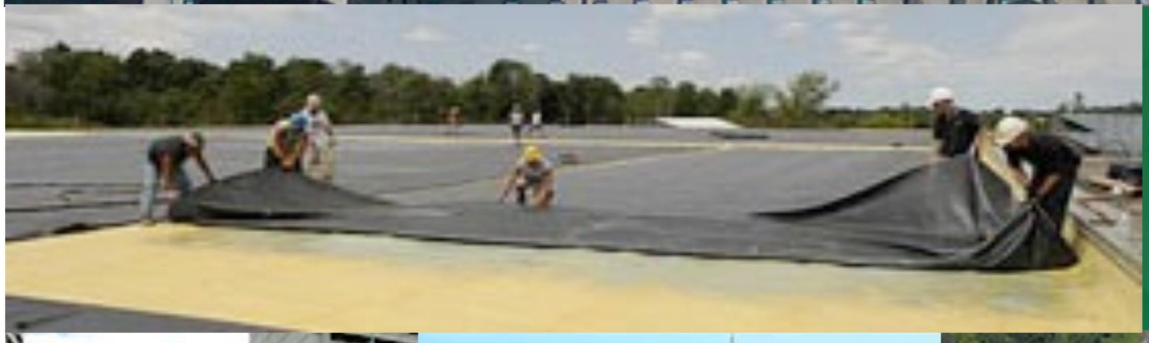
TTR®

TRI THERMAL ROOFING



The Most Energy Efficient Roof Under The Sun!

Spray Applied
TTR Foam

+

Spray Applied
TTR Adhesive

+

EPDM

=

TTR®

10,20 & 30 Year Renewable Warranties

Annual Inspections

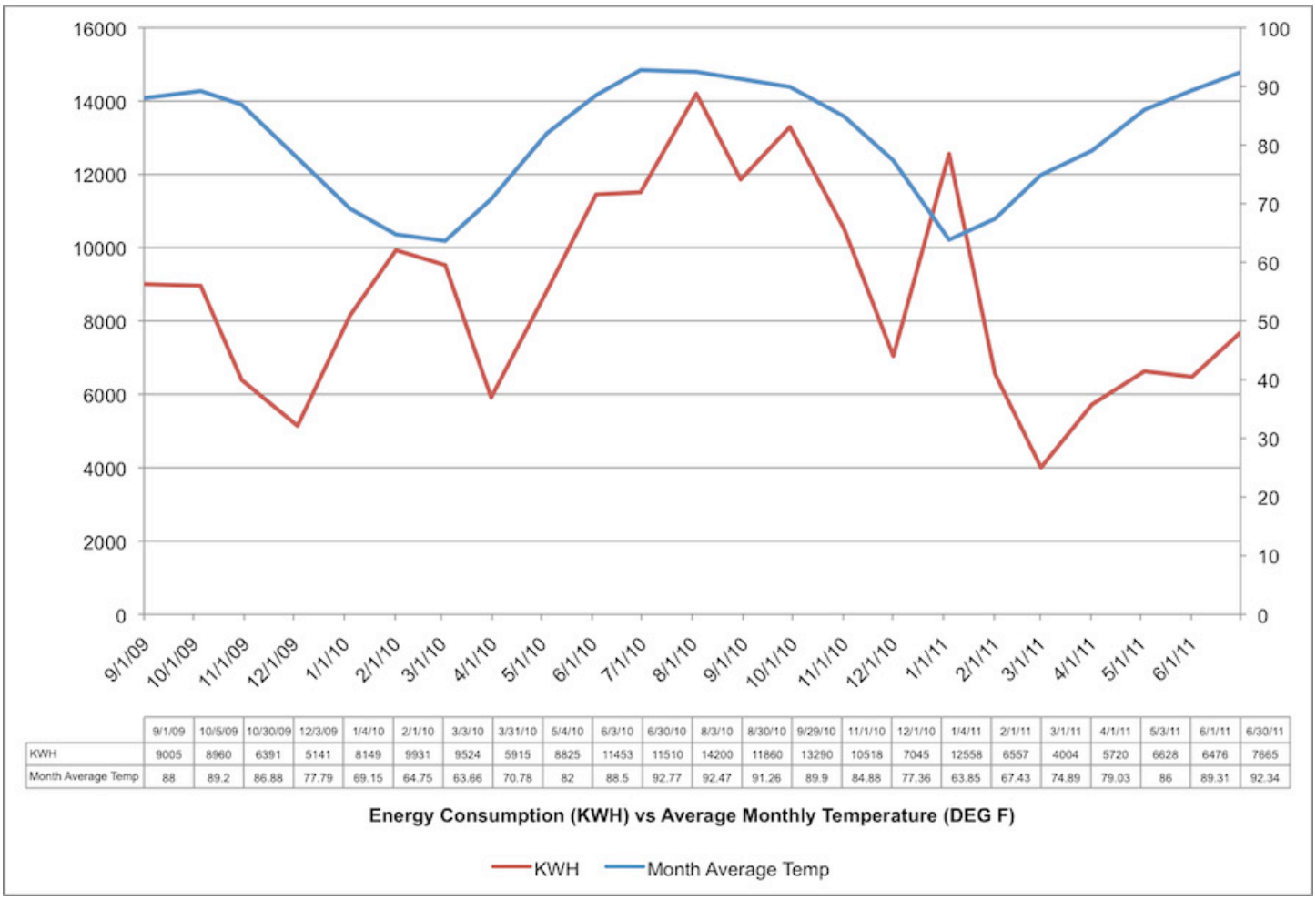
Light weight, energy efficient, and environmentally responsible. A true green product.

TRI THERMAL ROOFING

PERMA-SEAL
INSULATION TECHNOLOGY

CASE STUDY

Central Florida Urban League
Pine Hills Service Center
2804 Belco Drive
Orlando, Fl 32808



	9/1/09	10/5/09	10/30/09	12/3/09	1/4/10	2/1/10	3/3/10	3/31/10	5/4/10	6/3/10	6/30/10	8/3/10	8/30/10	9/29/10	11/1/10	12/1/10	1/4/11	2/1/11	3/1/11	4/1/11	5/3/11	6/1/11	6/30/11
KWH	9005	8960	6391	5141	8149	9931	9524	5915	8825	11453	11510	14200	11860	13290	10518	7045	12558	6557	4004	5720	6628	6476	7665
Month Average Temp	88	89.2	86.88	77.79	69.15	64.75	63.66	70.78	82	88.5	92.77	92.47	91.26	89.9	84.88	77.36	63.85	67.43	74.89	79.03	86	89.31	92.34

Energy Consumption (KWH) vs Average Monthly Temperature (DEG F)

KWH Month Average Temp

BEFORE

AFTER

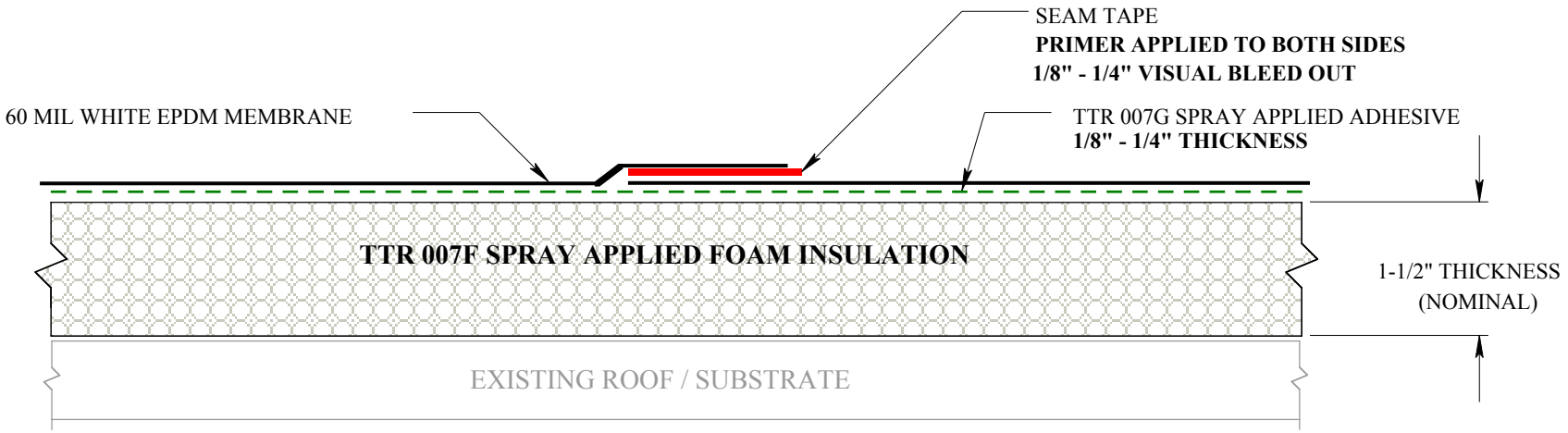
YEAR TO YEAR ENERGY CONSUMPTION COMPARISON						
Winter Month	AVE TEMP*	KWH**		Summer Month	AVE TEMP*	KWH**
March 2010	63.66 F	9524		June 2010	92.77 F	11510
March 2011	74.89 F	4004		June 2011	92.34	7665
ENERGY SAVINGS		*42%*		ENERGY SAVINGS		*66%*

* Weather data provided by www.wunderground.com.
** Energy consumption provided by client's Progress Energy Utility Bill.

Proven 42%- 66% Energy Savings !!

Roof Was Installed 02/2011

(800) 461-8339 www.TTRSYSTEMS.com support@ttrsystems.com



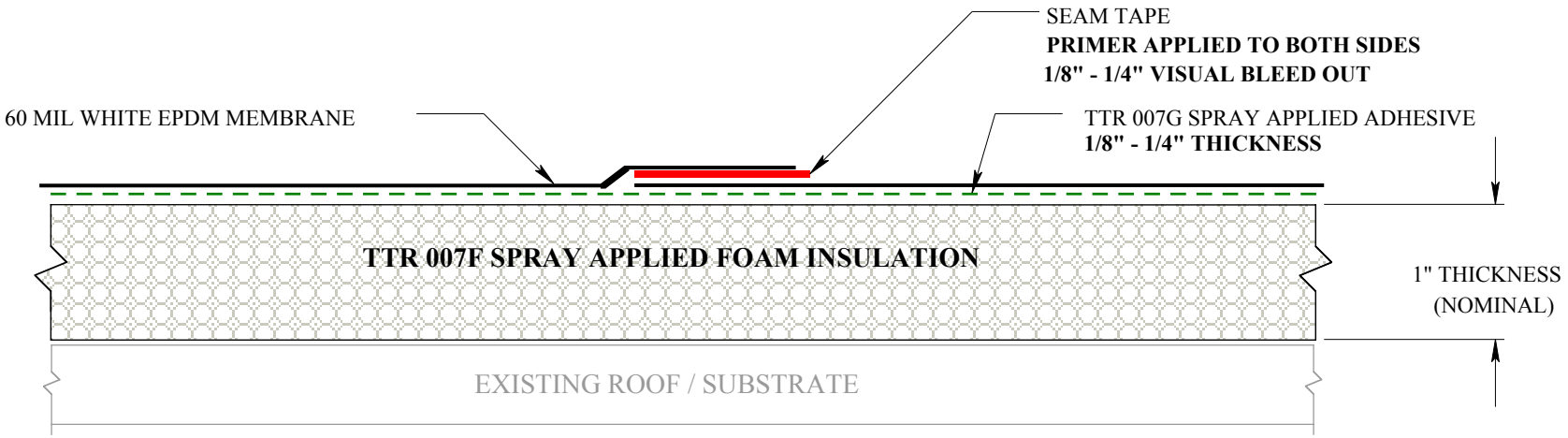
--NOT DRAWN TO SCALE--

TRI THERMAL ROOFING

PERMA-SEAL

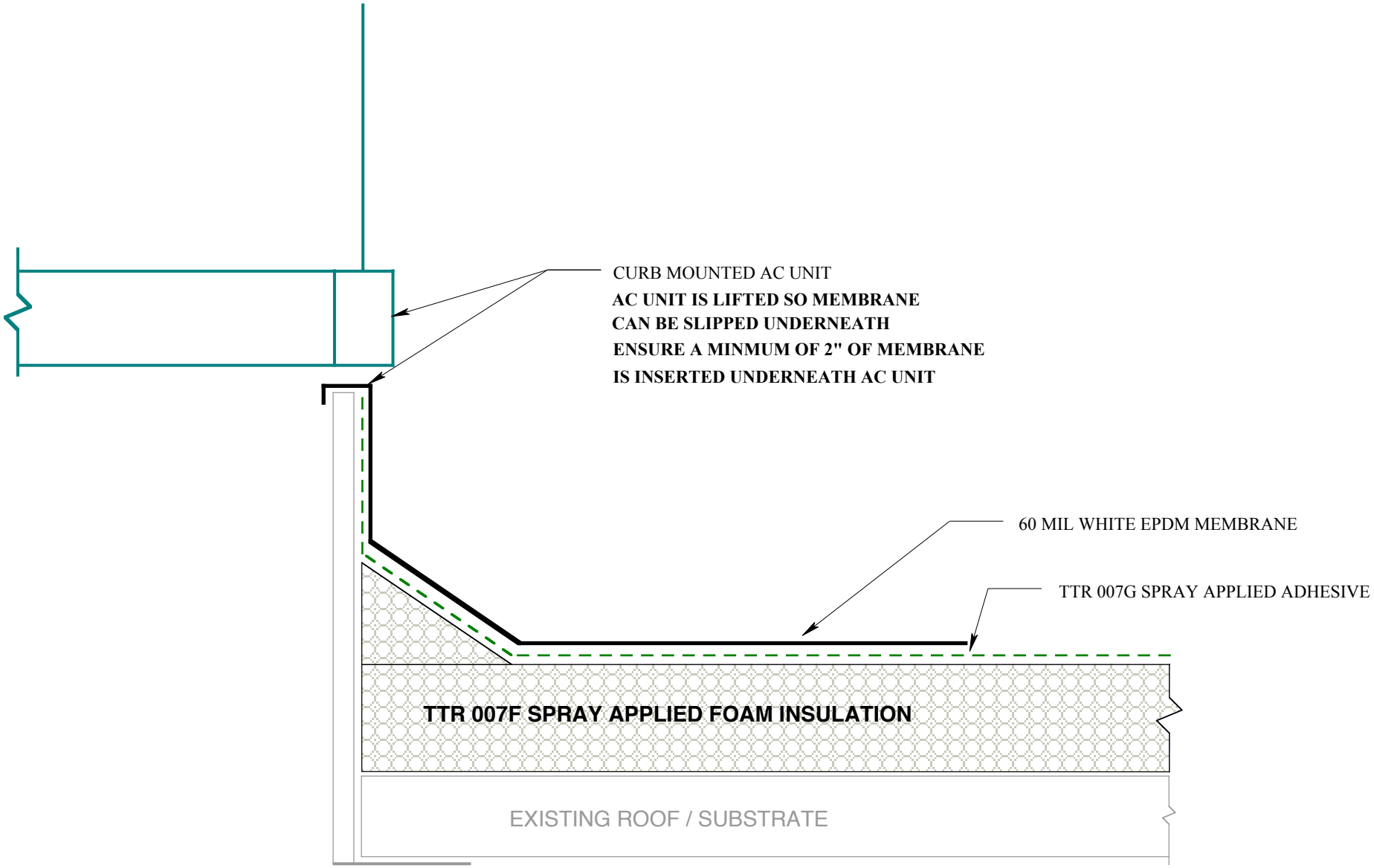
INSULATION TECHNOLOGY

TTR 150 ROOF SYSTEM FIELD DETAIL	
Issue / Revision Date:	12-02-2011
Detail No.:	FIELD-01



--NOT DRAWN TO SCALE--

TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	TTR 100 ROOF SYSTEM FIELD DETAIL
		Issue / Revision Date: 12-02-2011
		Detail No.: FIELD -02



