



SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.

February 10, 2017
TRB #01-17

Technical Resources Bulletin

To: SMACNA Members
SMACNA Chapter Executives

From: Technical Resources Department

Subject: **STRI Wind Uplift Testing**
ANSI/SPRI/FM 4435 ES-1-2017 Test Standard for Edge Systems Used With Low Slope Roofing Systems

The SMACNA Testing and Research Institute (STRI) completed wind uplift testing on custom-fabricated fascia and coping architectural elements constructed in accordance with the SMACNA's *Architectural Sheet Metal Manual*.

The physical testing was conducted to verify compliance with the International Code Council's (ICC) International Building Code (IBC) requirement:

1504.5 Edge securement for low-slope roofs. Low-slope built-up, modified bitumen and single-ply roof system metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, except V_{ult} wind speed shall be determined from Figure 1609A, 1609B, or 1609C as applicable

Physical Testing

All pull-off testing was done per the ANSI/Single Ply Roofing Industry (SPRI) /FM 4435 ES-1 2017 Test Standard by an ANSI-accredited testing laboratory, Intertek-Architectural Testing Incorporated (ATI) of York, Pennsylvania.

The SPRI ES-1 2017 tests are included in this Technical Resource Bulletin (TRB) for convenience and completeness. The report is available on the Technical portion of the SMACNA website at <https://www.smacna.org/technical/browse/papers-and-guidelines>.

The final test report demonstrates that fascia and coping constructed in accordance with the SMACNA's *Architectural Sheet Metal Manual* resists very high pull-off forces.



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Using This TRB

For the Designer

Typically, the architect or a design agent will calculate the specific pull-off requirements for each architectural element. To do these calculations, building height, local terrain exposure, importance classification, basic wind speed, roof edge fascia height or coping height and width are all required. Since the pull-off requirements can vary on every elevation either the worst-case requirement should be specified by the designer or the pull-off requirement for each architectural element must be provided for the calculations on the construction documents.

For the Contractor

In a design-build arrangement where no roofing consultant is involved or an architect is not responsible for the roof design, contractors can develop preliminary pull-off data using a calculator provided on SPRI's website at:

http://www.spri.org/pdf/Wind_Calculator.htm

Note :

1. The wind design calculator is used to calculate the roof edge design pressure required to meet the ANSI/SPRI ES-1 Wind Design Standard and the 2003 International Building Code Section 1504.5 "Edge Securement for Low Slope Roof."
2. The SPRI web site provides additional instruction and precautions regarding the calculations.

For Sheet Metal Construction

The wind uplift testing was conducted on custom-fabricated fascia and coping architectural elements constructed per SMACNA's *Architectural Sheet Metal Manual*. The physical testing was done per ANSI/SPRI/FM 4435 ES-1-2017 **Test Standard for Edge Systems Used With Low Slope Roofing Systems**. All elements constructed must comply with the requirements of the SPRI standard **and** conform to the designs as tested:

- **All fascia and coping metal thicknesses must meet the minimum requirements.**
- **All fasteners must be used at the dimensions listed.**
- **All fasteners must have at least as the same diameter and length as those used in the test and be of a metal with an equivalent strength.**
- **Nailing patterns for fascia must adhere to those listed in SMACNA's ASMM Figure 2-1.**
- **No face height or width can exceed those tested.**
- **Continuous cleats must be used and must be of at least the same thickness.**

Thicker gages than the ones tested can be used. Closer fastener spacing can be used. Longer and larger diameter fasteners may be used. Narrower metal heights and widths can be used. However, even though these "increases" probably enhance the pull-off resistance, no pull-off resistance higher than achieved in the physical testing by Intertek-ATI can be claimed.

For Membrane and Attachment Requirements for Fascia

A reinforced membrane was used in the tests. The test results clearly demonstrate that the pull-out forces that can be withstood by the membrane is primarily a function of the membrane's strength.

The fastener pattern must follow that used in the physical testing conducted by Intertek-ATI. The testing results follow this page.



