ASPHALT ROOFING®
MANUFACTURERS ASSOCIATION

Spring Committee Meetings

May 22 - 23, 2017

The Gwen Hotel
521 North Rush Street
Chicago, IL 60611

ARMA Spring Committee Meetings
May 22 - 23, 2017
Chicago, Illinois

ASPHALT ROOFING™
MANUFACTURERS ASSOCIATION

To: ARMA Members and Staff

From: Reed Hitchcock, Executive Vice President

Re: <u>Antitrust Compliance - Quick Reference</u>

The Asphalt Roofing Manufacturers Association ("**ARMA**" or "**Association**") has in effect an Antitrust Compliance Policy ("Policy"). The Policy is intended for the guidance of ARMA member company representatives, officers, directors and staff, when engaged in any activity conducted in the name of, or on behalf of, ARMA. All such persons are expected to be familiar with the Policy and to follow it both in letter and spirit.

The following cautionary statements are taken from the full Policy and are intended to be used as a quick reference tool. This document is not a substitute for the full Policy, which is available from the Association's office and with which all are expected to be conversant. At all Association meetings and events, including informal gatherings before, during or following such meetings and events, **ARMA** members, their representatives and guests will not discuss any of the following competitively sensitive topics:

1. Current or future prices, price levels, costs or profit margins.
2. What is a fair or rational profit level.
3. Actions which could lead to standardizing or stabilizing prices.
4. Pricing or bidding methodologies or procedures.
5. Pricing practices or strategies, including methods, timing or implementation of price changes.
6. Whether or how prices, warranties or other terms of sale are advertised.
7. Cash or any other discounts, rebates, service charges or other terms and conditions of sale.
8. Credit terms.
9. Product warranty terms.
10. Actual, planned or projected production, production capacity or capacity utilization.
11. Projected demand.
12. Confidential company plans for new products.
13. Dividing or allocating geographic or product markets or customers.
14. Whether or on what terms to do business with a supplier, competitor or customer.
15. Whether or on what terms to solicit other companies' employees for employment.
16. The business practices of individual firms.
17. The validity of any patent or the terms of any patent license.
18. Ongoing litigation, unless being reported upon by ARMA's General Counsel or discussed appropriately at ARMA's Counsel Forum.

We hope the above rules will be helpful as you participate in ARMA meetings and other activities. If you have any questions about antitrust compliance, do not hesitate to contact ARMA's General Counsel:

C. Michael Deese
ARMA General Counsel
Howe & Hutton, Ltd.
Tel: (202) 466-7252 x103
Email: cmd@howehutton.com

Thank You Sponsors!

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Asphalt Roofing Manufacturers Association
Communications, Marketing, and Education Committee Agenda
Monday, May 22, 2017

Communications, Marketing, and Education Committee
Chair: Sue Burkett, Owens Corning
Vice-Chair: Sara Jonas, SOPREMA, Inc.

Time	Discussion	Back-up Materials
1:00pm (5 minutes)	Call to Order • Review of Antitrust Policy • Review of Meeting Agenda • Review and Approval of Previous Meeting Minutes	-April 10 Meeting Minutes -ARMA Antitrust Quick Reference
1:05pm (25 minutes)	CMEC Communications PowerPoint • Overview of 2017 Projects and Activities • Key Succeses So Far This Year	-Activity Report
1:30pm (30 minutes)	Website Redesign • Beta Site Review	
2:00pm (15 minutes)	eBooks • Mod-Bit Design Guide • The Good Application Guide for 3-Tab Shingles	
2:15pm (30 minutes)	2017 Video Projects • Slope to Drain Script/storyboard review • Video II – Ventilation?	
2:45pm (15 minutes)	Networking Break	
3:00pm (15 minutes)	2018 FMD e-Newsletter Discussion	
3:15pm (35 minutes)	2018 PR Planning & Brainstorming	
3:50pm (10 minutes)	Other Business / New Business	
4:00pm	Adjournment	

Asphalt Roofing Manufacturers Association
Codes Steering Group - Working Meeting Agenda
May 22, 2017

Codes Steering Group
Chair: Aaron, Phillips, TAMKO Building Products, Inc.
Vice-Chair: Marcin Pazera, Owens Corning

Time	Discussion Topic	Back-up Materials
1:00pm (10 minutes)	**Call to Order** • Self-Introductions • Antitrust Reminder • Agenda Review • Approval of Past Meeting Minutes	-Antitrust Quick Reference -April 27 ARMA CSG Teleconference Draft Minutes
1:10 pm (1 hour)	**Stakeholder Discussion** • NRCA and ARMA Collaboration - Jason Wilen and Mark Graham	
2:10 pm (40 minutes)	**Codes and Standards Update** • ICC Code Proposal Concepts • ASTM D7158	-ARMA Codes and Standards Report
2:50 pm (15 minutes)	**Break**	
3:05pm (20 minutes)	**State and Local Code Activity** • Florida • FBC HVHZ Requirements • Texas and TDI	
3:25pm (25 minutes)	**Task Force & Technical Resource Group (TRG) Activities** • ASTM D7158 • Cool Roof Issues • Ventilation Issues • Air-permeable Insulation Issues	
3:50 pm (5 minutes)	**New / Other Business** • Code Official Outreach	
3:55pm (5 minutes)	**Action Item Review**	
4:00pm	**Adjournment**	

Asphalt Roofing Manufacturers Association
Health, Safety, and Environment Committee Agenda
Tuesday, May 23, 2017

Health, Safety, and Environment Committee Meeting
Chair: Annmeza Szeto, IKO Production, Inc.
Vice-Chair: Devlin Whiteside, Owens Corning

Time	Session	Back-up Materials
7:30am (60 minutes)	Breakfast	
8:30am (15 minutes)	**Introduction and Opening Remarks** -Call to Order -Review of Antitrust Policy -Housekeeping -Review of Meeting Agenda -Introductory Activity	-Antitrust Quick Reference -HSE Committee Meeting Agenda
8:45am (90 minutes)	**Regulatory Update** -Led by: Art Sampson, ARMA Regulatory Counsel Review Administration and Congressional Impact to Regulatory Agencies EPA, DOE, OSHA, etc.	
10:15am (15 minutes)	Networking Break	
10:30am (15 minutes)	**Industrial Hygiene Quality Assurance/Control Update** -Led by: Mark Klein, GAF Update on IH QA/QC Task Force, Third-Party Administrator, and Meeting in Phoenix, AZ.	
10:45am (30 minutes)	**OSHA Silica Roundtable** -ARMA Involvement Moving Forward (i.e. Training)	
11:15am (45 minutes)	**HSE Committee 2017 Discussion** -Led by: Annmeza Szeto, IKO Production, Inc., and Devlin Whiteside, Owens Corning Discuss current HSE ARMA projects, upcoming projects, and project suggestions. • EPA MACT/GACT RTR • EPA Wet-Formed Fiberglass Mat RTR • Emissions Factor Update • Washington Stormwater Roofing Research Update	
12:00pm	Adjournment	

Asphalt Roofing Manufacturers Association
Technical Affairs Committee - Working Session Agenda
Tuesday, May 23, 2017

Technical Affairs Committee
Co-Chair: Jean-Francois Cote, SOPREMA, Inc.
Co-Chair: Sid Dinwiddie, PABCO Roofing Products

Time	Discussion Topic	Back-up Materials
7:30am (1 hour)	Breakfast	
8:30am (5 minutes)	**Call to Order** -Self-Introductions -Antitrust Reminder -Agenda Review	-Antitrust Quick Reference
8:35am (40 minutes)	**CRRC Technical Discussion** -Method Evaluation Retesting	
9:15am (20 minutes)	**Stakeholder Discussion** -NRCA -IBHS -ICC	
9:35am (40 minutes)	**Onondaga County Reroof Project** -Review of Onondaga County Draft Report -Data Collection Activity -Next Steps	-Onondaga County Draft Report
10:15am (15 minutes)	Break	
10:30am (10 minutes)	**Sustainability Task Force Activity** -ARMA Life Cycle Assessment (LCA) Expansion -SBS Torch Applied System and Self-Adhesive SBS System	
10:40am (40 minutes)	**ARMA Technical Review Task Force Activity** -Review of ARMA technical bulletin / publications priority list -Steep slope and low slope documents to be reviewed -Next steps	-ARMA Publication / Technical Bulletin Priority List
11:20am (20 minutes)	**National Research Council of Canada (NRC) Initiative for Climate Resistant Roofs**	
11:40am (20 minutes)	**New / Other Business** -Code Official Educational Opportunities	
12:00pm	Adjournment	

Asphalt Roofing Manufacturers Association
Industry Speakers Session Agenda
Tuesday, May 23, 2017

Industry Speakers Session
Jeff Steuben, Cool Roof Rating Council (CRRC)
Dave Stanczak, Construction and Demolition Recycling Association (CDRA)
Louisa Nara, American Institute of Chemical Engineers (AIChE)
Mike Fischer, Asphalt Roofing Manufacturers Association (ARMA)

Time	Session
12:00pm (1 hour)	Lunch
1:00pm (5 minutes)	**Introduction and Opening Remarks** -Call to Order and Introductions -Review of Antitrust Policy -Review of Meeting Agenda
1:05pm (50 minutes)	**Cool Roof Rating Council (CRRC) Technical Update** -Jeffrey Steuben, CRRC
1:55pm (50 minutes)	**Asphalt Shingle Recycling Initiatives** -Dave Stanczak, Southwind RAS, Construction and Demolition Recycling Association (CDRA)
2:45pm (15 minutes)	Break
3:00pm (45 minutes)	**Risk Based Process Safety Program for Roofing** -Louisa Nara, American Institute of Chemical Engineers (AIChE)
3:45pm (1 hour)	**Roofing Rules: Codes and Standards Overview** -Mike Fischer, ARMA
4:45pm (15 minutes)	**ARMA Committee Meeting Debrief** -New / Other Business
5:00pm	Adjournment
5:30pm (1.5 hours)	**ARMA Members Reception**

ASPHALT ROOFING®
MANUFACTURERS ASSOCIATION

Summer Committee Meeting Draft Minutes September 13, 2016

Meeting Attendees

Carrie Niezgocki	3M
Frank Klink	3M
Randy Morgan	3M
Rebecca Everman	3M
Tom Lecorchick	Bitumar, Inc.
Jacques Martin	Building Products of Canada
Alex Pecora	CertainTeed Corporation
Barb McDonough	CertainTeed Corporation
Bob Gardiner	CertainTeed Corporation
Robert Jenkins	CertainTeed Corporation
Kermit Stahl	CertainTeed Corporation
Mark Harner	CertainTeed Corporation
Mark Simon	CertainTeed Corporation
Jeff Stermer	Crafco Inc.
Jennifer Sherwin	Firestone Building Products
Michelle Benatti	Firestone Building Products
William Woodring	GAF
Lynn Picone	GAF
Marty Ward	GAF
Scott Morrison	Haag Engineering Co.
Don Shaw	IKO Production, Inc.
Jay Keating	IKO Production, Inc.
Andrew Ford	Kraton Polymers
Amy Ferryman	Malarkey Roofing Products
Brendan Dineen	Malarkey Roofing Products
Eileen Dutton	Malarkey Roofing Products
Gregory Malarkey	Malarkey Roofing Products
Edward Harrington	Owens Corning
Marcin Pazera	Owens Corning
Sue Burkett	Owens Corning
Sid Dinwiddie	PABCO Roofing Products
Husnu Kalkanoglu	SOPREMA, Inc.
Jean-Francois Cote	SOPREMA, Inc.
Todd Jackson	SOPREMA, Inc.
Johnathan MacBride	Specialty Granules LLC
Aaron Phillips	TAMKO Building Products, Inc.

ARMA Staff, Counsel, & Consultants

Allie Carmichael	ARMA Communications Specialist
Ron Gumucio	ARMA Communications Director
James Hilyard	ARMA Consultant
Jim Kirby	ARMA Director of Technical Services
Mike Fischer	ARMA Director of Codes and Regulatory Compliance
Reed Hitchcock	ARMA Executive Vice President

Mike Deese	ARMA General Counsel
Jared Rothstein	ARMA Industry Affairs Coordinator
Chelsea Ritchie	ARMA Legislative & Regulatory Affairs Coordinator
Adair Douglas	ARMA Staff Associate

Introduction and Opening Remarks

ARMA President, Greg Malarkey, Malarkey Roofing Products, called the meeting to order at 8:32am PDT, thanked the staff, sponsors and attendees for their efforts on behalf of ARMA.

Mike Deese, ARMA General Counsel, reminded attendees that the meeting and all events associated with the meeting would be conducted in accordance with and subject to the ARMA Antitrust Compliance Policy.

Jared Rothstein, ARMA Industry Affairs Coordinator, presented the ARMA 2016 Summer Committee General Business Agenda that had been provided to all those in attendance.

Communications, Marketing and Education Committee Update

Sue Burkett, Owens Corning, presented an update on Communications, Marketing and Education Committee (CMEC) activities. Program highlights included Spanish translation of technical bulletins, new informational videos, social media placement, and the ARMA website. Burkett noted that in 2016 42 million people were reached by ARMA. Also discussed were promotional activities regarding the QARC awards, placements of articles in trade magazines and impressions in the general media when ARMA was referenced or ARMA representatives were quoted as subject matter experts. Also discussed was the potential redesign of the ARMA website to improve ARMA's public presence and analytics capabilities. Burkett noted that the ARMA bookstore is in the process of transitioning into E-books and is beginning to generate profit.

Codes Steering Group Update

Mike Fischer reviewed the mission, structure, and activities of the Codes Steering Group and Fischer recognized the members for their participation and support. Fischer provided an update on the ICC Model Code Development and reviewed the schedule of the Group B cycle. The upcoming Public Comment Hearings in October in Kansas City, MO were noted. Fischer highlighted greater collaboration with other industry stakeholders on code activity and strategies. An overview was provided of ARMA's proposals in the current cycle as well as proposals from other stakeholders. Fischer discussed future code development issues including ASHRAE 90.1, 90.2, and 189.1.

Fischer discussed state and local code adoption issues and focused on ARMA's activities at the Florida Building Commission including the update of the Roofing and Testing Application Standards. Additional future activities at the Florida Building Commission were also discussed including research on building and roofing performance.

ACTION: Mike Fischer will follow up with Florida Building Commission on the status of the Phase 2 Report of the Spray Foam Roof Deck Performance Study.

Fischer discussed other ARMA codes and standards monitoring and activity at ASTM and RICOWI. Stakeholder outreach was discussed for IBHS and the opportunities for ARMA to collaborate on their research and code activities. An overview was provided of the calendar and timeline for the public comment hearings.

Jim Kirby provided an update on the Ventilation Task Force. Kirby discussed ICC code development within the Task Force on attic ventilation related code proposals and communications activities with trade publication articles. Kirby emphasized the importance of language and data support for the passage of the ICC Public Comments and noted the upcoming ventilation article related to attic ventilation when reroofing and other future communications opportunities.

ACTION: Jim Kirby will develop a process for position development of ARMA's guidance documents with Chairs and Staff.

The Cool Roof Task Force update was given by Kirby; the revised RFP for in situ reflectance testing was developed after the ARMA Board of Directors limited the scope of the study to provide greater focus on asphaltic products. Kirby reviewed the bids submitted by the vendors. The next steps will be to have a CRTF meeting and develop a recommendation. This will need to be reviewed by the ARMA Board and approved in order to proceed with the study.

Technical Resource Groups Update

Marcin Pazera provided an update on ASTM D7158. The standard update was led by ARMA with the support of consultants, stakeholders, members, and staff. The standard went out for balloting, and after working with other stakeholders on a number of revisions, the standard was approved at ASTM. Regarding the Florida Building Commission, the update of the Roofing and Testing Application Standards protocols were successful. ARMA developed code modification proposals and worked with other stakeholders to revise the protocols. The Florida Building Commission approved all of ARMA's proposals. ARMA will next be working through the glitch cycle to determine if any other changes are needed in the 6th edition of the code. Fischer gave an update on the Onondaga County Reroofing Project, noting that he is expecting a final report on the project by the end of September. The contractor is also developing a proposed budget if ARMA wants to continue data collection.

There was a break at 10:00am PST.

The meeting resumed at 10:17am PST.

American Society of Civil Engineers (ASEC) Update

Speakers Jennifer Goupil, Ron Hamburger, and Tim Reinhold, representing the American Society of Civil Engineers (ASCE), were introduced. Each speaker provided a brief introduction of their experience and past work. A review was given on the development process for ASCE7, its historical development, and the technical changes to the standard. The ASCE representatives discussed the nature of the 2016 standard updates. Noted were some reductions in the wind load maps and the adjustment to the seismic loads depending on the region, as well as revisions to the snow maps. The technical changes to

ASCE7-16 and the reasons for the updates were discussed. Ron Hamburger emphasized that participants do not have to be a member of ASCE to belong to the Committee. Tim Reinhold focused the technical changes to ASCE 7-16 Wind Provisions.

"Fortified Wise" Roofing Education Update

Tim Reinhold and Mark Zenhal, IBHS, provided an update on IBHS's "Fortified Wise" Roofing Education Program, research and testing programs. The "Fortified Wise" program is a voluntary independent verification system-based approach to building resilience. An overview of the compliance methods and recommendations for the program was given. The Roofing Compliance Form was distributed.

There was a break at 12:16pm PST.

The meeting was resumed at 1:14pm PST.

Single-Ply Roofing Industry (SPRI) Update

Mike Ennis, Single-Ply Roofing (SPRI), discussed the SPRI Roof System Listing Service Program, which is being designed to be a searchable database regarding the wind uplift resistance of roofing system assemblies. Ennis also discussed the current process that design professionals use and why SPRI feels its new database is needed. An overview of how the SPRI program will work and be implemented was provided. The goal for SPRI's program is to be a "one stop" database to locate listings that meet code requirements. Ennis asked for members' opinions on the program and discussed the scope, work plan, security and functionality.

Roofing Industry Wind Load Panel Discussion

Fischer introduced Lee Shoemaker, Metal Building Manufacturers Association, and Mike Ennis, SPRI. Fischer, Shoemaker, and Ennis then discussed the process and outcome of the updates to ASCE-7 and the effects on the roofing industry. Topics discussed were the effects of the updates to different roofing components including parapets, walls, purlins, skylights, and cladding loads. The panel fielded questions from the ARMA members in attendance, which included questions regarding whether there are failures in the field due to wind load underdesign.

Technical Affairs Committee Update

Sid Dinwiddie, PABCO Roofing Products, presented the Technical Affairs Committee updates. Dinwiddie discussed the update process for technical bulletins and publications and meeting education opportunities for member input.

Amy Ferryman, Malarkey Roofing Products, presented the Sustainability Task Force update. Ferryman noted that ARMA's EPDs are close to completion after UL verification. Ferryman provided an overview of the EPD development process and the method of generating the content for the documents. ARMA's EPDs have been sent to ARMA's legal counsel for review, following which they will be sent to the ARMA

Counsel Forum for review. The expectation is to have the documents reviewed and approved at the ARMA Board of Directors meeting in November.

Jim Kirby discussed ARMA's involvement in the IBHS/RICOWI best practices field guide. Kirby reviewed the outline of the guide and discussed ARMA's involvement in providing input on its development.

ACTION: ARMA's further participation in the development of the IBHS/RICOWI Field Guide will be discussed with and determined by the ARMA Executive Committee

There was a break at 3:27pm PST.

The meeting was resumed at 3:40pm PST.

ARMA Health Safety and Environment Committee Update

Annmeza Szeto, IKO Production, Inc., provided an update on the ARMA Health, Safety, and Environment Committee (HSE). The goals of ARMA's Health, Safety, and Environment Committee are to improve involvement from the different member companies, create best practices to be shared with all member companies and to focus on projects such as the ARMA Emission Factor, new OSHA Silica Standard, IH database, and the Washington State Roof Runoff Toxicology Study. Szeto provided a summary of the Accident Prevention Contest created by ARMA's Health, Safety, and Environment Committee. Szeto discussed the OSHA Silica Standard and noted that ARMA's HSE held a webinar in July that reviewed the OSHA Silica Standard. ARMA's HSE has teamed up with the Asphalt Institute (AI) to provide information to the EPA to be used to conduct a Risk and Technology Review (RTR). Szeto provided an overview of ARMA's role in the Washington State Roof Runoff Toxicology Study.

Washington State Roof Runoff Toxicology Study Update

Nancy Winters and Taylor Haskins, Washington Department of Ecology, were introduced. Winters noted that the focus of the study was to examine roofing runoff in the Puget Sound. Roofing products were identified as a significant source of contaminants from rain runoff. A review was given on the purpose of the study to assess the rate of roofing materials leach depending on different precipitations. Winters discussed how the study was designed, set up, and then conducted. She noted the comparatively positive results of the study with respect to asphalt roofing products. Winters also discussed a new study design for the Washington Stormwater Center, supported in part by ARMA, to provide toxicological analyses. The preliminary results of the second study were shared. Winters thanked ARMA for its assistance.

Adjournment: There being no further business to come before the committee, the meeting was adjourned by general consensus at 5:03 PM PST.

ARMA Communications, Marketing, and Education Committee

Asphalt Roofing Manufacturers Association
Communications, Marketing & Education Committee
Monthly Meeting April 10, 2017 @ 2 p.m. ET

Chair:
Sue Burkett – Owens Corning

Attendees:
Mary Corbin, Kevin Olson – PABCO
Alex Pécora – CertainTeed
Paul Casseri – Atlas Roofing
Carol Perkins – IKO Production, Inc.
Bobby Labrix – Malarkey Roofing
Carrie Niezgocki – 3M

ARMA Staff & Consultants:
Ron Gumucio – Kellen Staff
Jeff Kotuby – Kellen Staff
Jared Rothstein – Kellen Staff
Allie Carmichael – Kellen Staff

Review Antitrust Policy:
The conference call was called to order at 2:02 PM ET by Ron Gumucio, Kellen. Jeff Kotuby reviewed the Antitrust Compliance Policy governing the meeting.

Review and Approval of Previous Meeting Minutes
Motion: (Sue Burkett, Owens Corning/Carol Perkins, IKO Production, Inc.) to approve the minutes of the March 13, 2017 Communications, Marketing, & Education Committee Meeting as presented. The motion passed unanimously.

Media Update – Recent Coverage & Upcoming Bylines
Mr. Gumucio reported that the recent press release regarding ARMA's new Environmental Protection Documents (EPDs) has been featured on the websites of multiple prominent trade publications. These include *Building Enclosure, Facility Executive, Asphalt and Roofing magazines. RCI Interface* magazine is also planning to run it in their July issue. Additional placements will be pursued. In addition, the editor of *This Old House* conducted an interview with ARMA's former Director of Technical Services, Jim Kirby. The homeowner's guide will feature asphalt roofing and is expected to be published in May. Mr. Gumucio also reported that *Canadian Roofing Contractor & Design* has ceased production and the ARMA article that we submitted would be considered for one of their other publications. Should follow-up prove unsuccessful, Kellen will try to get the article placed in another publication.

Press Releases
Mr. Gumucio reported two press releases are also being developed. One is for ARMA's support for National Roofing Week, which was sent to the CMEC for review. We'll incorporate the member's edits and issue the release to the media at the end of the week, pending the National Roofing Contractors Association (NRCA) sending theirs out first. The second release is in support of the Occupational Safety and Health Administration's (OSHA) Safety Stand-Down campaign, which is currently being reviewed by legal and will be sent for member approval this week.

QARC Outreach
Mr. Gumucio said Kellen is currently pitching editors at the different roofing trade publications to secure one byline article for each winner of the 2017 QARC Awards. Once we secure placements, Kellen will draft the articles and share them with the committee for review and approval.

FMD Q2 Article
Mr. Gumucio informed the group that the ventilation topic for the FMD Q2 article has been put on hold and is expected to be approved at the ARMA Spring Committee Meeting. In its place, we'll draft an article highlighting the benefits of asphalt roofing, including the different types and colors of shingles, and asphalt's recyclability.

Modified Bitumen Design Guide Update
Mr. Gumucio said the guide is currently being converted into an eBook and a print-on-demand solution, which could take up to 8 weeks to be posted to the ARMA website and the major online retail bookstores. Once the guide is completed, a press release will be developed and distributed to the media, as well as be promoted on LinkedIn.

ARMA Spring Committee Meetings – CMEC Agenda
Mr. Gumucio reported that the meeting will be held on May 22 from 1 – 4 PM, ET. The meeting agenda has been confirmed and will be sent to members over the next week or so. At the meeting, the CMEC will have a chance to brainstorm future projects and activities for consideration for 2018 and beyond.

Website Update
Mr. Gumucio informed the group that the ARMA Task Force has approved a sitemap for the website. The task force will be given two different design templates to consider. Once selected, Kellen's digital team will begin designing the website and migrating the content from the old website. The goal is to review a beta site during the Spring Committee Meeting in May.

Adjournment

There being no further business to come before the committee, the meeting was adjourned by consensus at 2:18 PM ET.

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Asphalt Roofing Manufacturers Association
Communications, Marketing and Education Committee
Activity Report
April 1 – 30, 2017

MEDIA PLACEMENTS

Publication: *Roofers Coffee Shop*
Title: ARMA Honors 3 Projects as Premiere Asphalt Roofing Installations in North America
Date: March 28, 2017
Impressions: 2,508 UVPM
- The 2017 QARC Award winners were featured on *Roofers Coffee Shop*, a contractor's classifieds and directory site.
https://rooferscoffeeshop.com/arma-honors-three-projects-as-premier-asphalt-roofing-installations-in-north-america/

Publication: *Asphalt Online*
Title: New asphalt roofing EPDs will aid green building projects
Date: April 1, 2017
Impressions: Circulation - 21,000
-*Asphalt Online* posted ARMA's press release informing the public of its 5 Environmental Product Declarations (EPDs).
http://asphaltmagazine.com/armaepds/

Publication: *Facility Executive Online*
Title: New Asphalt Roofing EPDs Will Aid Green Building Projects
Date: April 6, 2017
Impressions: 48.849 UVPM
- *Facility Executive Online* posted ARMA's press release about its 5 new EPDs.
https://facilityexecutive.com/2017/04/new-asphalt-roofing-epds-will-aid-green-building-projects/

Publication: *Roofers Coffee Shop*
Title: ARMA VIDEO: 6 Steps to Enhancing the Service Life of Your Roof System
Date: April 6, 2017
Impressions: 2,508 UVPM

-*Roofers Coffee Shop* posted ARMA's "6 Steps to Enhancing the Service Life of Your Roof System" video to their website.
https://rooferscoffeeshop.com/arma-video-enhancing-service-life-roof-system/

Publication: *Building Enclosure Online*
Title: ARMA Develops 5 EPDs for Asphalt Roofing
Date: April 7, 2017
Impressions: 17,468 UVPM, 18,000 subscribers
- *Building Enclosure Online* posted ARMA's press release about its 5 new EPDs on its website and its eNewsletter.
www.buildingenclosureonline.com/articles/86693-arma-develops-5-epds-for-asphalt-roofing

Publication: *FacilitiesNet*
Title: Greener Roofs: Sustainability Documents Available
Date: April 7, 2017
Impressions: 136,961 UVPM, 55,000 subscribers
- *FacilitiesNet* posted ARMA's press release about its 5 new EPDs on its website and its daily eNewsletter.
www.facilitiesnet.com/roofing/alerts/Greener-Roofs-Sustainability-Documents-Available--39020

Publication: *Retrofit Magazine Online*
Title: ARMA Develops EPDs for Asphalt Roofing Systems
Date: April 19, 2017
Impressions: 14,000 UVPM, 29,000 subscribers
- *Retrofit Magazine Online* posted ARMA's press release about its 5 new EPDs on its website and its weekly eNewsletter.
https://retrofitmagazine.com/arma-develops-epds-for-asphalt-roofing-systems/

Publication: *Proud Green Building*
Title: New asphalt roofing EPDs to aid green building projects
Date: April 19, 2017
Impressions: 19,106 UVPM
- *Proud Green Building* posted ARMA's press release about its 5 new EPDs on its website.
www.proudgreenbuilding.com/news/new-asphalt-roofing-epds-to-aid-green-building-projects/

Publication: *Building Enclosure Online*
Title: ARMA to Celebrate National Roofing Week
Date: April 19, 2017
Impressions: 17,468 UVPM
- *Building Enclosure Online* posted ARMA's press release announcing its participation in National Roofing Week to its website.
http://www.buildingenclosureonline.com/articles/86715-arma-highlights-asphalt-during-national-roofing-week

Publication: *Retrofit Magazine Online*
Title: ARMA to Celebrate National Roofing Week
Date: April 21, 2017
Impressions: 14,000 UVPM
- *Retrofit Magazine Online* posted ARMA's press release announcing its participation in National Roofing Week to its website.
https://retrofitmagazine.com/arma-to-celebrate-national-roofing-week/

Publication: *Roofing Contractor*
Title: ARMA Develops Environmental Product Declarations for 5 Types of Asphalt Roofing
Date: April 21, 2017
Impressions: 33,509 UVPM
- *Roofing Contractor* posted ARMA's press release about its 5 new EPDs on its website.
www.roofingcontractor.com/articles/92186-arma-develops-environmental-product-declarations-for-5-types-of-asphalt-roofing

Publication: *Facility Executive Online*
Title: ARMA Joins OSHA during National Safety Stand-Down
Date: April 26, 2017
Impressions: 48,849 UVPM
- *Facility Executive Online* posted ARMA's press release about their support for National Safety Stand-Down
www.roofingcontractor.com/articles/92186-arma-develops-environmental-product-declarations-for-5-types-of-asphalt-roofing

Publication: *Buildings Online*
Title: Leading Cause of Death for Construction Workers Addressed in Campaign
Date: April 27, 2017
Impressions: 60,707 UVPM

- *Buildings Online* covered ARMA's support for OSHA's National Safety Stand-Down campaign
www.buildings.com/news/industry-news/articleid/21110/title/leading-cause-of-death-for-construction-workers-addressed-in-campaign

Publication: *Retrofit Magazine Online*
Title: ARMA Supports OSHA in Campaign to Prevent Falls from Elevation
Date: April 27, 2017
Impressions: 14,000 UVPM
- *Retrofit Magazine Online* posted ARMA's press release about their support for National Safety Stand-Down
https://retrofitmagazine.com/arma-supports-osha-in-campaign-to-prevent-falls-from-elevation/

Snapshot of Social Media Engagement

TWEETS	FOLLOWING	FOLLOWERS	LIKES
3,646	2,180	3,192	178

Kellen

Building Enclosure @BldngEnclosure · Apr 19
#NationalRoofingWeek **#ARMA** to educate on the benefits of asphalt **#roofing**

ARMA Highlights Asphalt During National Roofing W...
ARMA to educate professionals on the benefits of asphalt roofing systems during weeklong campaign.
buildingenclosureonline.com

1

TWEETS	FOLLOWING	FOLLOWERS	LIKES
3,646	2,180	3,192	178

retrofit @RetrofitMag · Apr 21
ARMA To Celebrate **National Roofing Week**

ARMA To Celebrate National Roofing Week - retrofit
Designed to raise awareness for roofing systems, ARMA is proud to celebrate National Roofing Week and join the NRCA and other allied organizations in the weeklong ...
retrofitmagazine.com

TWEETS	FOLLOWING	FOLLOWERS	LIKES
6,527	1,968	3,038	1,081

Kellen


OSHA Training LV @OSHATrainingLV · Apr 26
ARMA Joins OSHA During National Safety Stand-Down - Facility Executive Magazine dlvr.it/P06dvz
1
TWEETS 10.5K
FOLLOWING 85
FOLLOWERS 152


Building Enclosure @BldngEnclosure · Apr 7
#ARMA has completed a multi-year effort to develop Environmental Product Declarations for asphalt #roofing systems
BREAKIN
ARMA Develops 5 EPDs for Asphalt Roofing
New asphalt roofing Environmental Product Declarations will aid green building projects.
buildingenclosureonline.com
TWEETS 3,646
FOLLOWING 2,180
FOLLOWERS 3,192
LIKES 178

Group C Media, Inc. @GroupCMedia · Apr 26

#FM **ARMA** Joins **OSHA** During National Safety Stand-Down dlvr.it/P06f1d @facilityexec

TWEETS	FOLLOWING	FOLLOWERS	LISTS
2,214	5,000	912	2

retrofit @RetrofitMag · Apr 27

#**ARMA** Supports #**OSHA** in Campaign to Prevent Falls From Elevation #StandDown4Safety

ARMA Supports OSHA in Campaign to Prevent Falls...