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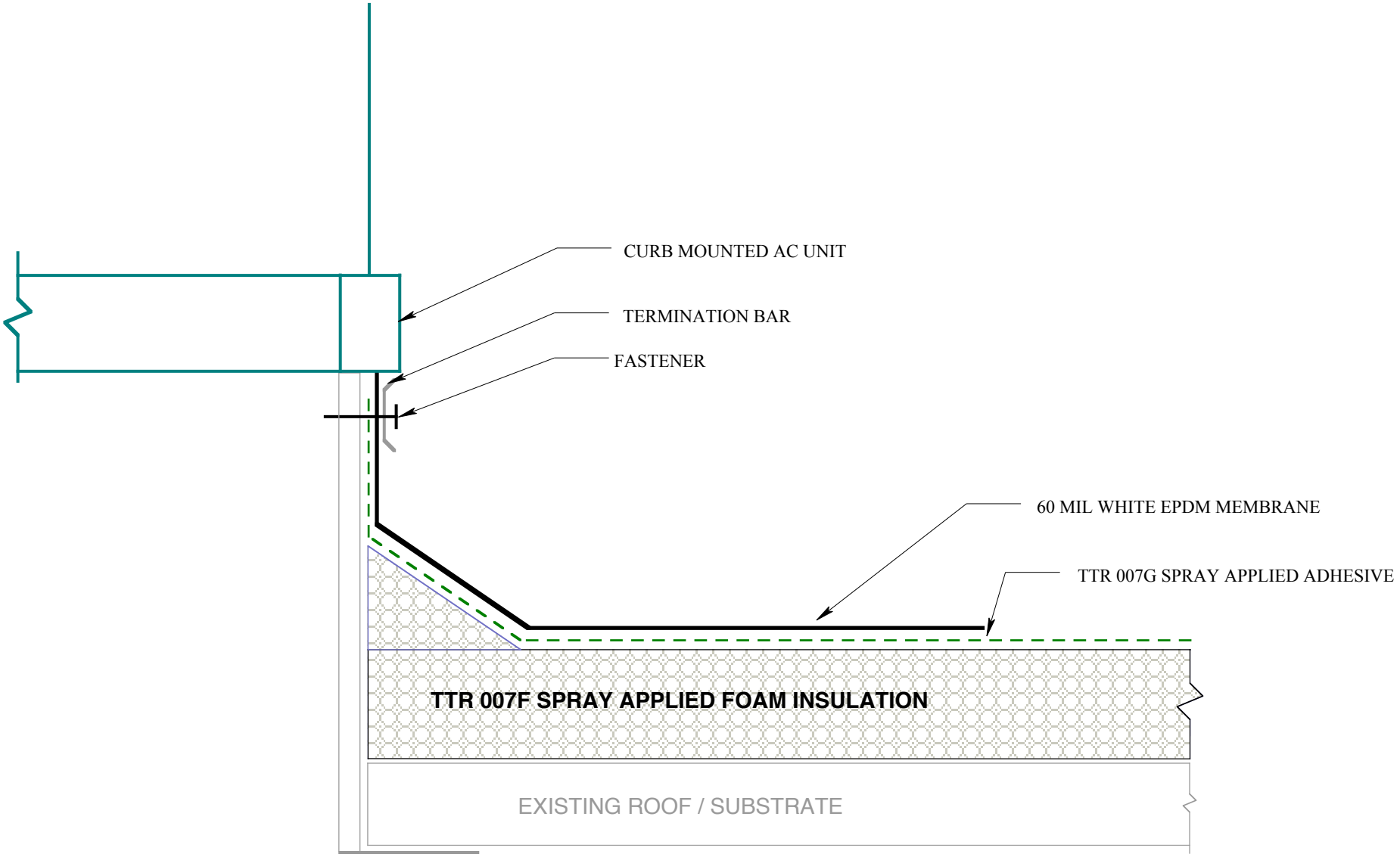
TTR® TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	AC CURB AC LIFTED DETAIL
		Issue / Revision Date: 12-02-2011
		Detail No.: CURB-01



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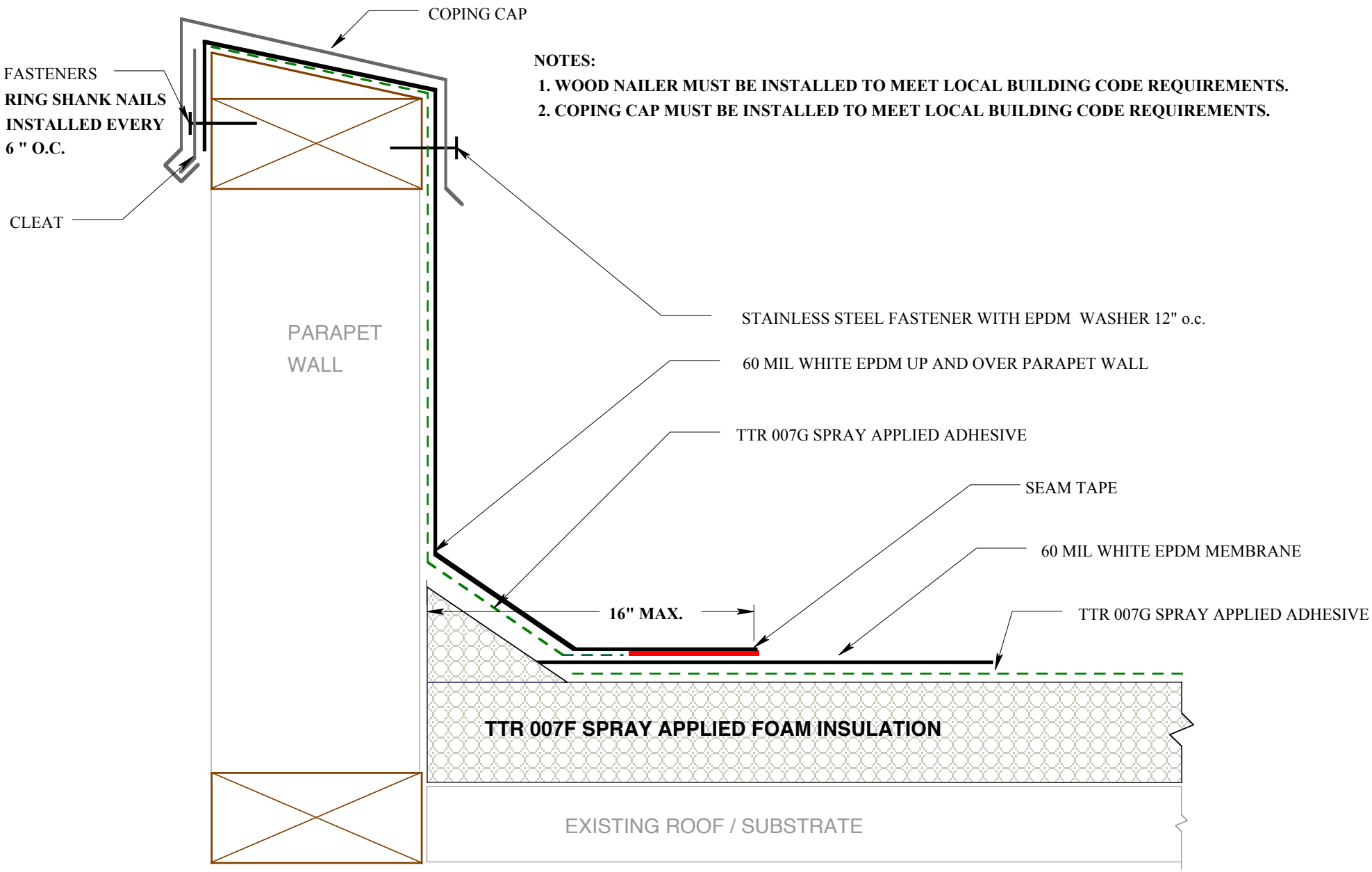
TRI THERMAL ROOFING

PERMA-SEAL

INSULATION TECHNOLOGY

AC CURB AC NOT LIFTED DETAIL	
Issue / Revision Date:	12-02-2011
Detail No.:	CURB -02



NOTES:

1. WOOD NAILER MUST BE INSTALLED TO MEET LOCAL BUILDING CODE REQUIREMENTS.

2. COPING CAP MUST BE INSTALLED TO MEET LOCAL BUILDING CODE REQUIREMENTS.

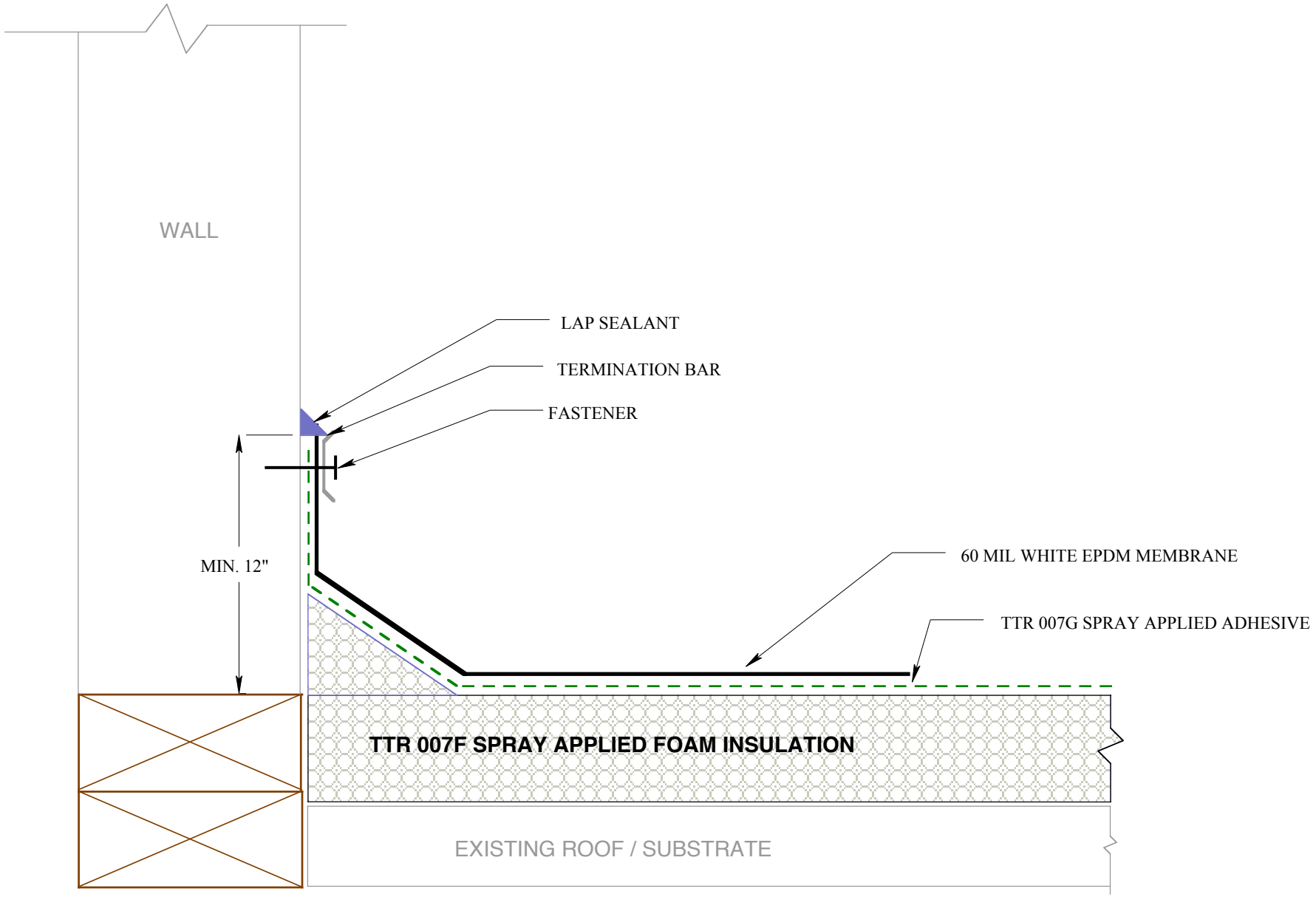
--NOT DRAWN TO SCALE--

TTR® TRI THERMAL ROOFING

PERMA-SEAL

INSULATION TECHNOLOGY

PARAPET WALL AND COPING CAP DETAIL	
Issue / Revision Date:	12-02-2011
Detail No.:	WALL -01



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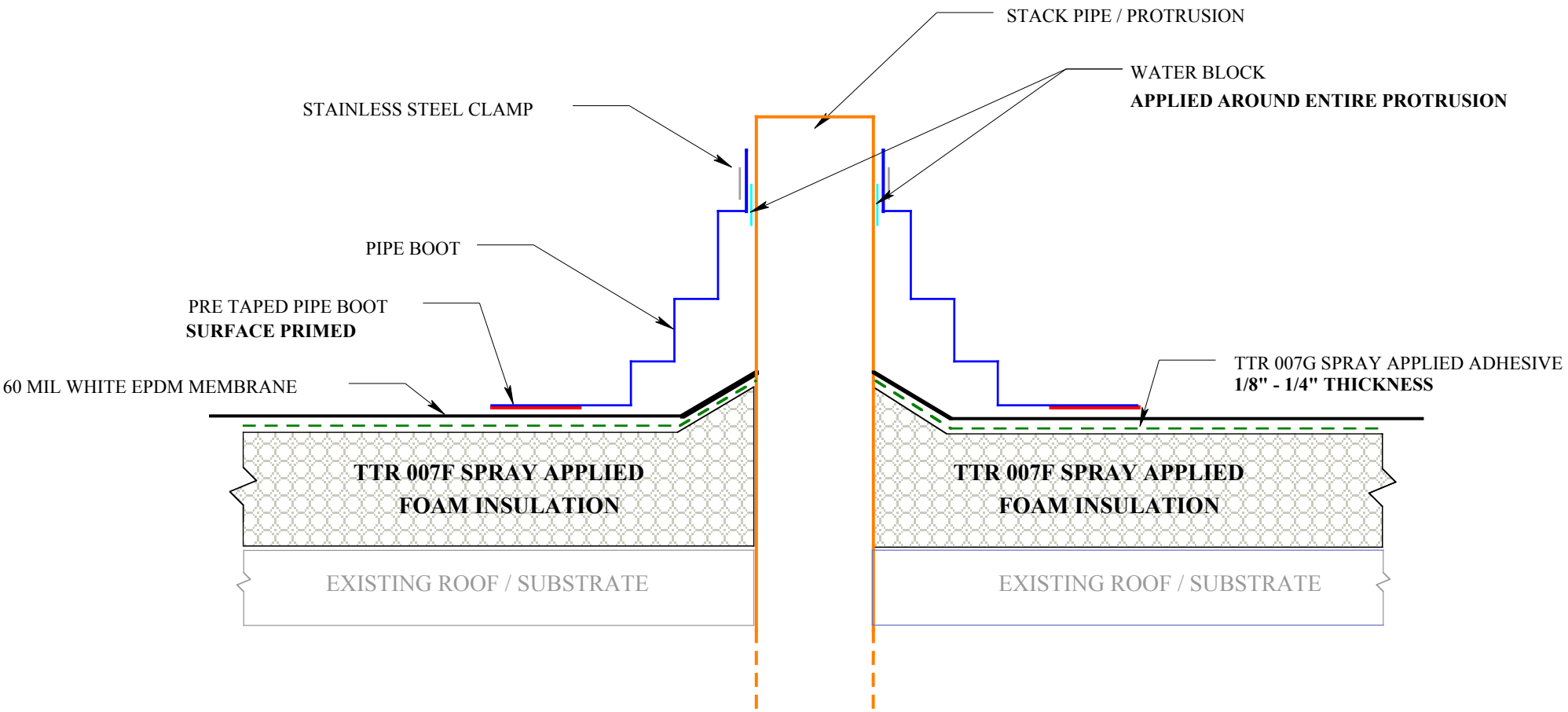
TTR® TRI THERMAL ROOFING