ANSI/SPRI ES-1 PERFORMANCE TEST REPORT

Rendered to:

SMACNA

For:

**20 ounce Copper, 0.063 in Aluminum, and
20 GA Steel Coping and Fascia Systems**

Report No.: G3737.01-119-16

Report Date: 01/19/17

Revision 1: 02/14/17

Test Record Retention Date: 12/06/20



PERFORMANCE TEST REPORT

Rendered to:

SMACNA
P.O. Box 221230
Chantilly, Virginia 20153-1230

Report No.: G3737.01-119-16

Test Dates: 11/28/16

Through: 12/06/16

Report Date: 01/19/17

Revision 1: 02/14/17

Test Record Retention Date: 12/06/20

1.0 General Information

1.1 Product

20 ounce Copper, 0.063 in Aluminum, and 20 GA Steel Coping and Fascia Systems

1.2 Project Summary

Architectural Testing, Inc., an Intertek company ("Intertek-ATI"), was contracted by SMACNA to perform ANSI/SPRI Test RE 1, RE-2 and RE-3 on formed steel, aluminum, and copper edge flashing and coping materials in accordance with the following:

ANSI/SPRI/FM 4435/ ES-1 2016 (draft), Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

1.3 Qualifications

Intertek-ATI in York, Pennsylvania has demonstrated compliance with ISO/IEC International Standard 17025 and is consequently accredited as a Testing Laboratory (TL-144) by International Accreditation Service, Inc. (IAS).

1.4 Witnessing

Ms. Delaine Deer from SMACNA was present from 11/28/16 – 11/30/16 to witness RE-1 and RE-2 testing conducted and reported herein. Mr. Scott Dietz from Specialty Fabricators Inc. was present to conduct the installation of the cleat, flashing and coping sections utilized for the RE-2 and RE-3 testing conducted and reported herein.

1.5 Conditions of Testing

All testing reported herein was conducted in a laboratory set to maintain temperature in the range of 68 ± 4°F and humidity in the range of 50 ± 5% RH.

2.0 ANSI/SPRI Test RE-1, Test for Roof Edge Termination of Ballasted or Mechanically Attached Roofing Membrane Systems

2.1 Test Procedure

Nominal 36 in wide sections of 0.035 in thick galvanized steel fascia were attached to a standard S-P-F roof edge mock-up utilizing a 0.042 in thick reinforced TPO roofing membrane. The 36 in fascia sections were cut to include eleven pre-punched holes for fasteners. All fasteners were 1-3/4 in x 0.155 in ring shank roofing nails. The loose end of the roofing membrane was fixed to the crosshead of a SATEC Unidrive, Model MII 50UD Universal Test Machine (ICN: Y002011) and pulled at an approximate 45° angle from the restrained gravel stop assembly at a speed of 0.25 in per minute. Load was applied until specimen failure, and load began to drop. See Photographs in Appendix A.

2.2 Test Results

ANSI/SPRI Test RE-1, Roof Edge Termination - Steel Test Date: 11/29/16

Specimen No.	Peak Load (lb) ¹
1	1294
2	1717
3	2074
4	1425
5	2223
6	1787
Average:	1754

¹Peak Load was the highest applied load at the time of failure

Mode of failure for all specimens was nails began withdrawing from the wood

3.0 ANSI/SPRI Test RE-2, Pull-Off Test for Edge Flashings

3.1 Specimen Description

Nominal 10 ft long sections of 5-1/2 in wide by 12 in high by 0.033 in thick galvanized steel, 0.060 in thick aluminum or 0.023 in thick copper flashing were attached to roof edge mock-ups constructed of S-P-F dimension lumber using 11-1/4 in wide by 3-1/2 in high by 0.033 in thick galvanized steel, 0.060 in thick aluminum or 0.023 in thick copper continuous cleats respectively. Prior to assembly, the front face of the flashing was drilled and fitted with ten 5/16 in eyebolts, weld nuts (with barrel) and two hex nuts and washer (outside only), six in from each end and twelve in on center, on the longitudinal centerline. The front face of the cleat was nailed to the edge of the S-P-F member with a single row of ten 1-3/4 in x 0.155 in ring shank roofing nails, 2 in from each end, 10 in on center (first space) and 12 in on center (typical). The flashing was then hooked onto the front bend of the cleat and its top face was nailed to the top of the S-P-F member with two staggered rows of 1-3/4 in x 0.155 in ring shank roofing nails 3 in / 6 in from each end and 6 in on center.

See Photographs in Appendix A and Drawings in Appendix B for additional details.