Falls from elevation has continued to be a leading cause of death for construction professionals in 2015, according to the Bureau of Labor Statistics (BLS).

retrofitmagazine.com

1 1

TWEETS	FOLLOWING	FOLLOWERS	LIKES
6,527	1,968	3,038	1,081

PUBLIC RELATIONS ACTIVITY

Media Relations

We wrote and issued three press releases to the trade media during the month of April. They included the following:

- ARMA's development of five new EPDs
- ARMA's support for National Roofing Week.
- ARMA's support for the National Safety Stand-Down campaign

Follow up with the media is ongoing. We're also monitoring the following two placements:

- *RCI Interface* is interested in publishing an article about ARMA's 5 EPDs in their July issue.

- The *This Old House* article which details what homeowners need to know before redoing their asphalt roof is slated to be published in the June issue. We continue to monitor this media placement.

ARMA Videos
Since being published in late October of 2016, ARMA's steep-slope whiteboard video *Your Guide to Algae Discoloration*, has been viewed 1,265 times.

ARMA's newest whiteboard video, *6 Steps to Enhancing the Service Life of Your Roof System*, was published in late January and has been viewed 455 times.

ARMA is planning to develop two new whiteboard roofing videos this year. The first will cover the issue of Slope-to-Drain while the second will focus on ventilation. Both are in the early planning stages.

FMD E-Newsletter Articles
The Q2 FMD article focuses on spring roof maintenance for steep and low slope roofing. This piece was originally written for *Canadian Roofing Contractor & Design* but because the publication has ceased production, we repurposed the article. The Q2 FMD e-newsletter will be distributed in early May.

ARMA Book Store
Kellen is working on updating ARMA's *Modified Bitumen Design Guide*, which is being converted into an eBook and a print-on-demand version. The guide is currently being redesigned and we are once again working with Lulu to convert the publication and to make both versions available for sale on ARMA's website.

In 2017, ARMA has sold five print copies and one eBook version of the *Good Applications Guide*, for a total profit of $30.86.

In 2017, ARMA has sold 15 eBook versions and 71 print-on-demand versions of the *Residential Asphalt Roofing Manual,* for a total profit of $1,251.05

2017 QARC Awards
We have secured media placements for two of the three 2017 QARC Award winners. *Builder Magazine* is interested in a byline article about the QARC Gold winning project, The Triangle Home. *Roofing Magazine* is interested in a byline article about the QARC

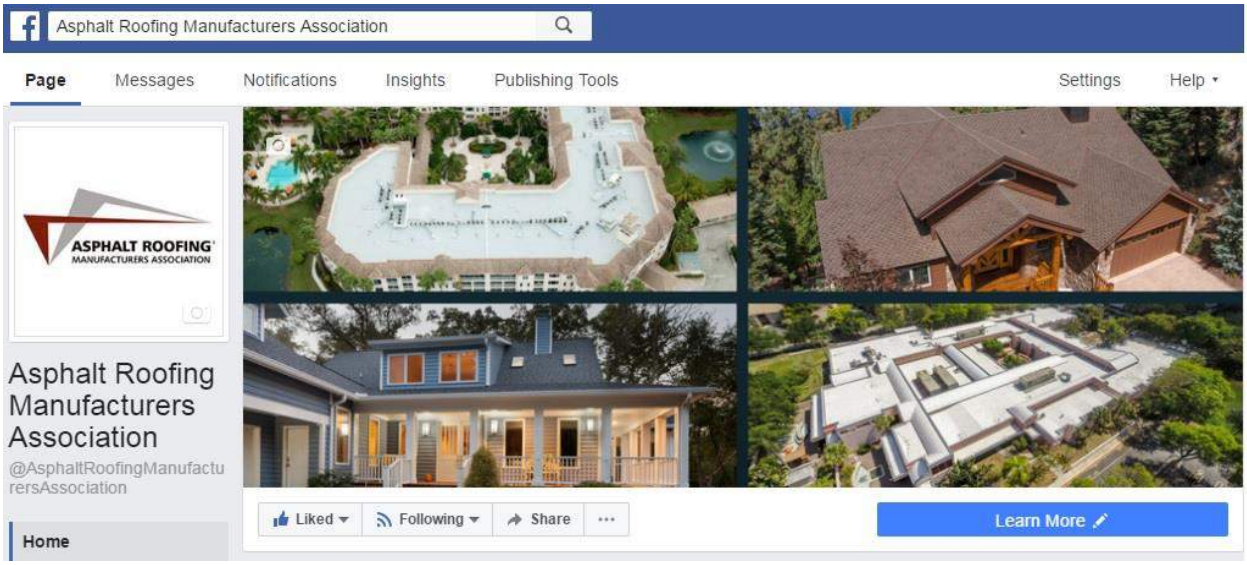
Bronze winning project, the Burlington Fire Department. Both publications are looking at potential June features. Media follow-up is ongoing to secure a placement for the QARC Silver Award winner.

Website Redesign Project

The Website Task Force has selected a template for the redesign. Kellen Digital will now begin to migrate existing content to the new site.

SOCIAL MEDIA

One of the goals of the CMEC was to join Facebook in 2017. In April, we created a Facebook page for ARMA as another platform to engage with our members, and reach roofing professionals and connect with them on social media. The Facebook page will allow us to promote our various projects, campaigns and activities as well as support our members and other groups.



The design of the page includes a mix of low-slope and steep-slope roofing photos to equally represent our membership.

OUTREACH
Kellen has drafted sample social media posts and collected photos and graphics that our members can use to support National Roofing Week on their own social media channels. The event takes place June 4-10, 2017.

The ARMA LinkedIn Profile continues to be a valuable resource for reaching new audiences, allowing us to connect with building construction professionals and driving new users to the ARMA website. We currently have 3,096 professional connections on our LinkedIn profile, an increase of 25 connections from March.

April LinkedIn posts:

- Join us for National Safety-Stand Down Week, May 8-12, to raise awareness of fall prevention in the roofing and building construction industries. As reported by Facility Executive Online, ARMA will support OSHA for this great cause: http://bit.ly/2oSXZgy (Received 1 like, 204 views)
- As seen on Asphalt Magazine Online, ARMA has developed 5 Environmental Product Declarations (EPDs) to aid building and construction professionals on designing with the environment in mind. http://bit.ly/2pPmNQq (Received 3 likes, 355 views)
- A reflective roof can save a home or business money on their heating and cooling bills. http://bit.ly/2nTvThx (Received 15 likes, 742 views)
- Asphalt shingles provide a level of Beauty, Affordability and Reliability that no material can match. http://bit.ly/1znnRLM (Received 12 likes, 617 views)
- ARMA has developed 5 Environmental Product Declarations (EPDs) in order to better educate construction professionals on asphalt roofing's place in sustainable building practices: http://bit.ly/2oUB028 (Received 6 likes, 843 views)
- Low-slope asphalt roofing has embraced new technology over the past century. See our video to learn more about the advances of asphalt roofing systems: http://bit.ly/2oWeqC3 (Received 10 likes, 1,023 views)
- Protecting your asphalt roof against algae is important to ensure its longevity. ARMA's new video explains what homeowners can do to address it: http://bit.ly/2oI5fFe (Received 12 likes, 804 views)
- ARMA has developed 5 Environmental Product Declarations (EPDs) for construction professionals in order to understand the environmental impact of asphalt shingles. For more info: http://bit.ly/2oUB028 (Received 12 likes, 876 views)

ARMA's Discussion Group, "The Asphalt Roofing Forum," currently has 1,425 members. We utilize the group to connect further with building construction and roofing professionals and drive them to the ARMA website.

April LinkedIn Group posts:

- **Join ARMA in Supporting National Roofing Week!** - As seen on Retrofit Magazine, ARMA is celebrating National Roofing Week. Join us June 4-10, 2017 as we help celebrate the asphalt roofs that keep us safe. http://bit.ly/2qjvItB (Received 1 like)
- **How To Take Care of Your Roof** - Featured on Roofers Coffee Shop, ARMA's latest whiteboard video provides 6 easy steps to follow in order to enhance the service life of your asphalt roofing system. http://bit.ly/2qbtSuT (Received 1 like)
- **Picking the Right Color for Your Roof** - Finding the right color for your asphalt shingle is critical for the look and feel of a home. Learn how different color shingles are made and more: http://bit.ly/YbD3NW (Received 3 likes)
- **The Benefits of a Whole System Approach** – This short video showcases the different types of low-slope asphalt roofing systems and the benefits of a whole-system approach: http://bit.ly/2oHXkaS
- **How your modified bitumen roof can beat the cold** - Cold weather can impact the installation of modified bitumen roofing systems. Here are some installation tips to help prevent mishaps when installing your roof in those colder months. http://bit.ly/2nIlfth

  ARMA Develops 5 EPDs - As featured on Facility Executive Online, ARMA's 5 new Environmental Protection Declaration documents give roofing professionals valuable information when making sustainable choices in roofing design. http://bit.ly/2oUZhF7

ARMA WEBSITE TRAFFIC

March	April	% Change – Mar to Apr
Sessions	**Sessions**	**Sessions**
12,626	12,829	1.58%

Users	Users	Users
11,161	11,324	1.43%
Page Views	**Page Views**	**Page Views**
20,357	19,978	-1.86%
Pages / Sessions	**Pages / Sessions**	**Pages / Sessions**
1.61	1.56	-3.1%
Avg. Session Duration	**Avg. Session Duration**	**Avg. Session Duration**
00:01:17	00:01:14	3 second decrease

RESPONSIVE WEB DESIGN

March	April	% Change – Mar to Apr
Mobile Sessions	**Mobile Sessions**	**Mobile Sessions**
5,689	4,625	18%
Mobile Bounce Rate	**Mobile Bounce Rate**	**Mobile Bounce Rate**
77.83%	77.58%	-0.32%
Mobile Time On Site	**Mobile Time On Site**	**Mobile Time On Site**
00:00:51	00:00:51	0 second increase
Tablet Sessions	**Tablet Sessions**	**Tablet Sessions**
1,162	1,290	11%
Tablet Bounce Rate	**Tablet Bounce Rate**	**Tablet Bounce Rate**
72.69%	78.68%	8.2%
Tablet Time On Site	**Tablet Time On Site**	**Tablet Time On Site**
00:01:17	00:01:01	16 second decrease

Kellen

WEBSITE TRAFFIC SOURCES

March	April	% Change – Mar to Apr
Search Traffic	**Search Traffic**	**Search Traffic**
10,453	10,444	-0.08%
Referrals From Websites	**Referrals From Websites**	**Referrals From Websites**
637	678	6.4%
Direct Visits	**Direct Visits**	**Direct Visits**
1,384	1,615	16.69%
Social	**Social**	**Social**
150	139	11 visit decrease

ARMA Codes Steering Group

Attendance

Jonathan MacBride	Specialty Granules LLC
Jacques Martin	Building Products of Canada
Kermit Stahl	CertainTeed Corporation
Mark Harner	CertainTeed Corporation
Tim McQuillen	Firestone Building Products Company
Marty Ward	GAF
Michael Stieh	GAF
Ming Shiao	GAF
Laura Soder	Henry Company
Brendan Dineen	Malarkey Roofing
John Kouba	Malarkey Roofing
Marcin Pazera	Owens Corning
Sid Dinwiddie	PABCO Roofing Products
Darren Perry	SOPREMA, Inc.
Jean-Francois Cote	SOPREMA, Inc.
Aaron Phillips	TAMKO Building Products, Inc.
Reed Hitchcock	ARMA Executive Vice President
Mike Fischer	ARMA Vice President of Codes and Regulatory Compliance
Jared Rothstein	ARMA Industry Affairs Coordinator
Ally Peck	ARMA Staff Associate

Call to Order

Mike Fischer, ARMA Vice President of Codes and Regulatory Compliance, called the meeting to order at 2:05 pm ET. Ally Peck, ARMA Staff Associate, read the roll and reminded all that the meeting would be subject to ARMA's Antitrust Compliance Policy. Aaron Phillips, TAMKO Building Products, Inc., provided an overview of the agenda.

Approval of Past Meeting Minutes

MOTION (Kouba/Dinwiddie): To approve the ARMA Codes Steering Group (CSG) March 30, 2017 draft minutes as presented. **The motion passed unanimously.**

Texas Department of Insurance (TDI) Update

Fischer provided an overview of the TDI meeting, which will take place on May 16, 2017 from 9am-12pm at the William Hobby Building, 333 Guadalupe Street, Austin, Texas 78701. There will be a scheduled preparation dinner the night of May 15 for all the ARMA attendees. The purpose of the meeting is to discuss with representatives of the TDI the lengthy delays in TDI's processing of roofing product applications for inclusion in the Texas Windstorm Insurance Program Product Listing.

ACTION ITEM: Ally Peck, ARMA Staff Associate, will email all the confirmed attendees of the TDI meeting to see who will be available to attend the dinner on May 15 and if transportation to the meeting is needed for any members.

Overall Stakeholder Discussion
Fischer advised all that staff from ARMA, IBHS and NRCA will be meeting in July to identify opportunities for collaboration in code development. Fischer and Reed Hitchcock will attend.

Fischer reported that the ARMA meeting with Miami-Dade went very well and he is confident that ARMA and Miami-Dade will continue to improve their working relationship. Fischer led a detailed technical discussion on tile slippage during the meeting.

Fischer noted he has developed ARMA Education Modules that will be available for members to use. He will be demonstrating and using one of these modules at the Chicago meeting in May. The CSG will review the program and provide feedback on intended audiences.

Florida Building Commission
Fischer provided an update on the FBC public comment process and noted that the 2017 process is complete. It remains unclear if there will be a "glitch" cycle. He noted that legislative activity continues regarding Florida's incorporation of the base ICC codes, the cycle length in Florida and the commission size and the makeup. The legislative session will end in mid-May; Fischer will have a report during the spring meetings.

ICC Code Development
Fischer noted that he had attended the ICC-700 NGBS (National Green Building Standard) meeting last week. The proposed updates from the meeting will be sent out in the read-ahead materials for the Chicago CSG meeting. Fischer mentioned that the ARMA education content may be presented to ICC Code Officials, which will enhance ARMA's credibility while providing better understanding of roofing requirements for plans examiners and building inspectors.

Cool Roof Task Force
Fischer provided an update on the Onondaga County Draft Report and discussed the possibility of publishing a paper. He encouraged the group to consider who should write the paper. He noted that he is setting up a meeting with the EPDM Roofing Association (ERA), and will have an update on that at the Chicago meeting in May.

Los Angeles County Requirements
Marcin Pazera, Owens Corning, discussed the next steps of engagement with the Los Angeles County. Pazera believes that the process is further along than LA County staff is revealing and he is trying to set up a meeting in order to get a better understanding of what is currently going on.

ACTION ITEM: Mike Fischer, ARMA Vice President of Codes and Regulatory Compliance, will coordinate times with Marcin Pazera, Owens Corning, to set up a call with LA County Staff.

ASTM D7158
Fischer discussed how mean roof height gets interpreted in the field and provided an overview of potential problems with the standard. Fischer discussed that ARMA may need a unified voice to address concerns about mean roof height in ASTM D7158 and that a recommendation will need to be sent to the ARMA Executive Committee if the CSG approves. Aaron Phillips, TAMKO Building Products Inc., discussed potential errors in the standard and the uncertainty about the correct roof height limitation for D7158.

Fischer suggested the ARMA TRG on ASTM D7158 be reconvened for a teleconference to discuss the matter and provide suggestions to the ARMA CSG.

ACTION ITEM: Ally Peck, ARMA Staff Associate, to schedule a teleconference for the ARMA TRG on ASTM D7158.

ACTION ITEM: Marcin Pazera, Owens Corning, to schedule a meeting of the ASTM D7158 task group with Mike Noone. The proposed meeting will be a placeholder subject to ARMA EC approval.

ARMA Annual Meeting

Fischer noted that the next meeting of the ARMA CSG will be in Chicago during the ARMA Annual Meeting. He followed up on previous discussion of an informal ARMA CSG activity on Monday evening.

ACTION ITEM: Ally Peck, ARMA Staff Associate, will circulate details for an informal Codes Steering Group activity on Monday night during the ARMA Spring meeting.

Adjournment

There being no further business to come before the group, the meeting was adjourned by general consensus at 3:07 pm ET.

Asphalt Roofing Manufacturers Association
Codes Steering Group
Activity Report May 2017

Updates on Key CSG Activities:

ICC Code Development

The 2018 International Codes are essentially complete. Committee and public comment hearing results are being reviewed by ICC staff for any necessary correlation, and updates to referenced standards that are already in the codes will be reviewed at the end of this year. Once those final steps have been completed, ICC will publish the codes, and we will begin the process of the 2021 I-Code development.

The 2021 ICC Schedule is attached below.

We will have several items to take forward in the next cycle, including:

- Air-permeable insulation in unvented attics. This new section in the 2018 IRC will include a "vapor diffusion port", which will require definition and scoping language to clean up the code.
- Roofing aggregate. ARMA will continue with recent progress on this front to remove the arbitrary ban on aggregate for low-slope roof surfaces. We will work with SPRI, IBHS, and other stakeholders to develop appropriate code provisions and propose the inclusion of parapet design as a control feature to maintain safety without an across the board product ban.
- Reflective roofing. ARMA will consider revisions to the IECC in order to correlate the prescriptive and performance paths in the code; today they are inconsistent.
- Existing buildings. The update to ASCE7-16 creates an issue for roof replacements on existing buildings that would likely add onerous structural retrofits when doing a simple roof replacement. ARMA will work with NRCA and IBHS, among others, to clarify these provisions.

Florida Building Commission

The FBC 2017 code update process has been completed. The effective date is set for January 1, 2018, but there may be some delays depending on completion of the Florida Fire Code. ARMA completed a project working with Miami-Dade to update the HVHZ provisions; those updates are included in the new code. We will continue this working relationship moving forward to upcoming cycles.

The Florida legislature passed HB 1021 earlier this month. It contains revisions to the Florida Building Code process, including eliminating the use of the International Codes most recent editions as the base code for Florida. Earlier versions of the bill language contained an extension of the code cycles to 6 years; that provision would have been unfavorable to ARMA members due to disconnect from referenced standards such as ASTM, which would likely result in additional expense. That change was not included in the bill. We are coordinating our efforts with ICC to provide appropriate assistance. It is unclear if the governor will sign the bill or veto it. We will continue to monitor and will update the ARMA Board as the process continues.

Los Angeles County

L.A. County is considering the implementation of cool roof requirements as part of efforts to reduce the urban heat island effect in unincorporated areas. This effort could be similar to measures previously adopted by the City of L.A.

ARMA staff and volunteer leaders had a conference call with project leaders from L.A. County and expressed ARMA's desire to be engaged in the process going forward. The project has no set timeline, and no draft requirements. We will continue to monitor and engage as appropriate to help streamline any labeling requirements and assist the County staff in developing common-sense provisions.

California Energy Commission (CEC)

The CEC staff members have indicated that their upcoming revision cycle to CA Title 24 do not include any planned increases in cool roof requirements. We are aware that other stakeholders will continue to push against this plan, so ARMA will keep a close watch on the process. ARMA staff will be represented at an upcoming CEC Stakeholder Workshop; the agenda includes envelope provisions to the code- such as high-performance roof and walls. In addition to the cool roof provisions, the envelope requirements also impact attic ventilation.

Texas Department of Insurance (TDI)

ARMA members continue to voice concerns about the TDI product lists and long delays in processing updates to their website. These delays create an artificially slanted playing field and could potentially restrict trade. ARMA staff and volunteers met with TDI last week; we will update the Board during the May meetings.

2018/2019 ICC CODE DEVELOPMENT SCHEDULE

(February 10, 2017)

STEP IN CODE DEVELOPMENT CYCLE	DATE	
	2018 – Group A Codes **IBC- E, IBC - FS, IBC -G, IFC, IFGC, IMC, IPC, IPMC, IPSDC, IRC – M, IRC- P, ISPSC, IWUIC, IZC**	**2019 – Group B Codes** **Admin, IBC-S, IEBC, IECC-C, IECC-R/IRC-E, IgCC (Ch. 1), IRC – B**
2018 EDITION OF I-CODES PUBLISHED	Fall/2017 (except 2018 IgCC, see Group B Codes on page 2)	
DEADLINE FOR RECEIPT OF APPLICATIONS FOR ALL CODE COMMITTEES	June 1, 2017 for the 2018/2019 Cycle. Call for committee posted in February /2017.	
DEADLINE FOR cdpACCESS ONLINE RECEIPT OF CODE CHANGE PROPOSALS	January 8, 2018	January 7, 2019
WEB POSTING OF "PROPOSED CHANGES TO THE I-CODES"	February 28, 2018*	March 4, 2019*
COMMITTEE ACTION HEARING (CAH)	April 15 – 25, 2018 Greater Columbus Convention Center Columbus, OH	April 28 – May 8, 2019 Albuquerque Convention Center Albuquerque, NM
ONLINE CAH ASSEMBLY FLOOR MOTION VOTE	Starts approx. two weeks after last day of the CAH. Open for 2 weeks.	Starts approx. two weeks after last day of the CAH. Open for 2 weeks.
WEB POSTING OF "REPORT OF THE COMMITTEE ACTION HEARING"	May 30, 2018	June 11, 2019
DEADLINE FOR cdpACCESS ONLINE RECEIPT OF PUBLIC COMMENTS	July 16, 2018	July 24, 2019
WEB POSTING OF "PUBLIC COMMENT AGENDA"	August 31, 2018*	September 4, 2019*
PUBLIC COMMENT HEARING (PCH) ANNUAL CONFERENCE DATES NOTED BY AC	October 24 – 31, 2018 Greater Richmond Convention Center Richmond, VA AC: October 21 – 23	October 23 – 30, 2019 Clark County, NV AC: October 20 - 22
ONLINE GOVERNMENTAL CONSENUS VOTE (OGCV)	Starts approx. two weeks after last day of the PCH. Open for 2 weeks.	Starts approx. two weeks after last day of the PCH. Open for 2 weeks.
WEB POSTING OF FINAL ACTION	Following Validation Committee certification of OGCV and ICC Board confirmation.	Following Validation Committee certification of OGCV and ICC Board confirmation.

* Web posting of the "Proposed Changes to the I-Codes" and "Public Comment Agenda" will be posted no later than scheduled. ICC will make every effort to post these documents earlier, subject to code change/public comment volume and processing time.

2018 Group A Codes/Code committees:

- IBC-E: IBC Egress provisions. Chapters 10 and 11.
- IBC-FS: IBC Fire Safety provisions. Chapters 7, 8, 9 (partial), 14 and 26. Majority of IBC Chapter 9 is maintained by the IFC. See notes.
- IBC-G: IBC General provisions. Chapters 3 – 6, 12, 13, 27 – 33.
- IFC: The majority of IFC Chapter 10 is maintained by IBC-E. See notes.
- IFGC
- IMC
- IPC
- IPMC (code changes heard by the IPM/ZC (IPMC & IZC) code committee)
- IPSDC (code changes heard by the IPC code committee)
- IRC-M: IRC Mechanical provisions. Chapters 12 – 23 (code changes heard by the IRC - MP code committee)
- IRC-P: IRC Plumbing provisions. Chapters 25 – 33 (code changes heard by the IRC - MP code committee)
- ISPSC
- IWUIC (code changes heard by the IFC code committee)
- IZC (code changes heard by the IPM/ZC (IPMC & IZC) code committee)

2019 Group B Codes/Code committees:

- Admin: Chapter 1 of all the I-Codes except the IECC, IgCC and IRC. Also includes the update of currently referenced standards in all of the 2018 Codes, except the IgCC.
- IBC-S: IBC Structural provisions. IBC Chapters 15 – 25 and IEBC structural provisions. See notes.
- IEBC: IEBC Non-structural provisions. See notes.
- IECC-C: IECC Commercial energy provisions.
- IECC-R/IRC-E: IECC Residential energy provisions and IRC Energy provisions in Chapter 11.
- IgCC: Chapter 1 of the IgCC. Remainder of the code is based on the provisions of ASHRAE Standard 189.1 *Standard for the Design of High-Performance Green Buildings, Except Low-Rise Residential Buildings*. The 2018 IgCC is scheduled to be published in the Summer/2018.
- IRC-B: IRC Building provisions. Chapters 1 – 10.

A 2020 Group C cycle is not scheduled.

Notes:

- Be sure to review the document entitled “2018/2019 Code Committee Responsibilities” which will be posted. This identifies responsibilities which are different than Group A and B codes and committees which may impact the applicable code change cycle and resulting code change deadline. As an example, throughout Chapter 9 of the IBC (IBC- Fire Safety), there are numerous sections which include the designation “[F]” which indicates that the provisions of the section are maintained by the IFC code committee. Similarly, there are numerous sections in the IEBC which include the designation “[BS]”. These are structural provisions which will be heard by the IBC – Structural committee. The designations in the code are identified in the Code Committee Responsibilities document.
- I-Code Chapter 1: Proposed changes to the provisions in Chapter 1 of the majority of the I-Codes are heard in Group B (see Admin above for exceptions). Be sure to review the brackets ([ ]) of the applicable code.
- Definitions. Be sure to review the brackets ([ ]) in Chapter 2 of the applicable code and the Code Committee Responsibilities document to determine which code committee will consider proposed changes to the definitions.
- Proposed changes to the ICC Performance Code will be heard by the code committee noted in brackets ([ ]) in the section of the code and in the Code Committee Responsibilities document

ARMA Awards Miami-Dade County for Public Partnership

Presentation recognizes Miami-Dade's staff collaboration on updates to Florida Building Code requirements in high-wind zones

WASHINGTON (May XX, 2017) – The Asphalt Roofing Manufacturers Association (ARMA) is proud to announce that the Miami-Dade Regulatory and Economic Resources Department is the recipient of the 2017 ARMA Public Partnership Award.

The exclusive award, given only for the recognition of extraordinary partnerships formed with ARMA, recognizes the strong collaboration between Miami-Dade and ARMA to update the Florida Building Code requirements in high wind zones. Aaron R. Phillips, Corporate Director of Technical Services at TAMKO Building Products, Inc. and chair of the ARMA Codes Steering Group, presented the award to Michael Goolsby, Miami-Dade Board and Code Administration Division Director. In addition, ARMA presented the staff members who worked on the project with individual certificates.

Over the past two years, Miami-Dade staff and ARMA representatives worked on updates to the roofing requirements for the High Velocity Hurricane Zone (HVHZ), during numerous meetings and conference calls to review the current provisions, develop code proposals and manage the Florida Building Commission process.

The collaboration spanned hundreds of hours to remove outdated references and coordinate the HVHZ protocols with national testing requirements. Revisions approved as a result of this effort will streamline the certification process for roofing manufacturers when launching new products or renewing existing approvals and help Miami-Dade staff better manage their product approval review process.

"Miami-Dade staff members are grateful for ARMA's recognition of our joint effort," said Goolsby. "It was only through our shared goal that we were able to get it done."

ARMA and Miami-Dade representatives attended the Florida Building Commission's Rule Development Workshop in early April in Ocala as the Commission approved the final changes. The 2017 Florida Building Code, scheduled for launch on January 1, 2018, will include every one of the dozens of proposals and public comments jointly submitted by ARMA and Miami-Dade.

"This kind of cooperation between a public regulator and a private trade association is rare enough," said ARMA's Vice President of Code and Regulatory Compliance, Michael Fischer. "The overwhelmingly positive results are unprecedented."

Phillips noted that the efforts aren't necessarily over. "We hope to build on this partnership and continue to improve the product approval process during future Florida code updates," he said.

ARMA's efforts in the codes, standards, and technical arenas translate to effective minimum code requirements, useful material standards, and a vast range of educational resources for the industry. Technical manuals, installation guides, Fast Facts, and technical bulletins are available on ARMA's website and provide best practices for a variety of roofing topics. Visit asphaltroofing.org for access to all of these materials and more.

###

About ARMA

The Asphalt Roofing Manufacturers Association (ARMA) is the North American trade association representing the manufacturers and suppliers of bituminous-based residential and commercial roofing products, including asphalt shingle roofing systems, roll roofing systems, built-up (BUR) roofing systems, and modified bitumen roofing systems. For more information, please visit www.asphaltroofing.org.

Goals of ICC Preferred Provider Program

The Preferred Provider Program focuses on training opportunities offered by various categories of ICC-approved education Providers, as identified in Section 1.6, which collectively form the ICC Preferred Provide Network (PPN). The Program recognizes and promotes ICC-approved educational offerings by a variety of Providers as they relate to codes, standards and guidelines, as well as building construction materials, products and methods.