PERMA-SEAL

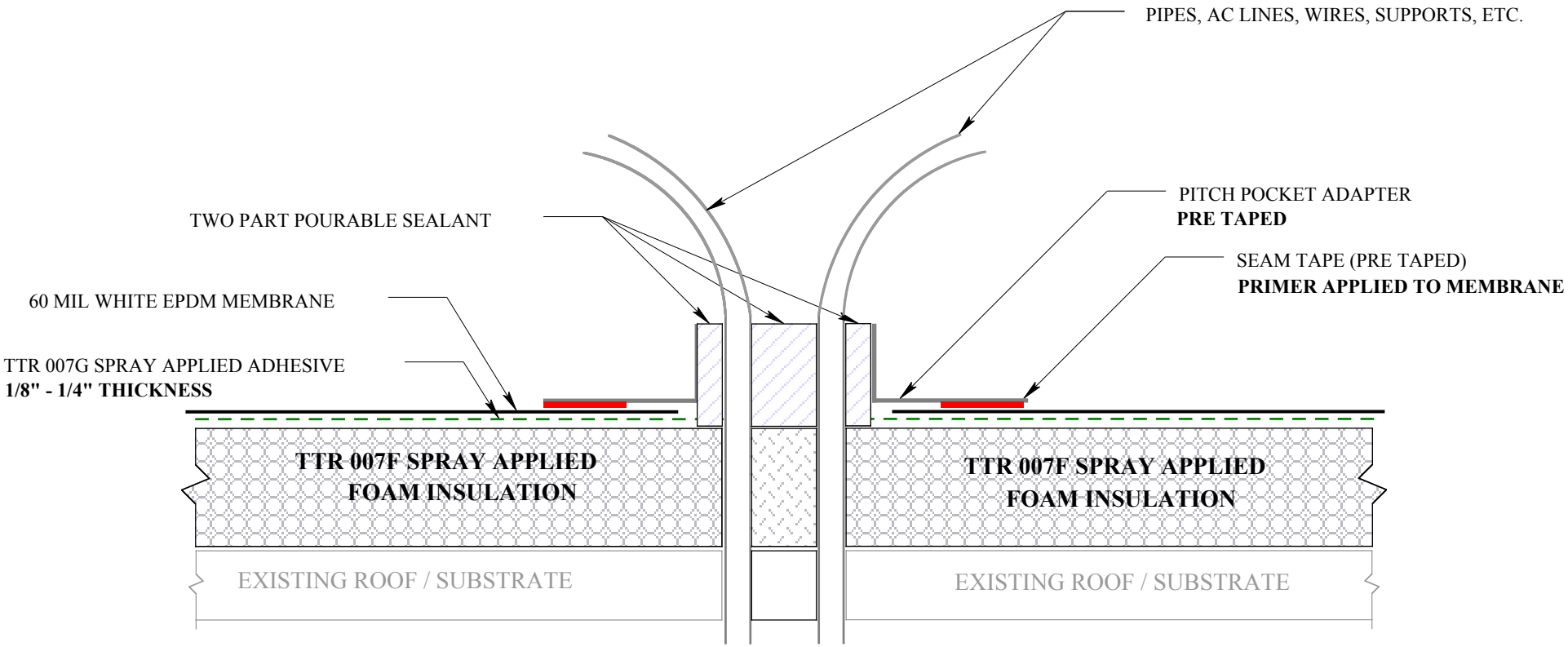
INSULATION TECHNOLOGY

WALL TERMINATION DETAIL	
Issue / Revision Date:	12-02-2011
Detail No.:	WALL-02



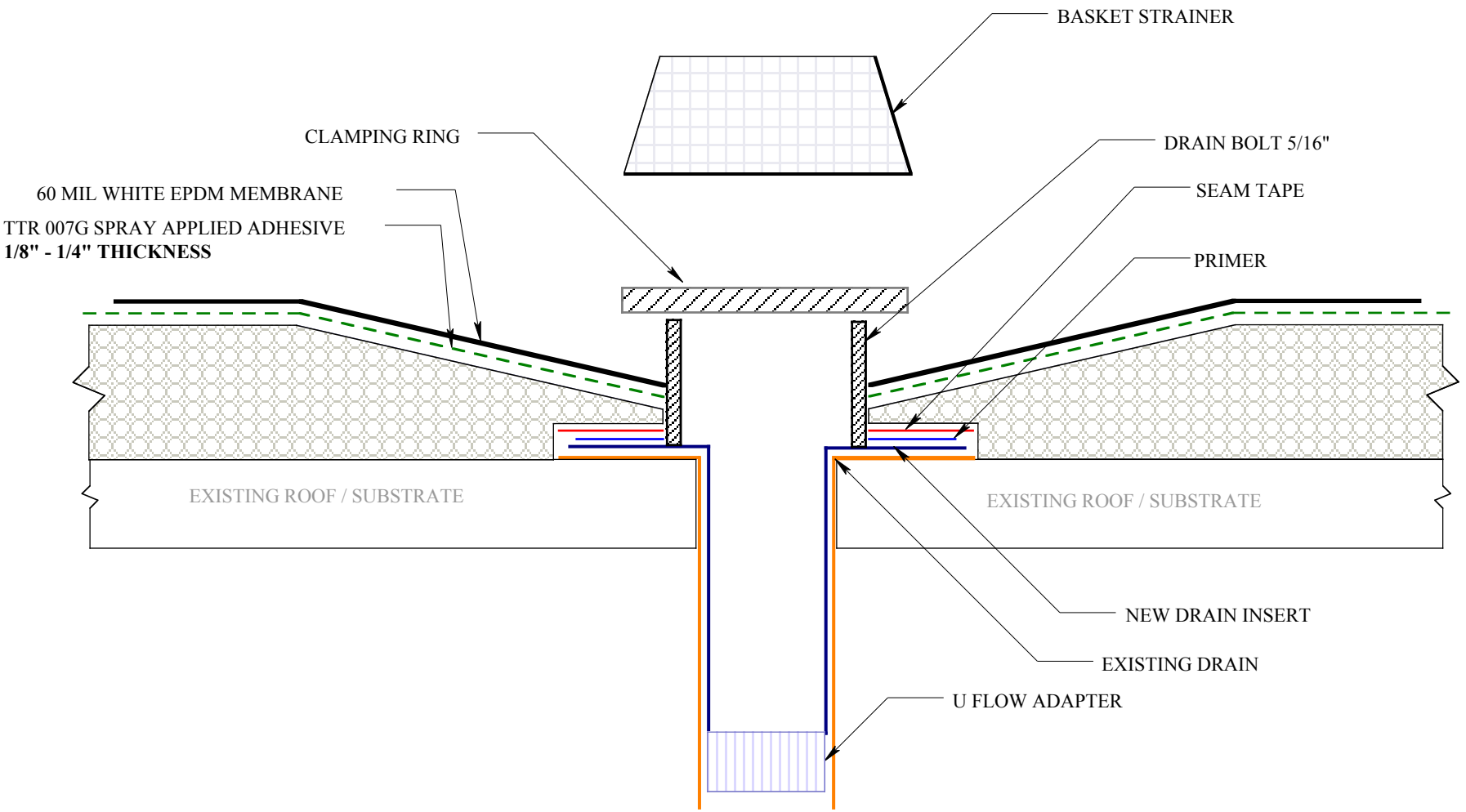
--NOT DRAWN TO SCALE--

TTR® TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	PROTRUSION DETAIL
		Issue / Revision Date: 12-02-2011
		Detail No.: PROTRUSION-01



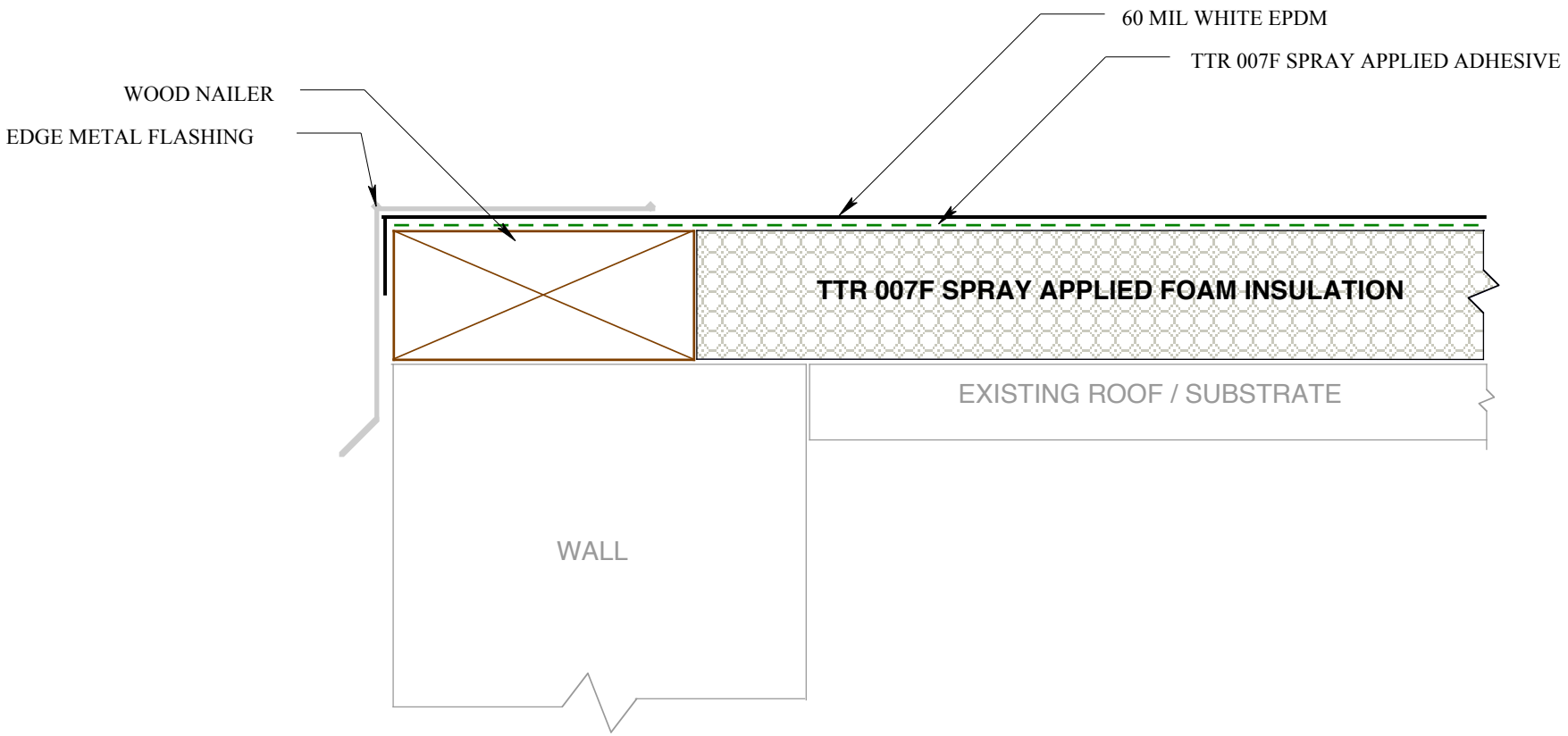
--NOT DRAWN TO SCALE--

TTR® TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	PITCH POCKET DETAIL
		Issue / Revision Date: 12-02-2011
		Detail No.: PITCH POCKET-01



--NOT DRAWN TO SCALE--

TTR® TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	DRAIN DETAIL
		Issue / Revision Date: 12-02-2011
		Detail No.: DRAIN-01



NOTES:

1. Wood nailer to be installed to meet local building code requirements.

2. Metal flashing to be mechanically attached to meet local code requirements.

--NOT DRAWN TO SCALE--

TTR® TRI THERMAL ROOFING	PERMA-SEAL INSULATION TECHNOLOGY	Edge Detail
		Issue / Revision Date: 12-02-2011
		Detail No.: EDGE-01

ECOroof
CASE STUDY

COOL ROOF PROJECT SUMMARY

A cool roof is a roofing system with high solar reflectivity and thermal emissivity to reduce the urban heat island effect and can be either a coating applied over an existing roof system or a new waterproofing membrane.

Building Type: Institutional

Total Cost (including engineering reports): $337,808

Eco-Roof Incentive Program funding received (2009): $14,355

Size of cool roof: 2,871 m^2

Cost per square metre: $66

Project timeline: 4 months

Black Creek Pioneer Village
1000 Murray Ross Parkway
Toronto, Ontario M3J 2P3

Website: blackcreek.ca
Phone: 416-736-1733 ext. 5442
Contact: Chris Bagley, General Manager, Black Creek Pioneer Village

Spring 2011

Black Creek Pioneer Village

Operated by the Toronto and Region Conservation Authority (TRCA), Black Creek Pioneer Village is a recreation of life in 19th-century Ontario and gives an idea of how rural Ontario might have looked at that time. The Black Creek Pioneer Village Visitors' Centre is a multi-functional facility built to accommodate public audiences, museum education and exhibitions, collections management, meeting and dining facilities, food service, retail and offices.

Black Creek Pioneer Village installed its cool roof in 2009

"The eco-roof was the right solution for the replacement roof in our 30 year old building. As a public educational institution, we have a responsibility to implement sustainable practices and to educate visitors about the importance of sustainable practices for the future of the planet."

Marty Brent, General Manager, Black Creek Pioneer Village

TORONTO Call 311 Livegreen Toronto

Quick Facts: Cool Roofs

- extend the lifespan of a roof by minimizing the extreme temperature fluctuations that cause wear and tear on traditional roofs;
- have the potential to reduce energy consumption on hot summer days by between .27 and 3.16 kWh per square meter of cool roof coverage;

Reference: Akbari, H. and Konopacki, S. (2004). "Energy effects of heat-island reduction strategies in Toronto, Canada." Energy 29: 191-210 (LBL Study).

- have the potential to reduce GHG emissions annually by an estimated 50 to 590 g of CO_2 equivalent per square metre of cool roof coverage;

Reference: Based on energy savings in Akbari, H. and Konopacki, S. (2004). "Energy effects of heat-island reduction strategies in Toronto, Canada." Energy 29: 191-210 (LBL Study).

- have the potential to reduce the ambient air temperature by .6 to 1.7 °C on hot summer days, thereby decreasing the urban heat island effect.

Reference: Akbari, H. and Konopacki, S. (2004). "Energy effects of heat-island reduction strategies in Toronto, Canada." Energy 29: 191-210 (LBL Study).

*The City of Toronto's Eco-Roof Incentive Program (ERIP) provides funds for green or cool roof retrofit projects on existing commercial, industrial and institutional buildings.

The program also provides funding for green roofs on new industrial buildings with a Gross Floor Area of 2,000 m^2 (21,528 sq ft) or greater, and new institutional and commercial buildings of less than 2,000 m^2.

Eligible green roof projects receive $50 / square metre up to a maximum of $100,000. Eligible cool roof projects receive $2 - 5 / square metre up to a maximum of $50,000.
Funding recipients must meet program eligibility criteria.

Building Characteristics and History

The two-storey 5,110 m^2 building, which was constructed in 1985, has been in continuous use and still serves its original purpose.

Project Description and Background

The decision to install a cool roof when the roof required replacement was guided by the TRCA's corporate ethics and strategic policies as well as their concern about energy efficiencies.

The TRCA hired an engineering consultant to spec the project and identify appropriate roofing types, which led to the choice of a specific product, and a supplier who licensed specific contractors. The TRCA tendered the eco-roof specifications to the short list of contractors provided by the supplier and received nine quotes.

Outcomes

- Keeps building cooler in summer, reduces energy used for air conditioning.
- Roof product consists of materials that are 100% recyclable at end of life.
- Consistent with Black Creek Pioneer Village's corporate environmental philosophy.
- Black Creek Pioneer Village provides information about its sustainable practices to the public.

Before Eco-Roof installation

CONSTRUCTION MATERIALS

TECHNOLOGIES

LABORATORY TEST REPORT

Report for: TTR Roofing International, Inc.
115 Fairway Drive
Callander ON P0H 1H0
Canada

Date: November 12, 2009

Attention: Stan Cox

Product Name:	Tri Thermal Roof Membrane Adhesive	**Manufacturer:**	TTR Roofing International
Date Received:	October 5, 2009	**Source:**	TTR Roofing International
PRI Report No.:	TTRI-001-02-01	**Metro-Dade Notification No.:**	PRI09099

Subject: The purpose of this project was to test TTR Tri Thermal Roof Adhesive for certain performance properties. The product is a spray applied

Test Methods: The test methods used included ASTM D 1621: *Standard Test Method for Compressive Properties Of Rigid Cellular Plastics,* ASTM D 1622: *Standard Test Method for Apparent Density of Rigid Cellular Plastics*; ASTM D 2126: *Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging*; ASTM D 2856: *Standard Test Method for Open-Cell Content of Rigid Cellular Plastic by the Air Pycnometer;* ASTM E 96: *Standard Test Methods for Water Vapor Transmission of Materials*, Procedure A: desiccant method.

Sample Description: The samples were received from TTR spray applied plywood. The specimens used for testing were cut from those samples.

PRI Construction Materials Technologies, LLC. 6408 Badger Drive Tampa, FL 33610 Tel: 813-621-5777 Fax: 813-621-5840 e-mail materialstesting@pricmt.com WebSite: http://www.pricmt.com

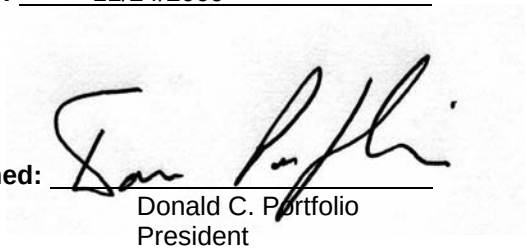
Results of Testing:

Physical Property	ASTM Test Method	Result
Density, pcf	D 1622	6.2
Compressive Strength, psi	D 1621	32
Water Absorption, %	C 209	5.3
Dimensional Stability @ 160°F and 97% RH for 7 days, %	D 2126	0.58
Tensile Strength, psi	D 1623	50
Closed Cell Content, %	D 2856	61
Water Vapor Permeability, perm inch	E 96A	4.36

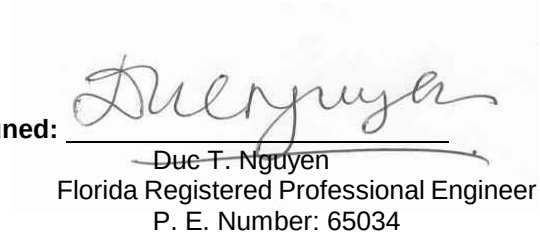
The physical properties reported for this material were determined in accordance with the test methods listed.

