Total Mods for Roofing in Pending Review: 102

Total Mods for report: 102

Proposed Code Modifications

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TAC: Roofing

Total Mods for **Roofing** in **Pending Review: 102**

Total Mods for report: 102

Sub Code: Building

R7603

1

Date Submitted	11/30/2018	**Section**	202	**Proponent**	Ann Russo5
Chapter	2	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal clarifies and makes corrections to the definition. Specifically, in the definition in the Building and Residential Codes it replaces one of the redundant "vapor retarder" listings with "underlayment".

Rationale

The revision to the definition of "roof assembly" removes duplicative wording and clarifies which items are in all roof assemblies. It clarifies that underlayment can be included in the roof assembly but it not a requirement of all roof assemblies.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improved definition clarifies items in proposed assembly for plan review and inspection

Impact to building and property owners relative to cost of compliance with code

No impact expected

Impact to industry relative to the cost of compliance with code

Helps incidental cost as it clarifies that systems have different components depending on use and listing

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

By clarifying definition and shifting focus to components that may be offered in systems, assists in evaluation based on usage and needs thus improving overall choices with positive impact of building integrity thus general health and safety

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves procedures for Code compliance as well as allowing for better comprehension as to effects of components in selecting system for use on specific projects needs

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

No, it assists in improving effectiveness

Modify as follows:

[BS]ROOF ASSEMBLY (For application to Chapter 15 only). A system designed to provide weather protection and resistance to design *loads.* The system consists of a *roof covering* and *roof deck* or a single component serving as both the roof covering and the *roof deck*. A roof assembly includes the *roof deck*, can also include an underlayment, ~~*vapor retarder*, substrate or~~ a thermal barrier, insulation, or a *vapor retarder* ~~and roof covering~~.

R8264

Date Submitted 12/14/2018
Chapter 2
Section 202
Affects HVHZ No
Proponent Joseph Crum
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

G24-16

Summary of Modification

This change will make the FBCB definition consistent with the ICC Green Building Code and ASTM D1079.

Rationale

This change will make the FBCB definition consistent with the ICC Green Building Code and ASTM D1079.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Code update only and has no effect on code enforcement.

Impact to building and property owners relative to cost of compliance with code

Code update only and will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Code update only and will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Code update only and will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Code update only and will update the code to current standards.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Code update only and will update the code to current standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Code update only and will update the code to current standards. Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

Code update only and will update the code to current standards. Does not degrade the effectiveness of the code

VEGETATIVE ROOF. An assembly of interacting components designed to waterproof~~ and normally~~ ~~insulate~~ a building's top surface that includes, by design, vegetation and related landscape elements.

R7161

Date Submitted	11/2/2018	**Section**	1501.1	**Proponent**	John Hall
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

No related modifications have been identified.

Summary of Modification

The modification provides for inclusion of Florida Building Code, Building Section 1507.18.1 in the High Velocity Hurricane Zone.

Rationale

Inclusion of Section 1507.18.1 in the High Velocity Hurricane Zone will provide pathways on roofs for firefighter access consistent with the requirements throughout the rest of the State of Florida. This will increase firefighter safety on roofs with photovoltaic panels. These provisions are currently not included in the High Velocity Hurricane Zone.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no impact to local enforcement entities in enforcement of the code. The time and expense required for inspection will not be affected. This modification increases firefighter safety and enhances firefighting operations.

Impact to building and property owners relative to cost of compliance with code

There is no cost impact to business and property owners. The only additional requirements not already included in NFPA 70 (NEC) are provisions for pathways and spacing around photovoltaic modules on roofs, allowing access and roof ventilation spaces for firefighter operations.

Impact to industry relative to the cost of compliance with code

There is no code compliance cost impact to industry. The only additional requirements not alreadi included in NFPA 70 (NEC) are provisions for pathways and spacing around photovoltaic modules on roofs, allowing access and roof ventilation spaces for firefighter operations.

Impact to small business relative to the cost of compliance with code

There is no code compliance cost impact to small business. The only additional requirements not alreadi included in NFPA 70 (NEC) are provisions for pathways and spacing around photovoltaic modules on roofs, allowing access and roof ventilation spaces for firefighter operations.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modification is specifically aimed at improving the health, safety, and welfare of firefighters. A safe means of accessing the roof and ready egress from the roof during firefighting operations increases firefighter safety. Firefighter effectiveness will increase safety to the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This strengthens the code in the HVHZ by applying standards already in force for the state as a whole.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposed modification does not discriminate against materials, products, methods, or systems of construction because none are specified in the proposed modification.

Does not degrade the effectiveness of the code

The proposed does not degrade the effectiveness of the code. To the contrary, the code is strengthened by this modification.

SECTION1501
GENERAL

1501.1 Scope.

The provisions of this chapter shall govern the design, materials, construction and quality of roof assemblies, and rooftop structures.

Exception: Buildings and structures located within the high-velocity hurricane zone shall comply with the provisions of Section 1503.7, Section 1507.18.1 and Sections 1512 through 1525.

Fiscal Impact Assumptions

1. This proposed modification is already in effect in all areas of the State of Florida except the High Velocity Hurricane Zone.
2. The code enforcement entity will already be sending inspection personnel to the roof to inspect the installation of the photovoltaic modules.
3. This modification simply specifies the location of photovoltaic modules and the location and dimensions of access pathways. These items can be verified while inspecting other items on the roof.
4. There are no new items required to be installed by this proposed modification. Only the location of the modules is specified.
5. The other requirements in the section of the Florida Fire Prevention Code proposed to be included in the HVHZ are already contained in Article 690 of NFPA 70 (National Electrical Code). These items include disconnecting means, marking of photovoltaic system raceways and components.
6. Because these requirements are already included in the Florida Fire Prevention Code, their inclusion in the HVHZ will provide coordination between building and fire requirements. This coordination will lower costs to the industry by not having to attempt to satisfy conflicting requirements.
7. This proposed modification will enhance the safety of fire fighters by providing access and safe egress from roofs during firefighting operations. Reducing potential injury to firefighters reduces costs to all entities involved.
8. By increasing the ease of access to the roof during firefighting operations, this proposed modification will enhance the effectiveness of firefighting operations. This enhanced effectiveness is likely to result in the quicker extinguishing of the fire, which will reduce losses to building and property owners.

R7182

Date Submitted	11/5/2018	**Section**	1514	**Proponent**	Michael Goolsby
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarifying roof drainage requirements.

Rationale

The modification clarifies location of structural requirements for roof drainage design and includes language consistent with the FBC definitions. Additionally, adds guidance when utilizing flow restricting drain inserts.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Removes confusion by providing accurate direction regarding guidance to applicable code sections.

Impact to building and property owners relative to cost of compliance with code

Will economize costs by eliminating confusion in achieving code compliance.

Impact to industry relative to the cost of compliance with code

Will economize costs by eliminating confusion in achieving code compliance.

Impact to small business relative to the cost of compliance with code

Will economize costs by eliminating confusion in achieving code compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modification ensures rain loads are not exceeded, thereby removing possible overloading of the structure and preventing collapse.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The modification ensures rain loads are not exceeded, thereby removing possible overloading of the structure and preventing collapse.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The change improves the effectiveness of the code by providing a path to compliant roof drainage design.

1514.4 Roof drainage. Unless roofs are sloped to drain over roof edges, roof drains shall be installed at each low point of the roof. If required, roof drains shall comply with the *Florida Building Code, Plumbing.* Where required for primary roof drainage, scuppers shall be placed level with the roof surface in a wall or parapet. The scupper shall be located as determined by the roof slope and contributing roof area. Scuppers shall be sized in accordance with the provisions contained in ASCE 7, ~~Section~~ Chapter 8 with commentary and shall comply with Section 1611 herein.

1514.4.1 Gutters. Gutters shall be in compliance with RAS 111.

1514.4.2 Overflow drains and scuppers. Where roof drains are required, overflow drains or overflow scuppers sized in accordance with *Florida Building Code, Plumbing* and ASCE 7, Chapter 8 with commentary shall be installed with the inlet flow line located not less than 2 inches (51 mm) or more than 4 inches (102 mm) above the low point of the finished roofing surface, excluding sumps. Overflow scuppers shall ~~be~~ have a minimum width dimension of 4 inches (102 mm) ~~in any dimension~~ and shall be located as close as practical to required vertical leaders, conductors or downspouts. The height of the scupper opening shall be at least one inch (25 mm) above the depth of water at its design flow, but not less than 4 inches (102 mm). Overflow drains and scuppers shall also comply with the *Florida Building Code, Plumbing*, and Section 1611 of this code.

1514.4.2.1 When overflow scuppers and roof drains are installed, they shall be lined with approved metal or other approved materials set forth, herein ~~in the roofing system assembly product approval~~.

1514.4.2.2 When recovering, reroofing or repairing an existing roof, the existing number of scuppers and/or roof drains shall not be reduced, unless a new drainage system is designed by a *registered design professional* ~~an architect or engineer~~, in compliance with the provisions of this code.

1514.4.2.3 When retrofit roof drains are installed into or over existing roof drains a *registered design professional* shall perform an analysis of the altered roof drainage system to ensure the roof will sustain the load of rainwater which will accumulate.

1514.4.3 Sizing and discharge. Roof drains, gutters, conductors and leaders shall be sized and discharge in accordance with the *Florida Building Code, Plumbing* and ASCE 7, Chapter 8 with commentary.

R7185

Date Submitted	11/5/2018	**Section**	1523.6.4	**Proponent**	Michael Goolsby
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarify required uplift test procedure.

Rationale

This code modification provides consistency with TAS 124 regarding uplift testing of mechanically attached roof systems. Additionally, by specifying the code section in RAS 124, the modification makes clear which of the two test methods are applicable when quality control testing of new roof systems are required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Removes confusion by providing accurate direction regarding which uplift test is required.

Impact to building and property owners relative to cost of compliance with code

Will economize costs by eliminating confusion regarding which uplift test is required.

Impact to industry relative to the cost of compliance with code

Will economize costs by eliminating confusion regarding which uplift test is required.

Impact to small business relative to the cost of compliance with code

Will economize costs by eliminating confusion regarding which uplift test is required.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, by providing guidance necessary to achieve compliance with the wind load requirements for new roof systems.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, by providing guidance necessary to achieve compliance with the wind load requirements for new roof systems.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The modification does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The proposal increases the effectiveness of the code and the protection of the public by providing clear guidance regarding the appropriate uplift test.