Purpose of the Preferred Provider Program

The ICC Preferred Provider Program is designed to accomplish several goals:

- Create an easily accessible network of extensive training opportunities from a variety of educational resources;
- Provide access to quality training on specialty topics and building products that are beyond the ICC core training programs;
- Provide increased quality and support for educational renewal requirements of the ICC Certification Program;
- Enhance the relationship between ICC and educational Providers in support of building safety and innovation in building products and construction practices; and
- Expand opportunities for maintaining high level of professional achievement demonstrated through obtaining ICC certification.

Benefits of Becoming a Preferred Provider

There are many important reasons that ICC Preferred Provider status benefits education Providers, including:

- **Connecting Preferred Providers to ICC members to create a vast network of educational opportunities.** The International Code Council has over 58,000 members who rely on educational and informational opportunities to stay current on varied aspects of building construction and use. The Program brings education Providers together with these members, as well as over 350 ICC chapters and 40,000 ICC-certified individuals, to greatly expand the amount and quality of available training needed to serve the significant needs. With a subscription base of more than 220,000 and database of over 450,000, significant access opportunities are available. ICC's periodic communication with its members and customer bases regarding the PPP and links to the PP website will facilitate the connection between ICC members and customers with Preferred Providers.

- **Leveraging a partnership between the Provider and ICC.** The Program exposes the services and products of education Providers to ICC's broad audience through a Provider directory, listing of Provider educational offerings, and links to Provider websites. In addition, the Provider can use the ICC Preferred Provider logo and brand for marketing purposes. See Appendix G for ICC Preferred Provider Logo Usage Requirements.
- **Support of ICC Certification Renewal Program.** The ICC certification program certifies over 14,000 code officials, inspectors, plan reviewers, permit technicians, special inspectors, and students every year in over 40 national examination categories. Such certifications must be renewed every three years, with renewal based primarily on participation in educational programs. Every year more than 12,000 individuals renew one or more of their certifications. To maintain a level of quality assurance for the credibility of the ICC certification renewal program, the use of ICC or Preferred Provider training is now required as a condition of all certification renewals. More information is available in Appendix C.
- **Participation in ICC Chapter Education Benefit Program (CEB).** Eligible ICC chapters are awarded chapter education benefits (CEB) that have historically been limited to ICC-provided training. The benefit has now been expanded so that chapters can choose to obtain educational services from a Preferred Provider as the chapter benefit with a significant reimbursement from ICC. More information on the CEB program can be found in Appendix D.
- **Chapter discounted prices for ICC publications.** Preferred Providers that choose to offer ICC publications as an integral part of their training offerings will be able to purchase such publications from ICC at ICC Chapter seminar prices. ICC Chapter seminar prices are generally 20 percent lower than ICC Member prices; however, actual pricing may vary based on the individual publication.
- **Wall certificate.** Preferred Providers will receive a wall certificate from ICC in recognition of their initial approval as an ICC Preferred Provider.

ARMA Health, Safety, & Environment Committee

Asphalt Roofing Manufacturers Association
Health, Safety, and Environment Committee Meeting
Chair: Annmeza Szeto, IKO Production, Inc.
Vice-Chair: Devlin Whiteside, Owens Corning
Tuesday, May 23, 2017

Emissions Factor Data Summary Update

(As of May 1, 2017)

Data has been received from 6 separate companies. Most of the data is for blowstills, and most blowstill responses give PM filterable emissions (no size distribution given, just total PM filterable). A few other pollutants are given for blowstill emissions, including NOx, SO2, CO, and VOC. Total number of data points for blowstills is approximately 120 (including all pollutants).

Other types of units have fewer responses, and mostly give only PM filterable and VOC results.

Data is expected to be received from one more member company. No response from the remaining organization.

Regarding phase 2, at this time there is not enough data to establish a database. One idea is to have consultant just compare the data collected to that in the 2003 document and 2005 paper to see whether the new data is supportive of those emissions factors.

Washington Stormwater Roofing Research Update

Dear ARMA Members,

As we are moving into spring and the rains will soon subside, we wanted to provide you an update on the roofing materials assessment monitoring. We have added two rain event sampling to the original six events we had planned, and have now sampled seven of the eight events. We added sampling events because we did not get *Ceriodaphnia dubia* and zebra fish toxicology results for the first two events. Pure rain water has virtually no buffering capacity and a very low pH, so that all the *C. dubia* died almost instantly. After the first two events, we followed EPA protocols and added buffering capacity and adjusted the pH for the samples before exposing the fish and *C. dubia*. We have been able to run both the *C. dubia* and the zebra fish on fresh sample (rather than frozen sample).

To make the project more manageable with the human resources we had, we limited the number of samples for zebra fish exposure to the six panels with the highest *C. dubia* mortality, plus the low slope glass panel. We ran zebra fish in runoff from the following panels: copper, treated wood, Zincalume, EPDM, asphalt shingle with AR, the built up roofing with APP, and the slow slope glass roof.

We have also been dealing with metals contamination in the rearing water for fish and daphnia (which we add for buffering and subsequent pH adjustment). We have identified and minimized those sources to the best of our ability.

At this point we have received a shipment of the coho salmon and are awaiting a final, hopefully large, (>0.5 in) rain event to run the coho toxicology experiment. We are learning that the Puyallup rains are not as predictable nor as large as those in the Olympia area. But we will keep monitoring the storms to sample the best available event over the next few weeks.

Warm Regards,

Lisa Rozmyn
Washington State University
Washington Stormwater Center

ARMA MACT/GACT RTR Update

Part D, NESHAP, Subpart LLLLL – Site Visit Questionnaire

What specific improvements or rule changes would you like to see that would help your facility with compliance or better rule implementation? (CertainTeed Response)

1. Similar inlet temperature provisions consistent with the GACT, whereby you can rely on manufacturers specifications
2. Similar pressure drop consistent with the GACT
3. Clarification on triggers for MACT, elimination for MACT, related to "once in, always in"
4. If malfunction does not exceed "X", we do not have to shut down

What specific improvements or rule changes would you like to see that would help your facility with compliance or better rule implementation? (Owens Corning Response)

Response: OC requests the EPA consider three modifications / clarifications to the rule.

First, OC requests that the EPA clarify any overlap in affected equipment with other NESHAP rules, specifically Subpart JJJJ and Subpart OOOO. Subpart JJJJ and Subpart OOOO apply to coating operations and include references to fiberglass textiles and substrates, however, both Subparts contain exemptions for equipment or processes covered by a more applicable Subpart. OC requests clarification that equipment subject to Subpart LLLLL is not subject to Subparts JJJJ or OOOO.

Second, OC requests that the EPA review and modify the means to determine parameter monitoring limits for fiberbed filter control devices. Currently the rule requires a stack test to determine the upper inlet temperature limit and the upper pressure drop across the main filter. OC contends that these filter units achieve compliance with the emission limits of the NESHAP throughout a range of temperatures and pressure drops. Stack testing is an infeasible means to demonstrate compliance across the entirety of the effective ranges. OC requests that the rule be modified to allow engineering determinations and/or manufacturer guarantees to establish the parameter limits for fiberbed filter control devices.

Third, OC requests that EPA exclude sealant/laminate extruder systems as affected equipment under the rule. Applicators should be defined as a pan system with wheels or other components that pull asphalt from the pan and applies it to the sheet. Extruders do not include a pan or equivalent source of asphalt emissions or HAPS and therefore should not be grouped into the definition of applicators. Extruder tips are small diameter and are a very minor source of asphalt emissions. It is our contention that capture devices and monitoring requirements for these sources are overly burdensome, impracticable, and infeasible. Using extruders systems in lieu of applicators is, in itself, a minimization and reduction in asphalt emissions, potentially better than a capture and control system.

ARMA Technical Affairs Committee

FINAL REPORT

LONG-TERM PERFORMANCE MONITORING OF VARIOUS ROOF ASSEMBLIES – A SIDE BY SIDE COMPARISON

Draft

February 2017

Submitted to:

Asphalt Roofing Manufacturers Association
355 Lexington Avenue
15th Floor
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Submitted by:

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EXECUTIVE SUMMARY

In 2009, Onondaga County sought to evaluate and compare the energy performance of green or vegetative roofing systems relative to other roofing options. A major roof replacement project on a multiple building facility near Syracuse NY offered the opportunity for a side-by-side test to evaluate different roofing systems. This evaluation was initiated to provide guidance for future roofing renovations on other county-owned buildings. A final report was completed (CDH Energy 2011) comparing four different roofing assemblies:

1. A conventional roof with 4 inches of insulation (R-value of 22, or R22) with a black ethylene propylene diene monomer (EPDM) single ply-rubber roof membrane.
2. A "cool roof" with R22 insulation and a thermoplastic polyolefin (TPO) single-ply membrane.
3. A vegetative roof with R22 insulation.
4. A highly-insulated cool roof (R45) with a TPO single-ply membrane.

A consortium of roofing industry associations (led by the Asphalt Roofing Manufacturers Association) provided funding to continue the field testing in order to assess the long-term performance of the different roofing membranes. This side-by-side test arrangement—with different roof assemblies installed at the same location on very similar buildings—offered a unique opportunity to compare the long-term performance of various roof types. This report summarizes the measurements and observations based on 6½ years of data collected from November 2009 through May 2016.

The objective of the extended testing effort was to compare the thermal performance of conventional (EPDM) and cool (TPO) roof assemblies. Cool or reflective roofs, such as TPO, lower summer time heat gains and therefore reduce cooling loads. However, the lower roof temperatures may increase heating loads in the heating season. Therefore, it is unclear if cool roofs provide net annual benefits in heating dominated climates such as Syracuse, NY. It is also possible that over the long term, the benefits of a cool roof diminish as the membrane properties change with time as surfaces become soiled or degrade.

The specific goals of this follow-on study were to:

- track and evaluate any long-term changes in heat flux or surface temperature that might occur due to aging or soiling of the EPDM or TPO membranes,
- compare the long term thermal performance between roof assemblies,
- evaluate the energy use and cost differences between the roofs for the heating and cooling seasons, and
- evaluate the impact that snow cover has on roof heat loss; compare ground snow cover to the inferred snow cover on each roof assembly.

The extended field testing of the different roof systems tracked the thermal performance over the 6½ year monitoring period. Data were collected at 15-minute intervals.

Some of the initial findings (CDH Energy 2011) continued over the long term:

- The EPDM membrane had roof temperatures that were as much as 60°F higher than the other TPO surfaces. This surface had higher heat gains in the summer but also more modest heat losses in the winter.

- The TPO membrane significantly reduced the surface temperatures in the summer but also resulted in greater heat losses in the heating season (since beneficial solar gains are reduced).
- The vegetative roof adds thermal mass to the roof assembly that dampens the temperature swings. Evaporation at the surface also provides cooling in the summer and swing seasons. The vegetative roof also retained more snow cover more often and had lower heat losses in the winter.

Over the long term, the TPO membrane had 30% to 45% higher thermal losses over the heating season, as measured at the roof surface. This higher heat loss increases heating costs by $23 per year per each thousand square feet of roof area. However, the reduced summer time heat gains equate to about $16 per thousand square feet in cooling energy savings. Overall, heating losses and cooling savings resulted in a net annual cost penalty of $8 per thousand square feet for the TPO roof.

Using different assumptions for internal gains and cooling system arrangement—corresponding to a small office with a packaged cooling system that uses economizer cooling in the swing season—changes the resulting impact on heating and cooling loads and energy use. The heating penalty of TPO over a shorter heating season drops to $16 per thousand square feet and the cooling benefit becomes $9 per thousand square feet. The net annual cost penalty of TPO compared to EPDM is still around $7 per thousand square feet.

The results from Hossieni (2014) and Hosseini and Akbari (2015) showed similar trends of heating losses and summer time cooling savings, with a slightly smaller net annual penalty of $1-2 per thousand square feet for nearby Toronto (using our assumptions). Details of building application (office, retail, institutional, etc.) and HVAC arrangement (economizer, cooling efficiency), as well as utility costs have a significant impact whether cooling roofs provide net cost penalties or savings in each climate.

We used data from the National Operational Hydrologic Remote Sensing Center (NOHRSC) in Chanhassen, MN to predict the hourly ground snow cover for the test site. We found that periods with ground snow cover also have roof surface temperatures that remain very close to freezing, regardless of outdoor temperatures. By combining the snow cover and roof temperature data, we could show that the roofs are generally covered with snow less often than snow is on the ground: the ratio of roof-to-ground snow cover ranged between 60 and 80%. The EPDM roof clears snow faster than the TPO roofs (as evidenced by temperature excursions above freezing). The TPO roof with extra insulation retained snow for longer since the reduced heat loss results in less melting at the roof surface.

We found that the temperature difference between the similarly-insulated EPDM and TPO roofs was higher when the roofs were first installed. Over the first two or three years, the temperature difference between EPDM and TPO roofs dropped by 10°F to 15°F. Generally, the peak temperature of the EPDM roof stayed about the same over the long term while the peak surface temperature of the TPO roof increased by 10°F to 15°F. This long-term change is less than what was observed in earlier studies using the first-generation cool roof membrane products (Miller et all 2004), but seems to be consistent with the published rating numbers for this TPO membrane (initial and 3-year reflectance ratings are 0.79 and 0.70, respectively).

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Glossary of Terms

ARMA	Asphalt Roofing Manufacturers Association
CRRC	Cool Roof Rating Council. Part of Energy Star cooling roofs program.
economizer	An optional HVAC arrangement where outdoor air is used to provide “free cooling” when outdoor conditions are favorable.
EnergyPlus	A building simulation software tool from the US Department of Energy. Used to determine theoretical heat transfer through the roof assembly to verify calculations in this study.
EPDM	Ethylene propylene diene monomer single-ply rubber roof membrane. Also a conventional or dark roof membrane.
HVAC	Heating ventilation and air conditioning. System that provides heating and cooling for a building.
TPO	Thermoplastic polyolefin roof membrane. Also a white, reflective or cool roofing membrane.
TRI	Temperature roof Inside. Temperature under the insulation layer.
TRO	Temperature roof outside. Temperature at the roof surface (but under the deck board).

Acknowledgements

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- Mike Fischer, Kellen Company, Coalition Chair, ARMA & PIMA
- Marcin Pazera, Owens Corning, ARMA
- Jerry Phelan, Bayer Material Science, PIMA
- Ellen Thorp, ERA
- Rick Gustin, Johns-Manville, ERA

Introduction

In 2009, Onondaga County sought to evaluate and compare the energy performance of green or vegetative roofing systems relative to other conventional and energy-efficient roofing options. A major roof replacement project on multiple units (or sections) at the Onondaga County Correctional Facility in Jamesville, NY, offered the opportunity for a side-by-side test to evaluate different roofing systems (see Figure 1). This evaluation was initiated to provide guidance for future roofing renovations on other county buildings

Figure 1. Aerial View of the Four Units at Jamesville Facility

. A final report was completed in October 2011 comparing four different roofing assemblies:

1. A conventional roof with 4 inches of polyisocyanurate foam insulation with a black ethylene propylene diene monomer (EPDM) single ply-rubber roof membrane (Unit 1).
2. A conventional roof with 4 inches of poly-iso insulation with a white thermoplastic polyolefin (TPO) roof membrane (Unit 2).
3. A vegetative roof with 4 inches of poly-iso insulation (Unit 3).
4. A highly-insulated roof with 8 inches of poly-iso insulation with a white TPO roof membrane (Unit 4).

A consortium of associations related to the roofing industry (led by the Asphalt Roofing Manufacturers Association, or ARMA) provided funding to continue the field testing in order to assess the long-term performance of the different roofing membranes. This side-by-side test arrangement—with different roof assemblies installed at the same location on very similar buildings—offered a unique opportunity to

compare the long-term performance of various roof types. This report summarizes the measurements and observations based on 6½ years of data collected from November 2009 through May 2016.

The objective of the extended testing effort was to compare the thermal performance of conventional (EPDM) and cool (TPO) roof assemblies. Cool or reflective roofs, such as TPO, lower summer heat gains and therefore reduce cooling loads. However, the lower roof temperatures may increase heating loads in the heating season. Therefore, it has been unclear if cool roofs provide net annual benefits in heating-dominated climates such as Syracuse, NY. It is also possible that over the long term, the benefits of a cool roof diminish as the membrane properties change with time.

The specific goals of this follow-on study were to:

- Track and evaluate any long-term changes in heat flux or surface temperature that might occur due to aging or soiling of the EPDM or TPO membranes.
- Compare the long term annual performance (heat loss and heat gains) between roof assemblies.
- Confirm that the simplified determination of heat flux used in the original study provides an accurate prediction of heating and cooling loads.
- Evaluate the annual energy use and cost differences between the roofs for both the heating and cooling seasons; extend the findings to other types of building applications and compare to other studies.
- Evaluate the impact that snow cover has on roof heat loss; compare ground snow cover to inferred snow cover on each roof assembly.

Monitoring Approach

CDH initially considered several approaches to quantifying the energy impact of the different roof systems, including measuring the heating energy use of the HVAC system before and after retrofit. Ultimately, we determined that measuring the temperature differences within the roof assembly was the most compatible with the project schedule, building configuration, and limited access inside the facility. Two independent monitoring stations were installed on each roof, for a total of eight stations. Each station used a Campbell Scientific datalogger. The eight loggers were located on top of the roof, spaced out over several hundred yards. A mix of hardwired and wireless networking was used to connect the loggers. Communications to transmit the data to back to CDH was achieved via a phone modem link. In 2014, the communications link was upgraded to a cellular modem.

Each monitoring station was based around a Campbell Scientific CR800 or CR1000 datalogger (Station 2A uses a CR1000 to accommodate extra data points). Communications between the loggers was provided by wired serial communications (RS-485) or wireless connections (915 MHz spread spectrum radio). The dataloggers were programmed to sample all sensors once per second. Calculated averages and totals were recorded for each 15-minute interval. After all records were created at each station, the datalogger located at 3A collected each record from all the other dataloggers. That master datalogger was called and data was downloaded each night by phone modem. The data was loaded into a database at CDH Energy for automatic verification and analysis.

Appendix A provides more details on the monitoring system. The rational for installing these points is given below.

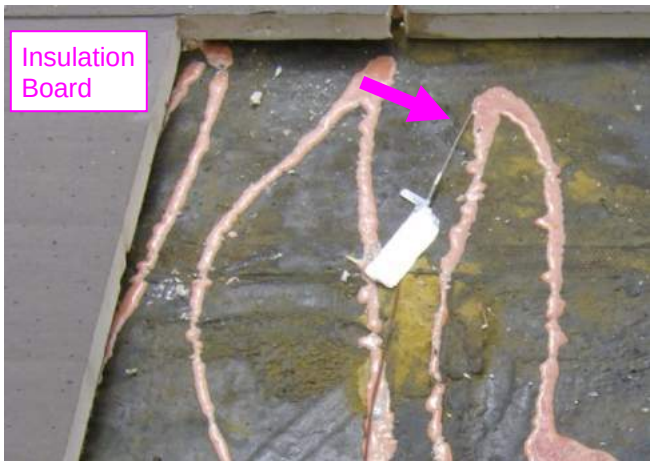
Instrumentation

A monitoring system was installed to measure the performance of each roofing system. The overall experimental approach was to measure and compare the temperatures in the different roofing systems in a side-by-side test in both seasonal and annual comparisons. The heat transfer through the roof surface is proportional to the temperature difference through each layer. Since all the roof systems are exposed to the same ambient conditions, as well as similar indoor temperatures, the performance of the different systems can be directly compared at each time step. The measurements listed in Table 1 were taken at two separate locations (A and B) on each building (Units 1, 2, 3, and 4), resulting in a total of eight monitoring locations.

Table 1. Instrumentation for Each Measurement Location or Station

Point	Description	Instrument	Eng. Units
TRO	Roof Temperature (on top of insulation, under roof board)	Type-T Thermocouple	ºF
TRI	Roof Temperature (under roof insulation, above deck)	Type-T Thermocouple	ºF
TAI	Indoor Temperature (just below the ceiling)	Type-T Thermocouple	ºF

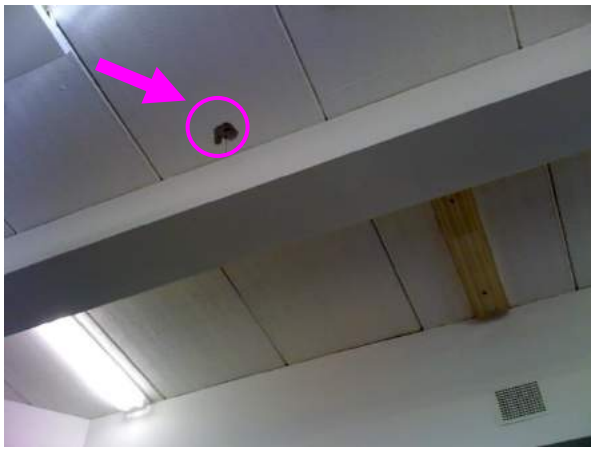
Figure 2 and Figure 3 show how the thermocouples are installed at each station. Figure 4 shows a schematic of a cross-section of the roof assembly indicating the sensor and thermocouple wiring locations. Low voltage wiring between the dataloggers are laid on the roof surface.



Thermocouple installed on top of roof deck (**TRI**), before insulation was installed

Thermocouple installed above the insulation and below the dense deck (**TRO**, location 1B)

Figure 2. Thermocouple Installations: TRI Below Insulation, and TRO Above Insulation



Thermocouple installed just below the ceiling (location 4B)

Thermocouple installed just below the ceiling (location 4A)

Figure 3. Thermocouple Installation for TAI

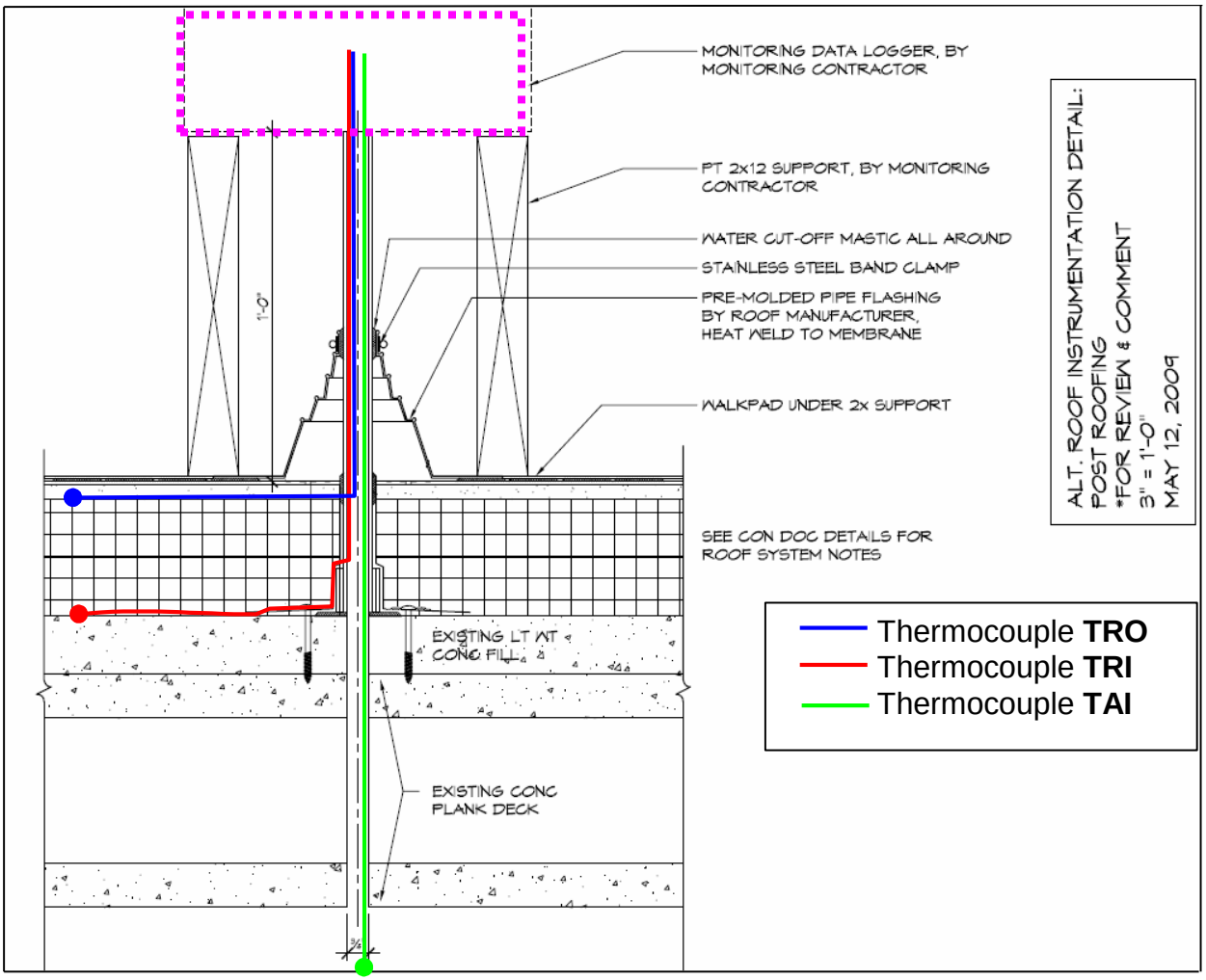


Figure 4. Detailed Drawing of Thermocouple Locations at Each Station (the colored lines indicate thermocouple wire routing through the roof assembly to the datalogger)

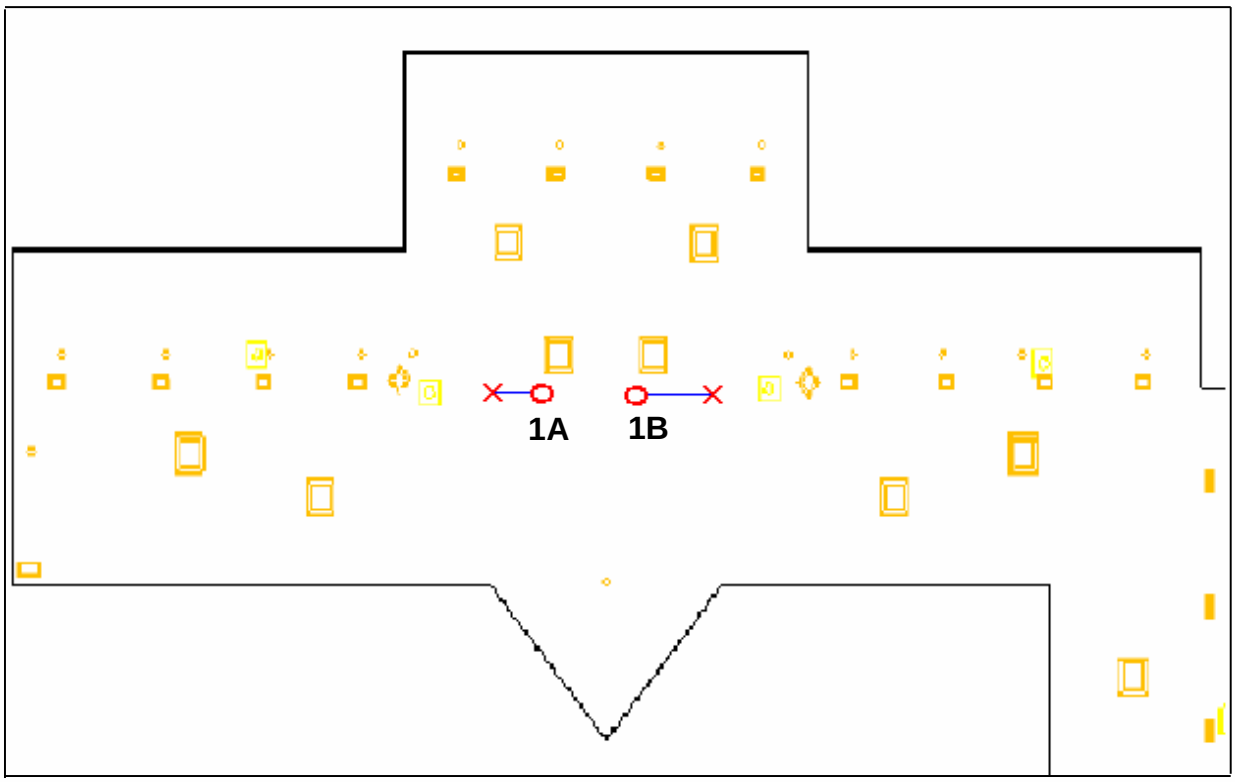


Figure 5. Unit 1 Station Positions (O: datalogger, X: thermocouple)

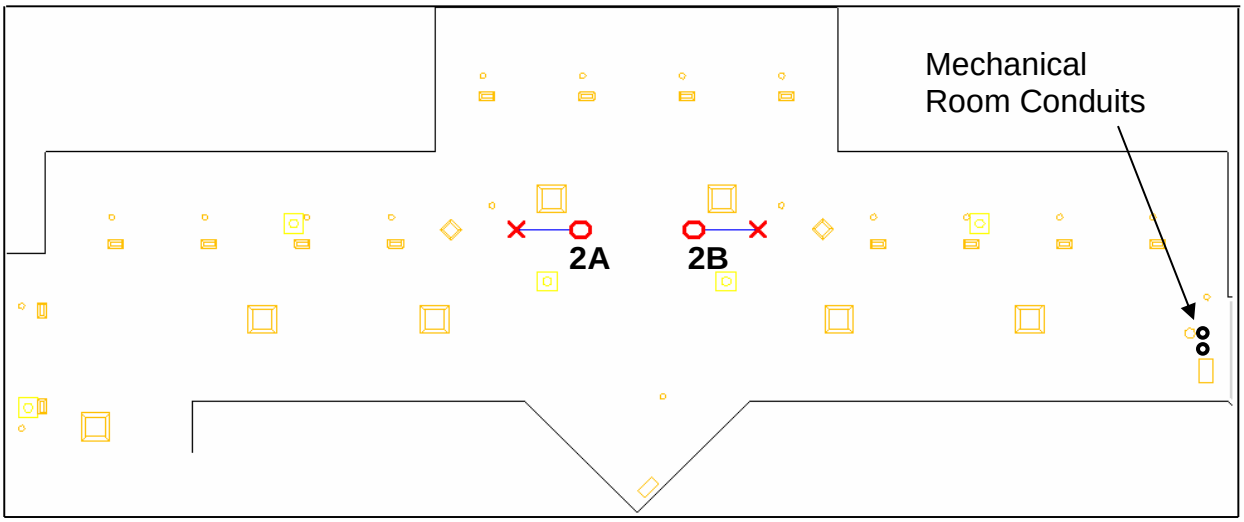


Figure 6. Unit 2 Station Positions (O: datalogger, X: thermocouple)