3.2 Test Procedure

Load was applied to the ten eye bolts using equal-length chains, a spreader beam, steel cable and an electric winch. Applied load was measured with an in-line 2000 pound load cell. Center-point deflection of the flashing face was measured with an electronic linear displacement transducer. Load was applied incrementally and held ("Sustained") for a minimum of 60 seconds with intermediate load relaxation periods for specimen deflection to stabilize.

Mode of failure for steel and aluminum specimens was cleat nails withdrawing from the wood, and for the copper specimens the cleat bent releasing the fascia. See Photographs in Appendix A for test set-up.

3.3 Test Results

ANSI/SPRI Test RE-2 Pull-Off Test for Steel Edge Flashing
Test Dates: 11/28/16 - 11/29/16

Specimen No.	Peak Load at Failure (lb)	Max. Sustained Load prior to Failure (lb)	Equivalent Sustained Pressure (psf)
1	1814	1700	170
2	1847	1700	170
3	1914	1800	180
Average:	1858	1733	173

ANSI/SPRI Test RE-2 Pull-Off Test for Aluminum Edge Flashing
Test Dates: 11/29/16 - 11/30/16

Specimen No.	Peak Load at Failure (lb)	Max. Sustained Load prior to Failure (lb)	Equivalent Sustained Pressure (psf)
1	2514	2400	240
2	2698	2600	260
3	2392	2300	230
Average:	2535	2433	243

ANSI/SPRI Test RE-2 Pull-Off Test for Copper Edge Flashing
Test Date: 11/29/16

Specimen No.	Peak Load at Failure (lb)	Max. Sustained Load prior to Failure (lb)	Equivalent Sustained Pressure (psf)
1	670	500	50
2	709	700	70
3	610	600	60
Average:	663	600	60

4.0 ANSI/SPRI Test RE-3, Pull-Off Test for Copings

4.1 Specimen Description

Nominal 10 ft long sections of 12 in wide top face by 4-3/4 in high front and back face by 0.033 in thick galvanized steel, 0.060 in thick aluminum or 0.023 in thick copper coping were attached to roof edge mock-ups constructed of S-P-F dimension lumber using 2 in wide by 4-1/2 in high by 0.033 in thick galvanized steel, 0.060 in thick aluminum or 0.023 in thick copper continuous cleats respectively. Prior to assembly, the top and front faces of the coping were drilled and each fitted with ten 5/16 in eyebolts, weld nuts (with barrel) and two hex nuts and washer (outside only), 6 in from each end and 12 in on center, on the longitudinal centerlines. The front face of the cleat was nailed to the face of the S-P-F member with a single row of six 1-3/4 in x 0.155 in ring shank roofing nails 2 in from each end, 22 in on center (first space) and 24 in on center (typical). The coping was then hooked onto the front bend of the cleat, wrapped over the top of the mock-up, and its back face was fastened to the edge of the S-P-F member with a single row of six, #12-14 by 1-1/2 in, self-drilling, hex-head, coated carbon steel screws, 2 in from each end, 22 in on center (first space) and 24 in on center (typical).

See Photographs in Appendix A and Drawings in Appendix B for additional details.

4.2 Test Procedure

Load was applied to the ten eye bolts of the coping top surface using equal-length chains, a spreader beam, steel cable and an electric winch. Applied load was measured with an in-line 2000 pound load cell. Center-point deflection of the coping face was measured with an electronic linear displacement transducer. Load was applied to the ten eye bolts of the coping face surface, secured with cleat, using equal-length chains, a spreader beam, steel cable and an electric winch. Applied load was measured with an in-line 2000 pound load cell. The two loads were applied simultaneously, proportionally and incrementally and held ("Sustained") for a minimum of 60 seconds with intermediate load relaxation periods for specimen deflection to stabilize.

Testing of the steel and aluminum coping members was stopped prior to specimen failure due to test fixture limitations. Mode of failure for the copper specimens was coping deformation under load and subsequent disengagement from the lower lip of the cleat as load was relaxed. See Photographs in Appendix A for test set-up.