Signed: 
Charles Rumpeltin
Laboratory Technician

Date: 11/24/2009

Signed: 
Donald C. Portfolio
President

Date: 11/24/2009

Signed: 
Duc T. Nguyen
Florida Registered Professional Engineer
P. E. Number: 65034

Date: 11/24/2009

PRI Construction Materials Technologies, LLC. 6408 Badger Drive Tampa, FL 33610 Tel: 813-621-5777 Fax: 813-621-5840 e-mail materialstesting@pricmt.com WebSite: http://www.pricmt.com

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

EVALUATION OF THE EXTERNAL FIRE RESISTANCE CHARACTERISTICS OF ROOF COVERING SYSTEMS IN GENERAL ACCORDANCE WITH ASTM E 108-07a, *STANDARD TEST METHODS FOR FIRE TESTS OF ROOF COVERINGS:* CLASS A TESTING

SAMPLE ID: ***SPF with a 60 mil EPDM membrane and DensDeck substrate***

FINAL REPORT
Consisting of 21 Pages

SwRI® Project No. 01.14431.01.325b
Test Date: July 28, 2009, and November 13 and 23, 2009
Report Date: November 30, 2009

Prepared for:

TTR Roofing International Inc.
115 Fairway Drive
Callander, ON P0H 1H0 Canada

Prepared By:

John Marshall Sharp
Engineer
Fire Testing Services Section

11/30/09
Approved By:

Barry L. Badders, Jr., P.E.
No. 61907, Florida
Manager
Fire Testing Services Section

1.0 INTRODUCTION

This report presents the results of an investigation of the external fire resistance characteristics of the *SPF with a 60 mil EPDM membrane and DensDeck substrate* roof covering system in general accordance with Class A Spread of Flame requirements of ASTM E 108-07a, *Standard Test Methods for Fire Tests of Roof Coverings*. The objective of this standard is to measure the relative fire resistance characteristics of roof coverings under a simulated fire originating outside the building. This standard is used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment that takes into account all of the factors, pertinent to an assessment of the fire hazard of a particular end use. The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

2.0 CLASSIFICATION CRITERIA

Class A tests are applicable to roof coverings that are effective against severe test exposure, afford a severe degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard. To be regarded as Class A, a roofing system shall meet the requirements of eight tests: four Burning Brand tests, two Spread of Flame tests, and two Intermittent Flame tests. Each Class A Burning Brand test requires a Class A burning brand to be placed on the test deck. The brand must be positioned at the location considered most vulnerable to fire penetration. Each Class A Intermittent Flame test requires fifteen 2-min exposures to a 1400 °F ± 50 °F flame with a 2-min interval between each exposure. Each Class A Spread of Flame test requires a single 10-min exposure to a 1400 °F ± 50 °F flame. All tests are performed in the presence of a 1056 ± 44-ft/min air velocity.

In order to meet acceptance criteria in accordance with ASTM E 108-07a, a roof covering material shall meet the following conditions when subjected to the particular class of fire tests:

1. At no time during or after the Intermittent Flame, Spread of Flame, or Burning Brand tests shall:
    - Any portion of the roof covering material be blown or fall off the test deck in the form of flaming or glowing brands that continue to glow after reaching the floor,
    - The roof deck be exposed (except for roof coverings restricted to use over noncombustible deck), or

- Portions of the roof deck fall away in the form of particles that continue to glow after reaching the floor.

2. At no time during the Class A, B, or C Intermittent Flame or Burning Brand tests shall there be sustained flaming of the underside of the deck. If flaming does occur, conduct another series of tests, during which no sustained flaming shall occur.
3. During the Spread of Flame tests, the flaming shall not spread beyond 6 ft (1.8 m) for Class A, 8 ft (2.4 m) for Class B, nor 13 ft (4.0 m, the top of the deck) for Class C. There shall be no significant lateral spread of flame from the path directly exposed to the test flame.

3.0 TEST INFORMATION

Client:	TTR Roofing International Inc.
SwRI Project No.:	01.14431.01.325b
Test Specimen	
Identification:	*SPF with a 60 mil EPDM membrane and DensDeck substrate*
Date Received:	July 28, 2009 and November 11, 2009
Description:	TTR Roofing International Inc.'s SPF with 60 mil Firestone RubberGard non-reinforced EPDM membrane. The membrane was adhered to the SPF foam using a nominal 1/4-in. of spray applied adhesive. A 1/2-in. thick substrate of DensDeck was also used.
Dimensions:	N/A
Nominal Weight:	2.75-lb/ft^3 SPF
Construction Details:	In ascending order, the *SPF with a 60 mil EPDM membrane and DensDeck substrate* roofing system consisted of: 1. 15/32-in., 5-ply, Douglas Fir A-C grade plywood decking. 2. 1/2-in. thick DensDeck roofing board. 3. 1-1/2 to 2-in. thickness of SPF. 4. 1/4-in. thickness of spray applied adhesive. 5. Firestone RubberGard non-reinforced EPDM membrane, white in color and 60 mils thick.
Surveillance:	N/A
Color:	Off-white foam and adhesive, White and Black Membrane
Storage Conditions:	Ambient conditions
Test Details	
Test Dates:	July 28, 2009, and November 13 and 23, 2009
Test Location:	Southwest Research Institute's (SwRI's) Fire Technology Department in San Antonio, Texas
Miami-Dade Approval:	The Test Notification Number from Miami-Dade County Florida for this test program is SWRI 09036.
Witnesses:	Mr. Barry L. Badders Jr., P.E. No. 61907, Florida
Calibration Details:	See Appendix A
Tests Conducted:	ASTM E 108-07a Class A
Slope:	1/2:12

Observations: Selected photos taken during the test are presented in Appendix B. Observations made during each test can be found in Appendix C.

Other Details: Testing was also performed on a similar roofing system in which the white 60 mil membrane was replaced with a black 45 mil membrane. Based on previous testing conducted July 28, 2009 by SwRI, it was determined that the roofing system with the black membrane was the more critical system. Classification was sought for both systems; and therefore, SwRI performed Burning Brand testing on both the black and white membrane systems. SwRI performed Intermittent Flame testing only on the black membrane system. These test results are outlined in the results section.

Deviations: For the Intermittent Flame test, a Class A Burning Brand test deck was used in lieu of a Class A Intermittent Flame deck. However, the deck was placed onto the test apparatus backwards, such that the vertical plywood seam on the Burning Brand deck was located at the front of the apparatus closer to the burner location. This was done in order to more accurately represent the Intermittent Flame test deck.

4.0 RESULTS

TTR Roofing International Inc.'s *SPF with a 60 mil EPDM membrane and DensDeck substrate* roof covering system met the Class A Spread of Flame requirements of ASTM E 108-07a. Five additional tests were performed on the roofing systems provided by TTR Roofing International Inc. A summary of these test results are outlined in Table 1.

Table 1. Test Results.

Test No.	Type of Test	Membrane Used	Result
1	Class A BB	Black 45 mil	Pass
2	Class A BB	Black 45 mil	Pass
3	Class A BB	White 60 mil	Pass
4	Class A BB	White 60 mil	Pass
5	Class A IF	Black 45 mil	Pass

5.0 CONCLUSION

SwRI's Fire Technology Department performed testing in general accordance with the Class A requirements of ASTM E 108-07a for TTR Roofing International Inc. on July 28, 2009, and November 13 and 23, 2009. Mr. Barry L. Badders Jr. (Professional Engineer, License No. 61907, registered in the State of Florida) of SwRI was present to witness the testing. Messrs. Stan Cox, John Justice, and Angel Morales representing TTR Roofing International Inc. were present to witness the testing on July 28, 2009 only. The Test Notification Number from Miami-Dade County Florida for this test program is SWRI 09036. Based on the test results and the classification criteria, the *SPF with a 60 mil EPDM membrane and DensDeck substrate* roof covering system, manufactured by TTR Roofing International Inc. and described herein, met the ASTM E 108-07a Class A Spread of Flame requirements for roof coverings.

This system also passed two Class A Burning Brand tests. The SPF with a 45 mil EPDM membrane and DensDeck substrate roof covering system passed two additional Class A Burning Brand tests and a Class A Intermittent Flame test. Based on these test results, it is in the opinion of SwRI that the *SPF with a 60 mil EPDM membrane and DensDeck substrate* roof covering system would meet the full Class A requirements of ASTM E 108-07a.

APPENDIX A

CALIBRATION DATA

(Consisting of 1 Page)

Calibration Data

Calibration Date: July 28, 2009

Air Velocity (ft/min):	Right	1100	
	Center	1099	
	Left	1035	
Flame Temperature (°F):	2-min Average	1400	(760 °C)

Calibration Data

Calibration Date: November 13, 2009

Air Velocity (ft/min):	Right	1098	
	Center	1054	
	Left	1092	
Flame Temperature (°F):	2-min Average	N/A	

Calibration Data

Calibration Date: November 23, 2009

Air Velocity (ft/min):	Right	1086	
	Center	1075	
	Left	1086	
Flame Temperature (°F):	2-min Average	1416	(769 °C)

APPENDIX B

SELECTED TEST PHOTOGRAPHS

(Consisting of 5 Pages)

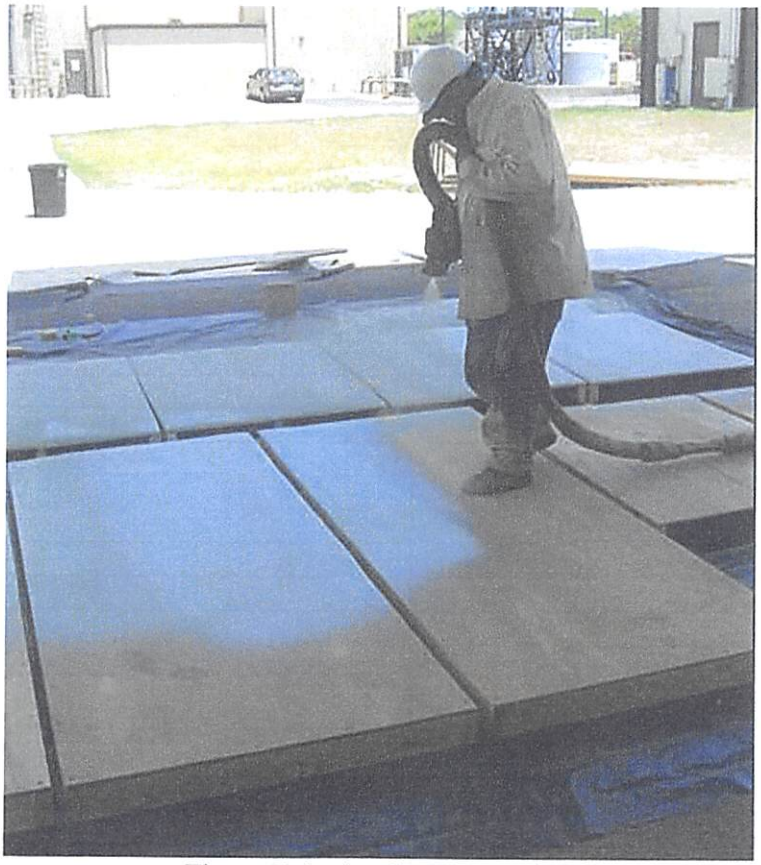

Figure B-1. Application of SPF.

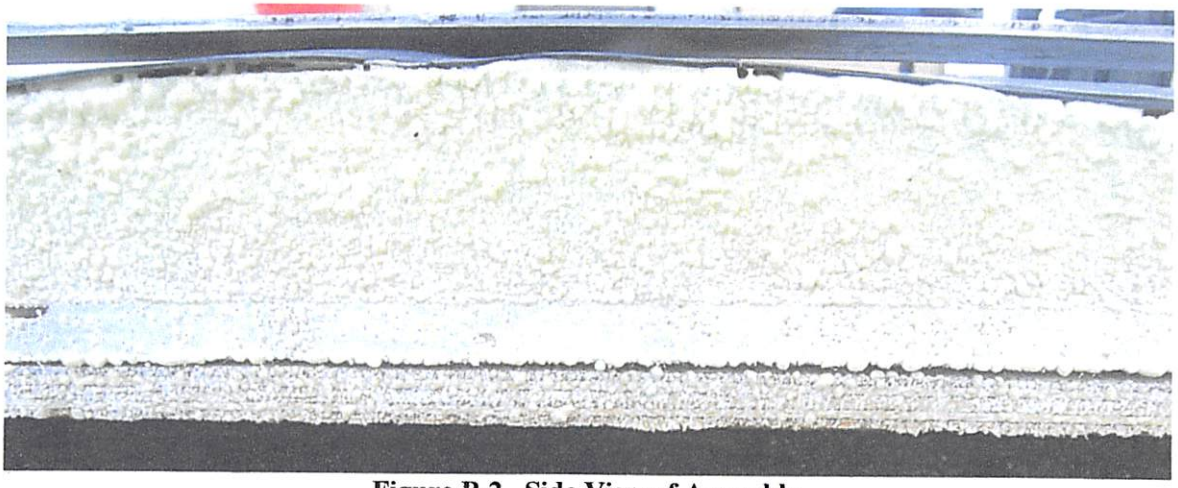

Figure B-2. Side View of Assembly.

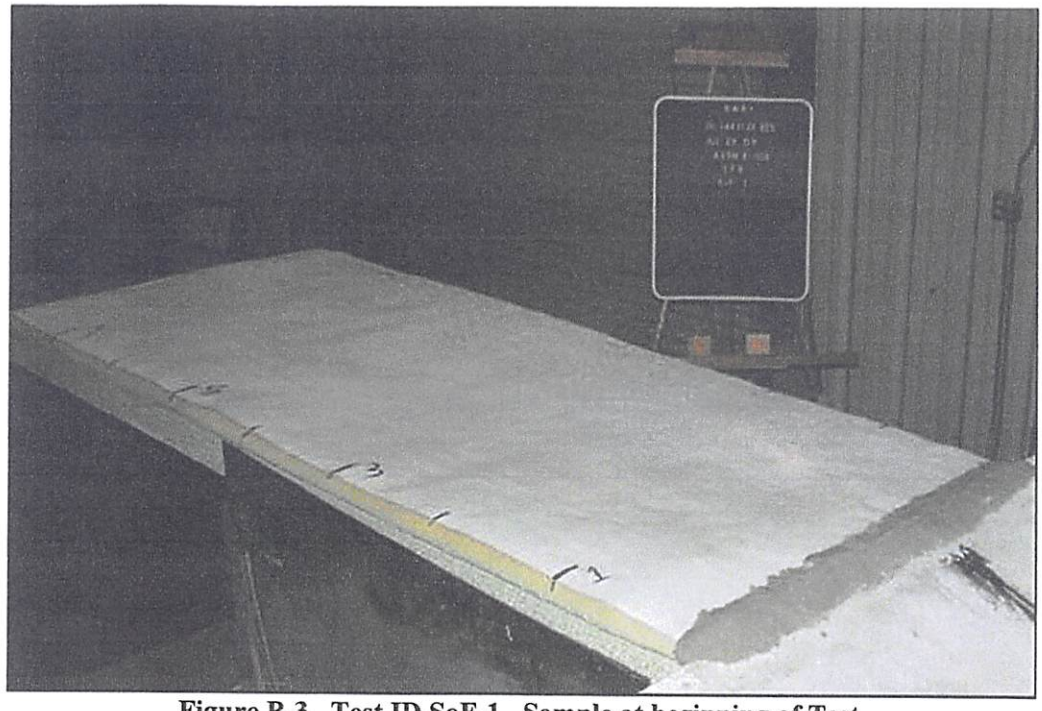

Figure B-3. Test ID SoF-1. Sample at beginning of Test.