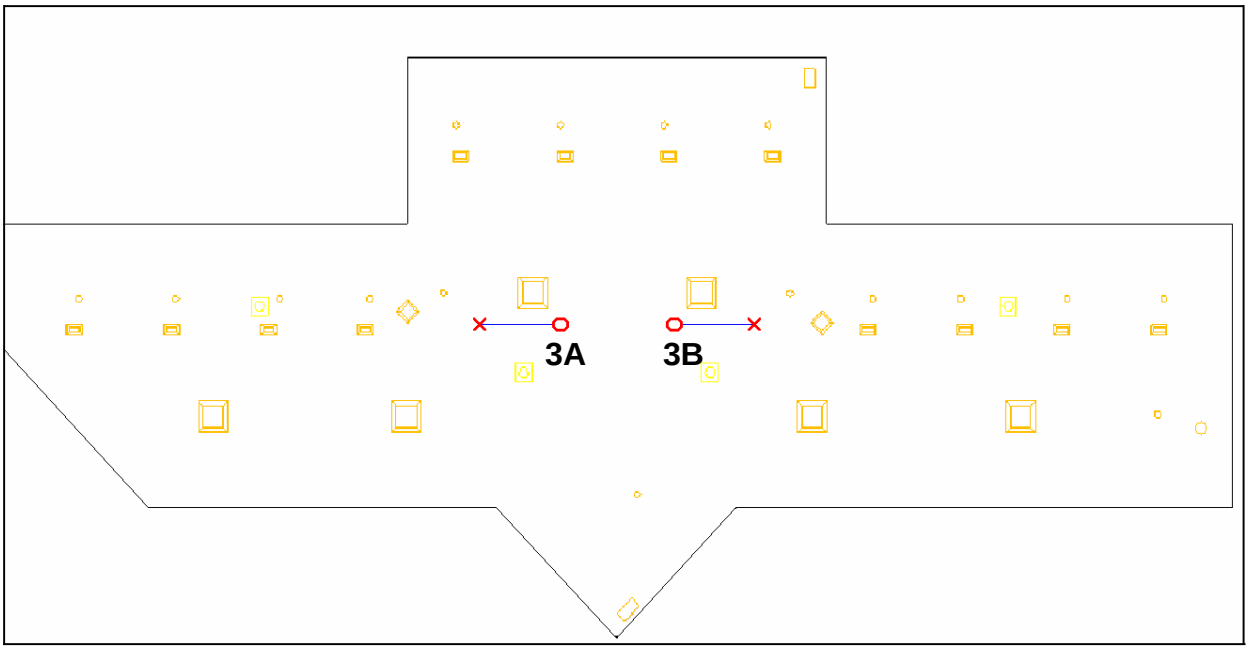


Figure 7. Unit 3 Station Positions (O: datalogger, X: thermocouple)

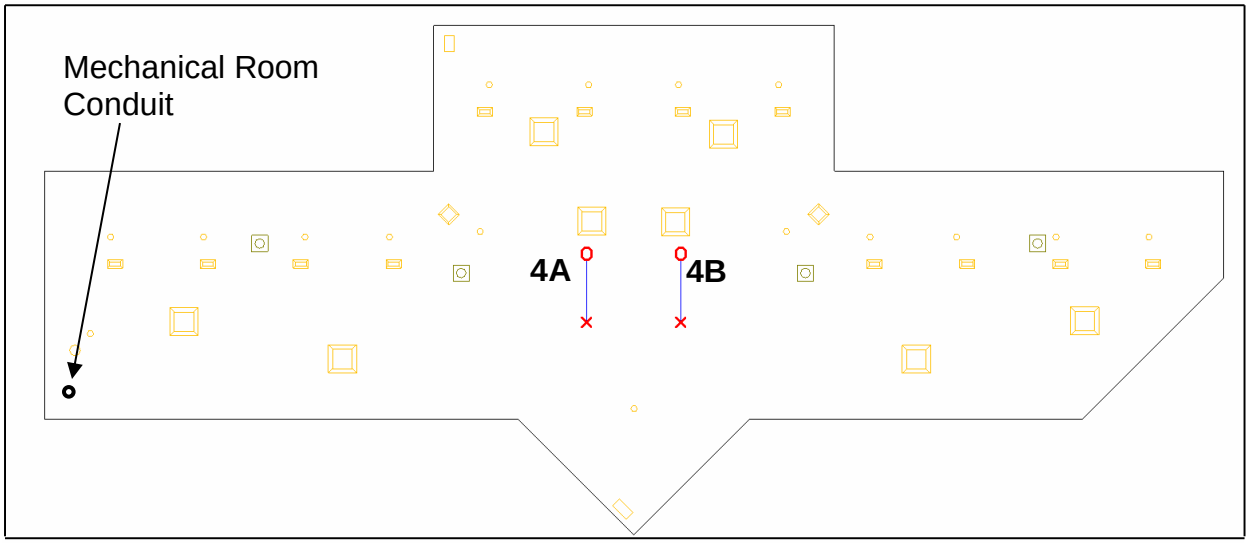


Figure 8. Unit 4 Station Positions (O: datalogger, X: thermocouple)

One of the stations (2A) also collected additional measurements for the overall site as listed in Table 2. A weather station was installed to measure ambient temperature (**TAO**), horizontal solar flux (**ISH**) and rainfall (**RAIN**). Other points were on the vegetative roof assembly.

Table 2. Instrumentation for Additional Measurements at Station 2A

Point	Description	Instrument	Eng. Units
TAO	Outdoor Temperature	Type-T Thermocouple	ºF
ISH	Solar Flux or Insolation (horizontal)	Licor LI200x	W/m^2
TGR	Green Roof Temperature (middle of soil layer)	Type-T Thermocouple	ºF
MGR	Green Roof Moisture Content (middle of soil layer)	Campbell Scientific CS616	0-1
RAIN	Rainfall	Texas Electronics 525	Inches
WF	Water Flow from Green Roof Mockup see the previous report (CDH Energy 2011)	Texas Electronics 525	Gal/h

Major Events During Monitoring Period

Table 3. Summary of Major Events Early in the Monitoring Period

May 2009
- Installed embedded thermocouples for 1A
- Installed embedded thermocouples for 1B

June 2009
- Installed embedded thermocouples for 2A
- Installed embedded thermocouples for 2B
- Installed embedded thermocouples for 3A
- Installed embedded thermocouples for 3B
- Installed embedded thermocouples for 4A
- Installed embedded thermocouples for 4B

September 2009
- Vegetative roof was installed

October 2009
- Installed dataloggers for each monitoring station
- Mockup sensors installed
- Indoor temperature sensors installed
- Data collection begins

November 2009
- The phone line for data collection operational
- The conduit for the pyranometer had been tilting; it was straightened and reinforced.

March 2010
- The collector on the rain gauge was knocked off the top of the device over the winter (precise date unknown). The top was replaced.

Description of Roofs

The four buildings or units at Jamesville that were included in this test program are shown in Figure 9 below. Each unit had a different roofing system installed, as described in Table 4.

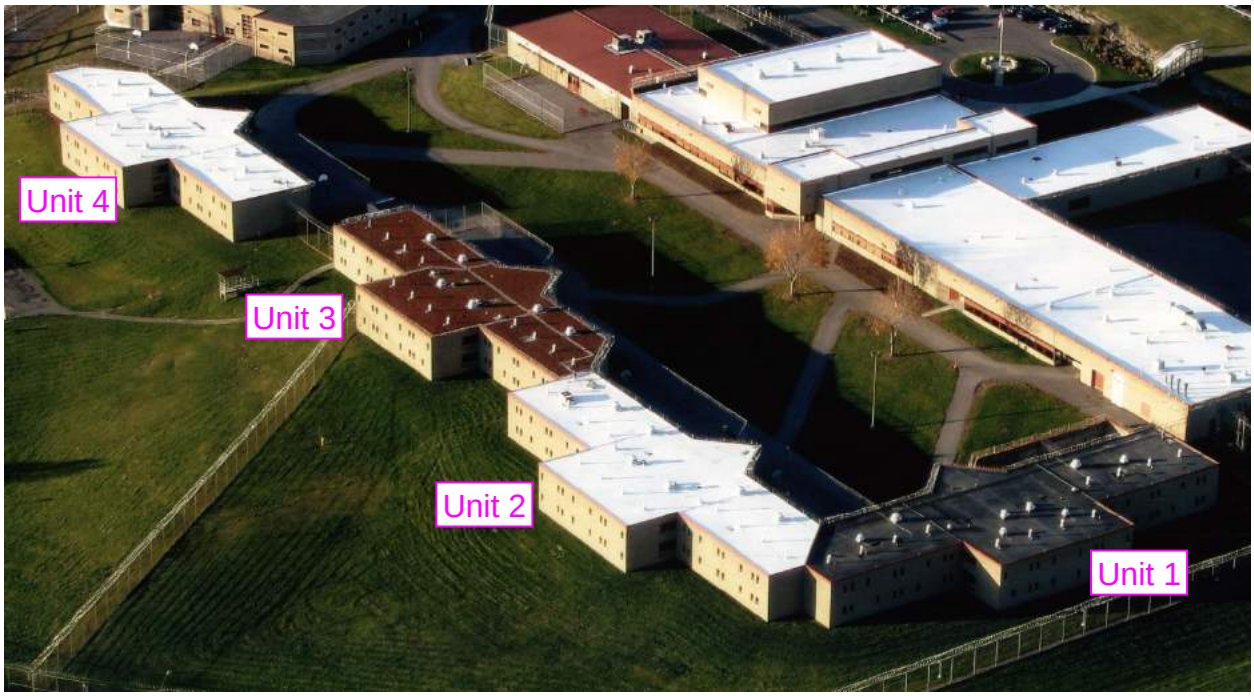


Figure 9. Aerial View of the Four Units at Jamesville Facility

Table 4. Construction Details for the Roofs on Each Unit

Location	Insulation	Surface
Unit 1	4 inches Poly Iso[1] foam board (R22)	EPDM rubber[2]
Unit 2	4 inches Poly Iso[1] foam board (R22)	TPO white[3]
Unit 3	4 inches Poly Iso[1] foam board (R22 + vegetative layer)	EPDM w/ vegetative assembly on top
Unit 4	8 inches Poly Iso[1] foam board (R45)	TPO white[3]

1- Polyisocyanurate foam board applied in 2-inch layers
2- Black EPDM (ethylene propylene diene monomer) single-ply rubber roof membrane
3- White TPO (thermoplastic polyolefin) roof membrane

The TPO membrane is rated by the Energy Star Cool Roofing Rating Council (CRRC) and ASTM D1519 with an initial reflectance of 0.79 and 3-year reflectance of 0.70.[1]

[1] As per Carlisle TPO-2007-18 (July 2007) and Carlisle Spec Sheet from December 2015.

Roof Assembly Details

The four roofs on the Onondaga County Correctional Facility were renovated at the same time during the summer of 2009. Units 1 through 3 are connected to each other at the roof (Figure 9). Unit 4 is completely detached from the other units. In each installation, adhesive foam secures the insulation to the roof. All of the roofing systems include a ½-inch layer of Georgia Pacific DensDeck™ fiberglass-reinforced gypsum board between the insulation and the roof membrane. The structural components of each roof are consistent on each unit. This includes a concrete plank deck beneath the insulation and roof membrane. The dimensions and details of the concrete plank deck are shown in Figure 10.

Concrete Plank Deck Details		
Section	Width (in)	Height (in)
Plank	36	7.38
Hole	2.75	5.38

Approximately 1 inch of solid concrete is above and below each hole with 1.63 inches between each hole.

Figure 10. Cross Section and Details for Concrete Plank Deck

Details of the roof on Units 1 to 3 are given in Table 5. Units 1 through 3 have a similar layout in terms of roof dimensions and placement of roof elements such as drains, vents, and access points. The first three units have a 4-inch layer of insulation that covers all of the surface area, except within 2 feet of the drains where it tapers to only 2 inches next to the drain. The slope for drainage is provided by a tapered lightweight concrete fill layer. The fill layer is 4 to 10 inches thick at the edge of the roof (average thickness at the edge is estimated to be 7 inches) and tapers down to approximately 3 inches thick when 2 ft from the center of the drain. The thickness of the concrete fill layer at the roof edge varies based on the distance to the drain, but the average fill layer thickness is estimated to be 5 inches. The roof edge detail and drain detail for Unit 1 through 3 is shown in Figure 11 and Figure 12.

Table 5. Roof Insulation and Fill Layer Details for Unit 1 - 3

Location	Thickness (in)
Nominal Insulation Layer	4
Insulation 2 feet from Center of Drain	4 to 2
Concrete Fill Layer at Roof Edge	4 to 10 7 avg
Concrete Fill Layer at Drain	3
Average Thickness of Concrete Fill Layer	5

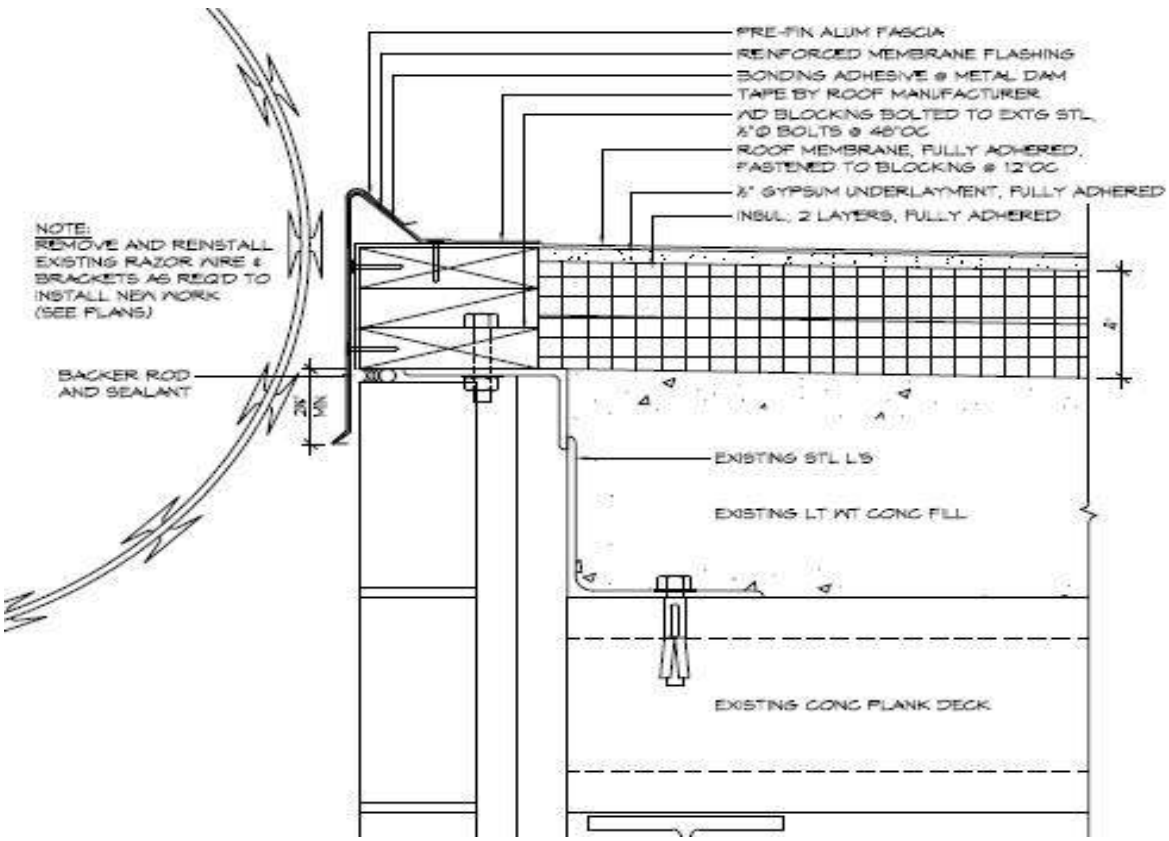


Figure 11. Roof Edge Detail for Units 1–3 with 8 inches of Concrete Fill

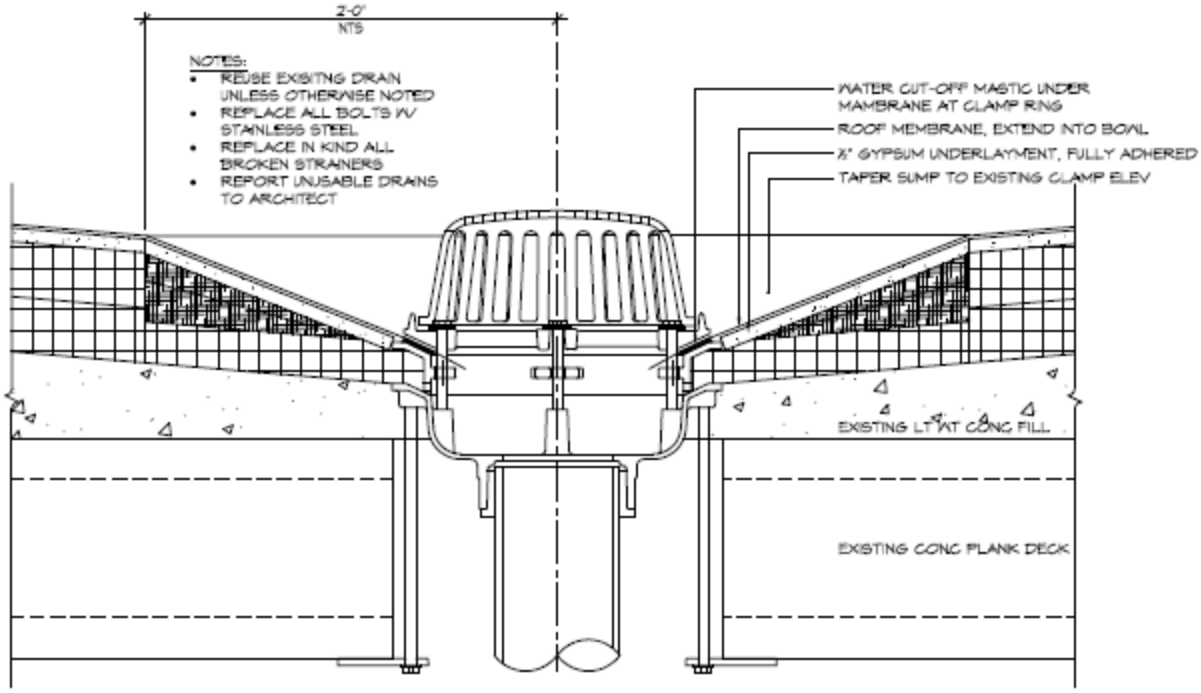


Figure 12. Drain Detail for Units 1–3

Unit 4 has more insulation on average than Units 1 to 3 (see Table 6). This unit, which was originally constructed after the other units, does not use lightweight concrete fill to provide tapering; instead the insulation on Unit 4 tapers down to the drains. Additional insulation board was added on top of the original insulation for this project. The insulation at the edge of the roof ranges from 8 inches to 14 inches (as shown in Figure 13 and Figure 14). The average thickness at the edge of the roof is 11 inches. The insulation tapers down to a minimum of 5 inches when 1.5 feet from the drains. The nominal insulation thickness is 8 inches.[2]

Table 6. Roof Insulation Details for Unit 4

Location	Thickness (in)
Insulation at the Roof Edge	8 to 14 11 avg
Insulation 1.5 feet from Center of Drain	5 to 4
Average Insulation Across the Roof Surface	8

The drain detail drawing for Unit 4 is shown in Figure 15. A tapered edge strip (shown on Figure 13) is added to the roof when the roof edge blocking is higher than the top of insulation.

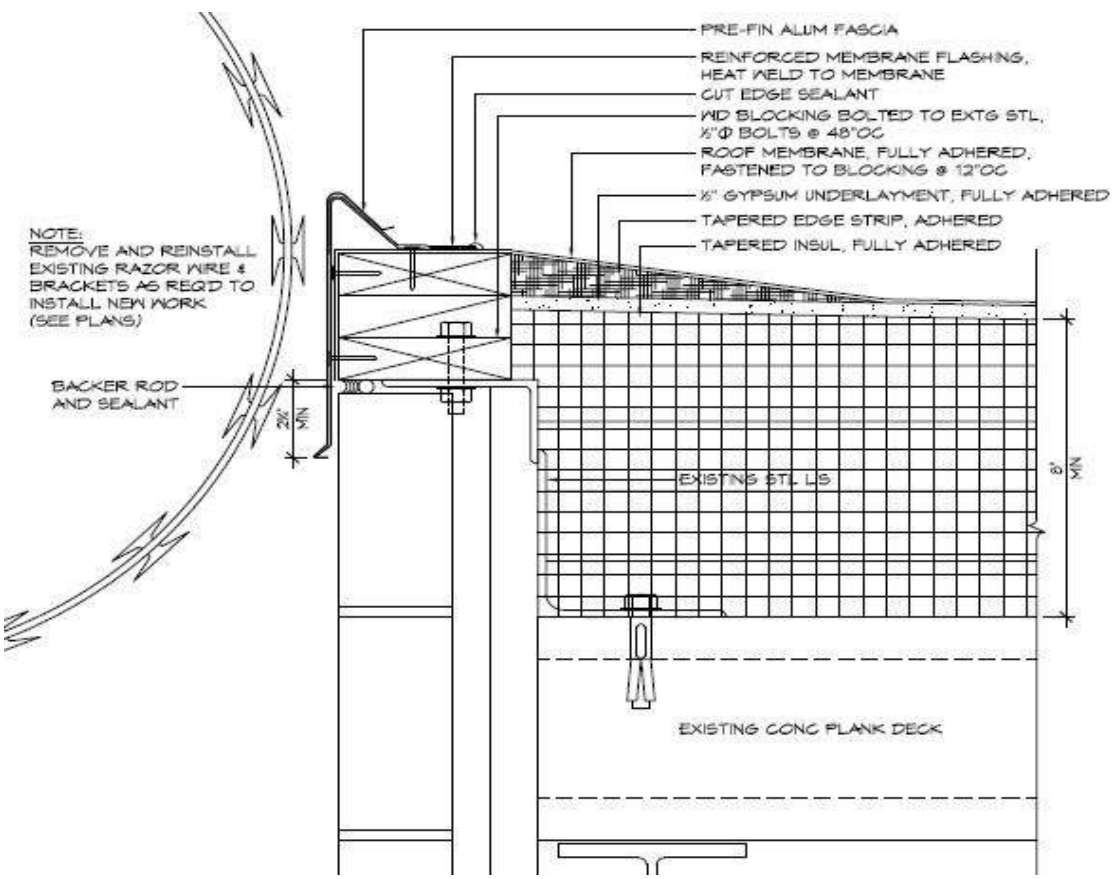


Figure 13. Roof Edge Detail for Unit 4 with 8 inches of Insulation

[2] We confirmed that the insulation thickness at the sensor locations for unit 4 (shown on Figure 8) was 8 inches.

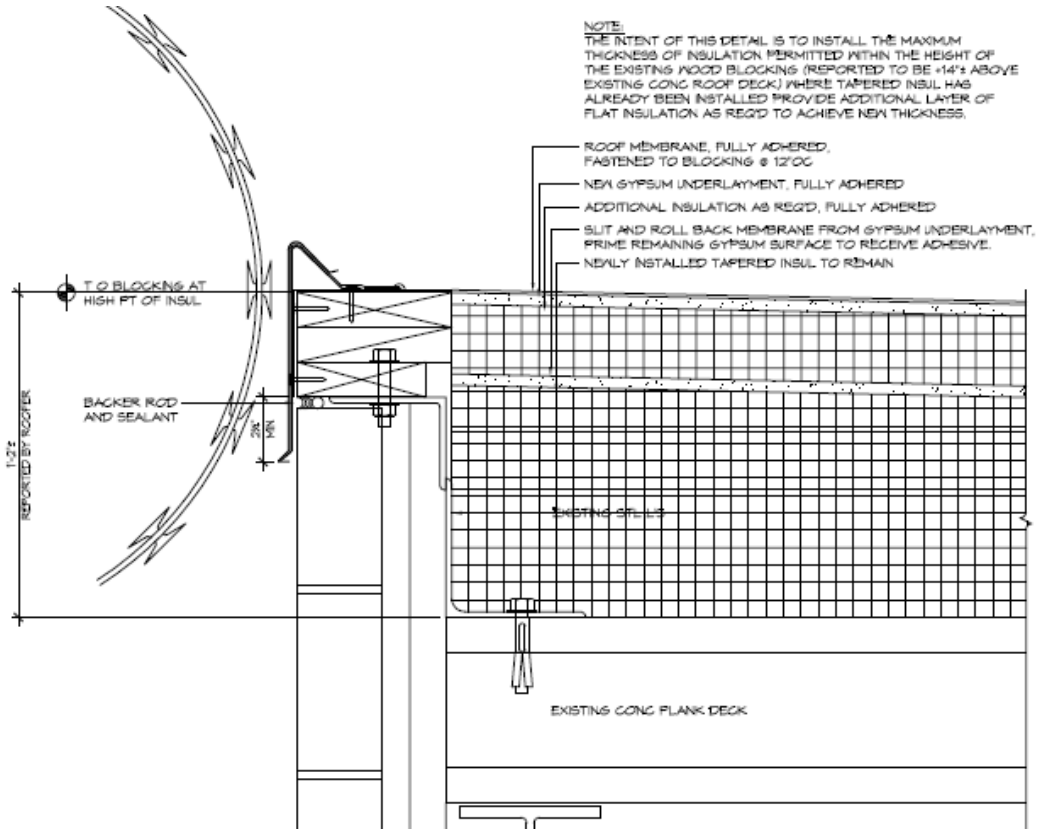


Figure 14. Roof Edge Detail for Unit 4 with 14 Inches of Insulation

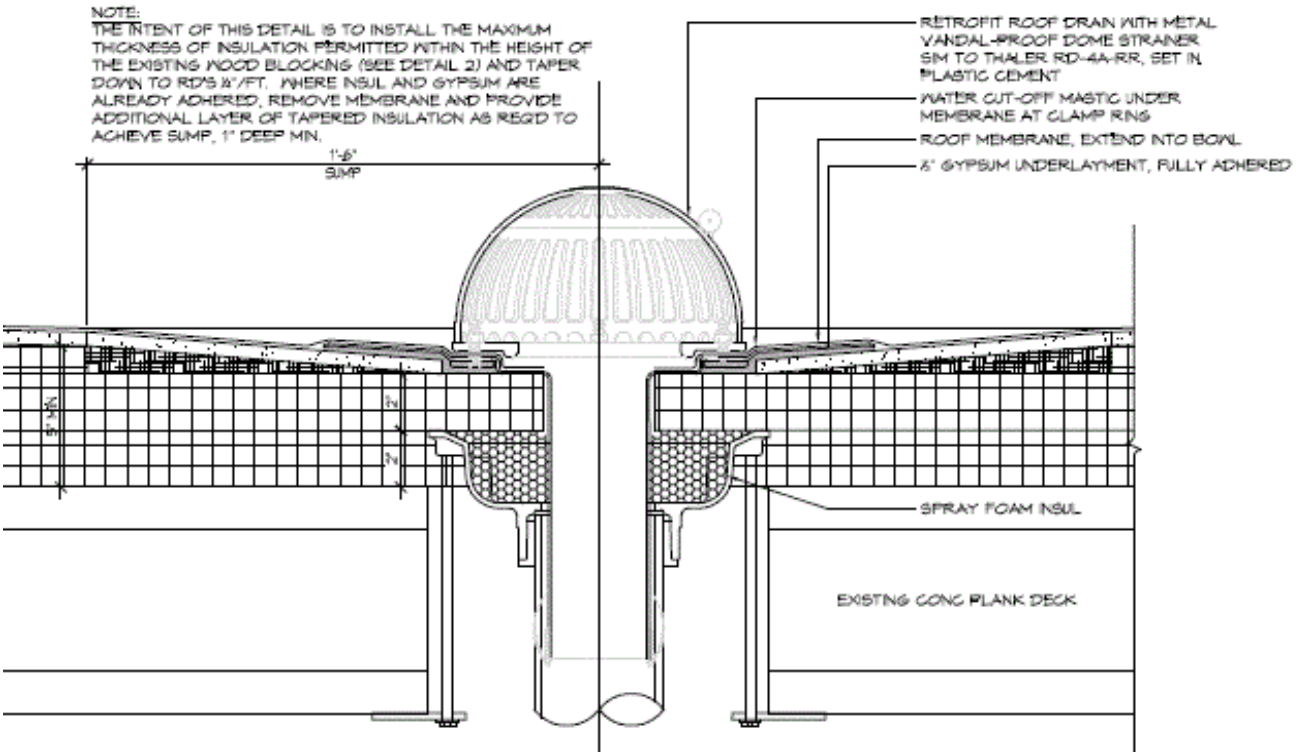


Figure 15. Drain Detail for Unit 4

The vegetative roofing system used was the Roof Garden System by Carlisle shown in Figure 16. The assembly includes a drainage board on top of the TPO membrane followed by a moisture retention mat and 2-3 inches of small aggregate. 12-inch by 15-inch sedum tiles are placed on top of the aggregate. The drainage board includes plastic cavities or cups to retain water.

Figure 16. Description of the Green Roof on Unit 3 (Roof Garden System from Carlisle)

Figure 17 shows photos of the roofs before installation, and Figure 18 shows the new roofing systems.

View from Unit 3 looking towards Unit 1

View from Unit 2 looking towards Unit 3

Figure 17. Photos of Roofs at Onondaga County Correction Facility (before installation)

View from Unit 3 (vegetative) looking towards Unit 2 (TPO)

View from Unit 4 looking towards Unit 3

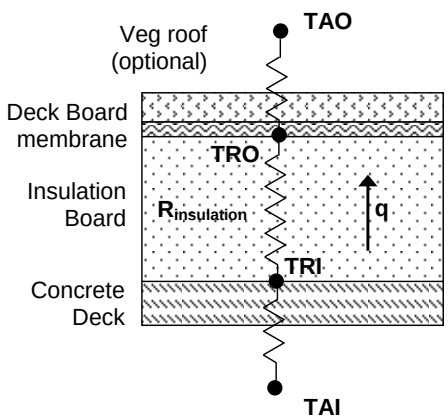
Figure 18. Photos of Roofs at Onondaga County Correctional Facility (after installation)

Data Analysis and Results

The data collection system at the site was fully commissioned starting on October 22, 2009. This section analyzes the data collected from November 1, 2009 through May 31, 2016.