1523.6.4 The building official may request that a quality control field uplift test be carried out on a continuous roofing system in compliance with test procedure TAS 124. Single-ply systems are not required to meet the deflection requirements established in the test protocol <u>if mechanically attached</u>. The roofing system shall resist the design pressures as calculated in compliance with Chapter 16 (High-Velocity Hurricane Zones), and as established in TAS 124<u>, Section 4</u>.

R7186

Date Submitted	11/7/2018	**Section**	1525	**Proponent**	Michael Goolsby
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

Modify the HVHZ Uniform Permit Application necessary to update formulas and elevated pressure zones for roof systems to coincide with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, merely updates the permit application as needed to coincide with ASCE 7-16.

Impact to building and property owners relative to cost of compliance with code

None, merely updates the permit application as needed to coincide with ASCE 7-16.

Impact to industry relative to the cost of compliance with code

None, merely updates the permit application as needed to coincide with ASCE 7-16.

Impact to small business relative to the cost of compliance with code

None, merely updates the permit application as needed to coincide with ASCE 7-16.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, by providing formulas necessary to determine wind load requirements for roof systems.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, by providing formulas necessary to determine wind load requirements for roof systems.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The modification does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Enhances the effectiveness of the code by ensuring adequate roof system wind performance.

1525
HIGH-VELOCITY HURRICANE ZONES—UNIFORM PERMIT APPLICATION

Florida Building Code ~~6~~ 7th Edition (20~~17~~20)
High-Velocity Hurricane Zone Uniform Permit Application Form

Section C (Low Slope Application)

Design Wind Pressures, From RAS 128 or Calculations:

~~P1~~ Zone 1':_____ ~~P2~~ Zone 1:_____ ~~P3~~ Zone 2:_____ Zone 3:_____

Fastener Spacing for Anchor/Base Sheet Attachment:

~~Field~~ Zone 1': ____" oc @ Lap, # Rows ____ @ ____" oc

Zone 1: ____" oc @ Lap, # Rows ____ @ ____" oc

~~Perimeter~~ Zone 2: ____" oc @ Lap, # Rows ___ @ ____" oc

~~Corner~~ Zone 3: ____" oc @ Lap, # Rows ____ @ ____" oc

Number of Fasteners Per Insulation Board:

~~Field~~ Zone 1' _____ Zone 1 _____ ~~Perimeter~~ Zone 2 _____ ~~Corner~~ Zone 3 _____

Section D (Steep Sloped Roof System)

Minimum Design Wind Pressures, If Applicable (From RAS 127 or Calculations):

~~P1~~ Zone 1':_____ ~~P1~~ Zone 1:_____ ~~P1~~ Zone 2:_____ Zone 3:_____

Section E (Tile Calculations)

For Moment based tile systems, choose either Method 1 or 2. Compare the values for M_r with the values from M_f. If the M_f values are greater than or equal to the M_r values, for each area of the roof, then the tile attachment method is acceptable.

Method 1 "Moment Based Tile Calculations Per RAS 127"

(~~P_1~~Zone 1:____ × ? ____ = ____) – Mg: ____ = M_{r1} ____ Product Approval M_f __________

(~~P_2~~Zone 2e:____ × ? ____ = ____) – Mg: ____ = M_{r2} ____ Product Approval M_f __________

(~~P_3~~Zone 2n:____ × ? ____ = ____) – Mg: ____ = M_{r3} ____ Product Approval M_f __________

(Zone 2r: ________ x λ ________ = ________) – Mg ________ = M_{r1} ________ NOA M_f ________

(Zone 3e: ________ x λ ________ = ________) – Mg: ________ = M_{r2} ________ NOA M_f ________

(Zone 3r: ________ x λ ________ = ________) – Mg: ________ = M_{r3} ________ NOA M_f ________

For Uplift based tile systems use Method 3. Compared the values for F' with the values for Fr. If the F' values are greater than or equal to the Fr values, for each area of the roof, then the tile attachment method is acceptable.

Method 3 "Uplift Based Tile Calculations Per RAS 127"

(~~P_1~~Zone 1:____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r1} ____ Product Approval F' __________

(~~P_2~~Zone 2e: ____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r2} ____ Product Approval F' __________

(~~P_3~~Zone 2n:____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r3} ____ Product Approval F' __________

(Zone 2r:____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r1} ____ Product Approval F' __________

(Zone 3e:____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r2} ____ Product Approval F' __________

(Zone 3r:____ x L ____ = ____ x w: = ____) – W: ____ x cos? ____ = F_{r3} ____ Product Approval F' __________

Where to Obtain Information

Description	Symbol	Where to find
Design Pressure	~~P1 or P2 or P3~~ Zones 1, 2e, 2n, 2r, 3e, 3r	From applicable Table in RAS 127 ~~Table 1~~ or by an engineering analysis prepared by PE based on ASCE 7

SECTION 1525
HIGH-VELOCITY HURRICANE ZONES—UNIFORM PERMIT APPLICATION

Florida Building Code **6th Edition (20~~17~~20)**
High-Velocity Hurricane Zone Uniform Permit Application Form

INSTRUCTION PAGE

COMPLETE THE NECESSARY SECTIONS OF THE UNIFORM ROOFING PERMIT APPLICATION FORM AND ATTACH THE REQUIRED DOCUMENTS AS NOTED BELOW:

Roof System	Required Sections of the Permit Application Form	Attachments Required See List Below
Low Slope Application	A,B,C	1,2,3,4,5,6,7
Prescriptive BUR-RAS 150	A,B,C	4,5,6,7
Asphaltic Shingles	A,C,D	1,2,4,5,6,7
Concrete or Clay Tile	A,B,D,E	1,2,3,4,5,6,7
Metal Roofs	A,B,D	1,2,3,4,5,6,7
Wood Shingles and Shakes	A,B,D	1,2,4,5,6,7
Other	As Applicable	1,2,3,4,5,6,7

ATTACHMENTS REQUIRED:

1.	Fire Directory Listing Page
2.	From Notice of Acceptance: Front Page Specific System Description Specific System Limitations General Limitations Applicable Detail Drawings
3.	Design Calculations per Chapter 16, or If Applicable, RAS 127 or RAS 128
4.	Other Component Notice of Acceptances
5.	Municipal Permit Application
6.	Owners Notification for Roofing Considerations (Re-Roofing Only)
7.	Any Required Roof Testing/Calculation Documentation

Florida Building Code 6th Edition (20~~17~~20)
High-Velocity Hurricane Zone Uniform Permit Application Form

Section A (General Information)

Master Permit No. ____________________ Process No. ________________________

Contractor's Name ____

Job Address ____

ROOF CATEGORY

☐ Low Slope ☐ Mechanically Fastened Tile ☐ Mortar/Adhesive Set Tile
☐ Asphaltic Shingles ☐ Metal Panel/Shingles ☐ Wood Shingles/Shakes
☐ Prescriptive BUR-RAS 150 (Broward County only.)

ROOF TYPE

☐ New Roof ☐ Re-Roofing ☐ Recovering ☐ Repair ☐ Maintenance

ROOF SYSTEM INFORMATION

Low Slope Roof Area (SF) ______________________ Steep Sloped Roof Area (SF) ______________________ Total (SF) ______________________

Section B (Roof Plan)

Sketch Roof Plan: Illustrate all levels and sections, roof drains, scuppers, overflow scuppers and overflow drains. Include dimensions of sections and levels, clearly identify dimensions of elevated pressure zones and location of parapets.

Florida Building Code 6th Edition (20~~17~~20)
High-Velocity Hurricane Zone Uniform Permit Application Form

Section C (Low Slope Application)
Fill in specific roof assembly components and identify manufacturer
(If a component is not used, identify as "NA")

System Manufacturer:________________________

Product Approval No.:________________________
Design Wind Pressures, From RAS 128 or Calculations:
~~P1~~ Zone 1':_____ ~~P2~~ Zone 1:_____ ~~P3~~ Zone 2:_____

Zone 3:_____

Max. Design Pressure, from the specific product approval system:___________________________

Deck:
- Type:_____________________________
- Gauge/Thickness:___________________
- Slope:_____________________________

Anchor/Base Sheet & No. of Ply(s): ___________________

Anchor/Base Sheet Fastener/Bonding Material:
____

Insulation Base Layer: ____________________________

Base Insulation Size and Thickness: _________________

Base Insulation Fastener/Bonding Material:
____

Top Insulation Layer: _____________________________

Top Insulation Size and Thickness: __________________

Top Insulation Fastener/Bonding Material:
____

Base Sheet(s) & No. of Ply(s): _____________________

Base Sheet Fastener/Bonding Material:
____

Ply Sheet(s) & No. of Ply(s): ______________________

Ply Sheet Fastener/Bonding Material:
____

Top Ply: ____________________________________

Fastener Spacing for Anchor/Base Sheet Attachment

~~Field~~ Zone 1': ____" oc @ Lap, # Rows ____ @ ____" oc

Zone 1: ____" oc @ Lap, # Rows ____ @ ____" oc

~~Perimeter~~ Zone 2: ____" oc @ Lap, # Rows ___ @ ___" oc

~~Corner~~ Zone 3: ____" oc @ Lap, # Rows ____ @ ____" oc

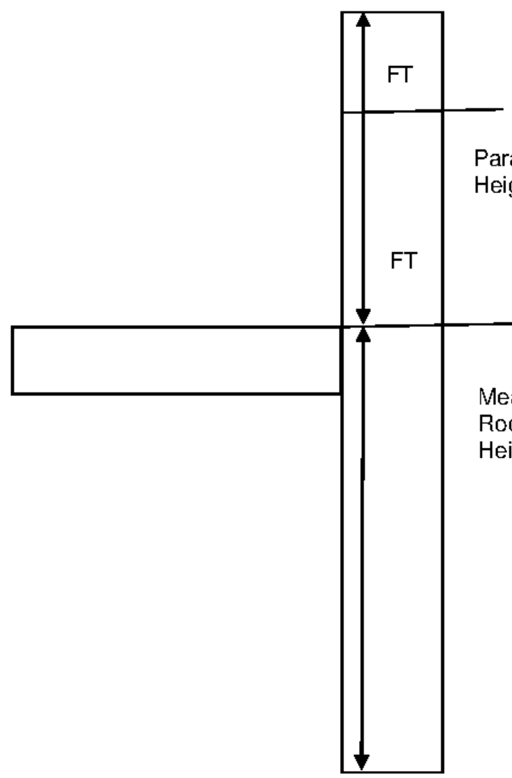
Number of Fasteners Per Insulation Board

~~Field~~ Zone 1' _____ Zone 1 _____ ~~Perimeter~~ Zone 2 _____
~~Corner~~ Zone 3 _____

Illustrate Components Noted and Details as Applicable:

Woodblocking, Edge Termination, Stripping, Flashing, Continuous Cleat, Cant Strip, Base Flashing, Counter-Flashing, Coping, Etc.