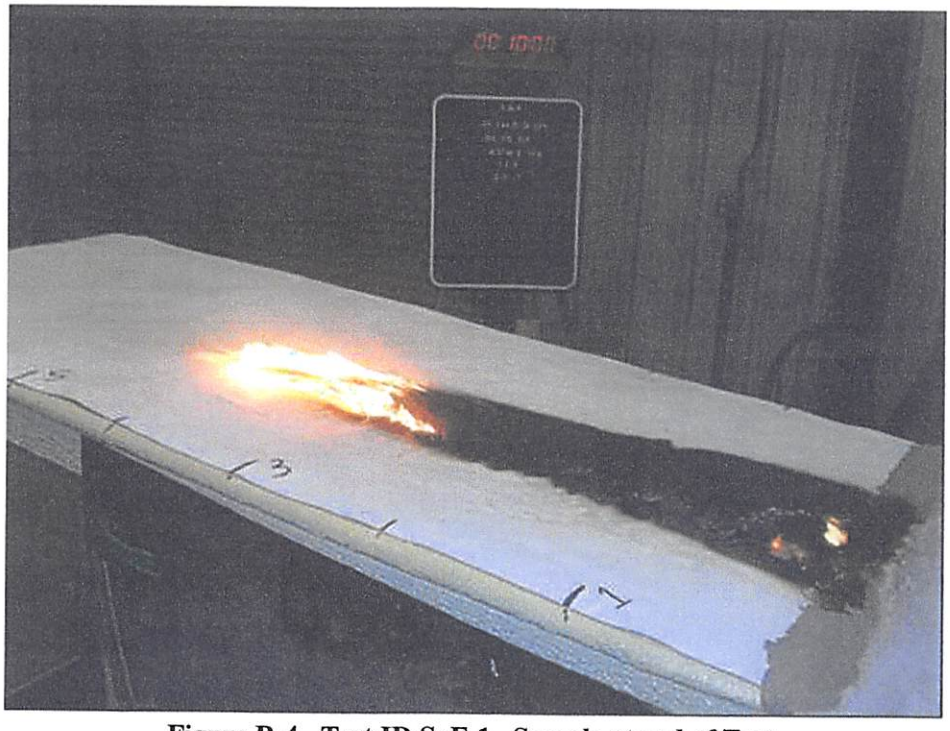

Figure B-4. Test ID SoF-1. Sample at end of Test.

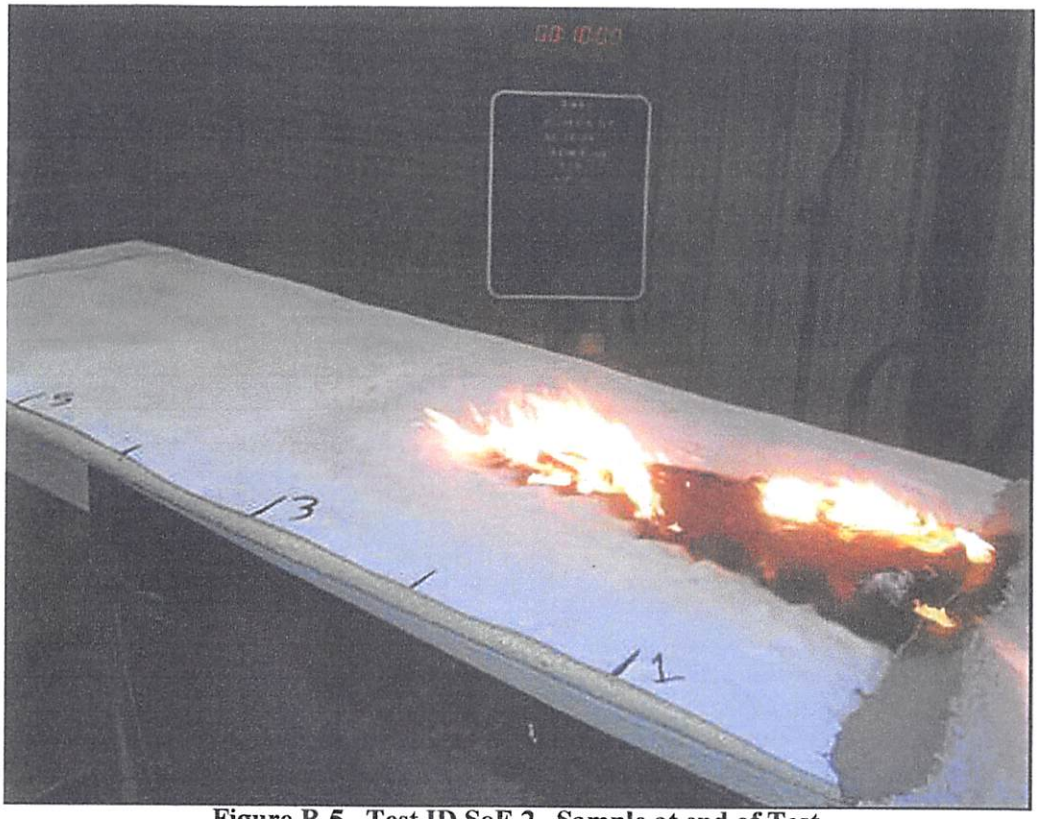

Figure B-5. Test ID SoF-2. Sample at end of Test.

Figure B-6. Test ID BB-1. Sample at end of Test.

Figure B-7. Test ID BB-1. Underside of Deck at end of Test.

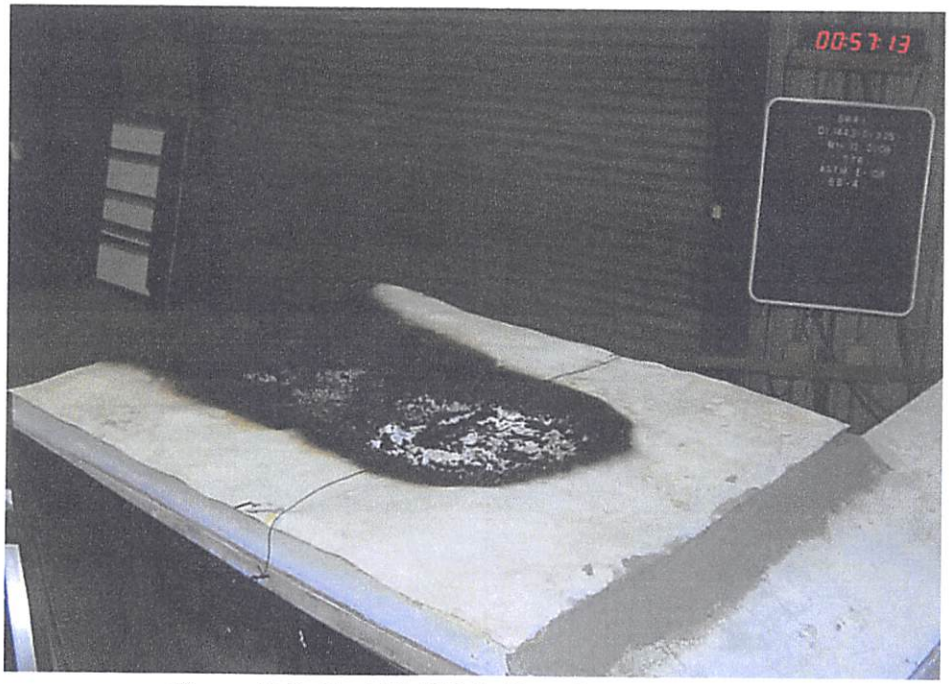

Figure B-8. Test ID BB-4. Sample at end of Test.

Figure B-9. Test ID IF-1. Sample at end of Test.

APPENDIX C

TEST OBSERVATIONS

(Consisting of 7 Pages)

Class A Burning Brand Test
November 13, 2009

Test ID No.:	BB 1 of 4
Specimen ID:	*SPF with a 45 mil EPDM membrane and DensDeck substrate*
Ambient Air Temperature:	70 °F (21.1 °C)
Deck EMC:	7.3 %
Brand Weight:	4.46 lb (2,021 g)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; brand placed on deck.
02:00	Flame spread to end of deck.
04:00	Flames spreading toward front of deck.
14:45	Flaming ceased. Brand 90% consumed.
22:00	Light smoking observed on underside.
39:30	Test stopped. No failure conditions present. **PASS**

Class A Burning Brand Test
November 13, 2009

Test ID No.:	BB 2 of 4
Specimen ID:	*SPF with a 45 mil EPDM membrane and DensDeck substrate*
Ambient Air Temperature:	73 °F (22.8 °C)
Deck EMC:	8.5 %
Brand Weight:	4.52 lb (2,053 g)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; brand placed on deck.
02:00	Flame spread to end of deck.
20:00	Flaming ceased. Minimal glowing near brand remains.
44:00	Test stopped. No failure conditions present. **PASS**

Class A Burning Brand Test
November 13, 2009

Test ID No.:	BB 3 of 4
Specimen ID:	*SPF with a 60 mil EPDM membrane and DensDeck substrate*
Ambient Air Temperature:	74 °F (23.3 °C)
Deck EMC:	8.3 %
Brand Weight:	4.71 lb (2,137 g)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; brand placed on deck.
02:30	Flame spread to end of deck.
16:30	Minimal flaming remains.
51:00	Test stopped. No failure conditions present. **PASS**

Class A Burning Brand Test
November 13, 2009

Test ID No.:	BB 4 of 4
Specimen ID:	*SPF with a 60 mil EPDM membrane and DensDeck substrate*
Ambient Air Temperature:	74 °F (23.3 °C)
Deck EMC:	8.6 %
Brand Weight:	4.39 lb (1,992 g)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; brand placed on deck.
03:00	Flame spread to end of deck.
50:00	Smoking observed on underside of deck.
56:20	Test stopped. No failure conditions present. **PASS**

Class A Intermittent Flame Test
November 23, 2009

Test ID No.:	IF 1 of 1
Specimen ID:	*SPF with a 45 mil EPDM membrane and DensDeck substrate*
Ambient Air Temperature:	61 °F (16.1 °C)
Deck EMC:	16.0%

TIME MIN:S	OBSERVATIONS
00:00	Start of test; Cycle #1 start. Blistering at leading edge after 30 s. Ignition at leading edge after 40 s.
02:00	Cycle #1 complete. Flames spreading toward end of deck.
04:00	Cycle #2 start. Flames spread to end of deck.
06:00	Cycle #2 complete.
08:00	Cycle #3 start. Flaming ceased at end of deck at 8 min 20 s.
10:00	Cycle #3 complete. Flaming ceased at leading edge of deck.
12:00	Cycle #4 start.
14:00	Cycle #4 complete. No ignition.
16:00	Cycle #5 start.
18:00	Cycle #5 complete. No ignition.
20:00	Cycle #6 start.
22:00	Cycle #6 complete. No ignition.
24:00	Cycle #7 start.
26:00	Cycle #7 complete. No ignition.
28:00	Cycle #8 start.
30:00	Cycle #8 complete. No ignition.
32:00	Cycle #9 start.
34:00	Cycle #9 complete. No ignition.
36:00	Cycle #10 start.
38:00	Cycle #10 complete. No ignition.
40:00	Cycle #11 start.
42:00	Cycle #11 complete. No ignition.
44:00	Cycle #12 start.
46:00	Cycle #12 complete. No ignition.
48:00	Cycle #13 start.
50:00	Cycle #13 complete. No ignition.
52:00	Cycle #14 start.
54:00	Cycle #14 complete. No ignition.
56:00	Cycle #15 start.
58:00	Cycle #15 complete. No ignition. Test stopped. No failure conditions present. **PASS**

Class A Spread of Flame Test
July 28, 2009

Test ID No.: SoF 1 of 2
Specimen ID: *SPF with a 60 mil EPDM membrane*
Ambient Air Temperature: 88 °F (31.1 °C)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; burner on.
00:45	Bubbling and ignition at leading edge of sample.
10:00	Test stopped. Flame-spread to 4-1/4 ft. No failure conditions present. **PASS**

Flame-Spread Distance and Time.

Distance	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft
Time (min:s)	1:50	3:45	5:45	9:30	-	-	-	-

Class A Spread of Flame Test
July 28, 2009

Test ID No.:	SoF 2 of 2
Specimen ID:	SPF with a 60 mil EPDM membrane
Ambient Air Temperature:	90 °F (32.2 °C)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; burner on.
01:00	Bubbling at leading edge.
03:25	Ignition at leading edge.
04:30	Flame-spread to 1 ft.
10:00	Test stopped. Flame-spread to 2-3/4 ft. No failure conditions present. **PASS**

Flame-Spread Distance and Time.

Distance	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft
Time (min:s)	4:30	7:45	-	-	-	-	-	-

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
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EVALUATION OF THE EXTERNAL FIRE RESISTANCE CHARACTERISTICS OF ROOF COVERING SYSTEMS IN ACCORDANCE WITH ASTM E 108-07a, *STANDARD TEST METHODS FOR FIRE TESTS OF ROOF COVERINGS:* CLASS A TESTING, SPREAD OF FLAME ONLY

SAMPLE ID: ***SPF with an EPDM membrane***

FINAL REPORT
Consisting of 12 Pages

SwRI® Project No. 01.14431.01.325a
Test Date: July 28, 2009
Report Date: September 1, 2009

Prepared for:

TTR Roofing International Inc.
115 Fairway Drive
Callander, ON P0H 1H0 Canada

Prepared By:

John Marshall Sharp
Engineer
Fire Resistance Section

9/1/09
Approved By:

Barry L. Badders, Jr., P.E.
No. 61907, Florida
Manager
Fire Resistance Section

1.0 INTRODUCTION

This report presents the results of an investigation of the external fire resistance characteristics of the *SPF with an EPDM membrane* roof covering system in accordance with Class A Spread of Flame requirements of ASTM E 108-07a, *Standard Test Methods for Fire Tests of Roof Coverings.* The objective of this standard is to measure the relative fire resistance characteristics of roof coverings under a simulated fire originating outside the building. This standard is used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment that takes into account all of the factors, pertinent to an assessment of the fire hazard of a particular end use. The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

2.0 CLASSIFICATION CRITERIA

Class A tests are applicable to roof coverings that are effective against severe test exposure, afford a severe degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard. To be regarded as Class A, a roofing system shall meet the requirements of eight tests: four Burning Brand tests, two Spread of Flame tests, and two Intermittent Flame tests. Each Class A Burning Brand test requires a Class A burning brand to be placed on the test deck. The brand must be positioned at the location considered most vulnerable to fire penetration. Each Class A Intermittent Flame test requires fifteen 2-min exposures to a 1400 °F ± 50 °F flame with a 2-min interval between each exposure. Each Class A Spread of Flame test requires a single 10-min exposure to a 1400 °F ± 50 °F flame. All tests are performed in the presence of a 1056 ± 44-ft/min air velocity.

In order to meet acceptance criteria in accordance with ASTM E 108-07a, a roof covering material shall meet the following conditions when subjected to the particular class of fire tests:

1. At no time during or after the Intermittent Flame, Spread of Flame, or Burning Brand tests shall:
    - Any portion of the roof covering material be blown or fall off the test deck in the form of flaming or glowing brands that continue to glow after reaching the floor,
    - The roof deck be exposed (except for roof coverings restricted to use over noncombustible deck), or
    - Portions of the roof deck fall away in the form of particles that continue to glow after reaching the floor.

2. At no time during the Class A, B, or C Intermittent Flame or Burning Brand tests shall there be sustained flaming of the underside of the deck. If flaming does occur, conduct another series of tests, during which no sustained flaming shall occur.
3. During the Spread of Flame tests, the flaming shall not spread beyond 6 ft (1.8 m) for Class A, 8 ft (2.4 m) for Class B, nor 13 ft (4.0 m, the top of the deck) for Class C. There shall be no significant lateral spread of flame from the path directly exposed to the test flame.

3.0 TEST INFORMATION

Client:	TTR Roofing International Inc.
SwRI Project No.:	01.14431.01.325a
Test Specimen	
Identification:	*SPF with an EPDM membrane*
Date Received:	July 28, 2009
Description:	TTR Roofing International Inc.'s SPF with Firestone RubberGard non-reinforced EPDM membrane. The membrane was adhered to the SPF foam using a nominal 1/4 in. of spray applied adhesive.
Dimensions:	40 in. wide × 96 in. long
Nominal Weight:	2.75-lb/ft³ SPF
Construction Details:	In ascending order, the *SPF with an EPDM membrane* roofing system consisted of: 1. 15/32-in., 5-ply, A-C grade plywood decking. 2. 1-1/2 to 2-in. thickness of SPF. 3. 1/4-in. thickness of spray applied adhesive. 4. Firestone RubberGard non-reinforced EPDM membrane, white in color and 60 mils thick.
Surveillance:	N/A
Color:	Off-white foam and adhesive, White Membrane
Storage Conditions:	Ambient conditions
Test Details	
Test Date:	July 28, 2009
Test Location:	Southwest Research Institute's (SwRI) Fire Technology Department in San Antonio, Texas
Miami-Dade Approval:	The Test Notification Number from Miami-Dade County Florida for this test program is SWRI 09033.
Witnesses:	Mr. Stan Cox, representing TTR Roofing International, Inc. Mr. John Justice, representing TTR Roofing International Inc. Mr. Angel Morales, representing TTR Roofing International, Inc. Mr. Barry L. Badders Jr., P.E. No. 61907, Florida
Calibration Details:	See Appendix A
Tests Conducted:	ASTM E 108-07a Class A Spread of Flame
Slope:	1/2:12
Observations:	Selected photos taken during the test are presented in Appendix B. Observations made during each test can be found in Appendix C.

4.0 RESULTS

TTR Roofing International Inc.'s *SPF with an EPDM membrane* roof covering system met the Class A Spread of Flame requirements of ASTM E 108-07a.