Roof Thermal Performance

Our experimental analysis of heat transfer through the Jamesville, NY roof assembly in the original report (October 2011) made several key assumptions. The analysis in the original report ignored heat storage in the concrete layer and assumed the insulation layer had insignificant thermal mass. A simplified one-dimensional, steady-state heat flux through the insulation layer was assumed to represent the heat flux through the entire roof assembly.



Where:

$R_{insulation}$ - R-value for Insulation layer (ºF-h-ft^2/Btu)

q - Heat flux through the roof assembly (Btu/h-ft^2)

$$q = \frac{(TRI - TRO)}{R_{insulation}} \qquad \text{(eqn. 1)}$$

An EnergyPlus model was developed and compared to the simple model (eqn. 1) to test the validity of this assumption. That analysis is summarized in Appendix B. The EnergyPlus analysis, using the finite difference method, showed that the simple model (eqn. 1) accurately represented the heat flux at the top of the roof assembly (i.e., into the top of the concrete layer). However, the heat flux into the space (i.e., from the bottom of the concrete layer) was much different. We found that the heat flux into the space predicted by EnergyPlus was reasonably represented by applying equation 2 below to the 15-minute interval data from EnergyPlus. Therefore, this equation provides an approximate correction for the field test data for the thermal mass (assuming the concrete layer is highly conductive relative to the insulation layer and is essentially at a uniform temperature represented by **TRI**).

$$\boldsymbol{q} = m * cp * \frac{\boldsymbol{TRI'} - \boldsymbol{TRI}}{t' - t} + \frac{\boldsymbol{TRI'} - \boldsymbol{TRO'}}{R_{insulation}} \qquad \text{(eqn. 2)}$$

The variable *q* is defined as positive heat loss from the space through the roof to ambient. On each roof, a different amount of insulation board (with an R-value of 5.7 ft^2-h-°F/Btu per inch) was installed on each unit (see Table 4). The variable *m* is defined as the mass per area at 46.6 lb/ft^2. The variable *cp*

represents specific heat at 0.1996 Btu/lb-°F. In the tables below, the overall, long term heat transfer is calculated using both methods (equations 1 and 2) and are shown to yield similar results.

Figure 19 and Figure 20 show the temperatures for the four different roofs during a Fall day in 2009 and 2015. The top of the insulation beneath the EPDM membrane on Unit 1 is at a warmer temperature during the day since more heat is absorbed from the sun. The TPO roofing surface on Unit 2 is significantly cooler since its higher reflectivity reduces solar gains. The vegetative roof provides thermal mass that smooths out the fluctuations across the daily cycle.

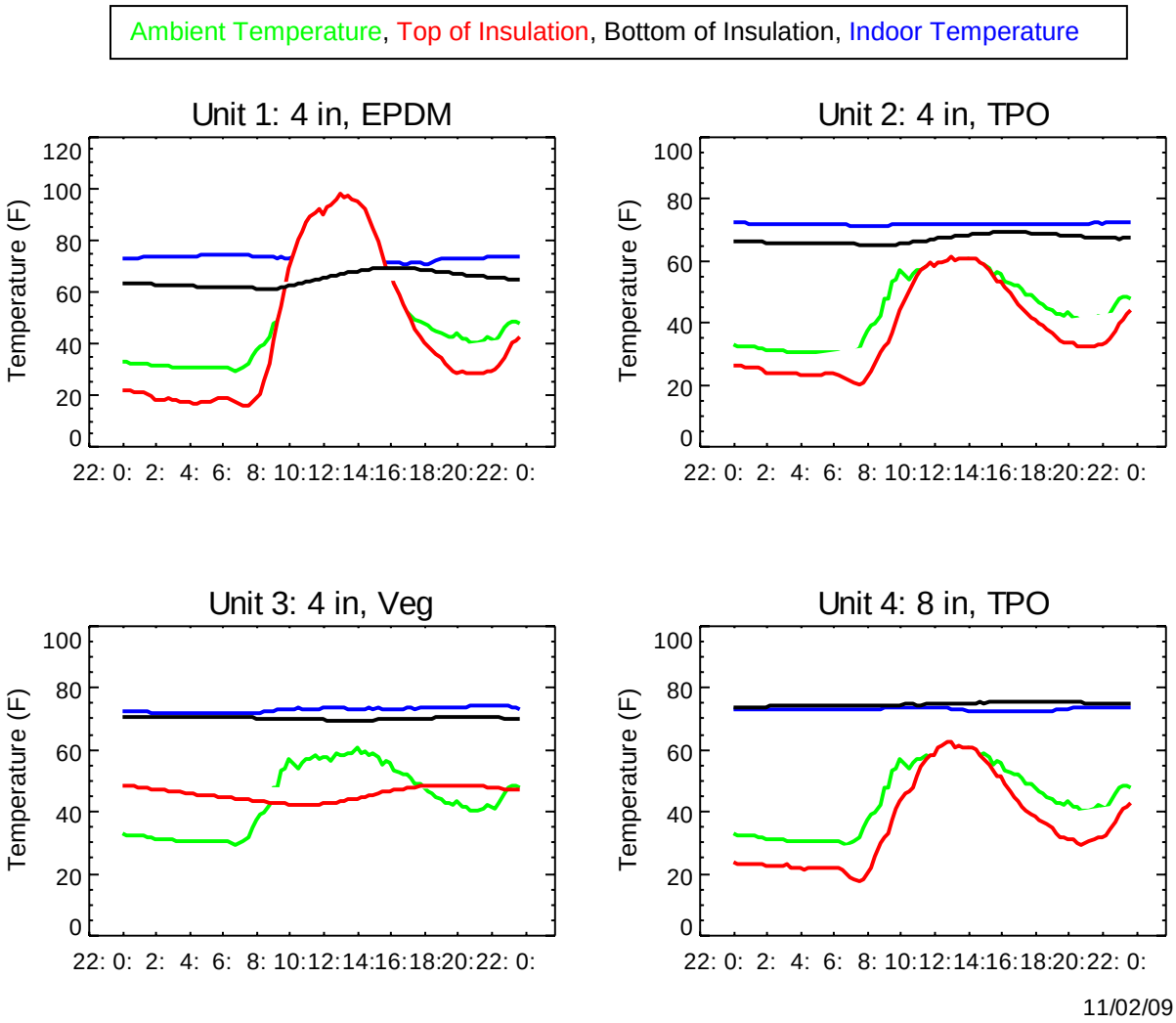


Figure 19. Daily Temperature Profiles for Each Roof Type (November 2, 2009)

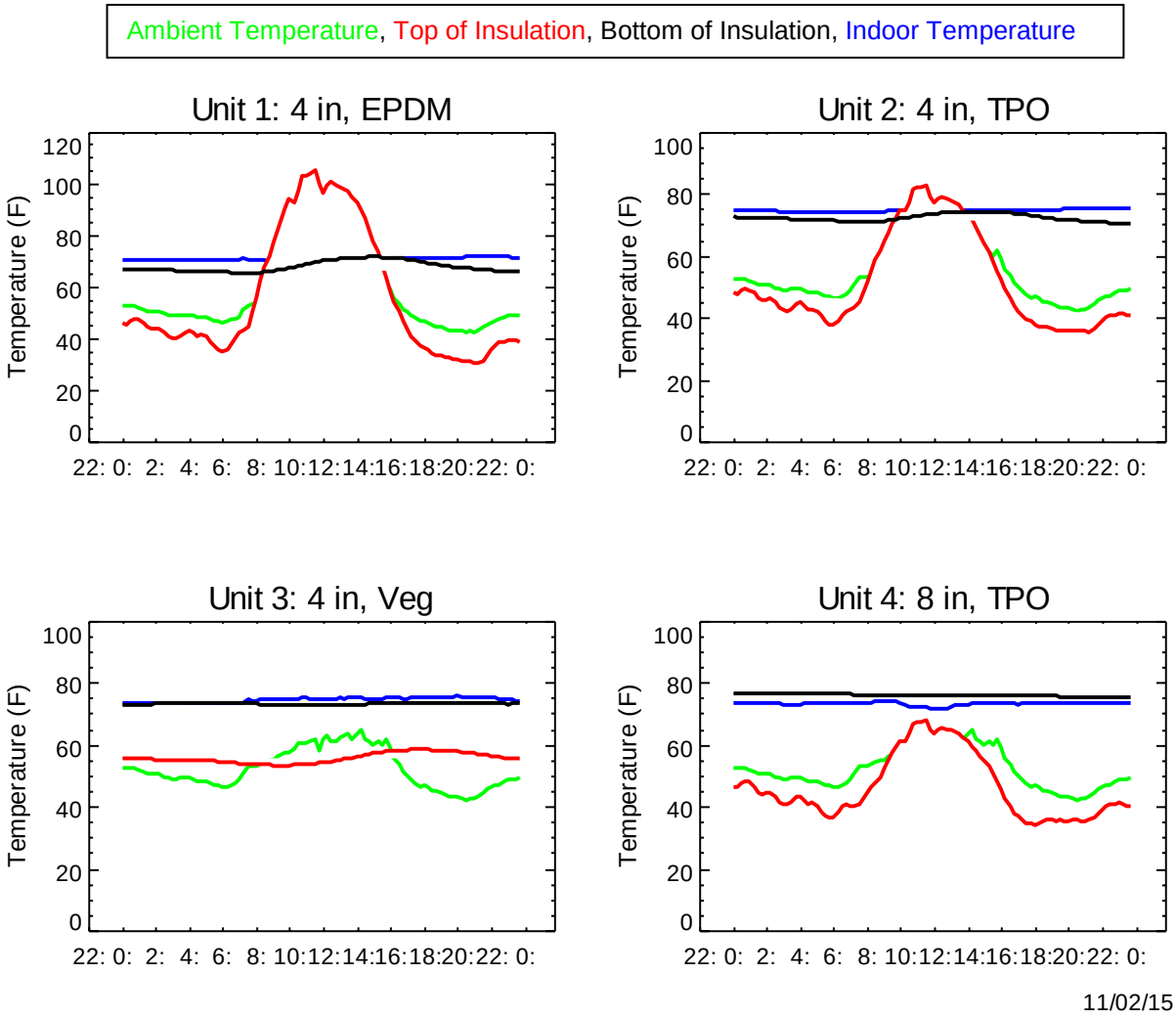


Figure 20. Daily Temperature Profiles for Each Roof Type (November 2, 2015)

The difference in peak temperatures between the EPDM and TPO roofs in November 2009 (six months after installation) was 37°F. For the similar November day in 2015, the temperature difference had dropped to 23°F.

Figure 21 and Figure 22 below show the heat transfer performance at the roof surface (using eqn. 1) for each roof type. A positive number represents net heat loss through the roof. The assemblies all experience heat loss in the early morning hours. The heat flow reverses direction for the EPDM roof as the roof surface heats up and drives heat into the roof assembly.

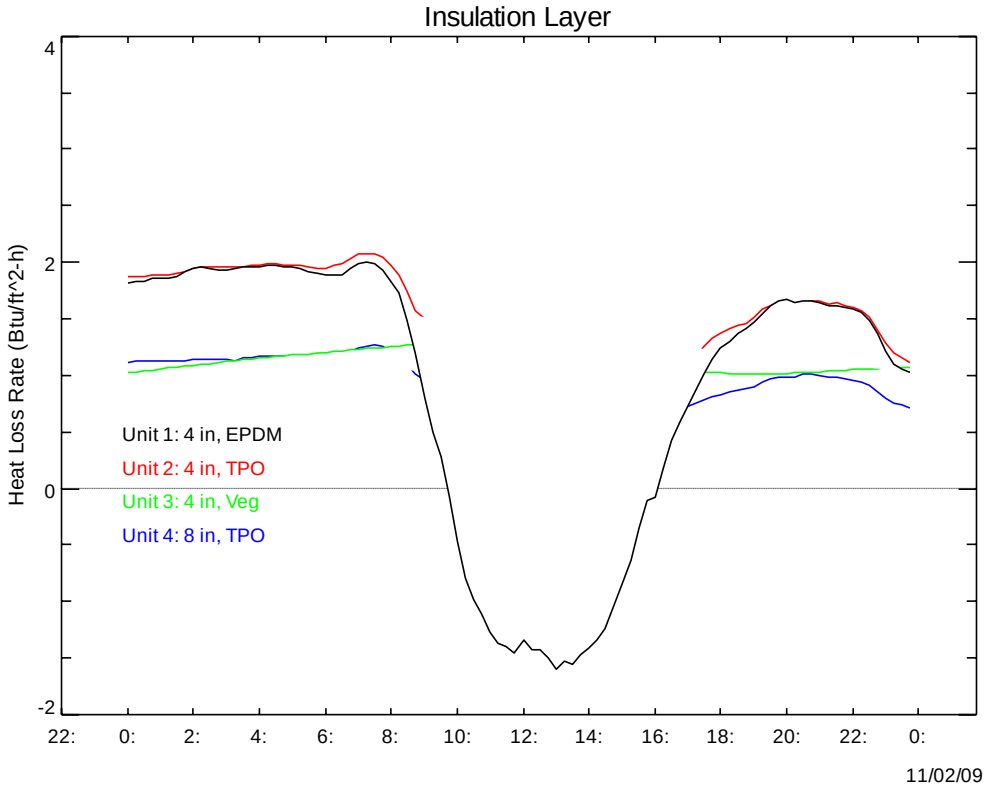


Figure 21. Heat Transfer Rates for Each Unit on November 2, 2009

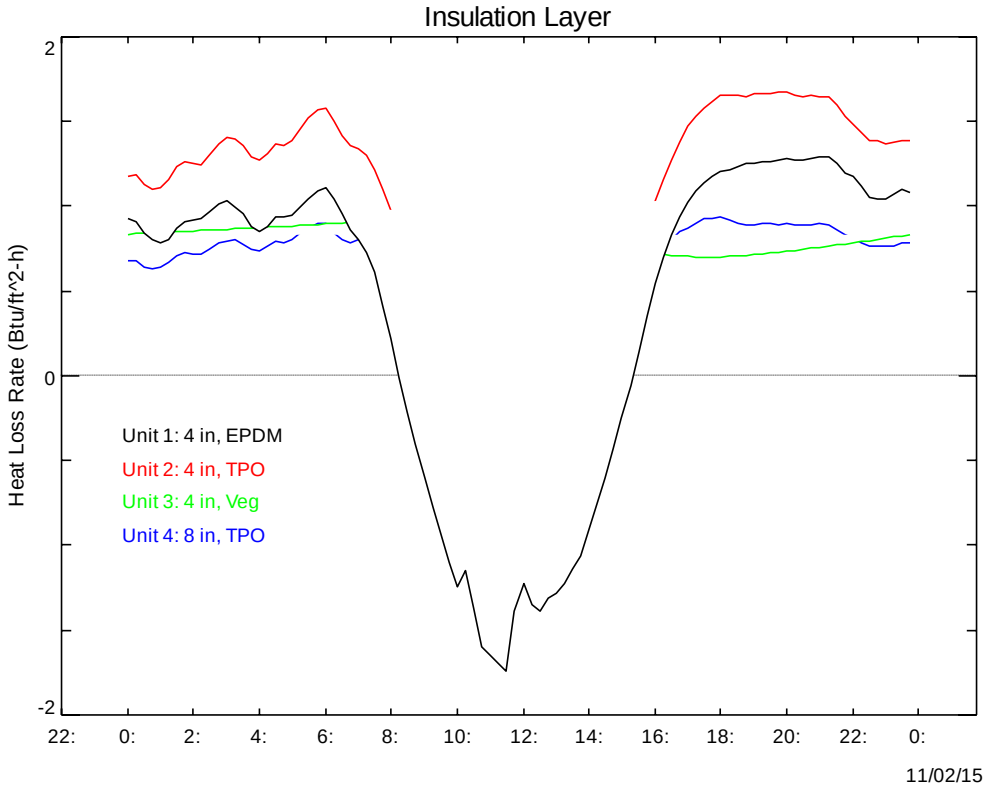


Figure 22. Heat Transfer Rates for Each Unit on November 2, 2015

Comparison of Daily, Seasonal and Annual Performance

Daily Trend with Outdoor Temperature

Figure 23 plots the heat loss (at the roof surface, eqn. 1) for each day versus the daily ambient temperature. Each data point plotted corresponds to one day in the 6 ½ year period; the roof system on each unit is shown as a different color. Each daily value is average of the A and B locations on each roof. All the roof systems show the general trend of more heat loss at lower outdoor temperatures, though the trend is not perfectly linear.

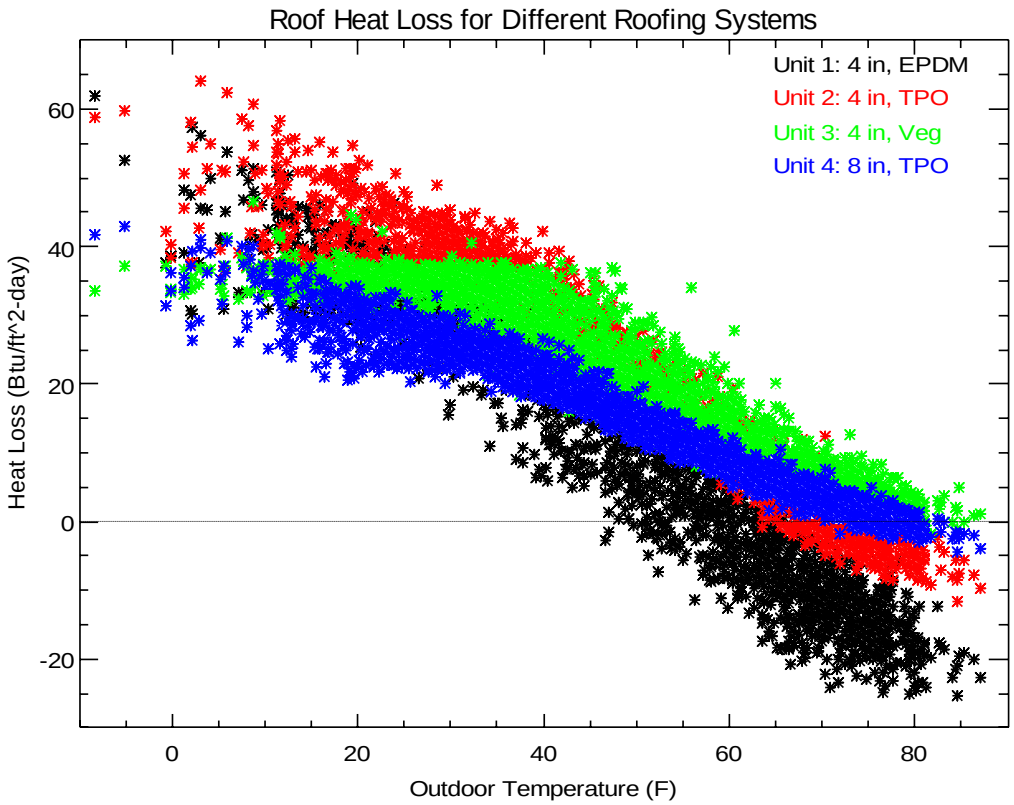


Figure 23. Daily Heat Loss vs. Outside Temperature (November 2009 through May 2016)

The EPDM roof (black) shows the strongest linear trend while the vegetative roof (green) shows an especially non-linear trend, with a "knee" corresponding to the freezing point (32°F). The knee for the vegetative roof occurs because the formation of ice in the vegetative layer keeps the roof surface temperature (TRO) near freezing and flattens the trend of heat transfer with lower outdoor temperatures. In contrast, the EPDM roof is less affected by formation of melting ice and snow at the roof surface since the black EPDM material heats up and causes more melting (so that less snow can accumulate on the roof). The two TPO roofs fall in between these two extremes. The TPO roof with 4 inches of insulation (red) has a slight knee in the trend since more snow can build up on the roof and create a freezing liquid-solid layer at the roof surface. The TPO roof with 8 inches of insulation (blue) has less of a knee in the trend, mainly because the lower rate of heat transfer means that the melting/freezing does not occur at roof surface. Therefore, there is no change of phase to create the non-linear trend.

Figure 24 through Figure 27 show the heat loss versus outdoor temperature separately for each roof type. Different symbols and colors are used on each plot for the different years over the 6½ year period. The dotted line represents the difference between heat loss (above the line) and heat gain (below the line). The linear and non-linear trends described above for each roof assembly are more obvious in these plots. While outdoor temperatures and the impact of snow might change from year to year, there is little to no discernable change in the trends from year to year.

The EPDM roof with 4 inches of insulation has the most heat gain during the summer and the lowest amount of heat loss in the winter (as also shown by Table 7 below). Figure 24 indicates for the EPDM roof that heat gain begins to occur at an ambient temperature around 50°F to 60°F. The TPO roofs with 4 inches and 8 inches of insulation (Figure 25 and Figure 27) do not experience heat gain until ambient temperatures reach 70°F to 80°F. It is not until temperatures reach above 80°F that the vegetative roof (Figure 26) may have some heat gain.

The ability of the TPO and vegetative roofs to reduce solar gains becomes a disadvantage in the winter. The figures above and below show a heat loss of 35 to 40 Btu/ft^2-day at 30°F for the TPO roof with 4 inches of insulation and the vegetative roof respectively. The EPDM roof has a slightly lower heat loss of 30 Btu/ft^2-day at the same ambient temperature. Higher heat loss in the winter is observed at all temperatures for the 4-inch TPO roof, especially when the roof is clear of snow (i.e., days at the top of the trend). The TPO roof with 8 inches of insulation shows a commensurate reduction in heat transfer.

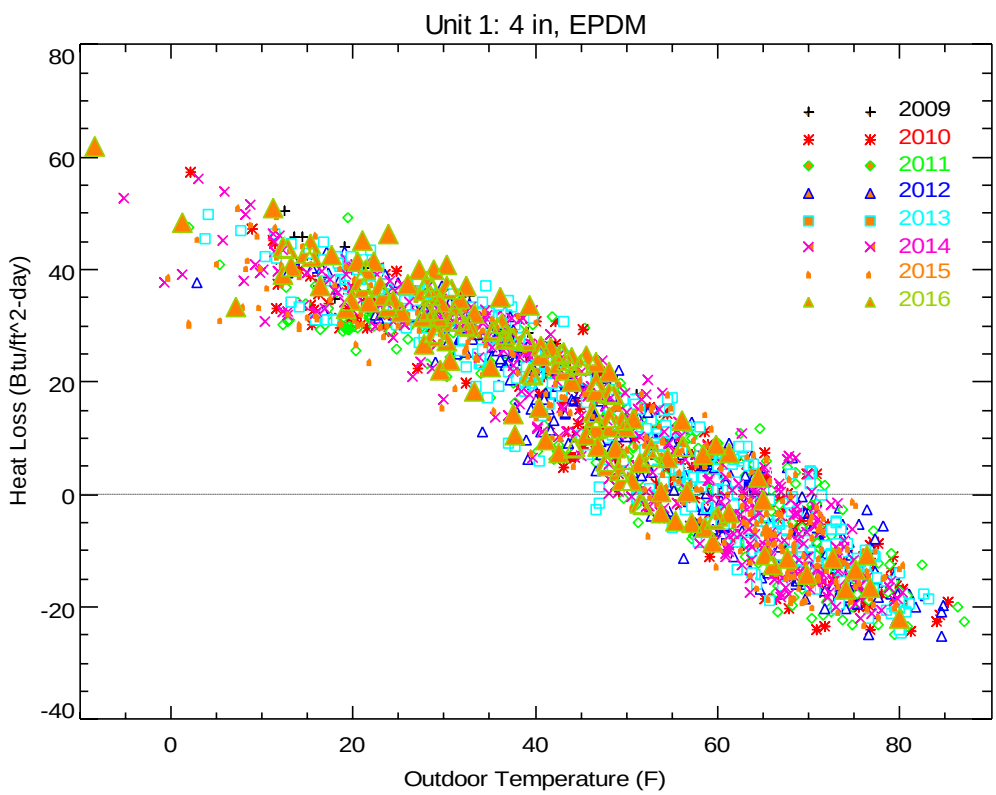


Figure 24. Daily Heat Loss vs. Outdoor Temperature – EPDM Roof

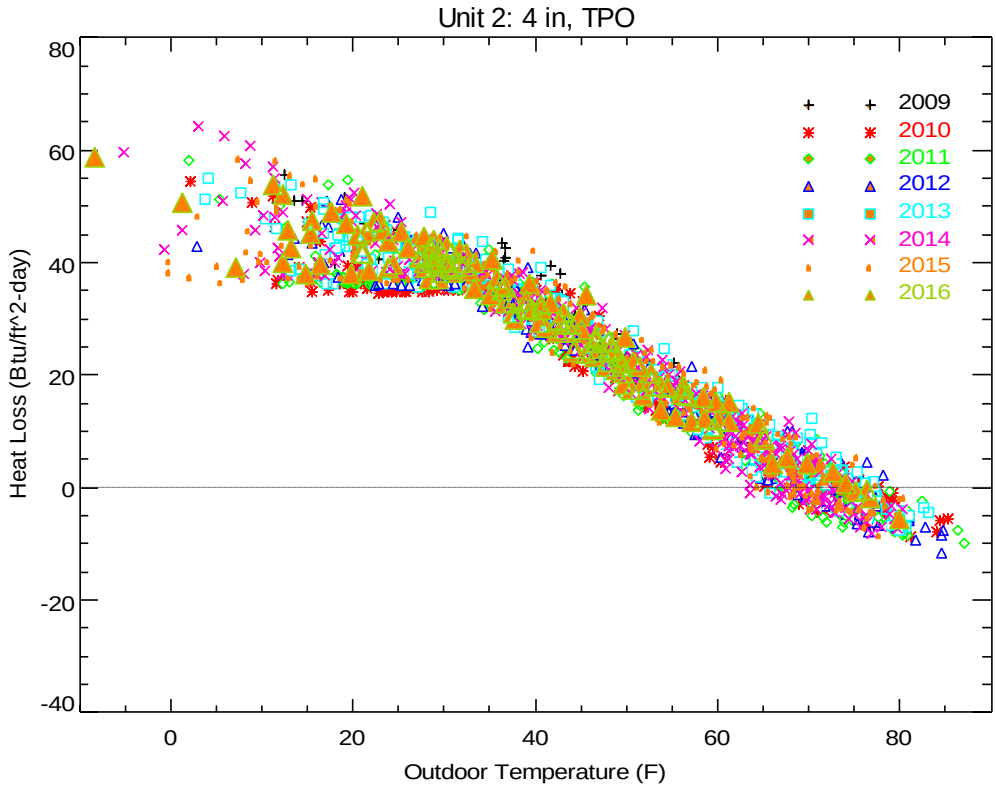


Figure 25. Daily Heat Loss vs. Outdoor Temperature – TPO Roof (4 in)

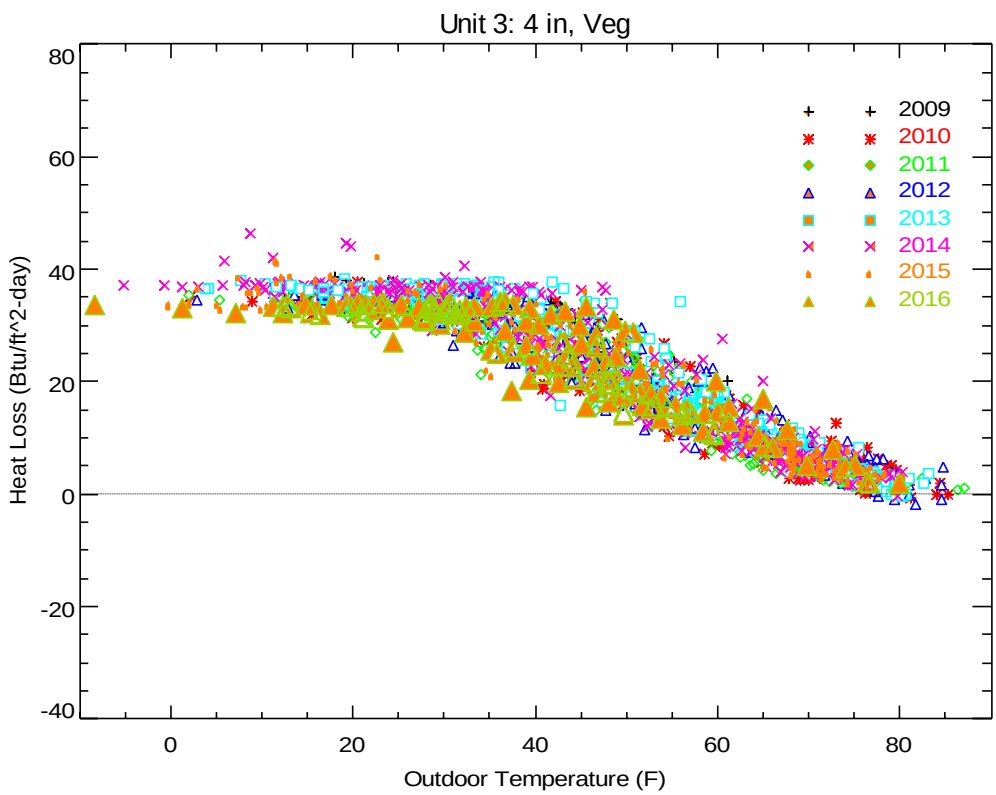


Figure 26. Daily Heat Loss vs. Outdoor Temperature – Vegetative Roof

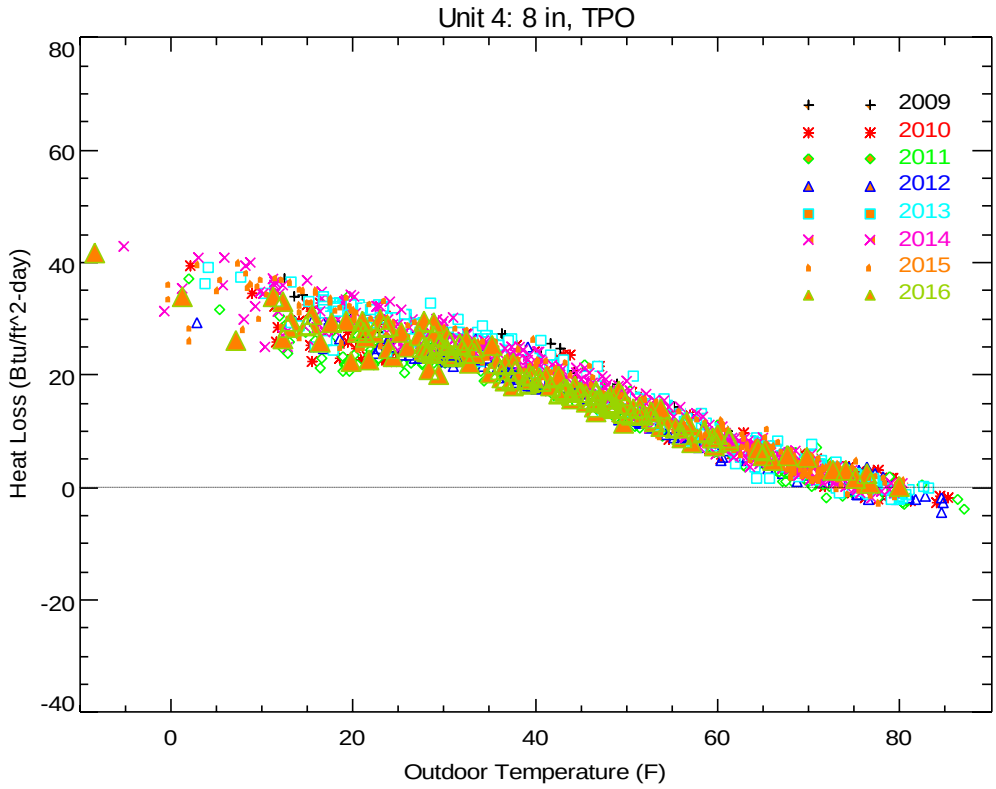


Figure 27. Daily Heat Loss vs. Outdoor Temperature –TPO Roof (8 in)

Table 7 shows the seasonal heat loss (and heat gain) for each roof type calculated two different ways:

- Without the thermal mass correction (eqn. 1) to calculate heat flux at the top of the roof
- With the thermal mass correction applied (eqn. 2) to calculate heat flux into the space

The heating season includes January through April and then October through December in each calendar year. The cooling season extends from May through September. The overall seasonal heat loss (and gain) calculated by the two methods are very similar when integrated over the long term (more than a few days). Appendix C provides monthly integrated heat loss for each month calculated both ways for the different roofing assemblies.