Indicate: Mean Roof Height, Parapet Height, Height of Base Flashing, Component Material, Material Thickness, Fastener Type, Fastener Spacing or Submit Manufacturers Details that Comply with RAS 111 and Chapter 16.



Florida Building Code 6th Edition (20~~17~~20)

High-Velocity Hurricane Zone Uniform Permit Application Form

Section D (Steep Sloped Roof System)

Roof System Manufacturer: ____________________

Notice of Acceptance Number: ____________________

Minimum Design Wind Pressures, If Applicable (From RAS 127 or Calculations):

~~P1~~Zone 1: __________ ~~P1~~ Zone 2e: __________ ~~P1~~Zone 2n: __________ Zone 2r: __________ Zone 3e: __________ Zone 3r: __________

Deck Type:

Type Underlayment:

Roof Slope: _____: 12

Insulation:

Fire Barrier:

Fastener Type & Spacing:

Ridge Ventilation? ________

Adhesive Type:

Type Cap Sheet:

Roof Covering:

Mean Roof Height: __________

Type & Size Drip Edge:

Florida Building Code 6th Edition (20~~17~~20)
High-Velocity Hurricane Zone Uniform Permit Application Form

Section E (Tile Calculations)

For Moment based tile systems, choose either Method 1 or 2. Compared the values for M_r with the values from M_f. If the M_f values are greater or equal to the Mr values, for each area of the roof, then the tile attachment method is acceptable.

Method 1 "Moment Based Tile Calculations Per RAS 127"

(~~P1~~ Zone 1:_______ x λ _______= _______) – Mg: _______ = M_{r1} _______ NOA M_f _______
(~~P2~~ Zone 2e:_______ x λ _______= _______) – Mg: _______ = M_{r2}_______ NOA M_f _______
(~~P3~~ Zone 2n:_______ x λ _______= _______) – Mg: _______ = M_{r3}_______ NOA M_f _______
(Zone 2r: x λ =) – Mg: = M_{r1} NOA M_f
(Zone 3e: x λ =) – Mg: = M_{r2} NOA M_f
(Zone 3r: x λ =) – Mg: = M_{r3} NOA M_f

Method 2 "Simplified Tile Calculation Per Table Below"

Required Moment of Resistance (M_r) From Table Below _________ NOA M_f _______

M_r Required Moment Resistance*					
Mean Roof Height → / Roof Slope ↓	15'	20'	25'	30'	40'
2:12	30.7	33.4	35.7	37.7	40.7
3:12	28.7	31.3	33.4	35.2	38.1
4:12	26.6	28.9	30.9	32.6	35.2
5:12	24.5	26.7	28.5	30.0	32.5
6:12	22.5	24.5	26.2	27.6	29.8
7:12	20.8	22.6	24.1	25.4	27.5

***Must be used in conjunction with a list of moment based tile systems endorsed by the Broward County Board of Rules and Appeals.**

For Uplift based tile systems use Method 3. Compared the values for F' with the values for F_r. If the F' values are greater or equal to the F_r values, for each area of the roof, then the tile attachment method is acceptable.

Method 3 "Uplift Based Tile Calculations Per RAS 127"

(~~P1~~ Zone 1: ____ x l: ____ = ____ x w: = ____) – W: ____ x cos θ: ____ = F_{r1}: ____ NOA F'____
(~~P2~~ Zone 2e: ____ x l: ____ = ____ x w: = ____) – W: ____ x cos θ: ____ = F_{r2e}: ____ NOA F'____
(~~P3~~ Zone 2n: ____ x l: ____ = ____ x w: = ____) – W: ____ x cos θ: ____ = $F_{r\cancel{3}2n}$: ____ NOA F'____
(Zone 2r: x l: = x w: =) – W: x cos θ: ____ = F_{r2r}: NOA F'
(Zone 3e: x l: = x w: =) – W: x cos θ: ____ = F_{r3e}: NOA F'
(Zone 3r: x l: = x w: =) – W: x cos θ: ____ = F_{r3r}: NOA F'

Florida Building Code 6th Edition (2020)
High-Velocity Hurricane Zone Uniform Permit Application Form

Where to Obtain Information		
Description	**Symbol**	**Where to find**
Design Pressure	~~P1 or P2 or P3~~ Zones 1, 2e, 2n, 2r, 3e, 3r	From applicable Table in RAS 127 ~~Table 1~~ or by an engineering analysis prepared by PE based on ASCE 7
Mean Roof Height	H	Job Site
Roof Slope	θ	Job Site
Aerodynamic Multiplier	λ	NOA
Restoring Moment due to Gravity	M_g	NOA
Attachment Resistance	M_f	NOA
Required Moment Resistance	M_r	Calculated
Minimum Characteristic Resistance	F'	NOA
Minimum Characteristic Force	F_r	Calculated
Average Tile Weight	W	NOA
Tile Dimensions	l= length w= width	NOA

All calculations must be submitted to the Building Official at the time of permit application.

R7316

Date Submitted	11/19/2018	**Section**	1511	**Proponent**	Michael Silvers (FRSA)
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Existing Building Section 706 Existing Roofing

Summary of Modification

This modification adds language to clarify that salvaged slate, clay and concrete roof tile of like kind can be used in certain applications

Rationale

There are several sections of the code that indicate that some reuse of these materials are permitted: 104.9., 602.1 and 1506.2.1 all at least suggest acceptance. Section 1511.5 states that existing material may be reinstalled. It is not clear on when existing material quantities can be augmented. FS 553.842 allows reuse if the product approval requirements haven’t changed. But it’s not clear if the particular material never had product approval or the approval has changed if it can be used. The proposed change clarifies when the reuse of slate, clay and concrete roof tile may be acceptable when current product approvals or notice of acceptance are not available.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

1511.5 Reinstallation/Reuse of materials.

Existing or salvaged slate, clay or ~~cement~~ concrete tile shall be permitted for reinstallation or reuse, to repair an existing slate or tile roof, except that salvaged slate or tile shall be of like kind in both material and profile. D~~d~~amaged, cracked or broken slate or tile shall not be reinstalled. The building official may permit salvaged slate, clay and concrete tile to be installed on additions and new construction, when the tile is tested in compliance with the provisions of Section 1507 and installed in accordance with Section 1507. Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Aggregate surfacing materials shall not be reinstalled.

R7338

Date Submitted	11/20/2018	**Section**	1521.13	**Proponent**	Gaspar Rodriguez
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Eliminate a reference in the code to a section that has been removed from the code.

Rationale

The reference being removed has been reserved from the notification for roofing considerations, in the standard roofing application form.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Eliminates reference to a reserved section of the code.

Impact to building and property owners relative to cost of compliance with code

No change to code requirements. Eliminates reference to a reserved section of the code.

Impact to industry relative to the cost of compliance with code

No change to code requirements. Eliminates reference to a reserved section of the code.

Impact to small business relative to the cost of compliance with code

No change to code requirements. Eliminates reference to a reserved section of the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Allows for a more accurate understanding of the existing code requirement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Allows for a more accurate understanding of the existing code requirement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The modification is not adding a new code requirement. The modification is intended to clarify the current base code provision as applicable in the HVHZ.

Does not degrade the effectiveness of the code

The modification does not degrade the code, instead, the modification is intended to clarify the current base code provision as applicable in the HVHZ.

1521.13 Prior to starting the work the contractor has the responsibility of notifying the owner~~, by means of the roofing permit and required owners notification for roofing considerations herein,~~ of any possibility of ponding water and recommend a structural review if ponding water is a possibility.

R7342

Date Submitted	11/20/2018	**Section**	1523.6.5.2.8	**Proponent**	Gaspar Rodriguez
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Correct a typo error.

Rationale

Correct the Section 7 reference to the correct Section 8 reference.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Correct a typo error.

Impact to building and property owners relative to cost of compliance with code

None. Correct a typo error.

Impact to industry relative to the cost of compliance with code

None. Correct a typo error.

Impact to small business relative to the cost of compliance with code

None. Correct a typo error.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Corrects a typo error, which, allows for a more understandable code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Corrects a typo error, which, allows for a more understandable code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Corrects a typo error, which, allows for a more understandable code.

Does not degrade the effectiveness of the code

Corrects a typo error, which, allows for a more understandable code.

1523.6.5.2.8 Roof board insulation. All roof board insulation shall be tested for physical properties as set forth in Section ~~7~~ 8 of TAS 110.

R7356

Date Submitted	11/20/2018	**Section**	1507.3	**Proponent**	Michael Silvers (FRSA)
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building Code Chapter 35
Residential Code Sections 905.3
Residential Code Chapter 46

Summary of Modification

This modification updates Referenced Standard: FRSA/TRI High Wind Concrete and Clay Roof Tile Manual from the Fifth to the Sixth Edition

Rationale

Updates Referenced Standard: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change modification does not discriminate any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

1507.3.2 Deck slope.

Clay and concrete roof tile shall be installed in accordance with the recommendations of FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, ~~Fifth~~ Sixth Edition where the V_{asd} as determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3 Underlayment.

Unless otherwise noted, underlayment shall be applied according to the underlayment manufacturer's installation instructions or the recommendations of the FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, ~~Fifth~~ Sixth Edition where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3.1 Slope and underlayment requirements.

Refer to FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, ~~Fifth~~ Sixth Edition (2012) where the basic wind speed V_{asd} is determined in accordance with Section 1609.3.1 for underlayment and slope requirements for specific roof tile systems or the recommendations of RAS 111, 118, 119 or 120.

1507.3.7 Attachment.

Clay and concrete roof tiles shall be fastened in accordance with Section 1609 or in accordance with *FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1.

1507.3.8 Application.

Tile shall be applied according to the manufacturer's installation instructions or recommendations of the *FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1 or the recommendation of RAS 118, 119 or 120.

1507.3.9 Flashing.

At the juncture of the roof vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions or the recommendations of the *FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1or the recommendation of RAS 118, 119 or 120.

R7380

Date Submitted	11/21/2018	**Section**	1507.9.6	**Proponent**	Joseph Crum
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

S40-16
1807.1.4, 2303.1.9

Summary of Modification

Revise out dated code language

Rationale

Reason: The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies code due to updated language

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates the code with proper language

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Revises outdated language for clarification only.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Revises outdated language for clarification only.

Does not degrade the effectiveness of the code

Revises outdated language for clarification only.