4.3 Test Results

ANSI/SPRI Test RE-3 - Pull-Off Test for Steel Coping
Test Dates: 12/02/16 - 12/06/16

Specimen No.	Max. Sustained Load prior to Failure (lb)		Equivalent Sustained Pressure (psf) ¹	
	Top	Face ²	Top	Face ²
1	4000	867	400	231
2	2700	570	270	156
3	2700	570	270	156
Average:	3133	669	313	181

¹ In order to comply with ANSI/SPRI/FM 4435/ES-1 2011 the top and face pressures are in the ratio of 1.68 to 0.97 for roof height 60 ft or less.

² Face loading was applied to the face attached to the cleat only.

ANSI/SPRI Test RE-3 - Pull-Off Test for Aluminum Coping
Test Dates: 12/05/16 and 12/06/16

Specimen No.	Max. Sustained Load prior to Failure (lb)		Equivalent Sustained Pressure (psf) ¹	
	Top	Face ²	Top	Face ²
1	2700	570	270	156
2	2700	570	270	156
3	2700	570	270	156
Average:	2700	570	270	156

¹ In order to comply with ANSI/SPRI/FM 4435/ES-1 2011 the top and face pressures are in the ratio of 1.68 to 0.97 for roof height 60 ft or less.

² Face loading was applied to the face attached to the cleat only.

ANSI/SPRI Test RE-3 - Pull-Off Test for Copper Coping
Test Date: 12/05/16

Specimen No.	Max. Sustained Load prior to Failure (lb)		Equivalent Sustained Pressure (psf) ¹	
	Top	Face ²	Top	Face ²
1	2000	410	200	115
2	1250	239	125	72
3	1600	319	160	92
Average:	1617	323	162	93

¹ In order to comply with ANSI/SPRI/FM 4435/ES-1 2011 the top and face pressures are in the ratio of 1.68 to 0.97 for roof height 60 ft or less.² Face loading was applied to the face attached to the cleat only.

5.0 Closing Statement

Intertek-ATI will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Intertek-ATI for the entire test record retention period.

Results obtained are tested values and were secured using the designated test methods. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimens tested. This report may not be reproduced, except in full, without the written approval of Intertek-ATI.

For INTERTEK-ATI:



Digitally Signed by: Adam J. Schrum

Adam J. Schrum
Lead Technician



Digitally Signed by: Virgal Thomas Mickley, Jr.

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Attachments (pages): This report is complete only when all attachments listed are included.

Appendix A - Drawings (2)

Appendix B - Photographs (6)

Revision Log

<u>Rev. #</u>	<u>Date</u>	<u>Page(s)</u>	<u>Revision(s)</u>
0	01/19/17	N/A	Original report issue
1	02/14/17	1 (Section 1.2)	Updated test standard version from 2011 to 2016 (draft)