5.0 CONCLUSION

SwRI's Fire Technology Department performed testing in accordance with ASTM E 108-07a Class A Spread of Flame for TTR Roofing International Inc. on July 28, 2009. Mr. Barry L. Badders Jr. (Professional Engineer, License No. 61907, registered in the State of Florida) of SwRI and Messrs. Stan Cox, John Justice, and Angel Morales representing TTR Roofing International Inc. were present to witness the testing. The Test Notification Number from Miami-Dade County Florida for this test program is SWRI09033. Based on the test results and the classification criteria, the *SPF with an EPDM membrane* roof covering system, manufactured by TTR Roofing International Inc. and described herein, met the ASTM E 108-07a Class A Spread of Flame requirements for roof coverings.

APPENDIX A

CALIBRATION DATA

(Consisting of 1 Page)

Calibration Data

Calibration Date: July 28, 2009

Air Velocity (ft/min):	Right	1100	
	Center	1099	
	Left	1035	
Flame Temperature (°F):	2-min Average	1400	(760 °C)

APPENDIX B

SELECTED TEST PHOTOGRAPHS

(Consisting of 2 Pages)

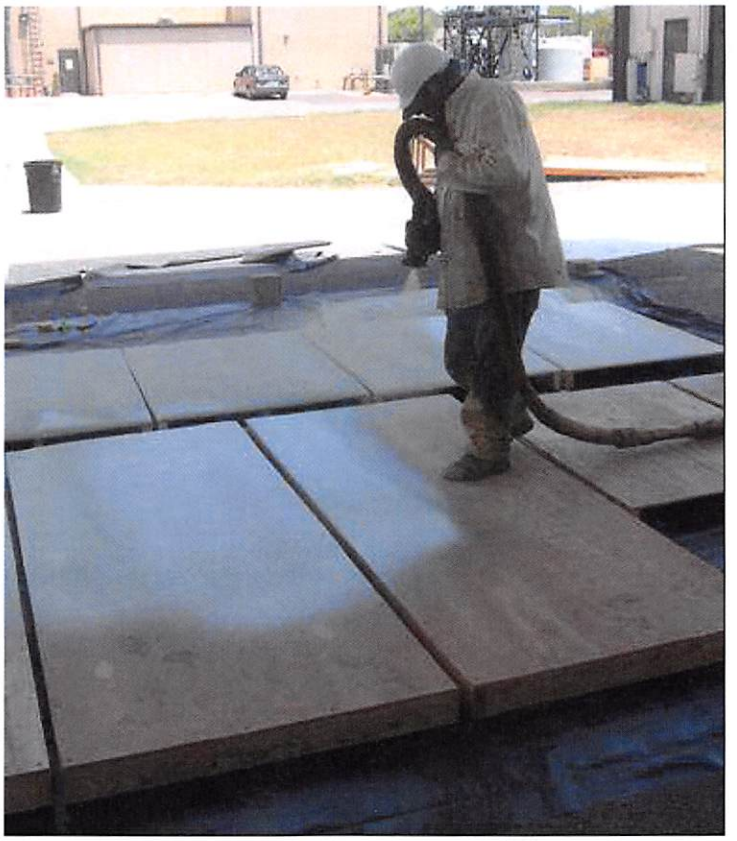

Figure B-1. Application of SPF.

Figure B-2. Test ID SoF-1. Sample at beginning of Test.

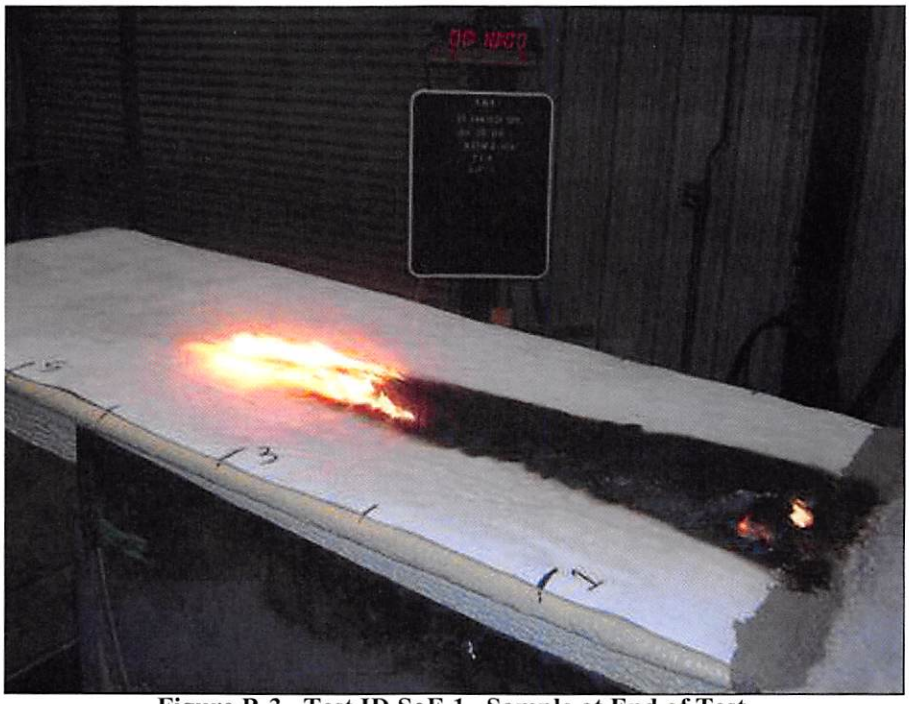

Figure B-3. Test ID SoF-1. Sample at End of Test.

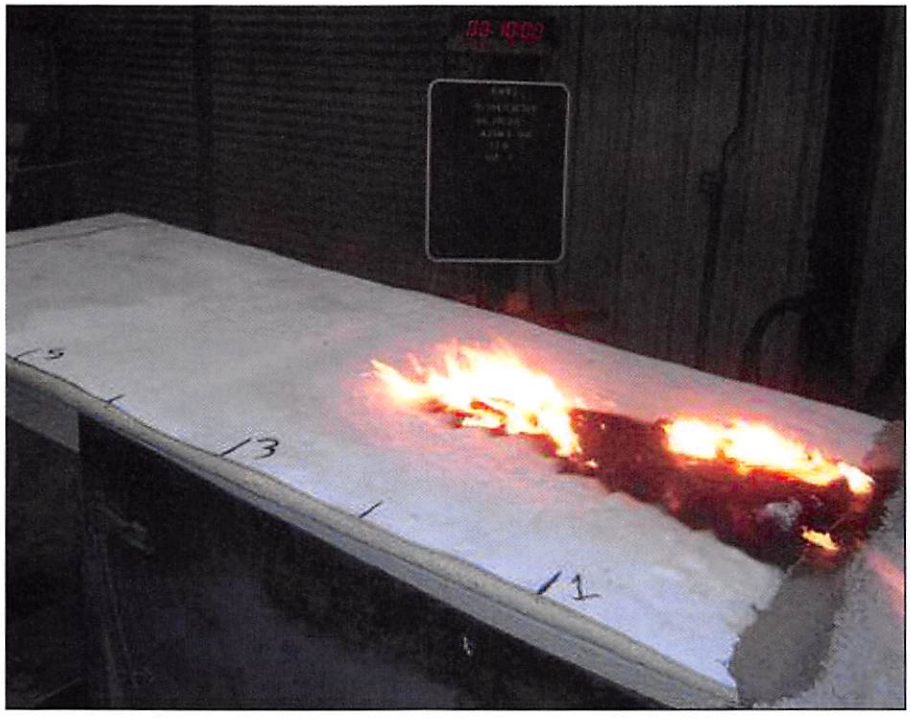

Figure B-4. Test ID SoF-2. Sample at End of Test.

APPENDIX C

TEST OBSERVATIONS

(Consisting of 2 Pages)

Class A Spread of Flame Test
July 28, 2009

Test ID No.: SoF 1 of 2
Specimen ID: *SPF with an EPDM membrane*
Ambient Air Temperature: 88 °F (31.1 °C)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; burner on.
00:45	Bubbling and ignition at leading edge of sample.
10:00	Test stopped. Flame-spread to 4-1/4 ft. No failure conditions present. **PASS**

Flame-Spread Distance and Time.

Distance	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft
Time (min:s)	1:50	3:45	5:45	9:30	-	-	-	-

Class A Spread of Flame Test
July 28, 2009

Test ID No.: SoF 2 of 2
Specimen ID: *SPF with an EPDM membrane*
Ambient Air Temperature: 90 °F (32.2 °C)

TIME MIN:S	OBSERVATIONS
00:00	Start of test; burner on.
01:00	Bubbling at leading edge.
03:25	Ignition at leading edge.
04:30	Flame-spread to 1 ft.
10:00	Test stopped. Flame-spread to 2-3/4 ft. No failure conditions present. **PASS**

Flame-Spread Distance and Time.

Distance	1 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft
Time (min:s)	4:30	7:45	-	-	-	-	-	-

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INVESTIGATION OF THE SURFACE BURNING CHARACTERISTICS OF A NOMINAL 0.25-IN. THICK URETHANE FOAM ADHESIVE, SPRAY APPLIED TO 0.25-IN. THICK CEMENT BOARD MATERIAL ID: TTR 007 G

FINAL REPORT
Consisting of 5 Pages
SwRI® Project No.: 01.14430.01.220

Test Date: July 30, 2009
Report Date: August 25, 2009

Prepared for:

TTR ROOFING INTERNATIONAL INC.
115 FAIRWAY DRIVE
CALLANDER, ONTARIO, P0H 1H0
CANADA

8/26/09

Prepared by:	Approved by:	Reviewed by:
A. L. Sauceda	Gladys M. Miller	Barry Badders
Anthony L. Sauceda	Gladys M. Miller, M.S., M.B.A.	Barry L. Badders, Jr., P.E.
Group Leader	Assistant Director	No. 61907, Florida
Material Flammability Section	Fire Technology Department	

INTRODUCTION

This report presents the test results for a specimen submitted by TTR Roofing International Inc., located in Callander, Ontario, Canada, and tested at Southwest Research Institute's (SwRI's) Fire Technology Department, located in San Antonio, Texas. The test is conducted in accordance with the procedure outlined in ASTM E 84 - 08a, *Standard Test Method for Surface Burning Characteristics of Building Materials* (NFPA 255, ANSI/UL 723 and UBC 8-1).

This test method is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period. The test is conducted with the material in the ceiling position.

The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame Spread and Smoke Developed index are reported. However, there is not necessarily a relationship between these two measurements.

This standard should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a fire-hazard assessment or a fire-risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

Test specimens are conditioned as appropriate in an atmosphere maintained between 68 and 78 °F and 45 to 55% relative humidity. Immediately prior to the test, the specimen is mounted in the furnace with the side to be tested facing the test flame. Cement board is placed on the unexposed side of the specimen to protect the furnace lid assembly. Sometimes, because of the nature of the material undergoing testing, additional support (e.g. wire, wire and rods, rods, and/or bars) is used to ensure that the specimen will remain in position during the test. The use of supporting materials on the underside of the test specimen may lower the Flame Spread Index from that which might be obtained if the specimen could be tested without such support, and the test results do not necessarily relate to indices obtained by testing materials without such support.

The flame front position and light obscuration are recorded throughout the 10-minute test and used to calculate the Flame Spread and Smoke Developed indices. The temperature at 23 ft is also recorded. The Flame Spread and Smoke Developed indices reported herein are relative to the results obtained for mineral fiber-reinforced cement board and select grade red oak (moisture content between 6 and 8%). The mineral fiber-reinforced cement board is the calibration material used to obtain 0 values for Flame Spread and Smoke; red oak decks are used to obtain 100 values for Flame Spread and Smoke.

The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

Two model building codes (2003 International Building Code®, Chapter 8 *Interior Finishes*, Section 803 *Wall and Ceiling Finishes*; NFPA 5000, Chapter 10 *Interior Finish*, Section 10.3 *Interior Wall or Ceiling Finish Testing and Classification*) classify materials based on the Flame Spread and Smoke Developed indices. For reference purposes, the classification criteria are listed below:

Classification	Flame Spread Index	Smoke Developed Index
A	0 – 25	0 – 450
B	26 – 75	0 – 450
C	76 – 200	0 – 450

ASTM E 84 – 08a REPORT

CLIENT: TTR ROOFING INTERNATIONAL INC.
SWRI PROJECT NO.: 01.14430.01.220
TEST DATE: JULY 30, 2009
DAILY TEST NO.: 4

DESCRIPTION OF SPECIMEN

DATE RECEIVED:	July 28, 2009
MATERIAL ID:*	TTR 007 G
DESCRIPTION:*	Urethane foam adhesive
THICKNESS:	0.25 in. (nominal)
UNIT WEIGHT:	30.8 lbs per board (nominal)
COLOR:	Yellow
SUBSTRATE:*	0.25-in. thick cement board
SPECIMEN SIZE:	Three boards, 24.0 in. wide × 96.0 in. long
CONSTRUCTION:	Mr. Stan Cox of TTR Roofing International Inc. spray-applied urethane foam adhesive to 0.25-in. thick cement board at a nominal thickness of 0.25 in. on July 28, 2009
CONDITIONING TIME:	2 days at 70 °F and 50% relative humidity
SUPPORT USED:	None
COMMENTS:	The test was performed under the supervision of Mr. Barry L. Badders (Professional Engineer, License No. 61907, registered in the State of Florida) of Southwest Research Institute. The Test Notification Number from Miami-Dade County Florida for this test program is SWRI 09032.

* From Client's material description and/or instructions

ASTM E 84 – 08a REPORT

CLIENT: TTR ROOFING INTERNATIONAL INC.
SWRI PROJECT NO.: 01.14430.01.220
TEST DATE: JULY 30, 2009
DAILY TEST NO.: 4

TEST RESULTS

FLAME SPREAD INDEX (FSI):	35
SMOKE DEVELOPED INDEX (SDI):	75

TEST DATA

UNROUNDED FSI:	32.9
UNROUNDED SDI:	76.3
FS*TIME AREA (Ft*Min):	64.0
SMOKE AREA (%*Min):	52.9
FUEL AREA (°F*Min):	5252.6

OBSERVATIONS DURING TEST

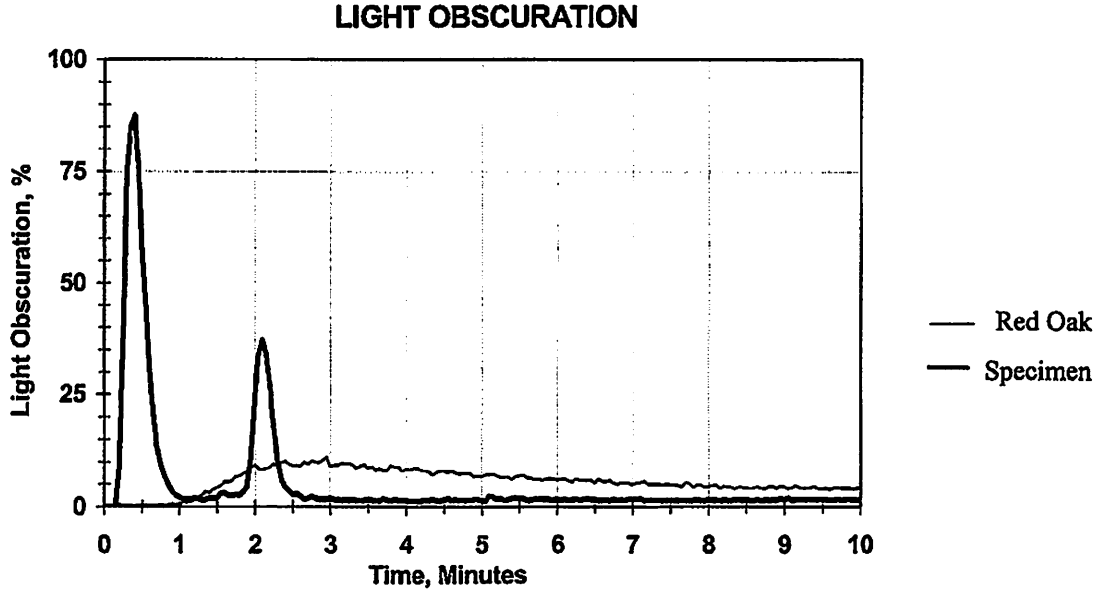
IGNITION TIME (Min:Sec):	00:08
MAXIMUM FLAME FRONT ADVANCE (Ft.):	6.5
TIME TO MAXIMUM ADVANCE (Min:Sec):	0:24
MAXIMUM TEMP. AT EXPOSED TC (°F):	580
TIME TO MAXIMUM TEMP. (Min:Sec):	9:54
TOTAL FUEL BURNED (Cu. Ft.):	55.0
DRIPPING (Min:Sec):	None
FLAMING ON FLOOR (Min:Sec):	None
AFTERFLAME TOP (Min:Sec):	None
AFTERFLAME FLOOR (Min:Sec):	None
SAGGING (Min:Sec):	01:45
DELAMINATION (Min:Sec):	None
SHRINKAGE (Min:Sec):	None
FALLOUT (Min:Sec):	05:41