2017 Florida Building Code Building

Section: 1507.9.6, 1807.1.4, 2303.1.9

Revise as follows:

TABLE 1507.9.6

WOOD SHAKE MATERIAL REQUIREMENTS

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shakes of naturally durable wood	1	CSSB
Taper sawn shakes of naturally durable wood	1 or 2	CSSB
Preservative-treated shakes and shingles of naturally durable wood	1	CSSB
Fire-retardant-treated shakes and shingles of naturally durable wood	1	CSSB
Preservative-treated taper sawn shakes of Southern pine treated in accordance with AWPA U1 (Commodity Specification A, Special Requirement 4.6 ~~Use Category 3B and Section 5.6~~)	1 or 2	TFS

CSSB = Cedar Shake and Shingle Bureau

TFS = Forest Products Laboratory of the Texas Forest Services.

R7427

Date Submitted	11/25/2018	**Section**	1510.7.1	**Proponent**	T Stafford
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Correlates the wind loading requirements in the code for rooftop PV with ASCE 7-16.

Rationale

This proposal correlates the wind loading requirements on roof mounted photovoltaic systems with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 contains two new methods for wind loads on photovoltaic systems. One method is based on the component and cladding loads applicable to the roof. The other method is based on entirely different criteria and research. Therefore, for clarification, this proposal simply references ASCE 7 for wind loads on rooftop PV systems.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

1510.7.1 Wind resistance. Rooftop-mounted *photovoltaic* systems shall be designed for wind loads in accordance with ASCE 7 ~~for component and cladding in accordance with Chapter 16 using an effective wind area based on the dimensions of a single unit frame~~.

R7437

Date Submitted	11/26/2018	**Section**	1515.2	**Proponent**	Gaspar Rodriguez
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7437; 7438; 7439. These three mods need to be considered concurrently.

Summary of Modification

Will allow for standing seam metal roof systems to be install to a minimum 1:12 slope.

Rationale

Many property owners have requested metal panel roof on low-slope roofs. This modification will allow the option for the property owner to install metal roof panels to a minimum 1:12 slope roofs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, it will require the same amount of enforcement.

Impact to building and property owners relative to cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to industry relative to the cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to small business relative to the cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The general public is asking for this option. This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Allows for greater options for low slope roofing, while maintaining product standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code, allows optional systems for certain low slope roofs.

TABLE 1515.2
MINIMUM SLOPE

SYSTEM TYPE	SLOPE
Fibrous Cement Shingles	4:12
Metal Panels	
Architectural	2:12[1]
Metal Shingles	4:12
Mortar or Adhesive Tile	2:12
Mechanically Fastened Tile	4:12
Asphalt Shingles	
Laminated	2:12
3-Tab	2:12
Quarry Slate	3-$^1/_2$:12
Wood	
Shakes	4:12
Shingles	3-$^1/_2$:12

1 Standing seam metal roof panel systems that pass the requirements of the Static Water Leakage Test criteria of FM 4471 Appendix G or ASTM E2140-01, shall be permitted to be installed to a minimum slope of 1:12.

R7438

Date Submitted	11/26/2018	**Section**	1523.6.5.2.4.1	**Proponent**	Gaspar Rodriguez
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7437; 7438; 7439. These three mods need to be considered concurrently.

Summary of Modification

Will allow for standing seam metal roof systems to be install to a minimum 1:12 slope.

Rationale

Many property owners have requested metal panel roof on low-slope roofs. This modification will allow the option for the property owner to install metal roof panels to a minimum 1:12 slope roofs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, it will require the same amount of enforcement.

Impact to building and property owners relative to cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to industry relative to the cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to small business relative to the cost of compliance with code

It is an option that many manufacturers will use to expand their product line.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The general public is asking for this option. This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Allows for greater options for low slope roofing, while maintaining product standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code, allows optional systems for certain low slope roofs.

1523.6.5.2.4.1 All metal roofing shall be tested in compliance with requirements set forth in TAS 110 and TAS 125, and shall be tested for wind-driven rain infiltration resistance in compliance with TAS 100.

1523.6.5.2.4.1.1 Standing seam metal roof panel systems that pass the requirements of the Static Water Leakage Test criteria of FM 4471 Appendix G or ASTM E2140-01, shall be permitted to be installed to a minimum slope of 1:12.

R7580

Date Submitted	11/29/2018	**Section**	1507.1.1	**Proponent**	Michael Silvers (FRSA)
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Residential 905.1.1

Summary of Modification

This modification adds an exception to underlayment attachment that provides for an existing self-adhering membrane to act as a secondary water barrier similar to the 4" wide strip in the current exception.

Rationale

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They usually cannot be removed. A new self-adhering membrane cannot be adhered to an existing membrane. This change provides a clear method to properly incorporate the membrane into the new roof system. It uses a similar approach to one that already is in code. It recognizes that the existing membrane provides similar protection to a 4" strip over the joints in the roof decking.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will not impact enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification will reduce the cost of roof replacement when a self-adhering membrane has been previously applied to the entire roof deck.

Impact to industry relative to the cost of compliance with code

This modification will not add to cost of compliance.

Impact to small business relative to the cost of compliance with code

This modification will not add to cost of compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They cannot be removed. This provides a clear method to properly incorporate the membrane into the new roof system.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They cannot be removed. This provides a clear method to properly incorporate the membrane into the new roof system.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against materials, methods, or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

TABLE 1507.1.1

UNDERLAYMENT TABLE

Underlayment Attachment

3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

Exceptions:

1. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.
2. An existing self-adhering modified bitumen underlayment complying with Underlayment Attachment 3. above has been previously installed over the roof decking and where it is required, re-nailing off the roof sheathing in accordance with 706.7.1 of the Florida Building Code, Existing Building can be confirmed or verified. An approved underlayment in accordance with Table 1507.1.1 for the applicable roof covering shall be applied over the entire roof over the existing self-adhered modified bitumen underlayment.

Date Submitted	12/4/2018	**Section**	1510.11	**Proponent**	Deborah Lawson
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

NONE

Summary of Modification

Creates new code section to provide minimum standards for positioning and securing metal conduit and electrical wiring near a roof assembly.

Rationale

Without guidance from the Florida Building Code it is becoming more and more common for electrical conduit and wiring to be encapsulated and completely hidden within roofing systems. The potential danger to persons and property when re-roofing, attaching roof top structures or performing roofing repairs is substantial and warrants guidance in the placement and installation of electrical conduit and wiring.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local code enforcement entities is anticipated with this proposed code amendment.

Impact to building and property owners relative to cost of compliance with code

The impact to building and property owners will vary for new versus existing construction and existing conditions. The cost to building and property owners up front is offset by a reduction in liability for damage to persons and property from hidden conduit and electrical wiring.

Impact to industry relative to the cost of compliance with code

The impact to industry if this code amendment is adopted would be positive in that it should increase safety and reduce injuries that may be caused by hidden electrical conduit and wiring.

Impact to small business relative to the cost of compliance with code

The impact to small businesses will be the same as the impact to building and property owners if a small business is the property owner. Again, the upfront cost should be offset by a reduction in liability for damage to persons and property caused by hidden conduit and electrical wiring.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed code amendment provides increased safety and a reduction in potential accidents impacting the health, safety and welfare of the general public including increased safety for workers, repair persons, building occupants and owners.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposed code amendment requires safe installation and placement of electrical conduit and wiring, strengthening and improving the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposed code amendment treats all materials, products, methods and systems equally and does not discriminate.

Does not degrade the effectiveness of the code

The proposed code amendment strengthens and does not degrade the code.

1510.11 Metal conduit and electrical wiring.

If metal conduit or electrical wiring needs to be placed near a roof assembly, where possible, the conduit shall be positioned and supported a minimum of 1-1/2 inches from the bottom side of the roof deck or substrate to which the roof system is applied. In no instances shall conduit of any type be run horizontally through any type of roofing insulation to include lightweight insulating concrete or polyisocyanurate.

Hangers or other supports used to attach and support metal or pvc conduit and electrical wiring should be attached to framing or roof deck supports and not the roof deck or substrate. Where it is not possible to place metal or pvc conduit or electrical wiring on the bottom side of a roof deck or substrate, the metal or pvc conduit or electrical wiring may not be hidden or encapsulated within the roofing system and must be visible, easily locatable and properly supported above the roofing system.

Roofing and electrical conduit

The electrical code provides some guidelines regarding conduit placement

by Mark S. Graham

During roof system removal operations or when mechanically attaching rigid board insulation or membranes, roofing professionals sometimes find electrical conduit embedded within roof systems or placed directly below roof decks. In many instances, the presence of electrical conduit is unforeseen, problematic and potentially dangerous.

However, the electrical code provides some guidance regarding electrical cables, raceways and boxes placed in or under roof decks.

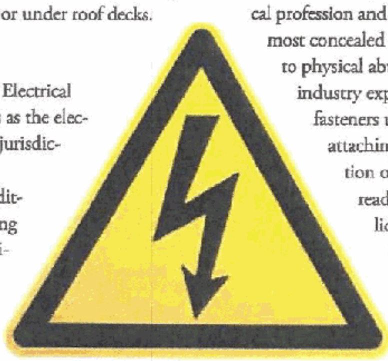
Electrical code

NFPA 70: National Electrical Code® (NEC) serves as the electrical code for most jurisdictions in the U.S.

In NEC's 2011 edition, Chapter 3-Wiring Methods and Materials provides placement and methods for wiring. Section 300.4-Protection Against Physical Damage includes the following statement specific to wiring installed in or under roof decks: "**(E) Cables, Raceways, or Boxes Installed in or Under Roof Decking.** A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (1½ in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable raceway, or box shall not be installed in concealed locations in metal-corrugated, sheet decking-type roof.

"Informational Note: Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and may be penetrated by the screws or other mechanical devices designed to provide 'hold down' strength of the waterproofing membrane or roof insulating material.

"Exception: Rigid metal conduit and intermediate metal conduit shall not be required to comply with 300.4(E)."



Generally, wiring placed in metallic conduit is considered "protected" by the electrical profession and appropriate for use in most concealed spaces and areas subject to physical abuse. However, roofing industry experience has shown fasteners used for mechanically attaching rigid board insulation or membranes can readily penetrate metallic conduit embedded within or directly underneath roof assemblies. By way of comparison, the wall thickness of ½-inch-thick metallic conduit is comparable to the metal thickness of a 20-gauge steel roof deck. Self-cutting or self-drilling roof fasteners can readily penetrate metals of these thicknesses.

Also, cutting and roof system removal operations can damage and penetrate metallic conduit. Another section of the NEC, Section 690.31-Methods Permitted, addresses wiring methods for solar photovoltaic systems: "**(1) Beneath Roofs.** Wiring methods shall not be installed within 25 cm (10 in.) of roof decking or sheathing except where directly below the roof surface covered by PV modules and associated equipment. Circuits shall be run perpendicular to the roof penetration point to supports a minimum of 25 cm. (10 in.) below roof decking.

