEAM
4. 2" RIGID INSULATION FILLER
5. 5/8" PLYWOOD FILLER
6. DRILL (2) 3/8" DRAIN HOLES AT DOOR SASH BOTTOM RAIL, 6" FROM EACH END
NON SEISMIC ZONE APPLICATION TYPICAL DETAILS
(TYP. FOR FLOOR 1, SILL, FLOOR 2 BYPASS)

BACKING BEAD, TREMCO, TREMIL, 318 (TYP)
POST INSULATION BEAD, TREMCO, TREMIL, 318 (TYP)
INSTALLATION BEAD BETWEEN T-BAR & WALLFRAME, TREMCO, DYMONIC 100 (TYP)

T-Bar Leading Edge Sealant, TREMCO, DYMONIC 100 (TYP)
T-BAR SET ON SEALANT, TREMCO, DYMONIC 100 (TYP)
T-BAR LEADING EDGE SEALANT, TREMCO, DYMONIC 100 (TYP)
P/SMEMBRANE SET ON PRIMER, TREMCO, EXOAIR
HEADBEAD, TREMCO, DYMIMIC 100
ALUMINUM MEMBRANE COVER

Insert Frame Perimeter Interior & Exterior Bead, Tremco, Tremil, 410 Silicon
Aluminum Strap Anchors
1/4" SHIM
Continuous Head Receiver Closer, Sealed at Splay

LEADING EDGE SEALANT BEAD PRIOR TO MEMBRANE INSTALLATION, TREMCO, DYMONIC 100 (TYP)
SECONDARY SEALS, T-BAR, TREMCO, TREMIL, 318 (TYP)
FIBROUS INSULATION, ROXUL (TYP)
#12-14X1-1/2" SD@12" C/C (TYP)
GALVANIZED SHEET BACKPAN (GAUGE 23)
BACKPAN BEAD, TREMCO, TREMIL, 318 (TYP)
POST INSULATION BEAD, TREMCO, TREMIL, 318 (TYP)
INSTALLATION BEAD BETWEEN T-BAR & WALLFRAME, TREMCO, DYMONIC 100 (TYP)

SEISMIC ZONE APPLICATION TYPICAL DETAILS
(TYP. FOR FLOOR 3 BYPASS & HEAD)

BACKING BEAD, TREMCO, TREMIL, 318 (TYP)
POST INSULATION BEAD, TREMCO, TREMIL, 318 (TYP)
INSTALLATION BEAD BETWEEN T-BAR & WALLFRAME, TREMCO, DYMONIC 100 (TYP)
T-Bar Leading Edge Sealant, TREMCO, DYMONIC 100 (TYP)
T-BAR SET ON SEALANT, TREMCO, DYMONIC 100 (TYP)
T-BAR LEADING EDGE SEALANT, TREMCO, DYMONIC 100 (TYP)
P/SMEMBRANE SET ON PRIMER, TREMCO, EXOAIR
HEADBEAD, TREMCO, DYMIMIC 100
ALUMINUM MEMBRANE COVER

Insert Frame Perimeter Interior & Exterior Bead, Tremco, Tremil, 410 Silicon
Aluminum Strap Anchors
1/4" SHIM
Continuous Head Receiver Closer, Sealed at Splay

LEADING EDGE SEALANT BEAD PRIOR TO MEMBRANE INSTALLATION, TREMCO, DYMONIC 100 (TYP)
SECONDARY SEALS, T-BAR, TREMCO, TREMIL, 318 (TYP)
FIBROUS INSULATION, ROXUL (TYP)
#12-14X1-1/2" SD@12" C/C (TYP)
GALVANIZED SHEET BACKPAN (GAUGE 23)
BACKPAN BEAD, TREMCO, TREMIL, 318 (TYP)
POST INSULATION BEAD, TREMCO, TREMIL, 318 (TYP)
INSTALLATION BEAD BETWEEN T-BAR & WALLFRAME, TREMCO, DYMONIC 100 (TYP)

LEADING EDGE SEALANT BEAD PRIOR TO MEMBRANE INSTALLATION, TREMCO, DYMONIC 100 (TYP)
SECONDARY SEALS, T-BAR, TREMCO, TREMIL, 318 (TYP)
FIBROUS INSULATION, ROXUL (TYP)
#12-14X1-1/2" SD@12" C/C (TYP)
GALVANIZED SHEET BACKPAN (GAUGE 23)
BACKPAN BEAD, TREMCO, TREMIL, 318 (TYP)
POST INSULATION BEAD, TREMCO, TREMIL, 318 (TYP)
INSTALLATION BEAD BETWEEN T-BAR & WALLFRAME, TREMCO, DYMONIC 100 (TYP)
SLOPED WEDGE

PLYWOOD @ HEAD RECESSED PANEL

RECESSED PANEL

TOP LEVEL 4"x8" HSS STEEL BEAM

GASKET

EXT.

3"

2⅛"

5¾"

INT.

HOPPER

RECESSED PANEL

TOP LEVEL 4"x8" HSS STEEL BEAM

3"

2⅛"

5¾"
TEST REPORT FOR TORO ALUMINUM  
Report No.: H2698.01-120-32  
Date: 04/12/18  

SECTION 13  
REVISION LOG

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