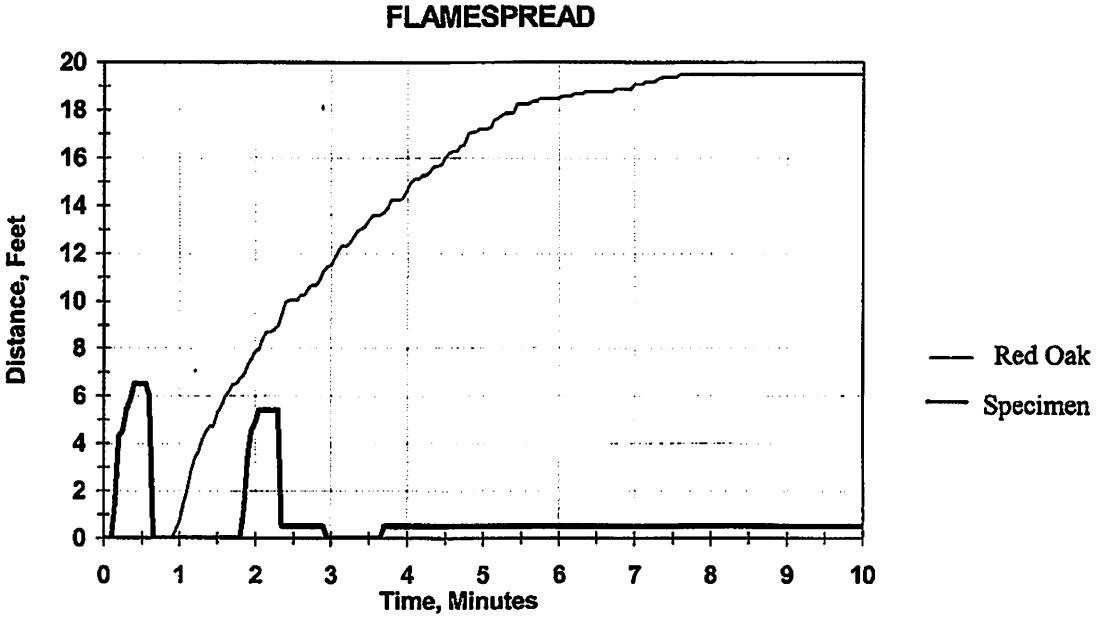
CALIBRATION DATA

RED OAK SMOKE AREA (%*Min):	61.0
RED OAK FUEL AREA (°F*Min):	8045
GRC BOARD FUEL AREA (°F*Min):	5164

ASTM E 84 – 08a REPORT

CLIENT: TTR ROOFING INTERNATIONAL INC.
SWRI PROJECT NO.: 01.14430.01.220
TEST DATE: JULY 30, 2009
DAILY TEST NO.: 4





MIAMI-DADE COUNTY

BUILDING CODE COMPLIANCE OFFICE (BCCO)
PRODUCT CONTROL DIVISION

MIAMI-DADE COUNTY, FLORIDA
METRO-DADE FLAGLER BUILDING
140 WEST FLAGLER STREET, SUITE 1603
MIAMI, FLORIDA 33130-1563
(305) 375-2901 FAX (305) 375-2908

NOTICE OF ACCEPTANCE (NOA)

TTR ROOFING INTERNATIONAL INC.
5317 Fruitville Rd. #49
Sarasota, FL. 34232

SCOPE:

This NOA is being issued under the applicable rules and regulations governing the use of construction materials. The documentation submitted has been reviewed by Miami-Dade County Product Control Division and accepted by the Board of Rules and Appeals (BORA) to be used in Miami Dade County and other areas where allowed by the Authority Having Jurisdiction (AHJ).

This NOA shall not be valid after the expiration date stated below. The Miami-Dade County Product Control Division (In Miami Dade County) and/or the AHJ (in areas other than Miami Dade County) reserve the right to have this product or material tested for quality assurance purposes. If this product or material fails to perform in the accepted manner, the manufacturer will incur the expense of such testing and the AHJ may immediately revoke, modify, or suspend the use of such product or material within their jurisdiction. BORA reserves the right to revoke this acceptance, if it is determined by Miami-Dade County Product Control Division that this product or material fails to meet the requirements of the applicable building code.

This product is approved as described herein, and has been designed to comply with the Florida Building Code and the High Velocity Hurricane Zone of the Florida Building Code.

DESCRIPTION: TTR007F Polyfoam and TTR007G adhesive with EPDM over Concrete Decks

LABELING: Each unit shall bear a permanent label with the manufacturer's name or logo, city, state and following statement: "Miami-Dade County Product Control Approved", unless otherwise noted herein.

RENEWAL of this NOA shall be considered after a renewal application has been filed and there has been no change in the applicable building code negatively affecting the performance of this product.

TERMINATION of this NOA will occur after the expiration date or if there has been a revision or change in the materials, use, and/or manufacture of the product or process. Misuse of this NOA as an endorsement of any product, for sales, advertising or any other purposes shall automatically terminate this NOA. Failure to comply with any section of this NOA shall be cause for termination and removal of NOA.

ADVERTISEMENT: The NOA number preceded by the words Miami-Dade County, Florida, and followed by the expiration date may be displayed in advertising literature. If any portion of the NOA is displayed, then it shall be done in its entirety.

INSPECTION: A copy of this entire NOA shall be provided to the user by the manufacturer or its distributors and shall be available for inspection at the job site at the request of the Building Official.

This NOA consists of pages 1 through 6.
The submitted documentation was reviewed by Alex Tigera.

MIAMI-DADE COUNTY APPROVED

ROOFING COMPONENT APPROVAL

Category:	Roofing
Sub-Category:	Spray Applied Polyurethane Roof System
Materials:	Polyurethane
Dect Type	Concrete
Maximum Design Pressure	**-402 psf**

TRADE NAMES OF PRODUCTS MANUFACTURED OR LABELED BY APPLICANT:

Product	Dimensions	Test Specifications	Product Description
TTR 007F	N/A	TAS 110	Polyurethane spray applied foam that utilizes an HFC blowing agent intended for roofing applications.
TTR007G	N/A	TAS 110	Two-part spray applied polyurethane foam used to adhere single ply roofing to insulation.

MANUFACTURING LOCATION:

1. Waukesha, WI.

TRADE NAMES OF PRODUCTS MANUFACTURED BY OTHERS:

Product	Dimensions	Test Specifications	Product Description	Manufacturer
RubberGuard EPDM	Various	ASTM D 4637	EPDM Membrane	Firestone Building Products Co.
RubberGuard ECO White EPDM	Various	ASTM D 4637	EPDM Membrane	Firestone Building Products Co.

EVIDENCE SUBMITTED:

Test Agency	Test Identifier	Test Name/Report	Date
PRI Construction Materials Technologies	GWI-003-02-01	TAS 110	01/09/07
	GWI-002-02-201	ASTM D 6083 Fed Spec TT-C-555B	01/09/07
	TTRI-001-02-01	ASTM D 1621 ASTM D 1622 ASTM D 2126 ASTM D 2856 ASTM E 96	11/12/09
Underwriters Laboratories	File R5663 Project 07NK02171	UL 790	03/13/07
Factory Mutual	ID. 3023644	4470 ASTM E 108 TAS 114	02/02/07
Atlantic & Caribbean Roof Consulting, LLC.	ACRC 08-004	TAS 114 App. D	01/29/08
Southwest Research Institute	01.14431.01.325a 01.14431.01.325b	Fire Classification	09/01/09 11/30/09

APPROVED ASSEMBLIES:

Deck Type 3: Concrete

Deck Description: 2500 psi structural concrete or concrete plank

System Type: Sprayed polyurethane foam covered with RubberGuard or RubberGuard Eco White EPDM membrane.

All General and System Limitations apply.

Surface Preparation: Concrete deck shall be in compliance with applicable Building Code and Roofing Application Standard RAS 109.

Substrate shall be primed in accordance with TTR Roofing International, LLC's recommendations, and shall be free of loose dirt, grease, oil or other contaminants prior to priming or foam application. Remove all loose dirt or debris by use of compressed air, vacuum or brooming. No washing shall be permitted. Oil, grease, release agents or other contaminants shall be removed with proper cleaning solutions.

All joint openings in concrete decks that exceed ¼" shall be grouted or caulked.

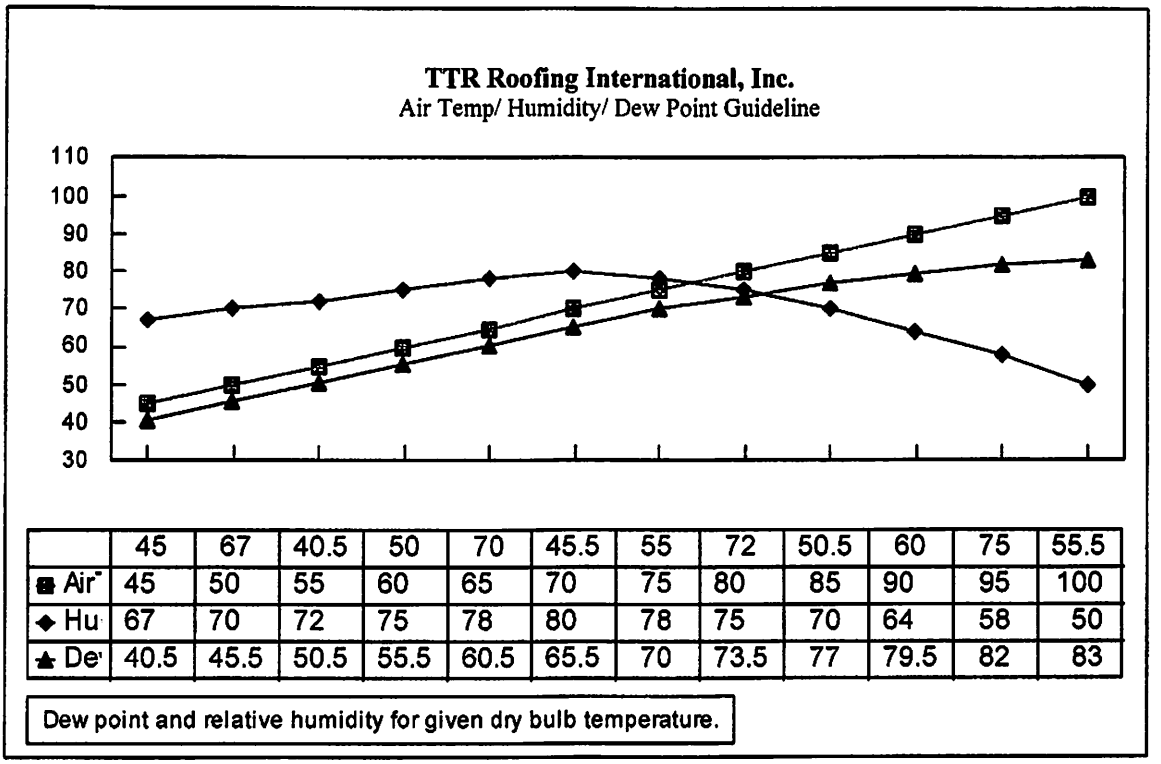
Polyurethane Foam Application: The polyurethane foam shall be applied directly and uniformly over the entire surface at the specified thickness in compliance with the requirements set forth in Roofing Application Standard RAS 109. The sprayed polyurethane foam shall be feathered at the edges to produce a smooth transition.

Top Layer Membrane: Polyurethane foam surface shall be free of moisture, dust, debris, oils, tars, grease or other materials that will impair adhesion of the RubberGuard or RubberGuard Eco White EPDM membrane. Any damage or defects to the polyurethane foam surface shall be repaired prior to the installation of the RubberGuard or RubberGuard Eco White EPDM membrane.

Once the TTR007F Polyurethane foam is set, attach the RubberGuard or RubberGuard Eco White EPDM membrane to the TTR007F Polyurethane foam surface with TTR007G adhesive foam. The TTR007G foam adhesive and RubberGuard or RubberGuard Eco White EPDM membrane shall be applied the same day as the foam when possible. If more than 72 hours elapse prior to the application of the coatings, the polyurethane foam shall be inspected for UV degradation.

Maximum Design Pressure: -402 psf.

TABLE 1
AMBIENT HUMIDITY APPLICATION LIMITS
SPRAYED POLYURETHANE FOAM



	45	67	40.5	50	70	45.5	55	72	50.5	60	75	55.5
■ Air°	45	50	55	60	65	70	75	80	85	90	95	100
◆ Hu	67	70	72	75	78	80	78	75	70	64	58	50
▲ De°	40.5	45.5	50.5	55.5	60.5	65.5	70	73.5	77	79.5	82	83

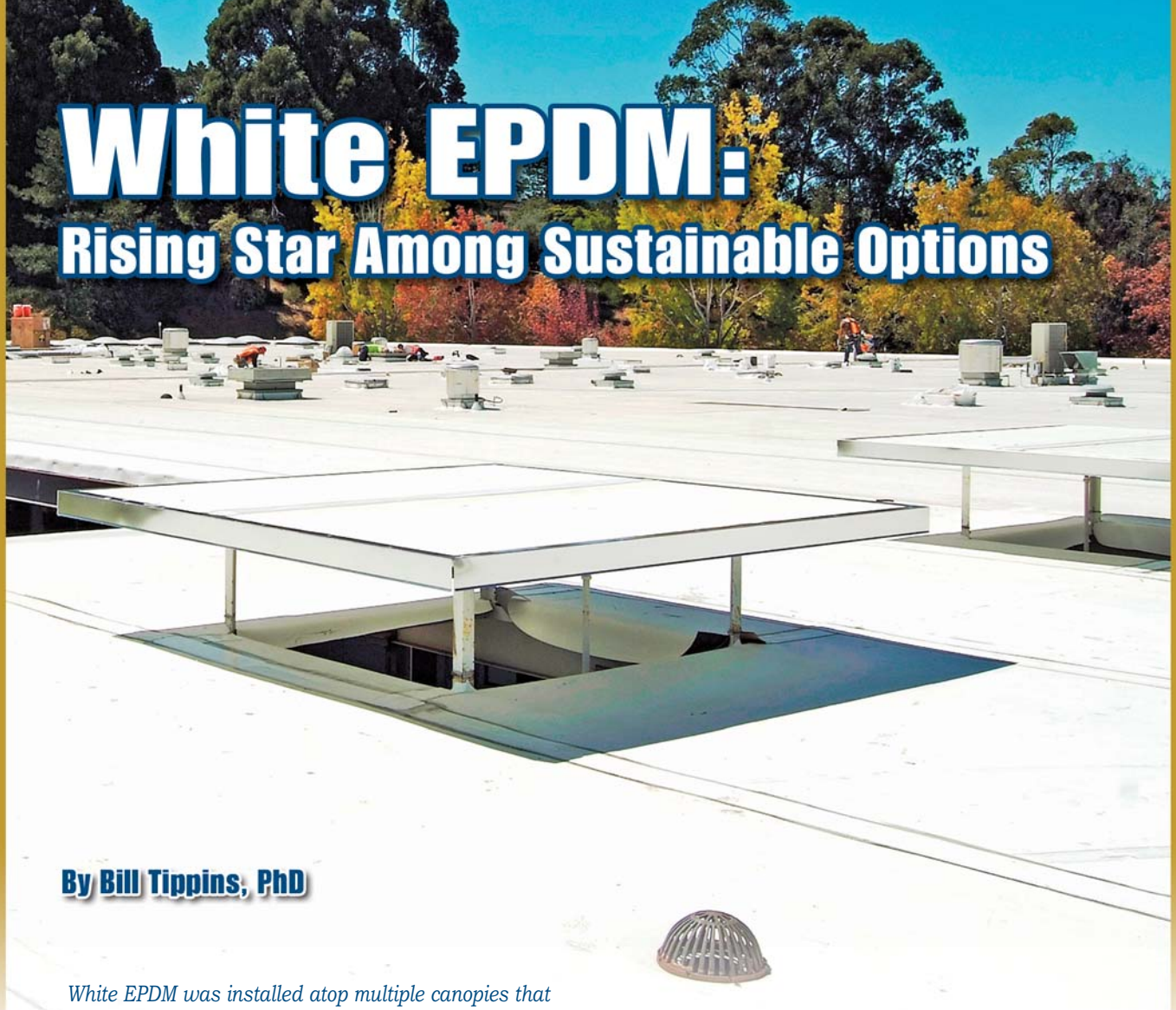
Dew point and relative humidity for given dry bulb temperature.