G3737.01-119-16

APPENDIX A

Drawings

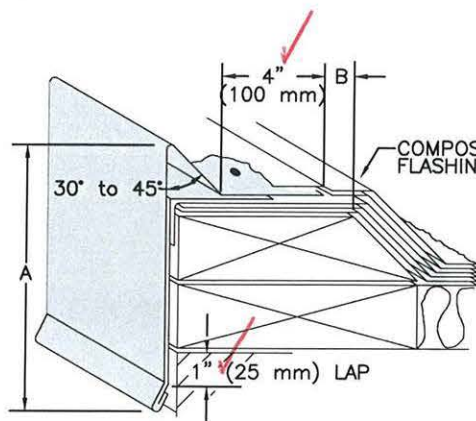


FIG 2-1A

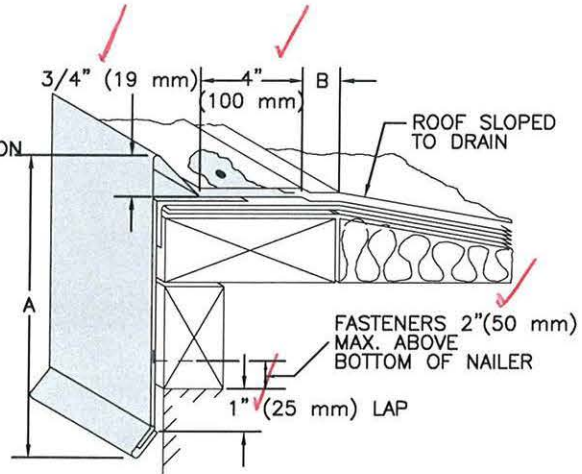
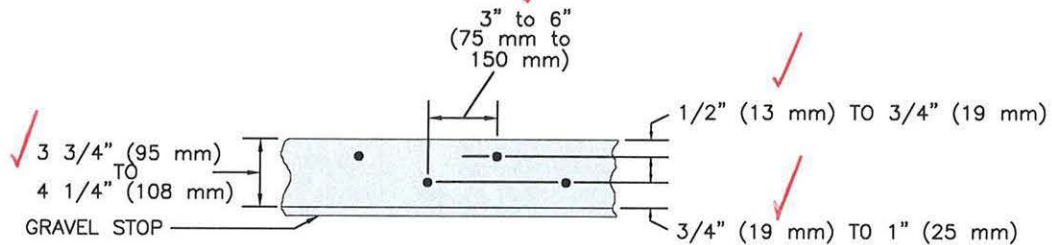
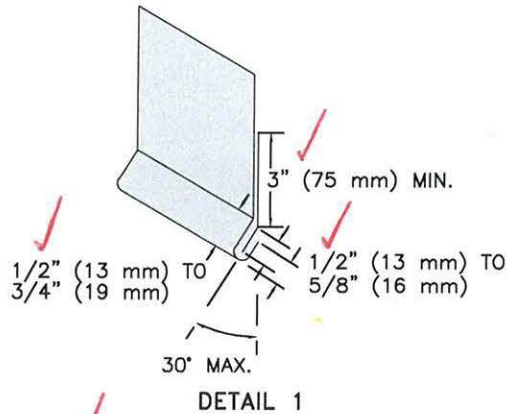


FIG 2-1B

A = 4" (127 mm) MAX. UNCLEATED
 A = 12" (300 mm) MAX. CLEATED
 B = 1/2" (13 mm) MIN.

- 20 Gauge Galvanized Steel
- .063 Aluminum
- 20 Oz. Copper



THESE REQUIREMENTS VARIES BY ROOF SYSTEM.
 REFER TO THE MEMBRANE MANUFACTURER'S INSTRUCTIONS.