"Informational Note: the 25 cm (10 in.) requirement is to prevent accidental damage from saws used by fire fighters for roof ventilation during structural fire."

This statement indicates NEC acknowledges the potential for accidentally cutting metallic conduit; however, it does not adequately restrict metallic conduit placement or prevent such accidental cutting during reroofing.

NRCA's recommendations

Electrical conduit embedded within roof systems or placed directly below roof decks can be problematic for roofing professionals. Although the electrical code provides some guidance regarding metallic conduit placement within or directly underneath roof systems, experience has shown these requirements are not adequate to address roofing industry concerns.

NRCA does not recommend metallic conduit or wiring be embedded within roof assemblies or placed directly below roof decks. If metallic conduit or wiring needs to be placed near the roof assembly, NRCA recommends it be positioned and supported at least 1½ inches from the bottom side of the roof deck or substrate to which the roof system is applied. Also, hangers or other supports used to attach and support metallic conduit and wiring should be attached to framing or roof deck supports, not the roof deck or roof substrate.

MARK S. GRAHAM is NRCA's associate executive director of technical services.

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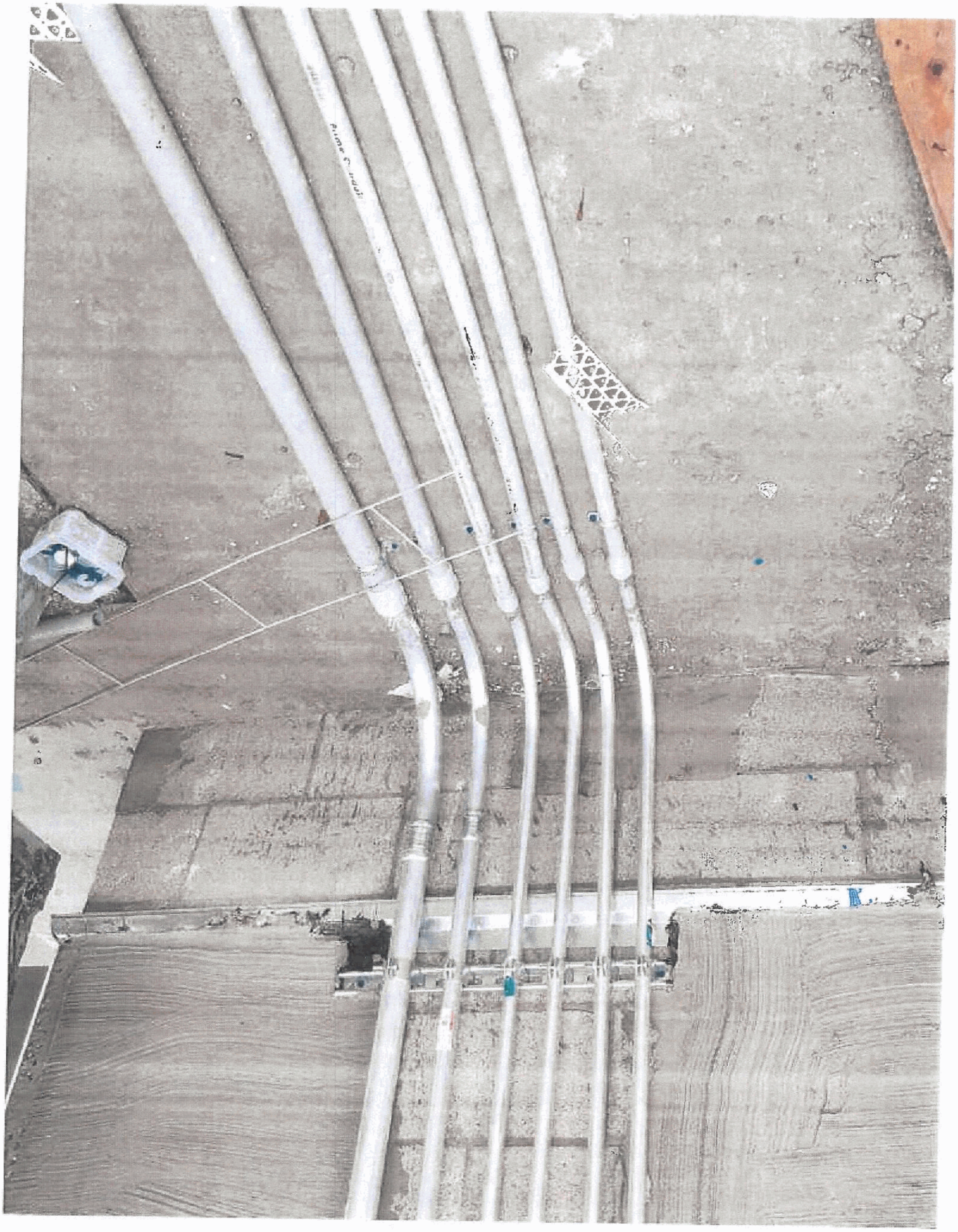

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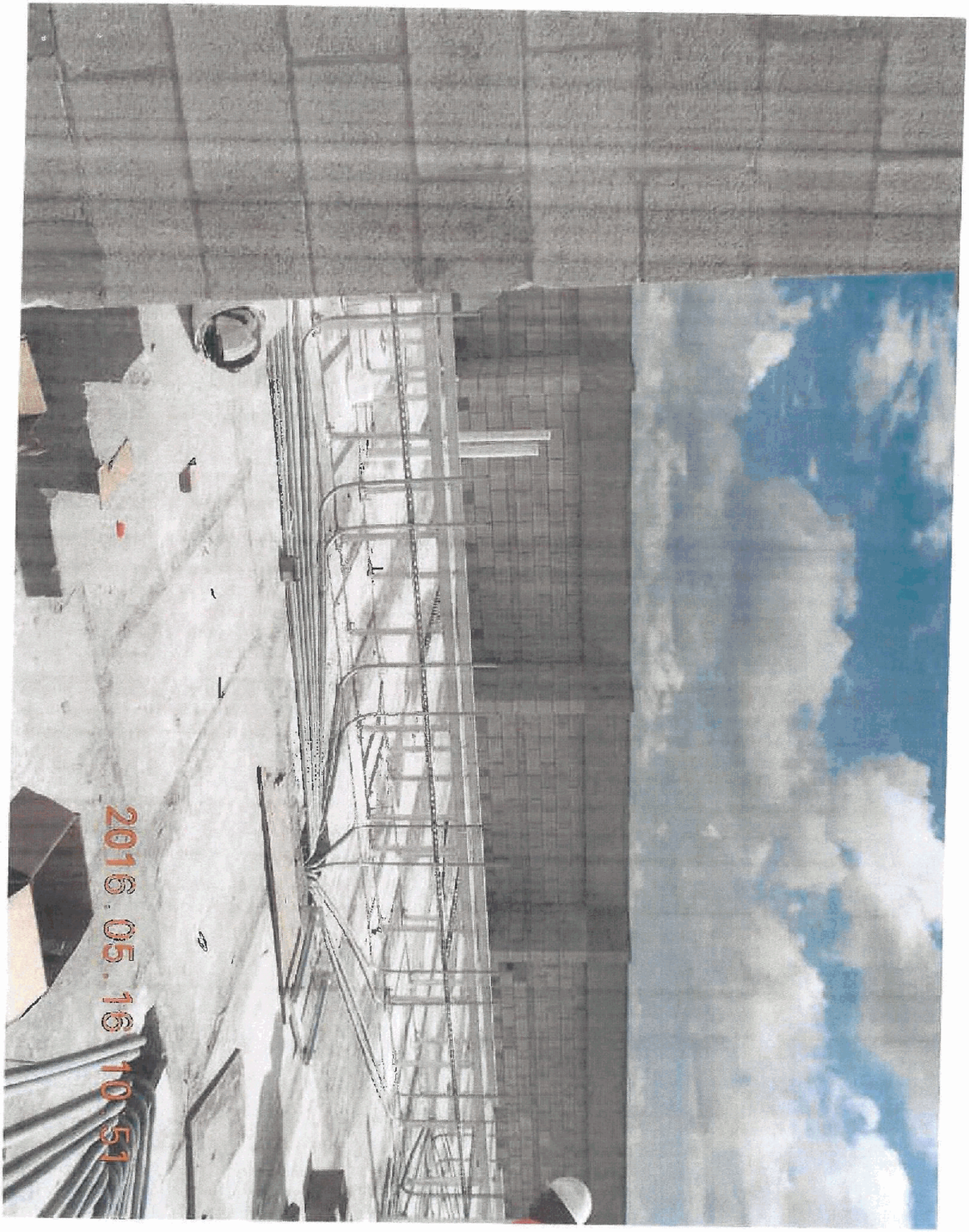