The seasonal winter heat losses and summer heat gains are shown for several different years in Table 7. The heat loss in the winter for the TPO roof was 30-45% greater than the EPDM roof, depending on the year. The heat loss from the vegetative roof was 10-33% greater than the EPDM roof for different years. The heat loss for the better insulated TPO roof was 7-15% lower than the baseline EPDM roof.

For the heating season, the roof with the EPDM membrane has lower overall heat loss in the winter (October to April) because of the solar gain reduces the heating load. In the summer, the TPO and vegetative roofs reduce the heat gain from the roof since the surface absorbs less solar energy and is cooler.

In the summer, the TPO and vegetative roofs had significantly lower heat gains than the EPDM roof.

Table 7. Seasonal Heat Loss, with and without Thermal Mass Corrections

	No Correction				w/ Thermal Mass Correction			
	Heat Loss (Btu/ft^2)				Heat Loss (Btu/ft^2)			
	Unit 1 4 in EPDM	Unit 2 4 in TPO	Unit 3 4 in Veg	Unit 4 8 in TPO	Unit 1 4 in EPDM	Unit 2 4 in TPO	Unit 3 4 in Veg	Unit 4 8 in TPO
2010 Htg Season	4,885	6,361	6,033	4,367	4,912	6,365	6,046	4,322
(Jan-Apr, Oct-Dec)	Diff	1,475	1,147	(519)	Diff	1,454	1,135	(589)
	% Diff	30%	23%	-11%	% Diff	30%	23%	-12%
2011 Htg Season	3,958	5,726	5,154	3,407	3,863	5,605	5,031	3,308
(Jan-Apr, Oct-Dec)	Diff	1,767	1,195	(551)	Diff	1,742	1,168	(555)
	% Diff	45%	30%	-14%	% Diff	45%	30%	-14%
2012 Htg Season	4,483	6,479	5,942	4,089	4,487	6,467	5,953	4,113
(Jan-Apr, Oct-Dec)	Diff	1,995	1,459	(394)	Diff	1,979	1,469	(370)
	% Diff	45%	33%	-9%	% Diff	44%	33%	-8%
2013 Htg Season	5,334	7,180	6,508	4,937	5,330	7,170	6,470	4,938.5
(Jan-Apr, Oct-Dec)	Diff	1,846	1,174	(396)	Diff	1,840	1,141	(391.0)
	% Diff	38%	24%	-8%	% Diff	35%	23%	-8%
2014 Htg Season	5,430	7,334	6,567	5,062	5,377	7,311	6,529	5,073
(Jan-Apr, Oct-Dec)	Diff	1,904	1,137	(368)	Diff	1,934	1,152	(304)
	% Diff	35%	21%	-7%	% Diff	36%	21%	-6%
2015 Htg Season	4,924	7,089	5,997	4,804	4,974	7,102	5,955	4,770
(Jan-Apr, Oct-Dec)	Diff	1,659	567	(625)	Diff	1,672	525	(660)
	% Diff	31%	10%	-12%	% Diff	31%	10%	-12%

	No Correction				w/ Thermal Mass Correction			
	Heat Loss (Btu/ft^2)				Heat Loss (Btu/ft^2)			
	Unit 1 4 in EPDM	Unit 2 4 in TPO	Unit 3 4 in Veg	Unit 4 8 in TPO	Unit 1 4 in EPDM	Unit 2 4 in TPO	Unit 3 4 in Veg	Unit 4 8 in TPO
2010 Clg Season	(1,189)	642	1,141	698	(1,220)	639	1,141	714
(May-Sep)	Diff	1,831	2,330	1,886	Diff	1,859	2,361	1,935
2011 Clg Season	(1,204)	477	1,009	559	(1,211)	483	1,007	559
(May-Sep)	Diff	1,681	2,214	1,763	Diff	1,694	2,218	1,769
2012 Clg Season	(1,333)	568	1,178	628	(1,340)	565	1,187	635
(May-Sep)	Diff	1,902	2,512	1,961	Diff	1,905	2,527	1,975
2013 Clg Season	(943)	1,050	1,409	882	(964)	1,060	1,443	906
(May-Sep)	Diff	1,993	2,352	1,825	Diff	2,024	2,407	1,870
2014 Clg Season	(1,037)	803	1,293	833	(967)	839	1,335	818
(May-Sep)	Diff	1,839	2,330	1,870	Diff	1,805	2,302	1,785
2015 Clg Season	(1,801)	76	551	154	(1,864)	61	550	132
(May-Sep)	Diff	1,113	1,588	1,191	Diff	1,098	1,587	1,169

Annual Energy and Operating Cost Differences for Each Roof Type

Table 8 compares the overall heating and cooling loads, energy use, and costs for the different roofs. The EPDM roof is used as the reference or baseline; fuel use and cost savings are compared relative to that roof system, assuming an 80% efficient heating system and a gas cost of $1.00 per therm. The table on the left shows the results without thermal correction (same method as in original report), while the table on the right shows results with the thermal correction. The results are similar regardless of whether the thermal correction was applied.

The similarly-insulated TPO and vegetative roofs result in slightly higher annual fuel costs in the winter, at $23 per 1,000 sq ft per year and $15 per 1000 sq ft per year, respectively. When comparing the results for the TPO roofs on Unit 2 and Unit 4, the extra 4 inches of insulation saves about $28 per 1000 sq ft per year.

The reduction in cooling energy use and costs were determined assuming a seasonal average cooling efficiency of 0.9 kW per ton and an electric cost of $0.12 per kWh. The TPO roof with R22 reduced annual costs by $16 per 1000 sq ft compared to EPDM with R22. The vegetative roof with R22 reduced cooling costs by $20 per 1000 sq ft.

Table 8. Annual Heating Load and Costs for Each Unit (CASE 1 - Heating: Oct-Apr, Cooling: May-Sep)

	No Correction				With Thermal Mass Correction			
Heating	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Avg Annual Heat Load (MMBTU per 1000 sq ft)	4.8	6.7	6.0	4.4	4.8	6.7	6.0	4.4
Annual Gas Use (therms per 1000 sq ft)	60.4	83.7	75.4	55.6	60.3	83.4	75.0	55.3
Annual Cost Per 1000 sq ft	$ 60	$ 84	$ 75	$ 56	$ 60	$ 83	$ 75	$ 55
saving per 1000 sq ft		$ (23)	$ (15)	$ 5		$ (23)	$ (15)	$ 5
Cooling	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Reduced Cooling (ton-hrs/yr per 1000 sq ft)		143.9	185.1	145.8		144.2	186.1	145.9
Reduced Cooling Power (kWh/yr per 1000 sq ft)		129.5	166.6	131.2		129.8	167.5	131.3
Savings per 1000 sq ft		$ 16	$ 20	$ 16		$ 16	$ 20	$ 16
Combined	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Net Saving per 1000 sq ft		$ (8)	$ 5	$ 21		$ (7)	$ 6	$ 21

Overall, the cost savings for cooling were slighting smaller than the added costs for heating with the TPO roof. The net annual impact for the TPO roof was to increase costs by about $8 per 1000 sq ft.

This analysis assumes that the facility was in the cooling mode for May through September and in the heating mode for the rest of the year—this approximately corresponds to a building balance point that is around the indoor setpoint (around 65-70°F). In many types of buildings, internal gains from lighting, plug loads and occupants can reduce the balance point so that space heating is not required in the building until the outdoor temperature drops to 50-60°F. Correspondingly, greater internal gains mean that cooling can be required at lower ambient temperatures. Buildings with differing levels of internal gains can require more cooling and less heating, thus changing the impact of the cool roof on energy

costs. If cooling is needed are moderate conditions (around 55 to 65°F) this cooling load can be satisfied by economizer operation at little to no energy use.

One way to approximate the impact of a lower balance point combined with economizer operation is to exclude months from the heating and cooling seasons. If we assume the heating season now only includes five months (November through March) and the cooling season only includes three months (June to August), the analysis can be repeated as shown in Table 9. This change reduces the heating penalty of the TPO roof with R22 but also decreases the cooling benefit. As a result, the net or combined cost impact changes very little for this case.

Table 9. Annual Heating Load and Costs for Each Unit (CASE 2 - Heating: Nov-Mar, Cooling: Jun-Aug)

	No Correction				With Thermal Mass Correction			
Heating	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Avg Annual Heat Load (MMBTU per 1000 sq ft)	4.2	5.5	4.9	3.6	4.2	5.5	4.9	3.6
Annual Gas Use (therms per 1000 sq ft)	52.7	68.8	61.4	45.5	52.6	68.5	61.2	45.3
Annual Cost Per 1000 sq ft	$ 53	$ 69	$ 61	$ 46	$ 53	$ 68	$ 61	$ 45
saving per 1000 sq ft		$ (16)	$ (9)	$ 7		$ (16)	$ (9)	$ 7
Cooling	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Reduced Cooling (ton-hrs/yr per 1000 sq ft)		83.0	114.5	93.8		84.4	115.7	95.3
Reduced Cooling Power (kWh/yr per 1000 sq ft)		74.7	103.1	84.4		75.9	104.1	85.7
Savings per 1000 sq ft		$ 9	$ 12	$ 10		$ 9	$ 12	$ 10
Combined	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**	**Unit 1 4 in EPDM**	**Unit 2 4 in TPO**	**Unit 3 4 in Veg**	**Unit 4 8 in TPO**
Net Saving per 1000 sq ft		$ (7)	$ 4	$ 17		$ (7)	$ 4	$ 18

Comparing Energy and Cost Results to Other Studies

A series of studies at Concordia University (Hosseini and Akbari 2014, Hosseini 2014, and Hosseini and Akbari 2015) used the DOE-2.1E simulation tool to evaluate the annual energy and cost performance of cool roofs in cold climates. They compared the annual energy performance of dark and white roofs and also considered the impact of snow accumulation on the thermal performance of the roof. They looked at different various building and HVAC types with various efficiency levels. Generally, they found that snow buildup on the roof had only a modest impact on overall heating loads and fuel use.

One of the cities they considered was Toronto, which has a comparable climate to the Jamesville test site. They simulated a new small office building that had a new building envelope (the roof had an R-value of 31.5). The heating and cooling system was supplied by a package cooling unit with gas furnace section. The HVAC system used and economizer to provide free cooling when outdoor temperatures were low enough. Several key parameters used in the Hosseini study are compared to our assumptions in the Table 10.

Table 10. Comparing Key Parameters and Assumptions

	Hosseini (2014)	CDH Analysis
Roof R-Value (ft^2-F-h/Btu)	31.5	25
Heating Efficiency	0.8	0.8
Cooling Efficiency (kW/ton)	1.33 nominal	0.9 avg

The cool roof savings from Hosseini (2014) without snow impacts are compared to the savings from this study in Table 11. The Hosseini results are based on the DOE-2.1E fuel and electricity reduction differences. Starting with those values, we use the efficiencies from Table 10 to infer the cooling and heating load impacts. For our results, we determined the load impacts and calculated the change in fuel and electricity using the efficiencies from Table 10. The results that were directly determined in each study are shown as bold and shaded in the table.

The results from this study are shown for both CASE 1 and CASE 2 described above. The CASE 2 results are expected to better reflect Hosseini's results for the office building with internal gains and an economizer. The heating penalty we determined is slightly larger than the value Hosseini found for Toronto (1.2 compared to 0.7 MMBtu per 1000 sq ft). This could in part be explained by the 20% higher R-value used in Hosseini's simulation model. The cooling energy use values are very similar between CASE 2 and the Hosseini results (75 and 74 kWh per 1000 sq ft, respectively). Where our study found a slight cost penalty for the TPO roof, the Hosseini data with cost assumptions are cost neutral. Hosseini (2014) used different utility cost assumptions and found slighter larger net cost savings (approximately $1-2 per 1000 sq ft).

Table 11. Comparing Cool Roof Savings From This and Other Studies

		Jamesville Results	
	Hosseini (2014) Toronto	**CASE 1 Table 8**	**CASE 2 Table 9**
Annual Heating Load Reduction (MMBtu per 1000 sq ft)	-0.7[1]	-1.9	**-1.2**
Annual Heating Fuel Savings (therms per 1000 sq ft)	**-8.8**	**-23.2**	-16.1
Annual Cooling Load Reduction (ton-h per 1000 sq ft)	56[1]	144	**84**
Annual Cooling Energy Savings (kWh per 1000 sq ft)	**74**	**129**	75
Net Cost Savings ($ per 1000 sq ft)	~0	--8	--7

Note: cost savings are based on $0.12/kWh and $1.00/therm

How Ground Snow Cover Relates to Roof Snow Cover

Obtaining NCDC Ground Snow Cover Data for Syracuse

The National Operational Hydrologic Remote Sensing Center (NOHRSC) in Chanhassen, MN is a division of the National Weather Service and NOAA (**http://www.nohrsc.noaa.gov/**).
NOHRSC has developed tools to estimate snow cover at various US locations. Snow cover data is available from station NY-OG-20, which located 1.9 miles southeast of Syracuse at an elevation of 587 ft. This station is about 3 miles from the facility in Jamesville, which is at a slightly higher elevation (about 740 ft). The "Modeled Snow Depth" for the NY-OG-20 station is shown in Figure 28 and Figure 29 for the seven winter seasons from 2009 through 2016.

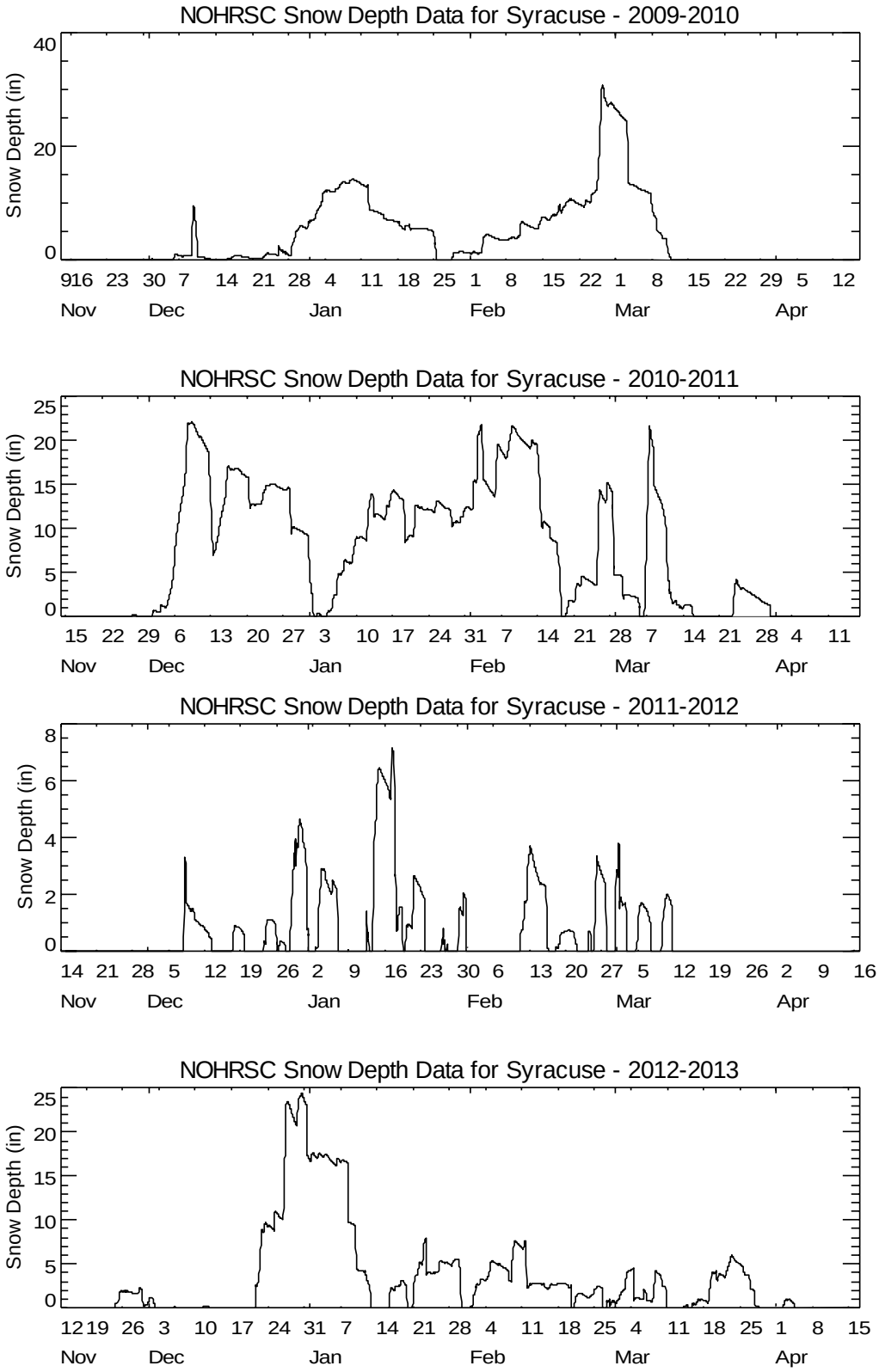


Figure 28. Snow Cover Data from NOHRSC Showing Winters from 2009 through 2013

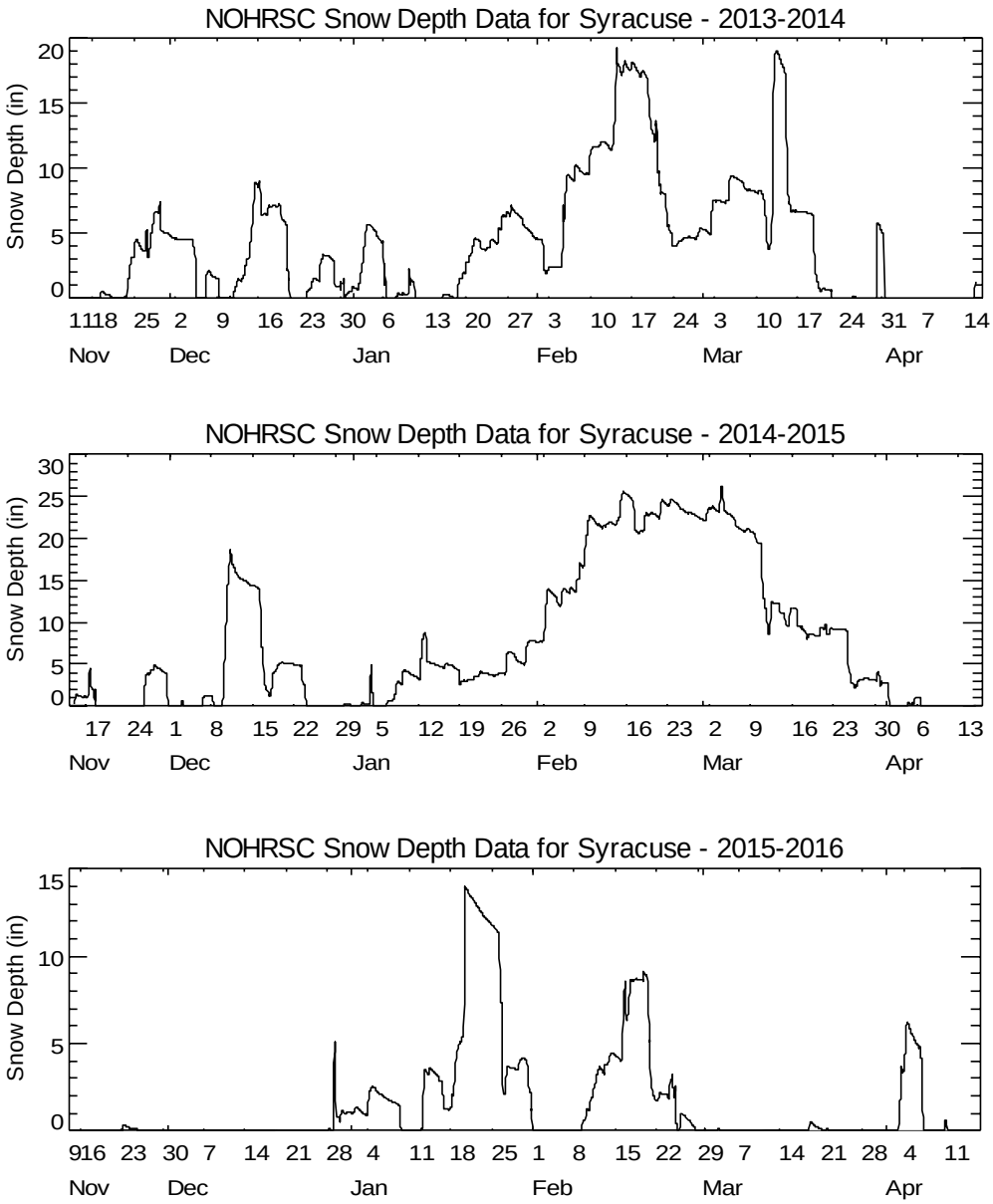


Figure 29. Snow Cover Data from NOHRSC Showing Winters from 2013 through 2016

Comparing Ground Snow Coverage from Roof Temperatures

The plots on subsequent pages compare the ground snow cover data from NOHRSC to the temperatures measured at the top of the roof insulation (TRO) for the **EPDM roof**, the **TPO roof with 4 inches of insulation**, and the **TPO roof with 8 inches of insulation**. Station A on each roof is shown with a solid line while Station B is shown with a dotted line. Figure 30 through Figure 36 compare snow cover and temperature data for the first three months of each year from 2010 through 2016.

From the graphs in Figure 30 through Figure 36 on the following pages, it is apparent that the periods with snow cover correspond to periods when the roof temperatures do not exceed the freezing point. The EPDM roof appears to "clear" its snow more quickly than the other roof types as indicated by a greater number of temperature excursions above freezing when there is a small amount of snow. For the EPDM roof, temperature excursions above freezing start when the ground snow level drops to approximately 5 inches. The TPO roof with 8 inches of insulation holds it snow longer and the temperature excursions above freezing more closely correspond to the periods with any snow cover on the ground. The roof surface temperature data generally all imply that the snow cover on each roof clears sooner than snow cover on the ground.