Architectural Testing

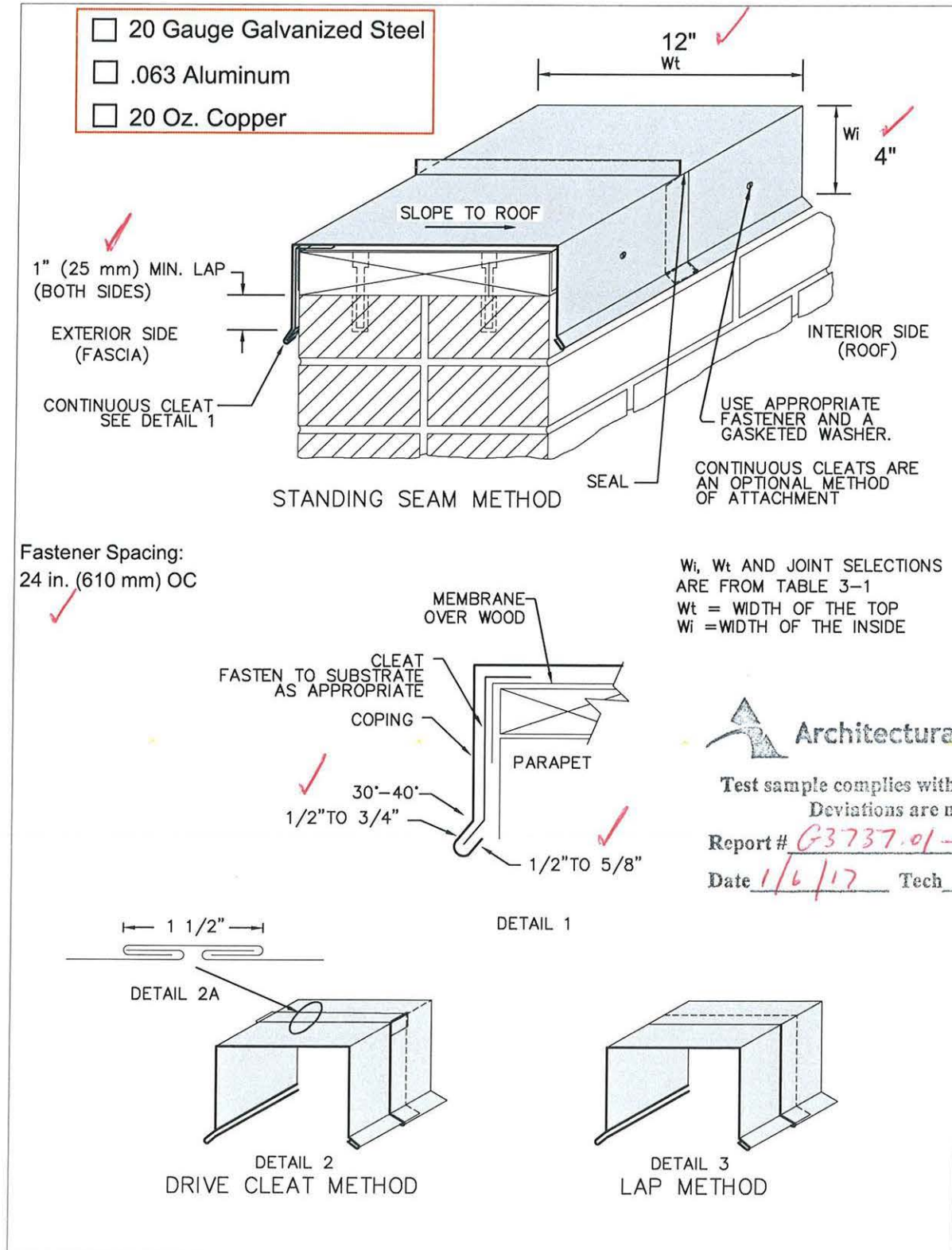
BASIC FLANGE NAILING PATTERN

Test sample complies with these details.
 Deviations are noted.

Report # G3737.01-119-16
 Date 1/6/17 Tech ATJ

FIGURE 2-1 FORMED GRAVEL-STOP-FASCIA — DESIGN DATA







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APPENDIX B

Photographs



Photo No. 1
ANSI/SPRI Test RE-1 Test Set-up



Photo No. 2
ANSI/SPRI Test RE-1 Typical Mode of Failure



Photo No. 3
ANSI/SPRI Test RE-2, Test Setup



Photo No. 4
ANSI/SPRI Test RE-2, Failure of Copper Cleat, Bent to Release Fascia

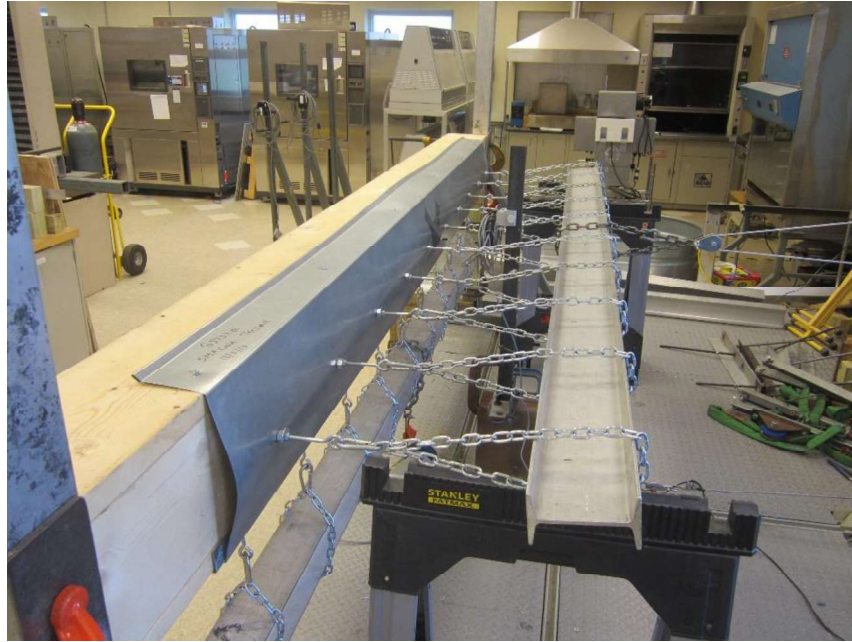


Photo No. 5

ANSI/SPRI Test RE-3, Coping Pull-Off Test In Progress; Tested with Face Down



Photo No. 6

**ANSI/SPRI Test RE-3, Coping Pull-Off Test In Progress
Face Loading Shown under Load**