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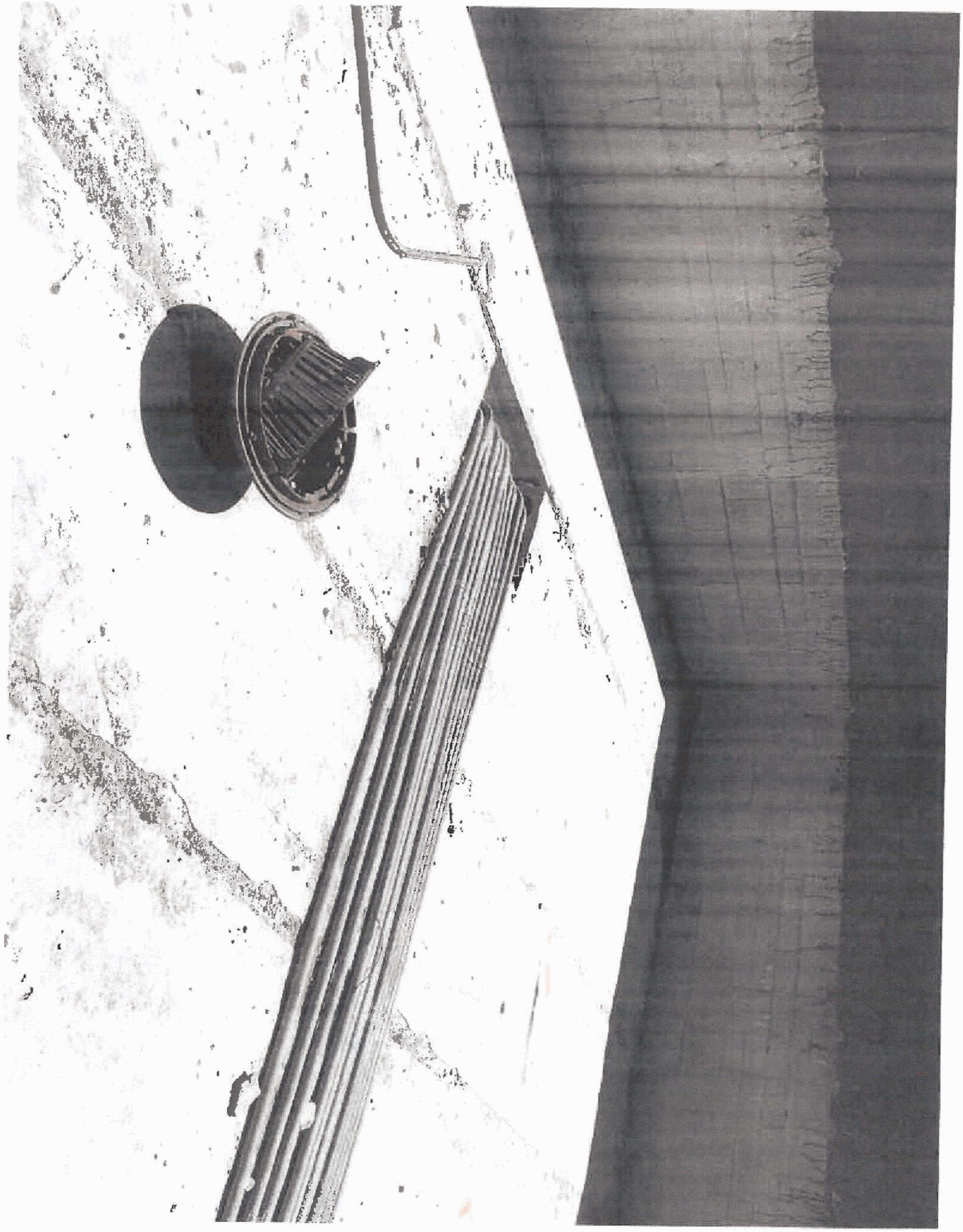

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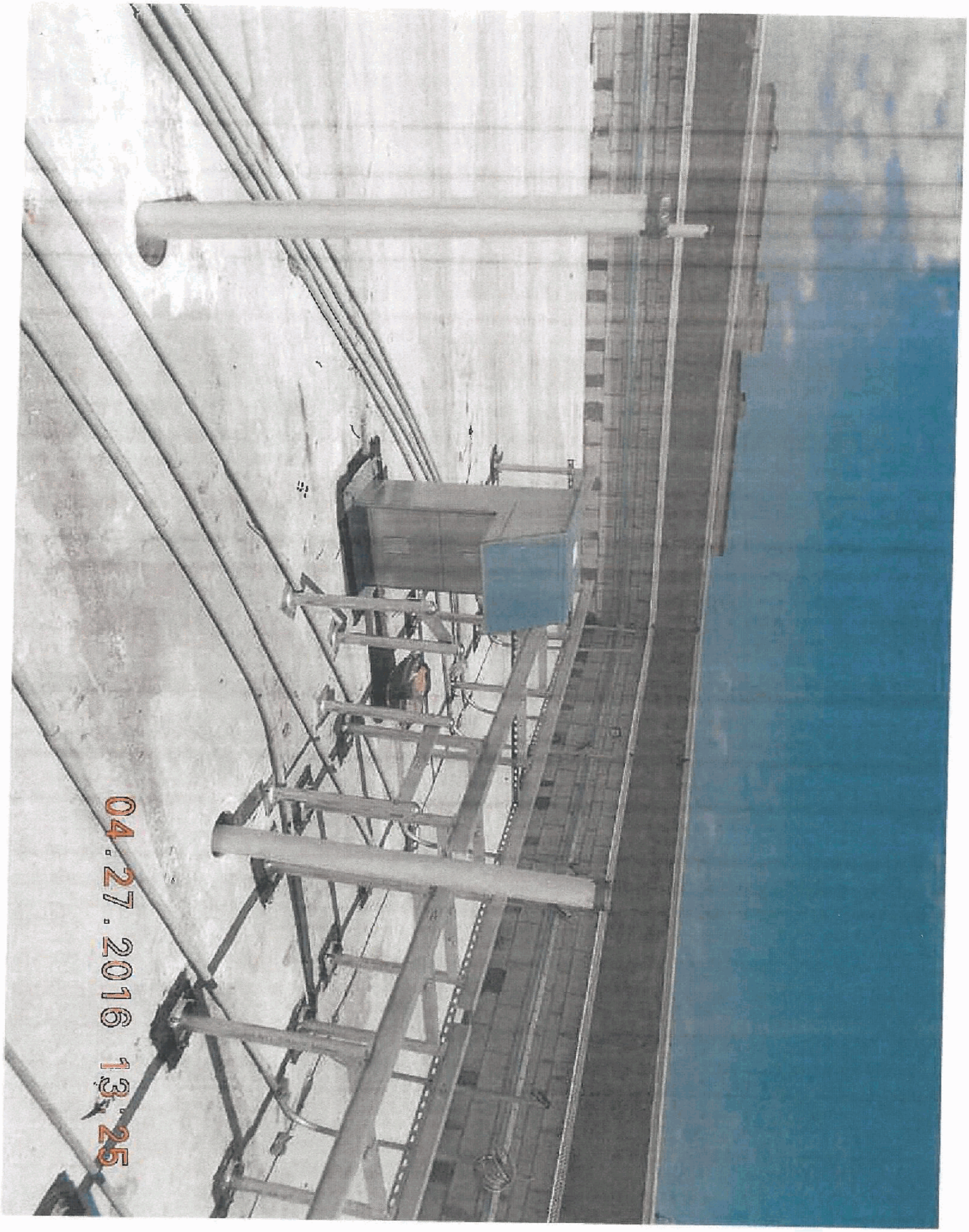

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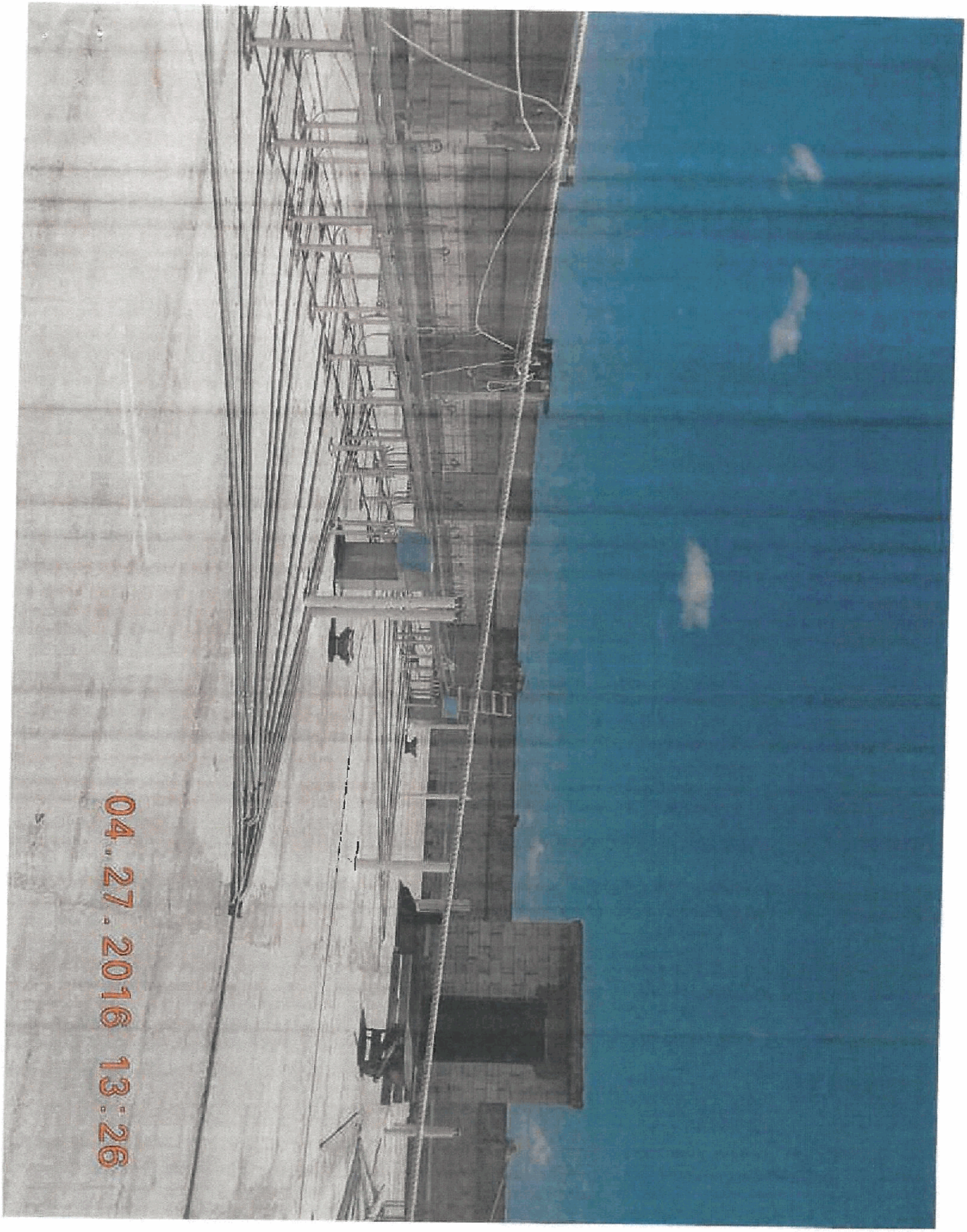