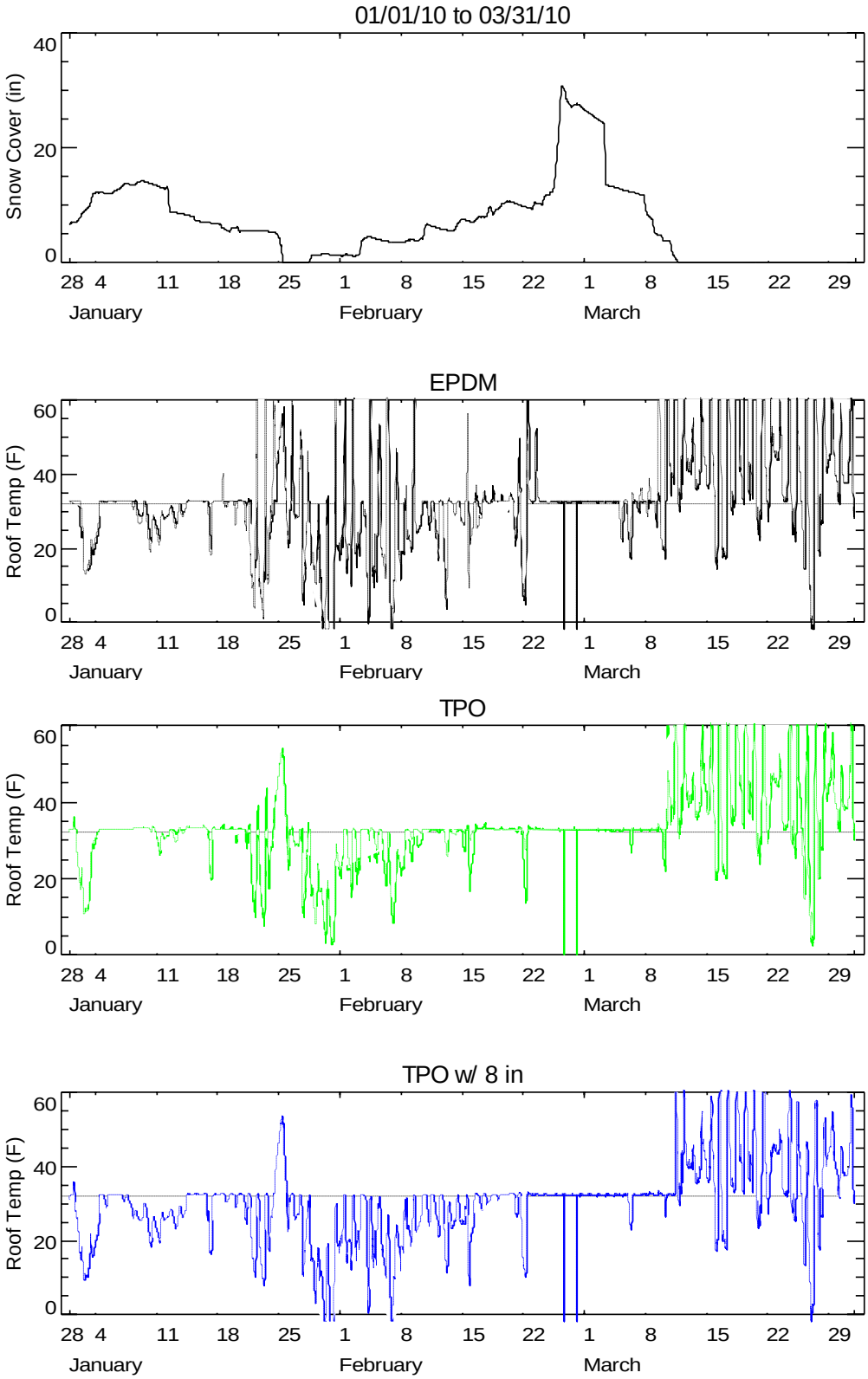


Figure 30. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2010

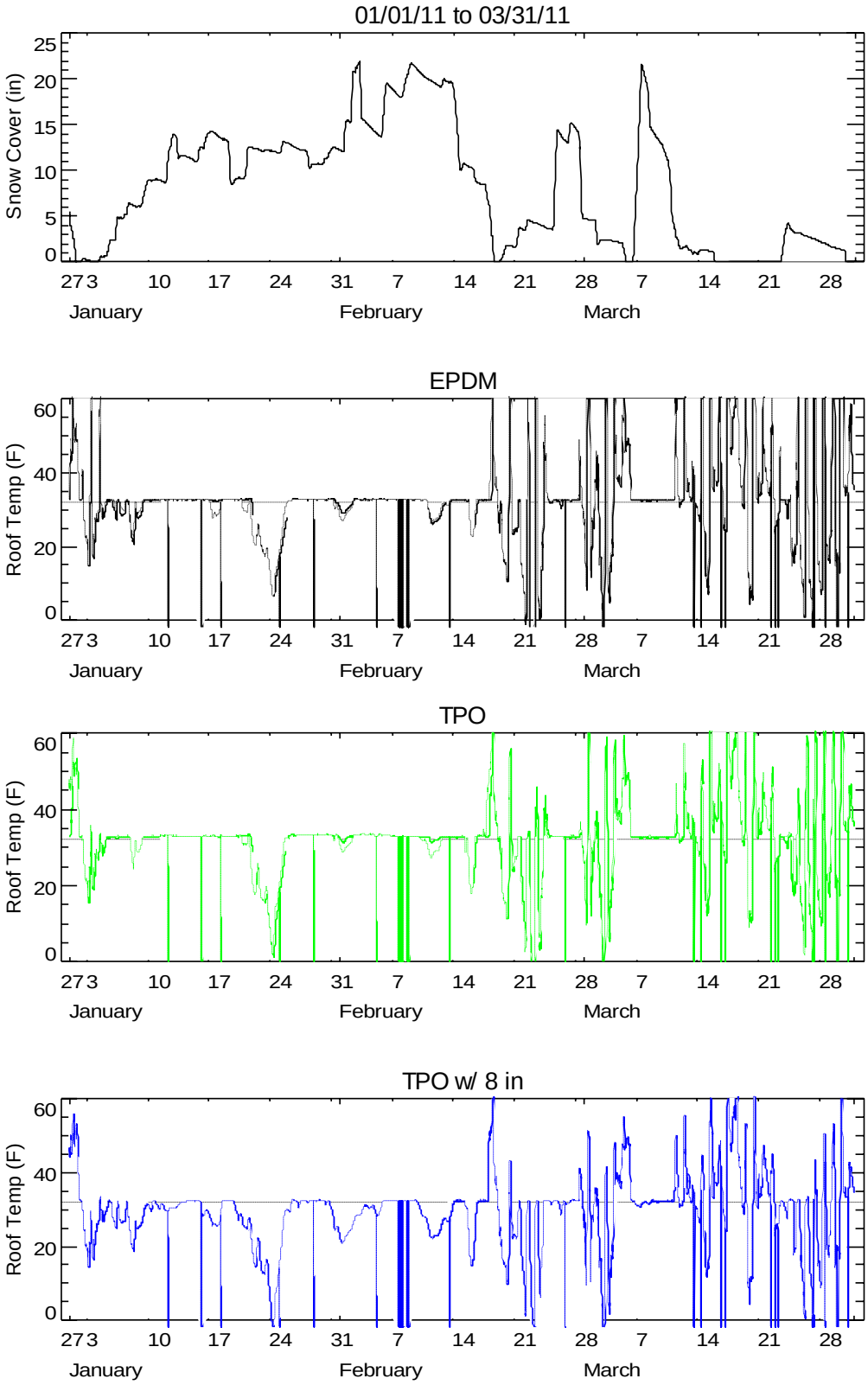


Figure 31. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2011

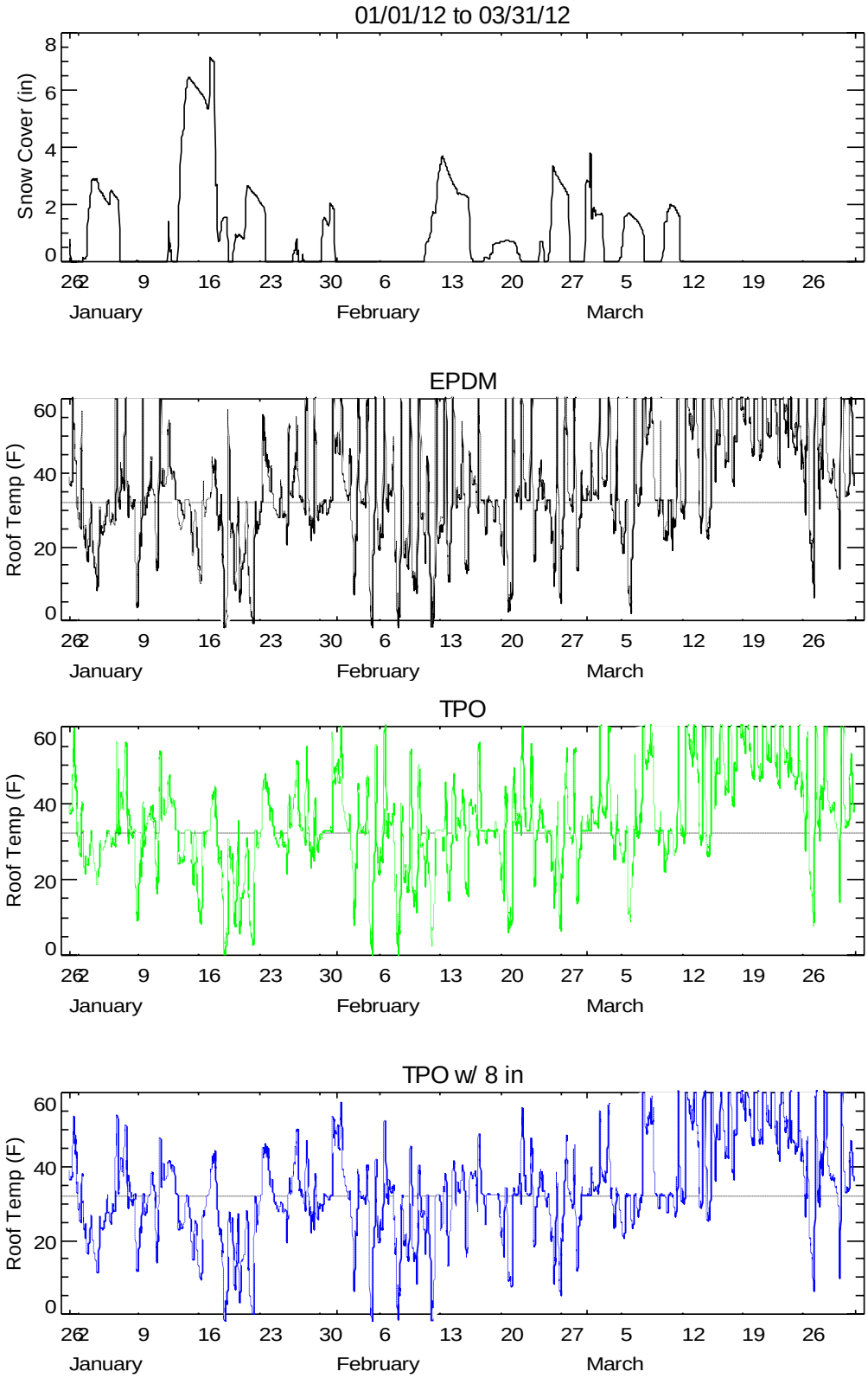


Figure 32. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2012

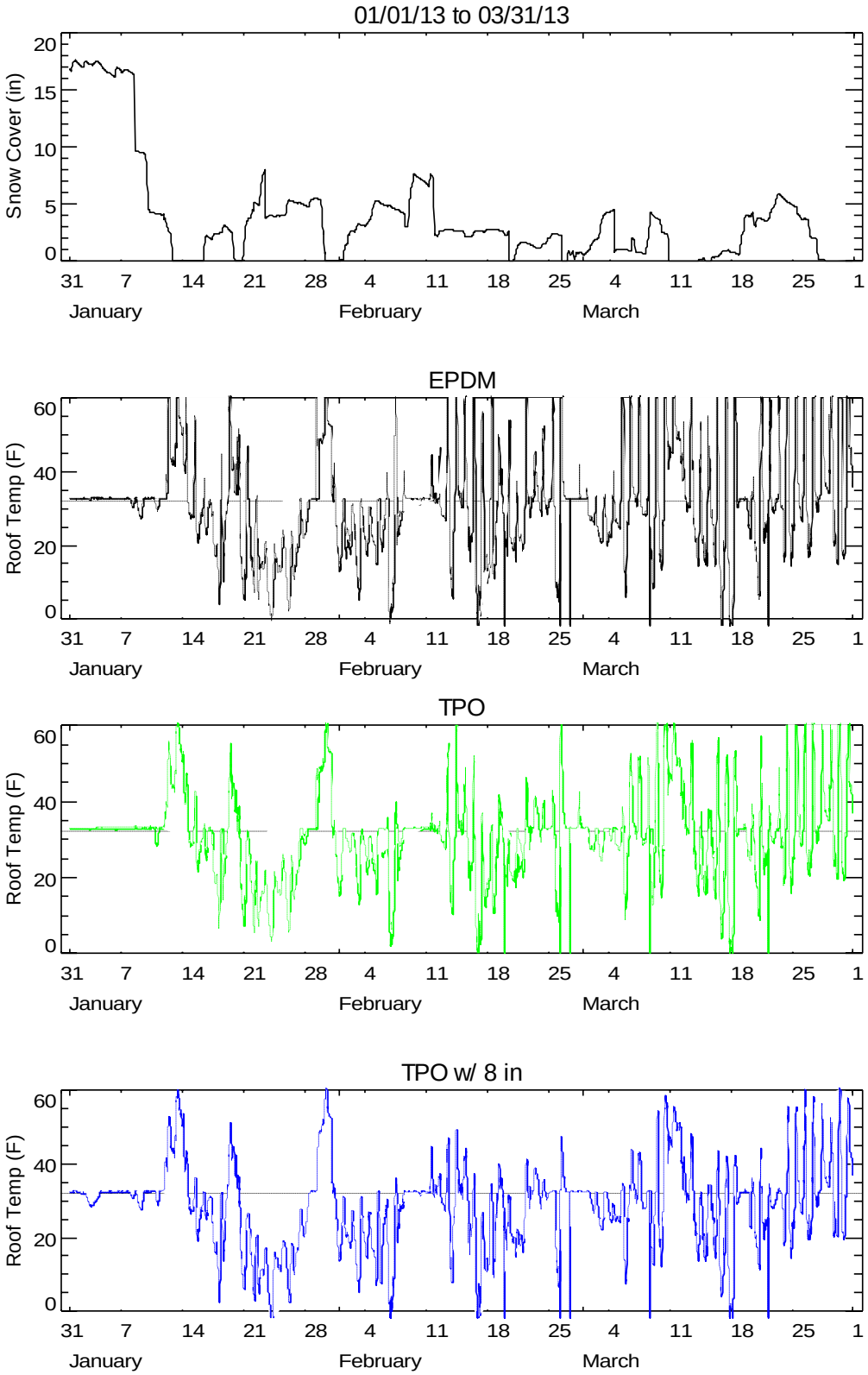


Figure 33. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2013

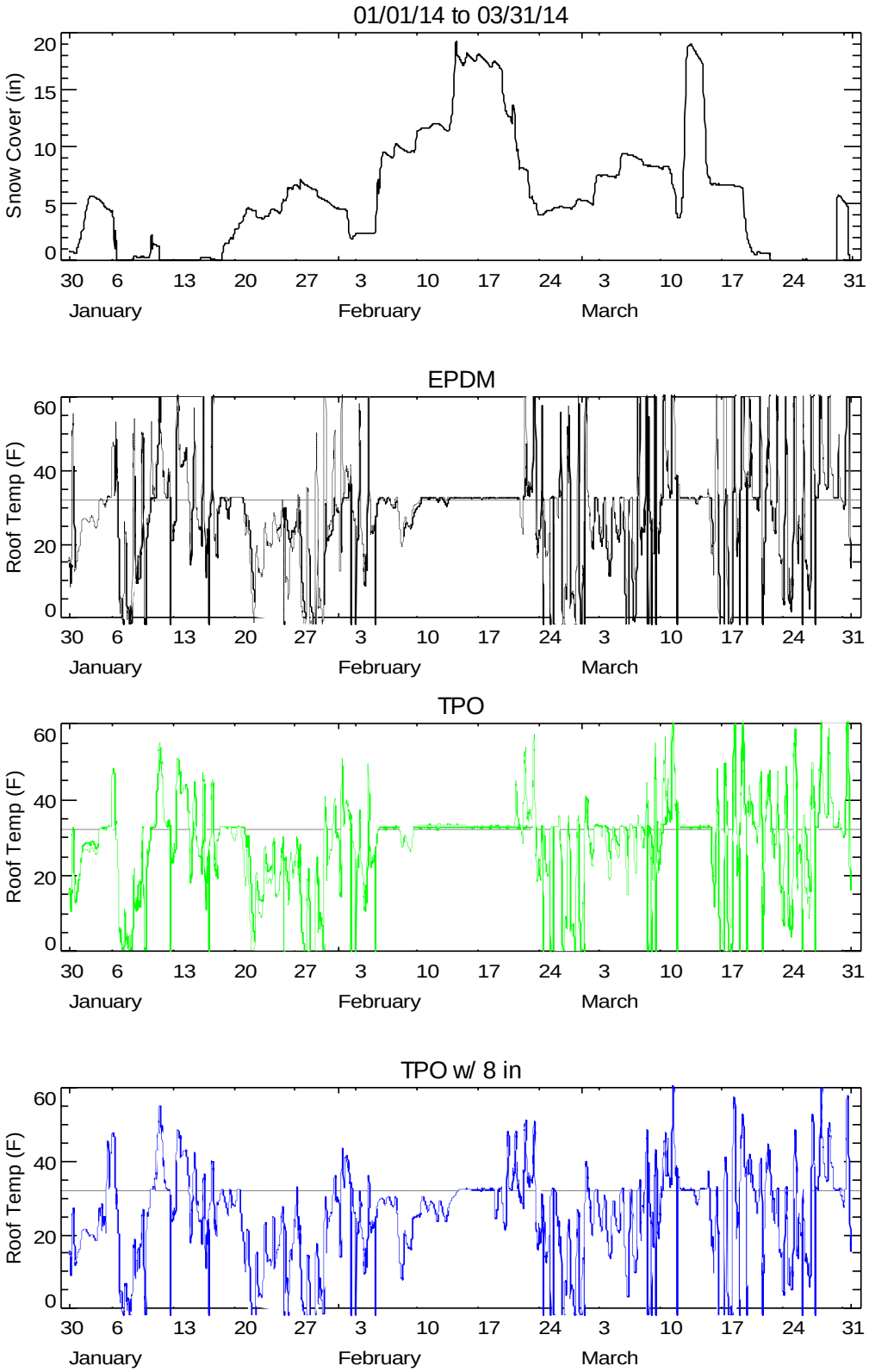


Figure 34. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2014

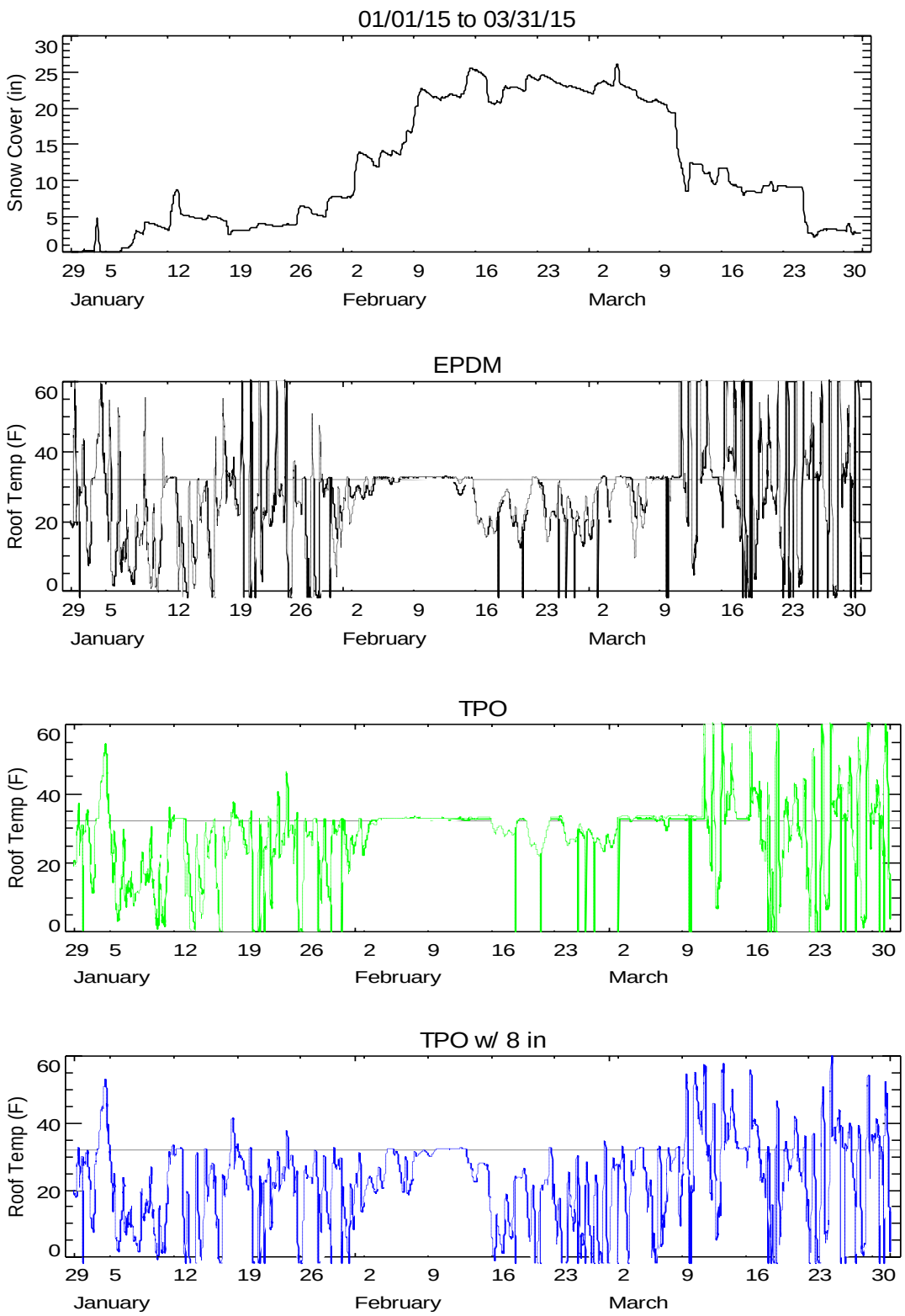


Figure 35. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2015

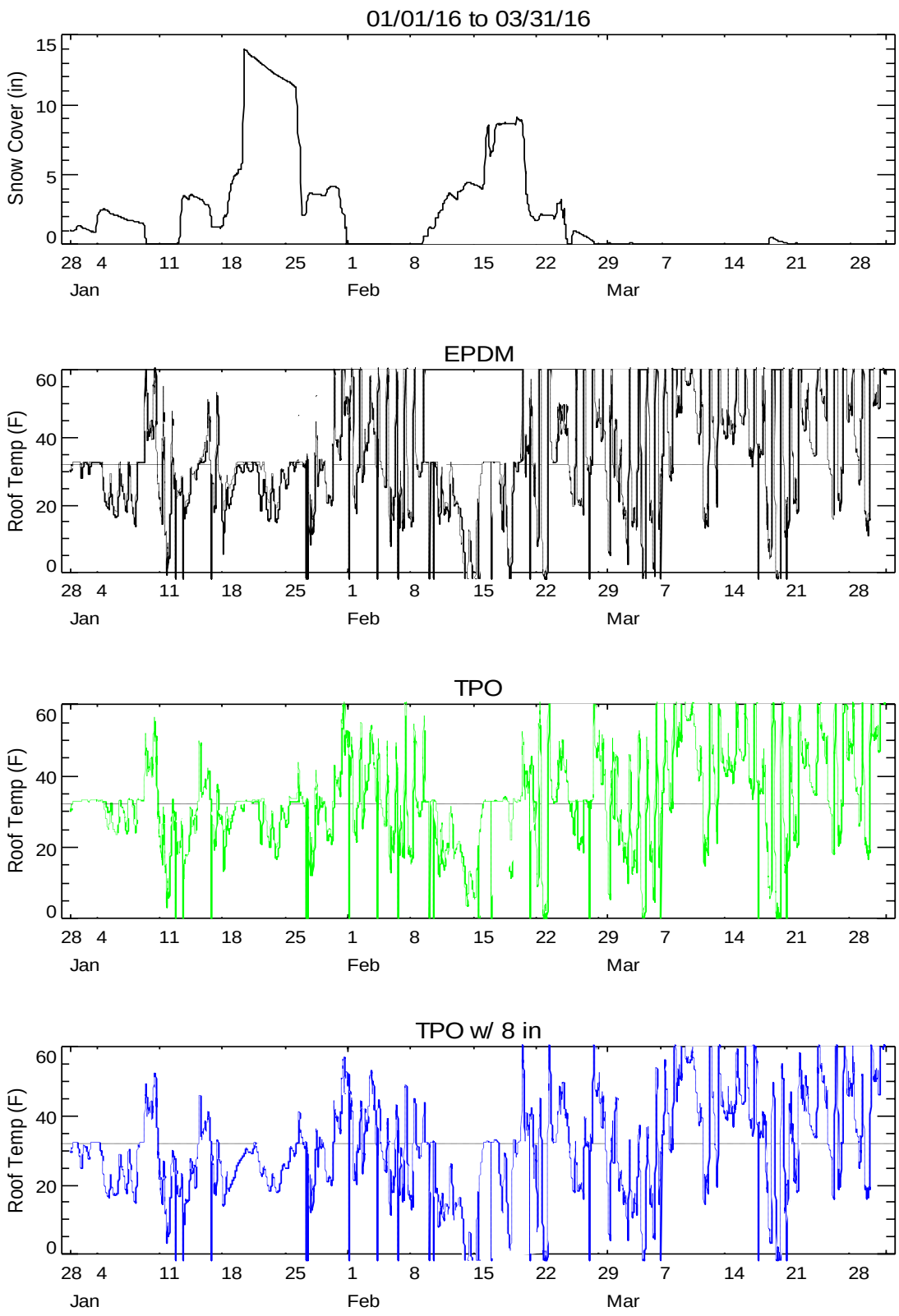


Figure 36. Comparing Snow Cover and Roof Temperatures (TRO) for Three Roof Types – Winter 2016

If we identify days when the modeled snow cover is greater than 1 inch for more than 18 hours we can determine the number of hours and days per year that there was snow cover on the ground. The number of snow-covered days for each year are shown as the row labeled "Ground" in Table 12. We assume that roofs have snow cover on days that have ground snow cover AND the peak daily roof surface temperature is lower than 35°F. The number of days that meet these criteria are shown in the subsequent rows in the table. Figure 37 uses this data from Table 12 to show the portion of time that each roof has snow cover compared to the ground snow cover.

Table 12. Summary of Roof Snow Covered Days for Each Year

	Number of Days with Snow Cover						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**AVG**
Ground	93	78	35	88	86	84	77.3
TPO8 Roof	90	60	25	62	66	61	60.7
TPO4 Roof	88	56	24	57	69	59	58.8
EPDM Roof	78	52	20	51	65	54	53.3

	Ratio of Roof-to-Ground Snow Cover						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**AVG**
TPO8 Roof	97%	77%	71%	70%	77%	73%	78%
TPO4 Roof	95%	72%	69%	65%	80%	70%	76%
EPDM Roof	84%	67%	57%	58%	76%	64%	69%

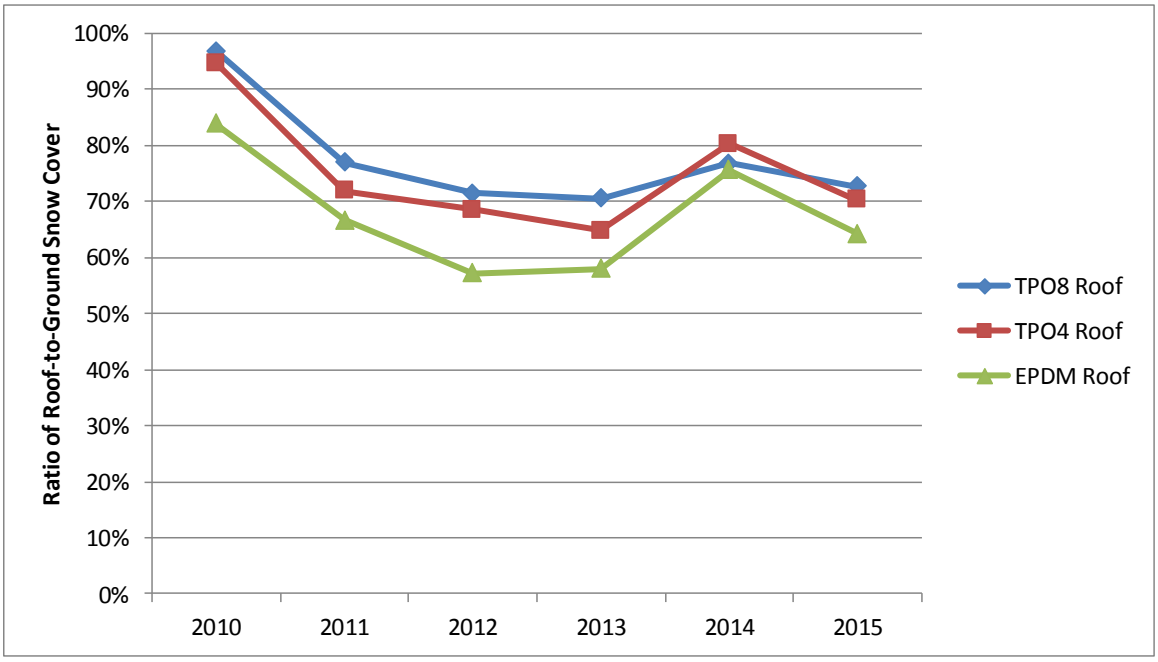


Figure 37. Percentage of Days with Snow Cover on Each Rooftop Relative to Ground Cover

Generally, the time with snow accumulation on each roof is about 60-80% of the time that snow is on ground. That percentage is lowest for the EPDM roof and is highest for the TPO roof with 8 inches of insulation.

Heat Loss on Snow-Free Days

The daily heat transfer plot in Figure 23 includes all days—both with and without snow cover. If days with ground snow cover are excluded, then the trends become much more linear, as shown by Figure 38. The knee in the trends at the freezing point is eliminated for all the roofing assemblies, except for the vegetative roof which still appears to retain moisture after the snow cover is gone. Table 13 summarizes the regression statistics for the best fit lines shown on the plot. The EPDM roof shows the highest degree of scatter, since variations in the daily solar flux has a larger impact on the heat loss for this roof. The TPO roofs absorb much less solar energy so the degree of scatter is significantly lower than for the EPDM roof. The greater insulation level further reduces the scatter (or reduces the impact of solar gains).

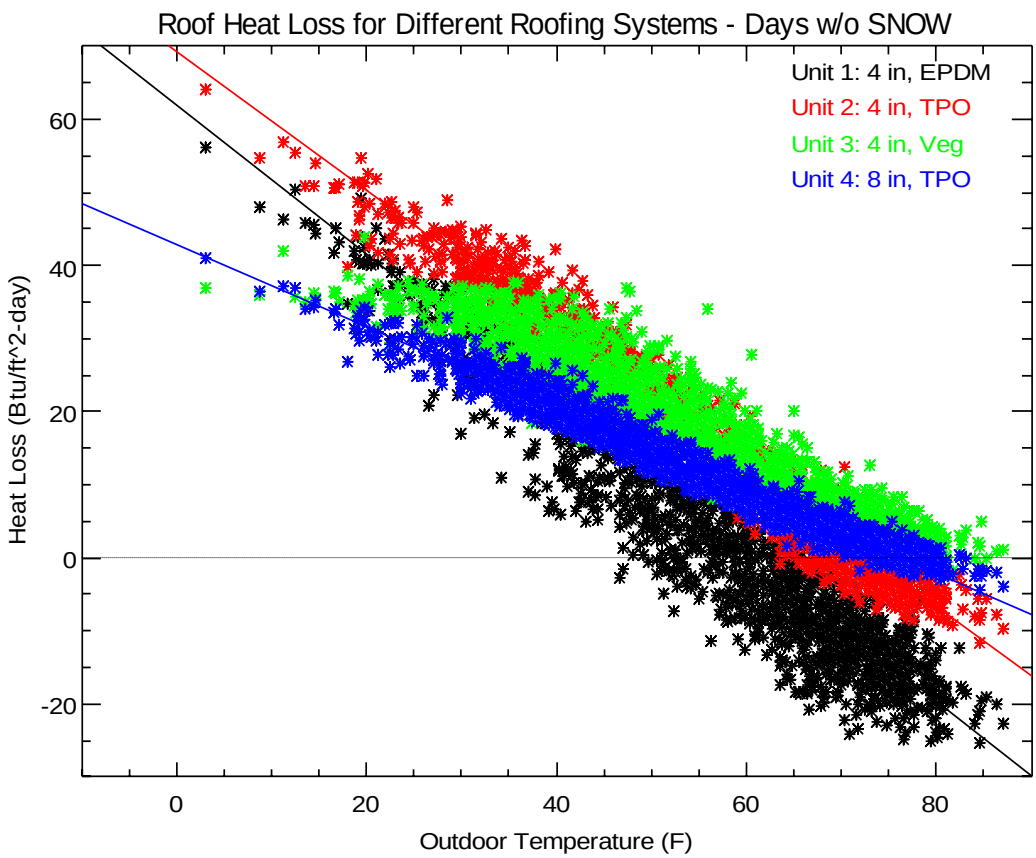


Figure 38. Daily Heat Loss vs. Outdoor Temperature on Snow-Free Days

Table 13. Linear Regression Statistics for Different Roof Assemblies (in Figure 38)

Roof Assembly	R-squared	Coefficient of Variation (CV)
EPDM	0.885	1.09
TPO with 4 inches	0.960	0.18
TPO with 8 inches	0.964	0.14

CV indicates the average variation of the data from the linear model

Long-term Difference Between EPDM and TPO Roofs

The EPDM roof was installed in May 2009 and the TPO roofs were installed in June of 2009. The monitoring was not fully functional until November 2009 (after the vegetative roof was completed).

For each day, we determined the maximum temperature for an EPDM roof (station 1A) and for a TPO roof (station 2B). By comparing peak roof temperatures on days with similarly high solar flux (Insolation), we can track any changes in roof absorbance/reflectance over the long term.

Figure 39 shows the difference in peak temperatures for several days in November from 2009 through 2015. The days with daily insolation levels over 2.5 kWh/m^2-day (i.e., days with high solar flux) are shown with black symbols. Slightly lower insolation levels are also shown with red and green symbols. The average of the high flux days in each year are shown by the line on the plot. These average values are also given in Table 14.