GENERAL LIMITATIONS:

1. Fire classification is not part of this acceptance, refer to a current Approved Roofing Materials Directory for fire ratings of this product
2. Spray polyurethane foam shall not be sprayed when ambient temperature is within 5 degrees of the dew point. Ambient humidity applications limits shall be as listed in Table 1 herein. Contractor shall monitor and record environmental conditions in the Job Log in compliance with RAS 109. Job Log shall be maintained at the job site and accessible to The Building Official.
3. Flashings and waterproof coverings for expansion joints shall be of compatible materials and in accordance with TTR Roofing International, Inc. published literature.
4. Miscellaneous materials such as adhesives, elastomeric caulking compounds, metal, vents and drains shall be a composite part of the roof system and shall be compatible with the foam and coating.
5. All attachment and sizing of perimeter nailers, metal profile, and/or flashing termination designs shall conform to Roofing Application Standard RAS 111 and the wind load requirements of applicable building code.
6. The maximum designed pressure limitation listed shall be applicable to all roof pressure zones (i.e. field, perimeters, and corners). Neither rational analysis, nor extrapolation shall be permitted for enhanced fastening at enhanced pressure zones (i.e. perimeters, extended corners and corners).

END OF THIS ACCEPTANCE

White EPDM:
Rising Star Among Sustainable Options



By Bill Tippins, PhD

White EPDM was installed atop multiple canopies that covered breezeways at Aragon High School in San Mateo, CA.

With each passing year, the green building movement continues to escalate within the commercial construction market, putting energy-efficient roofing technologies at the forefront. Much of the discussion about sustainable roofing options, however, has focused on photovoltaic (PV) solar panels, daylighting systems, vegetative or garden roofs, as well as white or light-colored reflective roof membranes such as thermoplastic polyolefins (TPO) and polyvinyl chloride (PVC) for low-slope applications.

As a result, it may be easy to overlook the positive environmental impact being made by ethylene propylene diene terpolymer (EPDM) roof membranes. With billions of square feet installed across all climate zones, 40+ years of proven field experience, and a history of research that supports its energy-saving characteristics and overall value, EPDM must be part of the conversation.

From energy efficiency to aesthetics, membrane color does and should play a role in many roofing decisions. However, from a sustainability perspective, consideration must also be given to the roofing materials' durability, life-cycle assessment (LCA), and overall environmental impact. In that regard, EPDM roofing systems – both black and white formulations – have proven they can provide a strong, energy-efficient option. In fact, white EPDM membranes have been among the fastest-growing segments of the single-ply roofing market in recent years due to the increased focus on sustainability.

In addition to the growing emphasis on environmentally responsible building practices, other forces are making LCA requirements more likely in the future. Specifically, these include more sophisticated criteria for financing of construction projects and increasing governmental regulation within the public construction sector.

EPDM – PROVEN HISTORY

According to the EPDM Roofing Association (ERA), EPDM rubber roofing membrane accounts for nearly 1 billion sq. ft. of new roof coverings in the United States annually. Despite being in use for more than four decades, EPDM has seen its most significant growth in the last 25 years. Today, there are well over 500,000 warranted roof installations totaling more than 20 billion sq. ft. of EPDM membrane in place nationwide.

Recent studies conducted on behalf of ERA firmly validate the long-term performance attributes of EPDM roof systems. White EPDM, in particular, has demonstrated that its combination of high reflectivity

and inherent physical characteristics (e.g., fatigue resistance, low-temperature flexibility, thermal-shock durability, etc.) are key considerations when specifying sustainable roof systems.

One study conducted by Tulsa, Oklahoma-based GreenTeam, Inc., a strategic environmental consulting firm specializing in building industry issues, examined LCA data for a variety of membrane types. Included in the study were EPDM (black and white), TPO (gray and white), PVC (gray and white), and SBS-modified bitumen, as well as several attachment methods. A summary of findings was published in the December 2010 *Interface* article "New Life Cycle Data for EPDM: Outstanding Performance in Reducing Environmental Impact," by Thomas Hutchinson, RRC, FRCI, AIA, and principal in the Hutchinson Design Group, Ltd., Barrington, IL.

Among the more noteworthy findings of the comprehensive study was that EPDM performed significantly better than comparable roof assemblies based on its long-term environmental impact. The research, which was based on the most current data available from industry and public sources, also reported that the environmental impact of EPDM is lower than previously thought.

As illustrated in *Figure 1*, the role of service life varies substantially by membrane type, while attachment method plays a less significant role in determining overall environmental impact. The study examined energy-related categories, such as global warming potential (GWP) as measured by kilograms of CO_2-equivalents, because they offer the most relevance. Among the membrane types, fully adhered, nonreinforced, 60-mil white EPDM was found to have the lowest GWP (22.4 kg/m^2), while a 140-mil, "unsurfaced"[1] SBS exhibited the highest (81.8 kg/m^2). Among the other materials studied, reinforced, 60-mil, white PVC produced GWPs of 67.8 kg/m^2 (mechanically attached) and 73.1 kg/m^2 (fully adhered), more than three times that of white EPDM. In fact, three of the four lowest GWP measurements were from EPDM systems.

Additionally, the GreenTeam determined the number of years each system would have to perform to negate the GWP created during its manufacture and installation. Using a service life of 15 years for the system with the lowest GWP – fully adhered, white EPDM – as the benchmark to compare all tested systems, the GreenTeam established that EPDM systems had the lowest service life equivalencies overall. White TPO membranes ranged from 20 to 20.7 years, white PVC systems were 45.4 and 49 years, which means a white PVC roof must stay in place three times longer than a white EPDM roof to achieve equivalency with respect to GWP.

System	Membrane	Attachment	Carbon Footprint (GWP) (kg CO^2 eq./ m^2)	Minimum Service Life to Achieve Equivalency (Years)[1]
EPDM	60-mil nonreinforced black	Ballasted	28.3	19.0
		Fully adhered	29.6	19.8
	60-mil reinforced black	Mech. attached	28.7	19.2
	60-mil nonreinforced white	**Fully adhered**	**22.4**	**15.0**
TPO	60-mil reinforced white	Fully adhered	30.9	20.7
		Mech. attached	29.8	20.0
	60-mil reinforced gray	Fully adhered	30.5	20.4
		Mech. attached	29.4	19.7
PVC	60-mil reinforced white	Fully adhered	73.1	49.0
		Mech. attached	67.8	45.4
	60-mil reinforced gray	Fully adhered	58.6	39.2
		Mech. attached	54.2	36.3
SBS	140-mil "unsurfaced"[2]	Fully adhered	81.8	54.8

(1) Using a conservative 15-year service life for the lowest-impact system (fully adhered white EPDM)
(2) "Unsurfaced" refers to the GWP impact relative to the modified bituminous sheet alone. No consideration is given to additional GWP impact for coatings, foils, or ceramic granule facings.

Figure 1 – Minimum service life to distribute GWP equally. Source: "Life Cycle Inventory and Assessment of Selected Low-Slope Roofing Systems in North America," TEGNOS Research, Inc., 2009.

As a result, the LCA study established that EPDM has the smallest carbon footprint and requires the least service life to be carbon-neutral, compared to other systems tested.

ROLE OF ROOF DURABILITY

In a white paper titled "Sustainable Buildings: Addressing Long-Term Building Envelope Durability," Dr. James Hoff, research director for the Center for Environmental Innovation in Roofing (CEIR), noted several industry researchers have expressed concern that today's green rating systems may not emphasize product durability enough.

Specifically, Hoff cited Jamie McKay, a LEED® Accredited Professional, who said, "The majority of green-building assessment systems focus on the design of the constructed building, with little focus on the effect of the building system's life during operation. This tendency has resulted in a failure of many rating systems to properly consider durability, life cycle cost, and the effects of premature building envelope failures."

Compared to traditional life cycle cost analysis, LCA is a better measure of a roofing material's cradle-to-grave impact and more accurately reflects its long-term economic and environmental value. As such, system durability is a critically important factor in sustainable roofing decisions. While this applies to all building types, it is especially relevant for applications where long-term building ownership is concerned, such as school districts and healthcare facilities.

WHITE EPDM

In use since 1987, white EPDM features similar physical properties and benefits of black EPDM, yet it provides a highly reflective solution to coated membranes and thermoplastics. With its high solar reflectance index value, the bilaminate, white-on-black cured membrane can help achieve points in the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) Green Building Rating System, specifically Section SS 7.2 regarding the heat island effect, which requires the membrane to have a solar reflectance index (SRI) value of greater

CRRC Product ID	Manufacturer	Brand	Solar Reflectivity		Thermal Emittance		Solar Reflectance Index	
			Initial	After 3 yrs.	Initial	After 3 yrs.	Initial	After 3 yrs.
0608-0027	Firestone Building Products	EcoWhite EPDM	0.80	0.72	0.84	0.86	99	88
0612-0009	Tremco	Premium FR T24 Modified Bitumen	0.75	0.63	0.86	0.88	92	76
0628-0003	Carlisle SynTec	Sure-White EPDM	0.76	0.64	0.90	0.87	94	77
0676-0040	GAF	EverGuard PVC White	0.87	0.61	0.95	0.86	111	72
0670-0015	Mule-Hide Products	PVC Bright White	0.87	0.61	0.95	0.86	111	72
0742-0001	Siplast, Inc.	Veral Polar White Spectra Mod Bit	0.62	0.60	0.87	0.81	74	69

Figure 2 – Source: Cool Roof Rating Council Directory of Rated Products (coolroofs.org), updated Nov. 14, 2011.

than 78 for low-slope roof systems.

As shown in *Figure 2*, the Cool Roof Rating Council's online directory of rated products lists solar reflectivity, thermal emittance, and SRI (initial and after three years) for a variety of single-ply thermoset and thermoplastic membranes, as well as modified-bitumen products. Given the increased attention being paid by building owners and roofing professionals to cost-efficient, sustainable roofing solutions, aged reflectivity has become a critically important data point to consider. Although the USGBC has incorporated LCA of building materials in its LEED® rating system, some industry experts believe there is an overemphasis on environmental benefits without equal concern for durability.

Additionally, as a rubber-based material, white EPDM roofing systems are more flexible than thermoplastic membranes, allowing for year-round application. In cooler temperatures, fully adhered EPDM membranes remain pliable and easy to install, while thermoplastics tend to stiffen and are often more difficult to install, particularly on irregular substrates and transition changes around vertical walls, parapets, and curbs.

White EPDM roofing membranes are ideal for UL- and FM-rated systems, while exceeding ASTM D4637 standards. They are well suited for new construction and reroofing applications, and they can be installed over steel, concrete, wood, and other common deck types.

Figure 3 provides a comparison of key physical properties between white and black EPDM. Conducted at Firestone Building Products' research laboratory in Indianapolis, IN, the analysis shows the many similarities between the two membranes across key performance criteria. Most notably for white EPDM is the fact that its performance meets or exceeds that of black EPDM for initial and heat-aged tensile strength, initial and heat-aged tear strength, and ultraviolet (UV) resistance.

Black vs. White EPDM				
Physical Properties	Test Method (per ASTM D4637)	ASTM Minimums	Typical Values Black EPDM (0.060")	Typical Values White EPDM (0.060")
Thickness, min. sheet overall	ASTM D412	0.054 in	0.059 in	0.056"
Tensile strength, min.	ASTM D412 (Die C)	1305 psi	1415 psi	1360 psi
Elongation, ultimate, min.	ASTM D412 (Die C)	300%	492%	468%
Tensile set, max.	ASTM D412 (Die C)	10%	2.58%	2.10%
Tear resistance, min.	ASTM D624 (Die C)	150 lbf/in	205 lbf/in	234 lbf/in
Brittleness point, max.	ASTM D2137	-49°F (-45°C)	-63°F (-53°C)	-69°F (-56°C)
Ozone resistance, no cracks	ASTM D1149	Pass	Pass	Pass
Water absorption, max., mass %	ASTM D471	+8, -2%	1.54%	2.50%
Factory seam strength, min.	ASTM D816 (50 lbf/in)	50 lbf/in or sheet failure	Sheet failure	Sheet failure
After Heat Aging (4000 hrs.)	ASTM D 573			
Tensile strength, min.	ASTM D 412 (Die C)	1205 psi	1477 psi	1317psi
Elongation, ultimate, min.	ASTM D412 (Die C)	200%	302%	325%
Tear resistance, min.	ASTM D624 (Die C)	125 lbf/in	176 lbf/in	240 lbf/in
Linear dimensional change, max.	ASTM D1204	±1.0%	-0.14%	-0.50%
Weather resistance:				
Visual inspection	ASTM D518	Pass	Pass	Pass
PRFSE, min.	ASTM D518	30%	64%	51%
Elongation, ultimate, min.	ASTM D412 (Die C)	200%	255%	277%
Ultraviolet weather resistance (Xenon-arc weathering)	ASTM G155	Pass (4000 hrs)	Pass	Pass

Figure 3 – Black vs. white EPDM. Source: Firestone Building Products, laboratory testing facility, Indianapolis, IN, 2007.

FOUNDATION FOR SOLAR PANELS

Most recently, white EPDM is proving to be a high-performance platform for PV roof systems as well. For example, when the San Mateo Union High School District sought to lower the $1.1 million annual electric bill generated by the seven public high schools it oversees just outside of San Francisco, it decided to install PV panels on as many of the schools as possible (*Photo 1*). Among the initial phases of the reroof project, more than 2,500 PV panels were installed atop three schools: Aragon, Mills, and Hillsdale. The facilities combined for more than 420,000 sq. ft. of roofing surface and required approximately 6,000 stanchions to support the PV panels.

Working with Quattrocchi Kwok Architects (QKA), a 50-person firm in Santa Rosa, CA, that specializes in public school design and construction, the school district needed a roofing system that would survive the life cycle of the PV panels, handle the foot traffic of the PV installation, and withstand the potential for ponding water. Those factors led to the specification of a fully adhered, 90-mil Firestone RubberGard™ EcoWhite™ EPDM membrane.

With BEST Contracting Services of Hayward, CA, serving as installation con-

Photo 1 – White EPDM roofing membrane serves as a high-performance foundation on a multifacility reroof project for the San Mateo Union High School District that featured more than 2,500 photovoltaic panels installed atop three California high schools.

tractor, the white EPDM membrane was adhered to a high-density cover board that was mechanically attached through the existing SBS modified-bitumen system and into the steel deck. After the white EPDM membrane was in place, BEST crews prepared the stanchions to support the PV panels using customized target patches and boots supplied by Firestone to help expedite the installation process across three separate buildings (*Photo 2*). Upon completion and inspection, a 30-year warranty was issued by Firestone, ensuring the roofing system was protected throughout the life expectancy of the PV system.

According to QKA architect Nick Stephenson, "In addition to the benefits of white EPDM with respect to solar heat gain, the school district needed a high-quality roof that could handle literally thousands of penetrations required for the PV support stanchions. White EPDM was a perfect fit."

At a ceremony dedicating the San Mateo Union High School District's solar-powered roofing system, which includes the new PV

Photo 2 – Customized white EPDM target patches and boots used around the stanchions to support the PV panels helped expedite the installation process.

panels installed over white EPDM membrane at the three schools, Tom Torlakson, California's state superintendent of public instruction, said, "This project at Aragon High School serves as an excellent model for future California school construction projects. Students deserve to have school environments that embrace the 21st century and are not relics of the past. The investment in renewable projects like this one shows how we can modernize our schools while creating jobs, saving money, protecting the environment, and generating thousands of teachable moments for students."

As the conversation about choosing the right roofing materials to help reduce overall energy costs continues, the environmental benefits of EPDM play an equally significant role in determining what roofing system is best suited for an individual building. White EPDM, in particular, possesses the same physical traits as its black counterpart while providing a highly reflective alternative to thermoplastics and coated membranes.

FOOTNOTES

1. "Unsurfaced" refers to the GWP impact relative to the modified-bituminous sheet alone. No consideration is given to additional GWP impact for coatings, foils, or ceramic granule facings.

REFERENCES

T.W. Hutchinson, "New Life Cycle Data for EPDM: Outstanding Performance in Reducing Environmental Impact," *Interface*, December 2010.

J.L. Hoff, "Sustainable Buildings: Addressing Long-Term Building Envelope Durability," *Proceedings of the RCI 24th International Convention and Trade Show*, March 12-17, 2009.

Bill Tippins, PhD

Bill Tippins, PhD, EPDM product manager for Firestone Building Products, LLC, is responsible for researching market needs and directing planning and development for the EPDM market. With more than 20 years of industry experience, Tippins' most recent position within Firestone Specialty Products includes developing new commercial and industrial markets for the company's EPDM, TPO, and polypropylene membranes. Previously, Tippins was the geomembrane product manager at GenFlex Roofing Systems, where he was responsible for the development, marketing, and sales of its geomembranes. Tippins has a doctorate in synthetic organic chemistry from the University of Georgia and a master's in business administration from the University of Houston. He is also a member of the Technical Committee for the EPDM Roofing Association.