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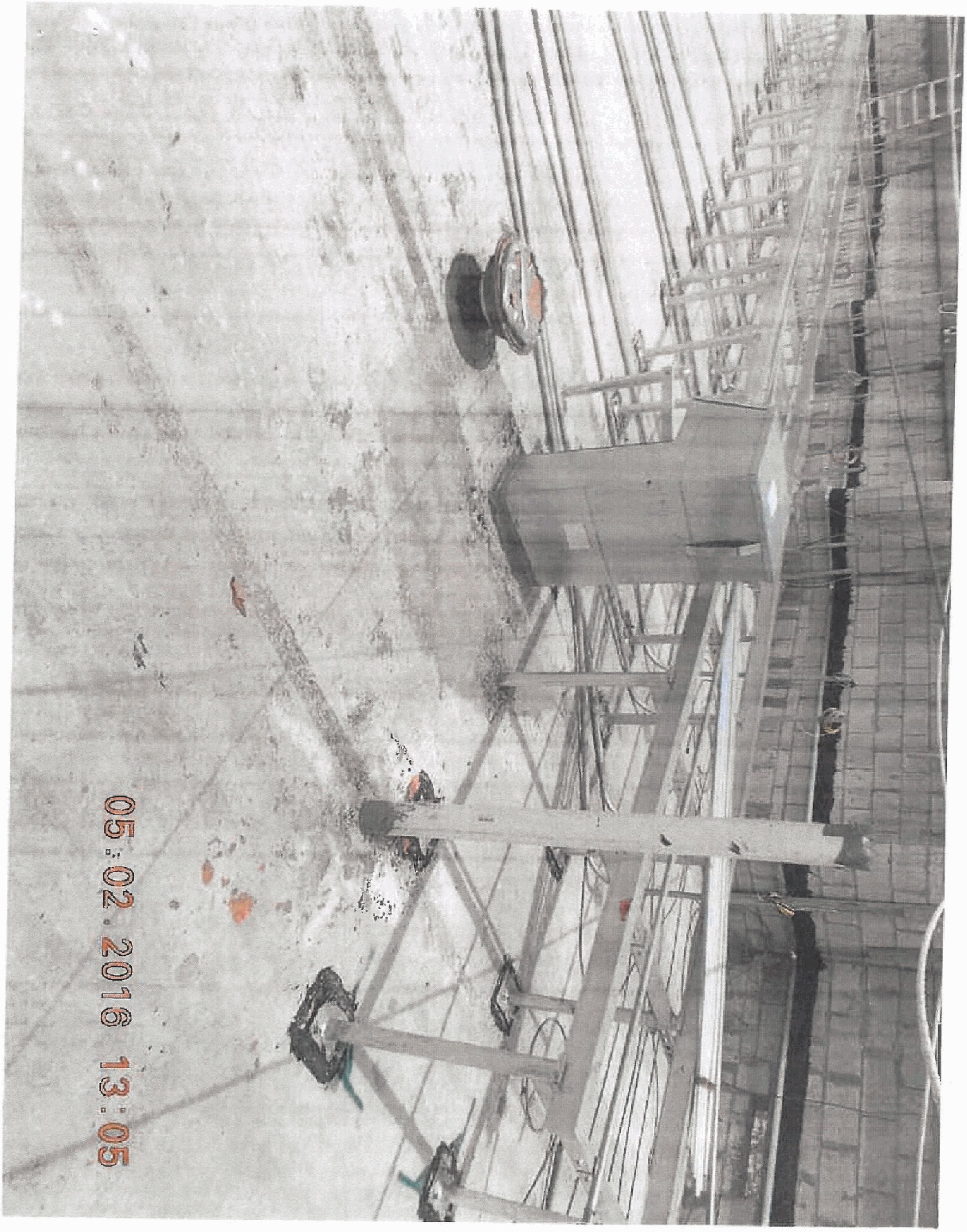

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R7696

Date Submitted 12/5/2018
Chapter 15
Section 1507.1.1
Affects HVHZ No
Proponent T Stafford
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No
Alternate Language No

Related Modifications

Summary of Modification

This proposal will require a sealed roof deck consistent with the IBHS Fortified Bronze designation.

Rationale

This proposal will require sealing of the the roof deck that is consistent with the IBHS Fortified Home Bronze designation. See uploaded support file for the rationale and justification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal will slightly increase cost. For roof slopes 4:12 and greater, the cost increase for a typical 2000 square foot roof will be approximately $220. For roof slopes less than 4:12, the cost increase for a typical 2000 square foot roof will be approximately $440.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal will reduce the amount of water infiltration through the roof deck when roof coverings are lost due to a wind event.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by requiring a sealed roof deck to reduce the amount of water infiltration through the roof deck when roof coverings are lost due to a wind event.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

1507.1.1 Underlayment. ~~Unless otherwise noted u~~Underlayment ~~for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels~~ shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a label indicating compliance to the standard designation and, if applicable, type classification indicated ~~in Table 1507.1.1~~. Underlayment shall be applied and attached in accordance with Section 1507.1.1.1, 1507.1.1.2, or 1507.1.1.3 as applicable ~~Table 1507.1.1~~.

1507.1.1.1 Underlayment for asphalt, metal, mineral surfaced, slate and slate-type roof coverings. Underlayment for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels shall comply with one of the following methods:

1. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

2. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

> **Exception:** A reinforced synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength of 15 lbf in accordance with ~~ASTM D1970 or~~ ASTM D4533 ~~of 20 pounds~~ and a minimum tensile strength of 20 lbf/inch in accordance with ASTM D5035 shall be permitted to be applied over the entire roof over the 4-inch wide (102 mm) membrane strips. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table 1507.1.1.1 for the applicable roof covering and slope~~, except metal cap nails shall be required where the ultimate design wind speed, V_{ult}, equals or exceeds 150 mph~~.

3. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C)), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

> **Exception:** A reinforced synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength of 15 lbf in accordance with ASTM D4533 and a minimum tensile strength of 20 lbf/inch in accordance with ASTM D5035 shall be permitted to be applied over the entire roof over the 4-inch wide (102 mm) membrane strips. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table 1507.1.1.1 for the applicable roof covering and slope.

4. Two layers of ASTM D226 Type II or ASTM D4869 Type III or Type IV underlayment shall be installed as follows: Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.

> **Exception:** Compliance with Section 1507.1.1.1 is not required for structural metal panels that do not require a substrate or underlayment.

TABLE 1507.1.1.1

UNDERLAYMENT WITH SELF-ADHERING STRIPS OVER ROOF DECKING JOINTS

Roof Covering	Underlayment Type	Underlayment Attachment	
		2:12 = Roof Slope < 4:12	Roof Slope > 4:12
Asphalt Shingles, Metal Roof Panels, Photovoltaic Shingles	ASTM D226 Type II ASTM D4869 Type III or IV ASTM D 6757	Apply in accordance with Section 1507.1.1.1 Item 4 or Section 1507.1.1.3 Item 3 as applicable to the type of roof covering.	Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
Metal Roof Shingles, Mineral-Surface Roll Roofing, Slate and Slate-type Shingles, Wood Shingles, Wood Shakes	ASTM D226 Type II ASTM D4869 Type III or IV		

~~TABLE 1507.1.1~~

~~UNDERLAYMENT TABLE~~

~~Roof Covering Section~~	~~Roof Slope 2:12 and Less Than 4:12 Underlayment~~	~~Underlayment Attachment[a]~~	~~Roof Slope 4:12 and Greater Underlayment~~	~~Underlayment Attachment[a]~~
~~Asphalt shingles 1507.2~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~ ~~ASTM D6757~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type III or IV~~ ~~ASTM D 6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D 1970~~	~~3~~
~~Concrete and Clay Tile 1507.3~~	~~See Section 1507.3.3~~			
~~Metal roof panels 1507.4~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~ ~~ASTM D6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~
~~Metal roof shingles 1507.5~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~ ~~ASTM D6757~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~	~~2~~

	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~
~~**Mineral-surfaced roll roofing 1507.6**~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTMD 1970~~	~~3~~
~~**Slate shingles 1507.7**~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~
~~**Wood shingles 1507.8**~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
~~**Wood shakes 1507.9**~~	~~Limited to roof slopes 4:12 and Greater~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~	
~~**Photovoltaic Shingles 1507.17**~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV ASTM D6757~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV ASTM D6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~

[a]~~Underlayment Attachment~~

~~1. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and less than four units vertical in 12 units horizontal (33-percent slope). Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.~~

~~2. Roof slopes of four units vertical in 12 units horizontal (33-percent slope) or greater. Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.~~

~~3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope) and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970(2015a) installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.~~

~~**Exception:** A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970(2015a), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.~~

<u>**1507.1.1.2 Underlayment for concrete and clay tile.** Underlayment for concrete and clay tile shall comply with one of the following methods:</u>

<u>1. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.</u>

2. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Section 1507.3.3 shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

3. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Section 1507.3.3 shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

Exception: Compliance with Section 1507.1.1.2 is not required where a fully adhered underlayment is applied in accordance with Section 1507.3.3.

1507.1.1.3 Underlayment for wood shakes and shingles. Underlayment for wood shakes and shingles shall comply with one of the following methods:

1. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

2. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C)), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Table 1507.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

3. Two layers of ASTM D226 Type II or ASTM D4869 Type III or Type IV underlayment shall be installed as follows: Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.

Insurance Institute for Business & Home Safety

Where building science leads to real-world solutions.

Hurricane Demonstration Testing

Insights on Wind-Driven Water Entry

The Insurance Institute for Business & Home Safety (IBHS) Research Center 2011 hurricane season demonstration test offered an opportunity to gain insight into roof and ventilation system wind-driven water entry issues.

This unique, full-scale study of how wind-driven water penetrates openings in residential roof systems was modeled on real world, post-event damage assessments in areas where hurricane winds were strong enough to rip off roof cover, but not strong enough to blow off roof sheathing. In such instances, significant property damage and extended occupant displacement routinely occur due to water intrusion. In addition to wind-driven water pouring in – or being blown through – cracks between roof sheathing elements when primary roof cover is damaged and the underlayment is lost, water intrusion through residential roofs can originate from attic ventilation elements (e.g., ridge vents, gable end vents, and soffit vents).

Such damage is particularly common in inland areas, where hurricane-strength winds occur, but building codes and standards are not as stringent as in coastal jurisdictions. For example, when 2005's Hurricane Wilma crossed the southern tip of Florida as a Category 2 hurricane with peak wind speed gusts of about 110 mph, she caused more than $10 billion of damage, most of which related to roof damage and resulting water intrusion. Much of this damage occurred far inland. Other hurricanes have caused catastrophic damage as they moved well inland. For example, after Hurricane Ike made landfall in Texas, it remained strong for two days, creating Category 1 hurricane force winds as far away as Ohio (and causing more than $1.5 billion of losses there).

Water penetration can cause extensive damage to interior finishes, furnishings and other contents, and can lead to ceiling collapse when insulation is saturated. Also, where power is lost and/or a house cannot otherwise be quickly dried out, mold growth is common. IBHS believes that the tremendous human and financial costs associated with water penetration during hurricanes could be substantially reduced through widespread adoption of relatively simple, inexpensive changes to residential roofing systems, such as sealing the roof deck (which only costs about $500 for an average-sized home).