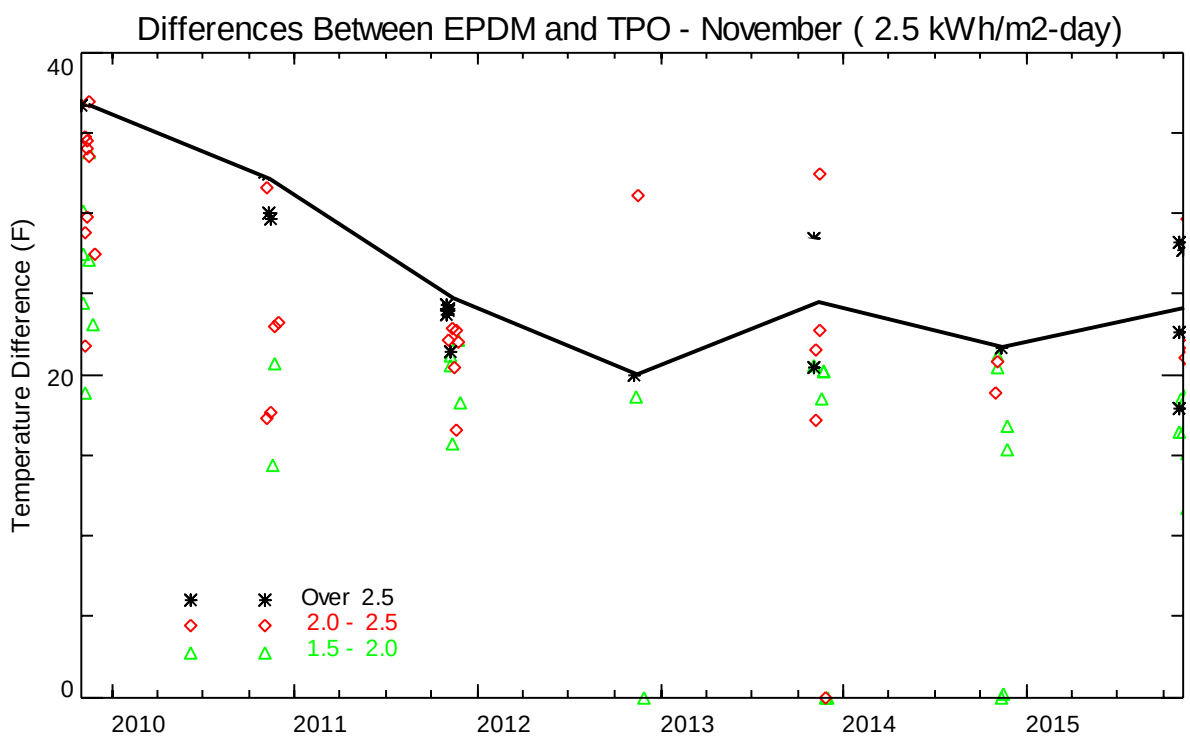


Figure 39. Differences Between EPDM and TPO Peak Temperatures from November 2009 to November 2015

Table 14. Differences Between EPDM and TPO Peak Temperatures from November 2009 to November 2015

	2009	2010	2011	2012	2013	2014	2015
Peak Temps – EPDM (°F)	97.6	97.9	97.6	75.9	93.4	97.0	105.8
Peak Temps – TPO (°F)	60.8	65.8	72.9	55.9	68.9	75.3	81.7
Temperature Difference (°F)	**36.7**	**32.0**	**24.7**	**20.0**	**24.4**	**21.7**	**24.1**

Table 14 allows shows the average peak temperatures that meet the same criteria for each year. These values are also shown in Figure 40 below.

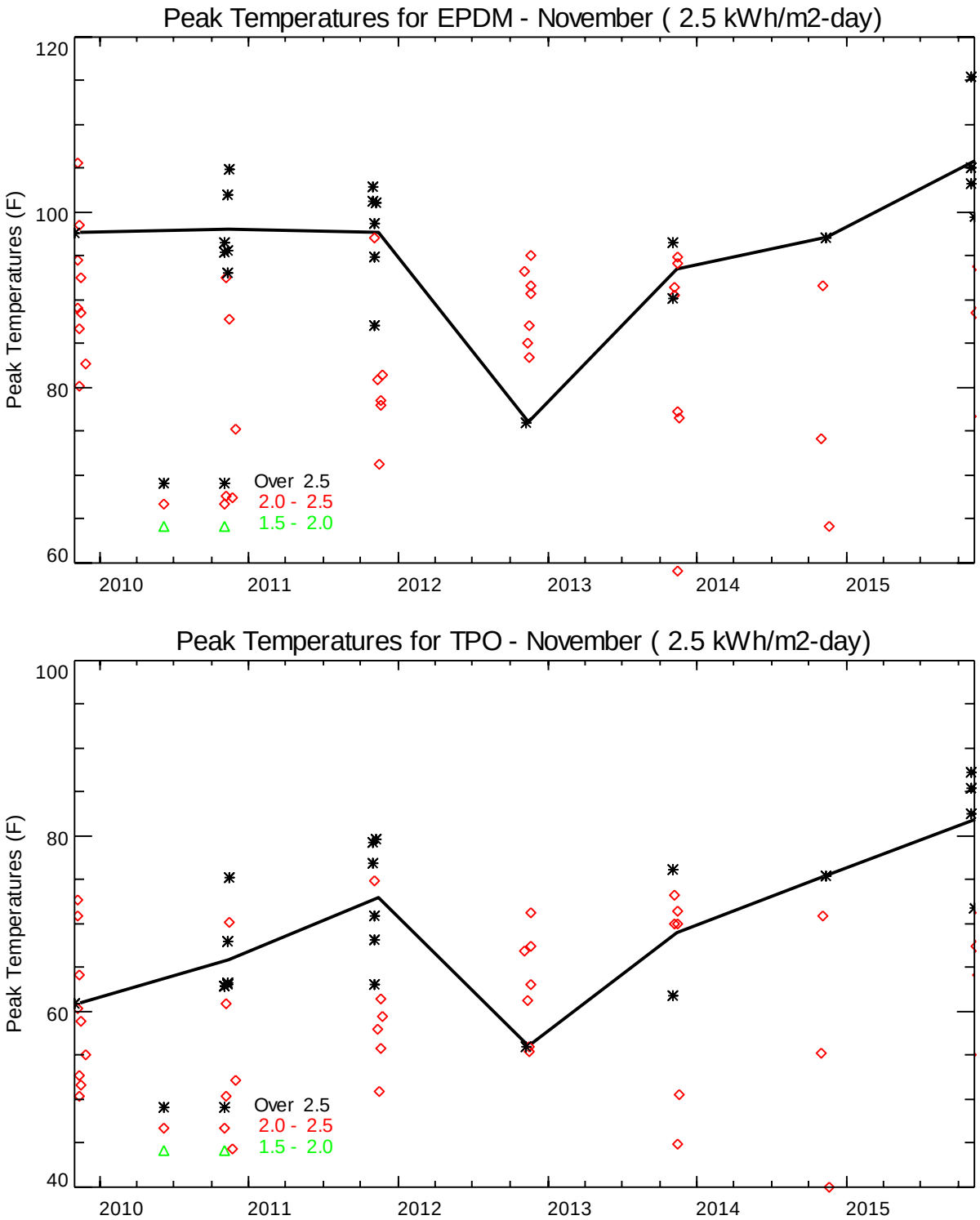


Figure 40. Peak Temperatures for EPDM and TPO Roofs from November 2009 to November 2015

The overall trends confirm that the difference between the peak temperatures generally decreases over time. The temperature difference between the EPDM and TPO roof surfaces is about 37°F in November 2009 (about 6 months after installation). That temperature difference decreases to about 30°F at 18 months (Nov 2010) and to 25°F at 30 months (Nov 2011). In subsequent years the temperature difference ranges between 20°F and 24°F. Overall the temperature difference drops by 15°F in the first 2-3 years of life.

The peak temperatures in Figure 40 show that the peak temperatures increase by corresponding amount for the TPO roof while the peak temperatures on the EPDM roof usually remain at similar values (except for 2012). The year-over-year variations in a given month can be large: the drop in peak roof temperatures in November 2012 is especially noticeable, implying there were fewer sunny days in this period. In spite of the 20°F lower temperatures, the temperature difference between the roofs was more consistent over the years.

We completed similar analyses for July and August, respectively. Figure 41 and Figure 42 similarly show the corresponding temperature difference and peak temperatures for July 2010 through July 2015 using a threshold of 7.5 kWh/m^2-day (appropriate for that month). Table 15 gives the average values in each year. Figure 43 and Figure 44 show the corresponding temperatures for August 2010 through August 2015 using a threshold of 6.5 kWh/m^2-day and Table 16 gives the average values in each year.

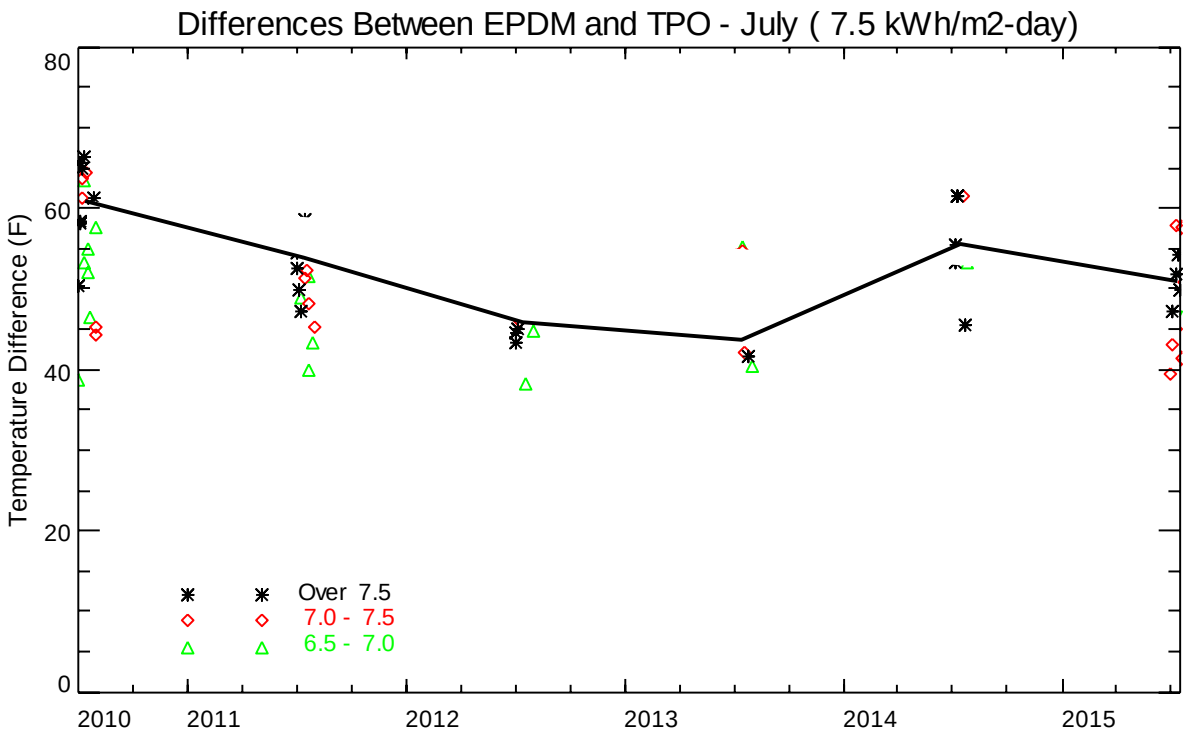


Figure 41. Differences Between EPDM and TPO Peak Temperatures from July 2010 to July 2015

Table 15. Differences Between EPDM and TPO Peak Temperatures from July 2015 to July 2015

	2010	2011	2012	2013	2014	2015
Peak Temps - EPDM (°F)	171.6	166.6	164.8	164.5	161.3	169.6
Peak Temps – TPO (°F)	110.9	113.0	119.0	121.0	105.8	118.8
Temperature Difference (°F)	**60.7**	**53.6**	**45.8**	**43.6**	**55.5**	**50.8**

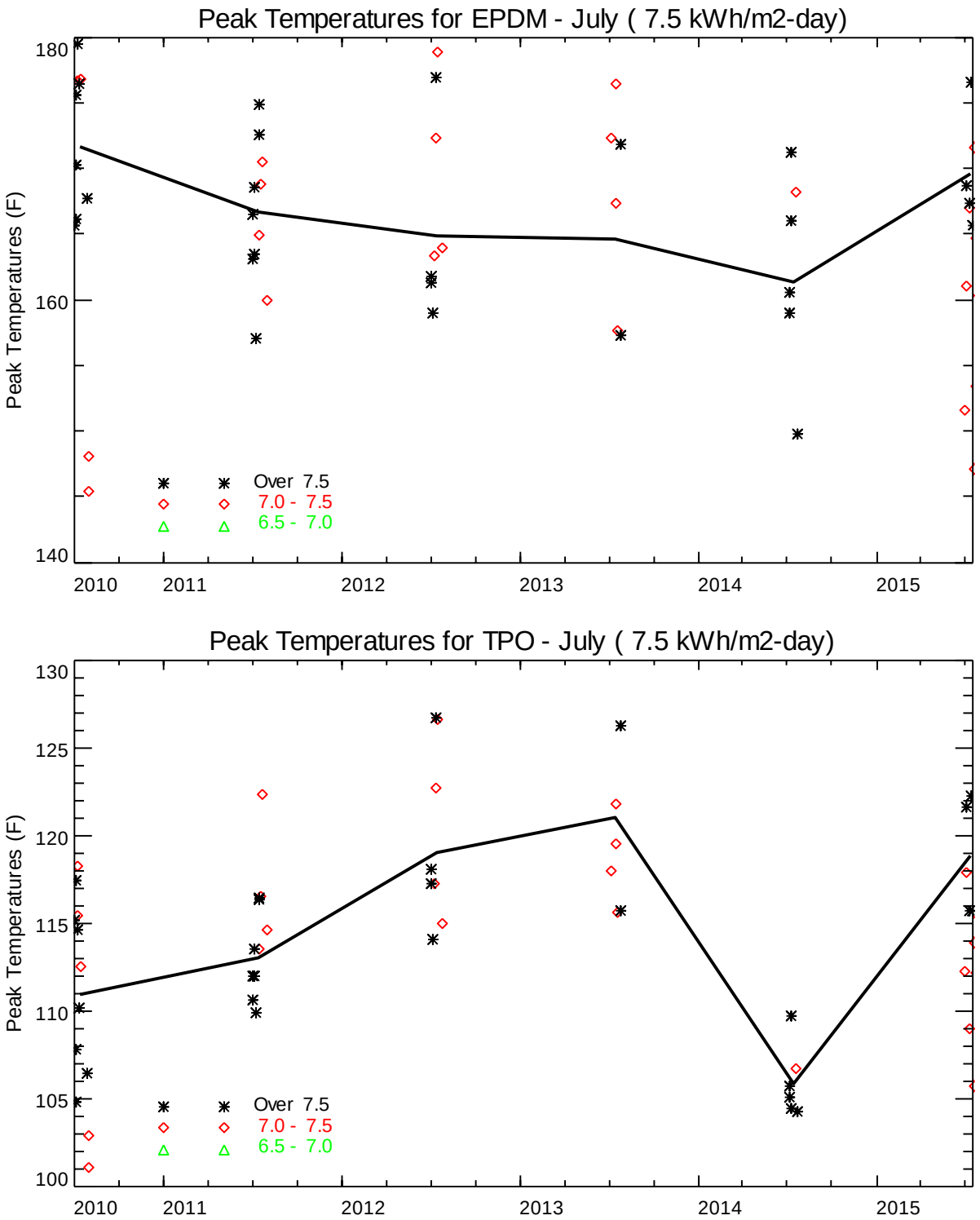


Figure 42. Peak Temperatures for EPDM and TPO Roofs from July 2010 to July 2015

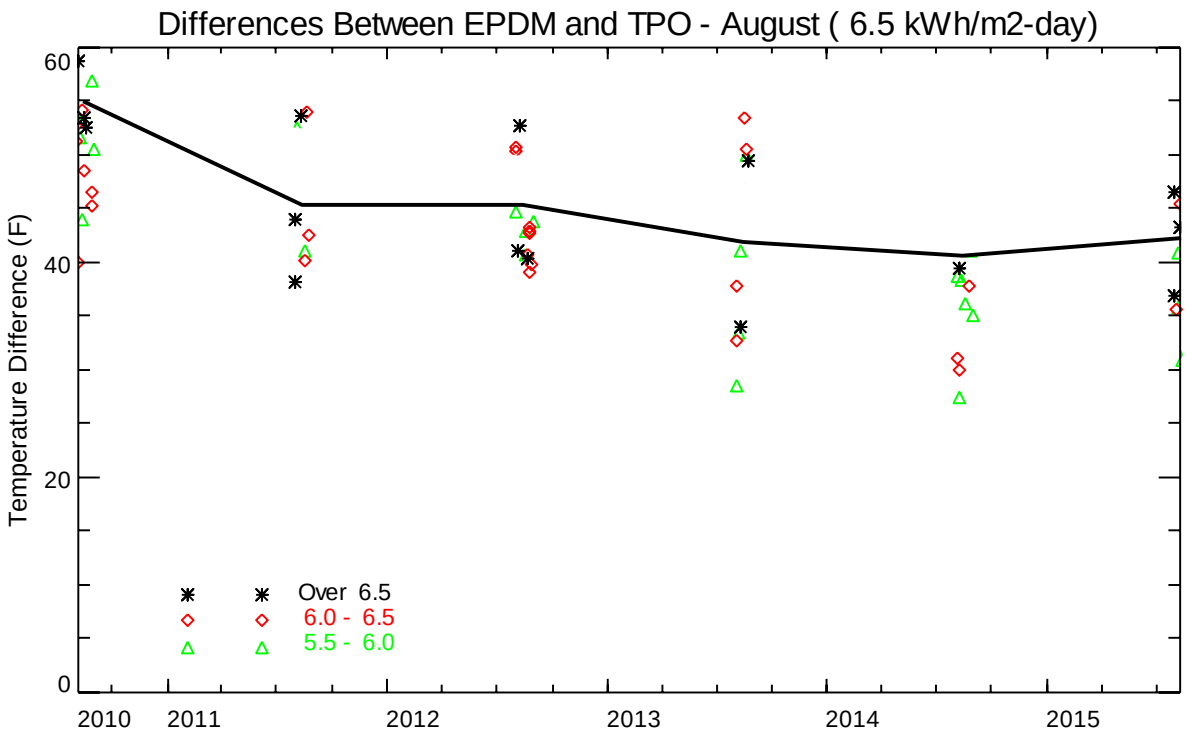


Figure 43. Differences Between EPDM and TPO Peak Temperatures from August 2010 to August 2015

Table 16. Differences Between EPDM and TPO Peak Temperatures from August 2010 to August 2015

	2010	2011	2012	2013	2014	2015
Peak Temps - EPDM (°F)	154.0	158.6	159.6	147.8	169.5	156.4
Peak Temps – TPO (°F)	99.2	113.4	114.3	106.1	129.0	114.2
Temperature Difference (°F)	**54.8**	**45.2**	**45.2**	**41.7**	**40.5**	**42.2**

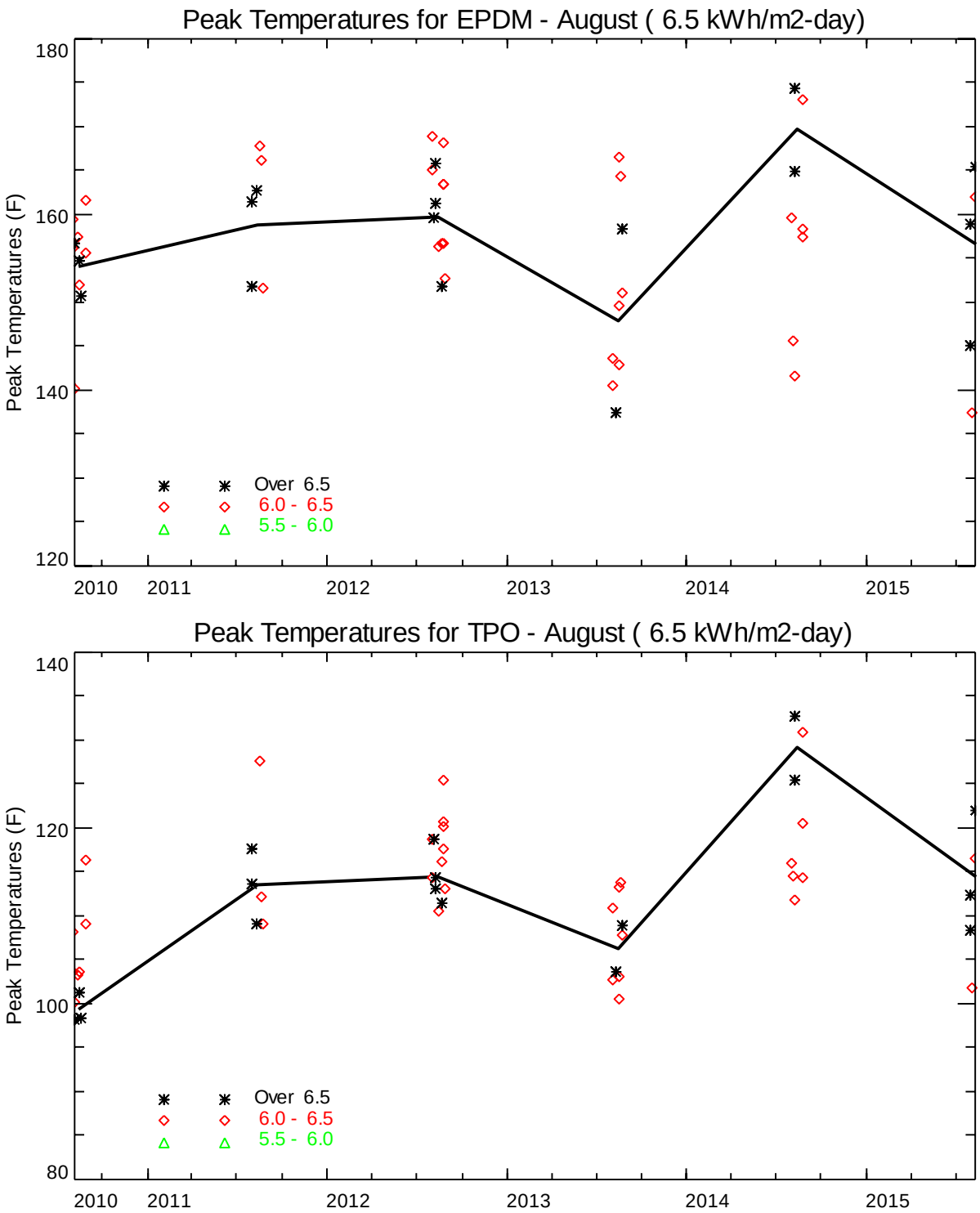


Figure 44. Peak Temperatures for EPDM and TPO Roofs from August 2010 to August 2015

Long Term Temperature Trends from Other Studies

Oak Ridge National Laboratory (ORNL) completed similar testing to determine the long-term trend of roof temperatures for reflective and conventional roof membranes (Miller et al. 2004). The membranes tested included a mix of reflective membranes, including polyvinyl chloride (PVC), polypropylene and thermoplastic polyolefins (TPO). The conventional baseline surface was a built-up roof (BUR).

ORNL studied the long term thermal performance of single ply membranes at its Envelope Systems Research Apparatus (ESRA) at Oak Ridge. The membranes were field-tested on a low-slope portion of the apparatus (the slope was ¼ inch per 12-inch run).

Each membrane experienced a loss in reflectivity and therefore a decrease in performance. ORNL found that a 30% to 50% loss of surface reflectivity occurred over the three-year time period. Most of the loss in reflectivity occurred in the first two years of exposure (which is consistent with our findings above). Six out of the twelve membranes experienced a leveling off in solar reflectivity loss after two years, while the other half of the membranes continued to degrade.

Peak membrane temperatures were more closely monitored for two of the reflective membranes and the baseline roof. The reflective membranes are identified as Code A and Code J to keep the brand and manufacturer anonymous. These membranes started with nominal reflectances over 0.8 and ended with reflectances in the range of 0.5 to 0.6 after 3½ years. Table 17 shows that the measured peak temperatures for the reflective roofs increased after one year by 26°F and 20°F, for Code A and Code J respectively. The long-term increases (by year 3) were 34°F and 9°F.

Table 17. Long-term Exposure Impact for Reflective Roofs (Codes A & J) and a Conventional Roof (BUR)

	Year 0 (Aug-1998)	Year 1 (Aug-1999)	Year 2 (Aug-2000)	Year 3 (Aug-2001)
Code A	106.1	132.9	133.6	140.2
Code J	110	130.5	121.5	119.1
BUR	169.2	168.6	159	162.8

Note: Peak temperatures for one week in August for each year from Miller et al (2004)

Conclusions

Extended field testing of the four different roof systems tracked the thermal performance over 6½ years, from November 2009 through May 2016.

Some of the initial findings (summarized in the October 2011 report) continued over the long term:

- The EPDM surface did result in roof temperatures that were as much as 60°F higher than the other surfaces. This surface had higher heat gains in the summer but also more modest heat losses in the winter.
- The TPO membrane significantly reduced the surface temperatures in the summer but also resulted in greater heat losses in the heating season (since beneficial solar gains are reduced).
- The vegetative roof adds thermal mass to the roof assembly that dampens the temperature swings. Evaporation at the surface also provides cooling in the summer and swing seasons. The vegetative roof also retained more snow cover more often and had lower heat losses in the winter.

Over the long term, the TPO membrane with 4 inches of insulation had 30% to 45% higher thermal losses over the heating season, as measured at the roof surface[3]. This higher heat loss increases heating costs by $23 per year per each 1000 sq ft of roof area. However, the reduced summer time heat gains equate to about $16 per year per 1000 sq ft in cooling energy savings. Overall, heating losses and cooling savings resulted in a net annual cost penalty of $8 per 1000 sq ft for the 4-inch TPO roof.

Using different assumptions for internal gains and cooling system arrangement—corresponding to a small office with a packaged cooling system that uses economizer cooling in the swing season—changes the resulting impact on heating and cooling loads and energy use. The heating penalty of the 4-inch TPO over a shorter heating season (caused by internal gains) drops to $16 per 1000 sq ft and the cooling benefit becomes $9 per 1000 sq ft. The net annual cost penalty of the 4-inch TPO roof compared to the EPDM roof is still around $7 per 1000 sq ft.

The results Hossieni (2014) and Hosseini and Akbari (2015) showed similar trends of heating losses and summertime savings, with a slightly smaller net annual penalty of $1-2 per 1000 sq ft for nearby Toronto (using our assumptions). Details of building application (office, retail, institutional, etc.) and HVAC arrangement (economizer, cooling efficiency), as well as utility costs have a significant impact whether cooling roofs provide net cost increases or savings in each climate.

To predict hourly ground snow cover for the Jamesville, NY site over the monitoring period, we used snow cover data from a monitoring station 3 miles from the Jamesville Facility provided by the National Operational Hydrologic Remote Sensing Center (NOHRSC) in Chanhassen, MN (a division of NOAA). We

[3] We applied a correction for thermal mass of the roof deck, developed from an analysis using EnergyPlus, that resulted in a similar heat loss rate at the ceiling over the long term.

found that periods with ground snow cover generally have roof surface temperatures that remain very close to freezing, regardless of outdoor temperatures. By combining the snow cover and roof temperature data, we were able to show that the roofs are generally covered with snow less often than snow is on the ground: the ratio of roof-to-ground snow cover ranged between 60 and 80%. The EPDM roof clears snow faster than the other roofs types (as evidenced by temperature excursions above freezing). The TPO roof with extra insulation retained snow for longer since the lower heat loss results in less melting at the roof surface.

When we only look at the days that are snow free, the trend of heat loss with ambient temperature becomes highly linear for the EPDM and TPO roofs. The TPO roof with extra insulation has the lowest degree of scatter from the linear trend, since the impact of solar gains are minimal in this case. The vegetative roof still shows a non-linear trend, even with snowy days excluded, since it retains moisture and ice even if there is no snow on the ground.

We found that the temperature difference between the similarly-insulated EPDM and TPO roofs was as high as 60°F on summer days when the roofs were first installed. Over the first two or three years, the temperature difference dropped by 10°F to 15°F. Generally, the peak temperature of the EPDM roof stayed about the same over the long term, while the peak surface temperature of the TPO roof increased by 10°F to 15°F. This long-term change is less than what was observed in earlier studies using the first cool roof membrane products (Miller et all 2004), but seems to be consistent with the published rating numbers for this TPO membrane (initial and 3-year reflectance ratings per Energy Star CRRC are 0.79 and 0.70, respectively).

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Priority	ARMA Technical Bulletins or Publications	Steep Slope / Low Slope (S/L)	Tech Bulletin / Publication (T/P)	Last Updated & Approved	Pulled from Website	Discarded	Notes
High	Nail Application of Asphalt Strip Shingles for New and Recover Roofing	S	T	2007			
High	Cold Weather Application Recommendations for Modified Bitumen Roofing	L	T	2009			
High	Color Shading of Asphalt Shingle Roofs	S	T	2007			
High	Self-Adhesive Modified Bituminous Roofing Membranes	L	T	2009			
High	Preventing Damage from Ice Dams	S	T	2007			
High	The Effects of Greases, Oils and Chemicals on Modified Bitumen Sheet Materials	L	T	2010			
High	The Effects of Ponding Water	L	T	2010			
Medium	Ventilation and Moisture Control for Residential Roofing	S	T	2014	x		
Medium	Application of Asphalt Shingles to Decks Installed over Insulation or Radiant Barriers	S	T	2012	x		
Medium	The 2010 Florida Building Code, Residential and Asphalt Shingle Wind Classifications	S	T	2012			
Medium	The 2010 Florida Building Code, Building and Asphalt Shingle Wind Classifications	S	T	2012			
Medium	ARMA Lightweight Structural Concrete Roof Decks Statement	L	T	2013			
Medium	Decking Recommendations for Built-Up Roofing and Modified Bitumen Membranes	L	T	2014			
Medium	Effects of Roof Color and Solar Reflectance on the Accumulation of Moisture in Roof Systems	L	T	2014			
Medium	VOC Considerations for Asphalt Roofing	L	T	2014			
Medium	Asphalt Roofing Residential Manual	S	P	2014			
Medium	Coating of Asphalt Shingles After Installation	S	T	2014			
Medium	Asphalt Shingle Recycling FAQs	S	T	2014			
Medium	Asphalt Shingle Recycling Do's and Don'ts	S	T	2014			
High	Good Application (3 Tab)	S	P	1999			
High	Use of Asphalt Shingle Underlayment	S	T	2005	x		
High	Recommendations for Application of Asphalt Shingles on Steep Slopes and Mansard Construction	S	T	2007			
High	Algae Discoloration of Roofs	S	T	2014			
High	Re-roofing: Tear Off vs. Re-Cover	S	T	2012	x		Referenced in both Good Application Guides
Low	Photovoltaic Systems and Low-slope Commercial Roofs	L	T	2014			
Low	Water Soluble Residue from Asphalt Roofing Products ("Tobacco Juicing")	L	T	2014			
Low	When Does a Shingle Comply with ASTM D3462?	S	T	2014			
Low	Good Application (Laminated)	S	P	2015			
Low	Photovoltaic Systems and Asphalt Shingle Roofs	S	T	2015			
Low	Self-Adhering Underlayment Removal Prior to Steep Slope Re-Roofing	S	T	2015			
Low	Use of Self-Adhering Membranes as Underlayments in Steep Slope Roofing	S	T	2015			
Low	Recommendations for Installation of Asphalt Roofing Shingles in Cold Weather	S	T	2015			
Low	Recommendations for Storage and Application of Asphalt Roofing Shingles in Hot Weather	S	T	2015			
Low	Plain Facts About Buckled Shingles	S	T	2015			
Low	Recommendations Regarding Built-Up Roofing Asphalt	L	T	2016			
Low	Cold Weather Recommendations for Built-Up Roofing	L	T	2016			
Low	Modified Bitumen Design Guide for Building Owners	L	P	2016			

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David Stanczak

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