Objectives for IBHS' first wind-driven water research program included:

- quantifying the relative volume of water penetration through different roof openings;
- cataloguing types of water penetration damage to different parts of a house;
- demonstrating effective individual damage mitigation techniques, such as sealing the roof deck; and,
- illustrating why sealed roof decks are core components of the IBHS FORTIFIED for Existing Homes™ and FORTIFIED for Safer Living® program requirements for hurricane-prone regions.

The building specimen designed and constructed for the demonstration was a duplex, where sheathing joints on one half of the roof deck were sealed prior to installing roofing materials and the other half was not sealed. Both halves of the roof were then covered with simple felt paper underlayment prior to installing the asphalt shingles. The building included gable ends fitted with gable end vents and one foot wide soffits at the eaves. The roof sheathing stopped short along the primary ridge so it was possible to install a ridge vent during one set of tests.

All of these features have been addressed in the IBHS FORTIFIED Existing Homes™ bronze designation, which incorporates current best practices in a systems based approach to reducing water entry related losses in high wind events. These recommendations are also incorporated in the IBHS Roofing the Right Way guide.

Figure 1 -Test duplex moving into the large test chamber at the IBHS Research Center.

The basic recommendations in the IBHS FORTIFIED Existing Homes ™ bronze brochure and the IBHS Roofing the Right Way guide related to preventing or reducing wind-driven water entry include:

1. Sealing the roof deck (joints or the entire surface) to prevent water from running into the attic through the gaps between the roof sheathing panels.

2. Ensuring that soffit panels (the flat panels installed between the bottom of the eaves at the roof edge and the wall of the house) are well attached to the house so they do not blow off in high winds, thereby creating an opening through which wind-driven water could enter the attic.

3. Covering gable end vents with flat shutter panels (plywood or some other flat material) when a hurricane threatens, to keep water from being blown into the attic.

4. Ensuring that ridge vents are products that have been tested and approved for resisting wind driven water entry and that they are adequately attached using the manufacturer's recommendations for high wind installations.

The 2011 hurricane demonstration test gave IBHS its first opportunity to illustrate the relative success and importance of taking these steps to reduce the potential for water entry using high-definition photos and videos of the consequences of water entry into attic spaces during the demonstration testing. Quantitative measurements of water entry were obtained by researchers opportunistically during this demonstration testing to provide preliminary measurements and insight into the quantity of water entering into an attic through vents and between sheathing joints.

Establishing Wind-Driven Rain Capabilities

Planning and research leading to the development of wind-driven rain capabilities at the IBHS Research Center have been ongoing for several years. IBHS provided support to the University of Florida (UF) to assist with deployment of a research disdrometer (an instrument that quantifies droplet size and rain fall rates, shown in Figure 2 on page 3) in Hurricane Ike.

IBHS followed up with partial support for a Ph.D. student to analyze rain droplet size distribution based on Hurricane Ike data, and then to use the UF wind simulator to select a commercially available spray nozzle to produce a similar distribution of rain droplet sizes in the IBHS Research Center test chamber. Thus, a realistic distribution of droplet sizes is required to achieve the same wetting patterns on buildings that occur during real world storms.

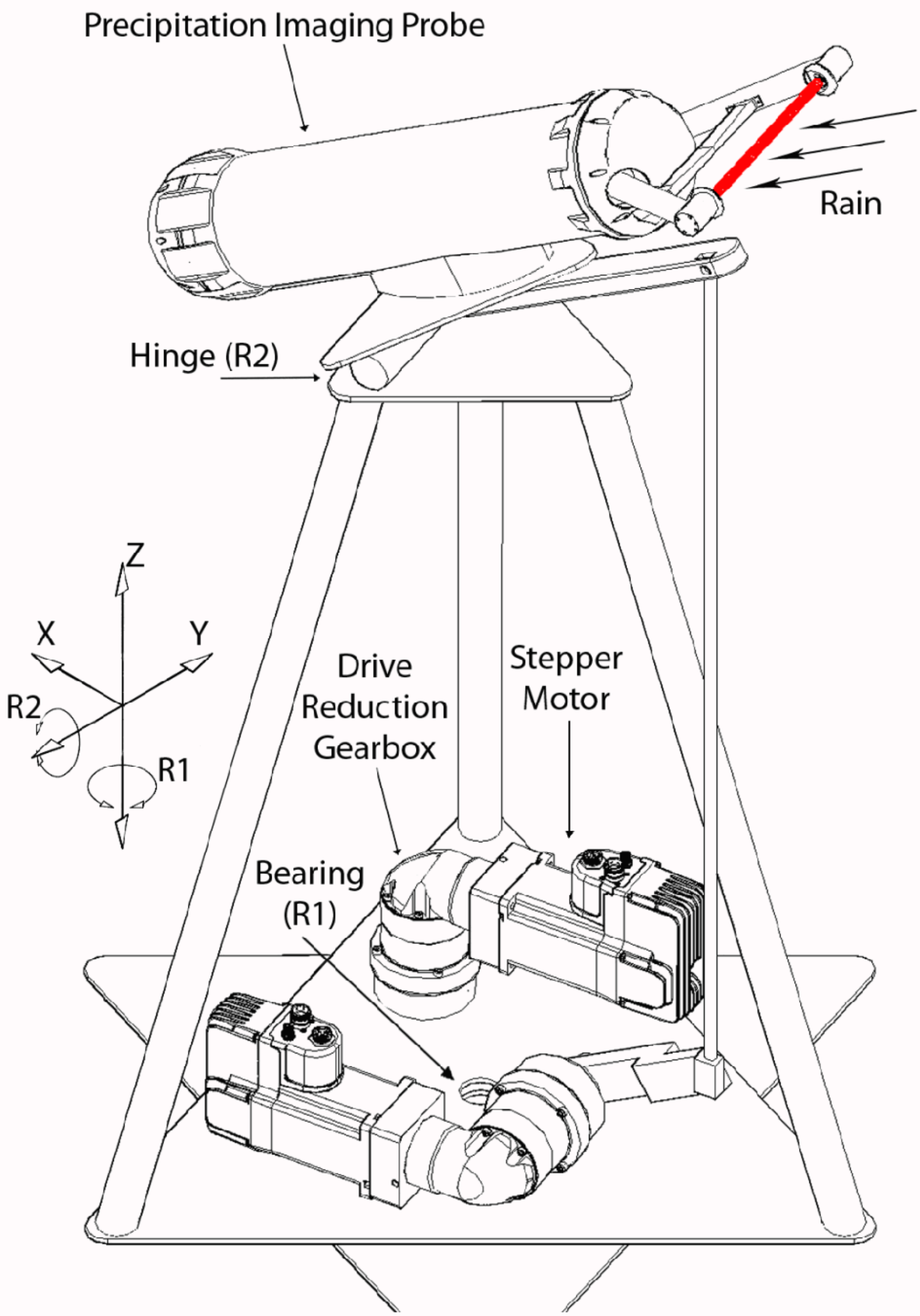

Figure 2 - Precipitation Imaging Probe (PIP) style disdrometer mounted on Florida Coastal Monitoring Program (FCMP) portable weather station for Hurricane Ike data collection by University of Florida.

This summer, the student brought the research disdrometer to the IBHS lab to conduct tests of the completed system. The validation tests demonstrated that target rain deposition rates (8 inches per hour in American Society of Testing and Materials and Florida Building Code test standards) and droplet size distributions were properly reproduced. NOTE: A Ph.D. dissertation is being written on this research and should be completed by the end of 2011.

Measuring Water Entry Rates

When the duplex was completed, including installation of wall board and ceiling drywall, drainage panels and tracks (DrySpaceTM) were installed to create water collection channels between the ceiling trusses, as shown in Figure 3. These channels were outfitted with drains and pipes that allowed collected water to be captured in plastic containers arranged throughout the interior (non-attic) space in the two halves of the duplex. The drainage system was installed in a modular system that allowed the collection of water in ceiling areas roughly 10 feet long by 2 feet wide. The trusses ran from front to back of the house and the 22½ inch space between the trusses was divided into three sections, each about 10 feet long. Each drainage channel directed water to a separate numbered plastic container. Typical drain and collection locations are shown in Figure 4, Figure 5, and Figure 6 (shown on page 6). Tests were typically conducted for a 20-minute period, during which a constant wind speed was maintained and rainfall rate was set to produce 8 inches per hour on the test building (i.e., horizontally driven rain). At the completion of each test, water in the buckets was measured and quantity was recorded.

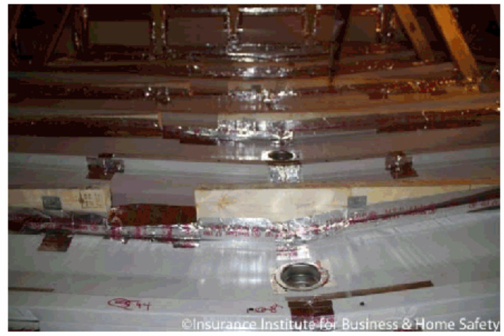

Figure 3 - Photograph of water collection channels between ceiling trusses in duplex.

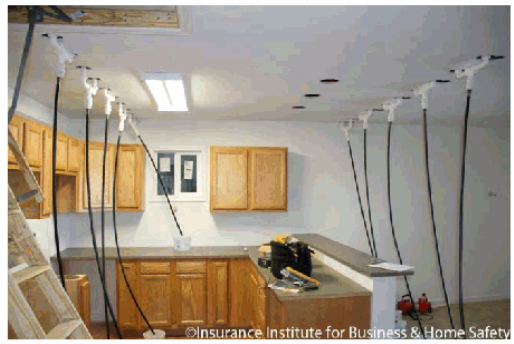

Figure 4 - Photograph of water collection drains to collection buckets in the duplex.

Figure 5 - Photograph of water collection drains to collection buckets in the duplex.

Figure 6 - Photograph of water collection drains to collection buckets in the duplex.

Quantitative Test Program Summary

A series of quantitative tests was conducted during the time available before the scheduled hurricane demonstration. The first test sequence involved measuring water entry rates when the soffit cover was missing along the entire length of the back eave of the duplex. The opening of approximately 8.5 sq. ft. under the eave of the roof where wind and wind-driven rain could enter the attic caused by the missing soffit is typical of the observed loss of the soffit cover in strong winds. Tests were conducted for wind speeds of 30 mph, 50 mph and 70 mph, during which the wall with the open soffit faced the wind flow, as shown in Figure 7. A quartering wind test (i.e., the wall with the open soffit was oriented at 45 degrees off perpendicular to the wind direction) was also conducted with a 50 mph wind speed.

The second test sequence involved repeating soffit tests with a typical perforated vinyl soffit panel intact, thus quantifying differences in water entry for typical soffits that remain undamaged vs. soffit material blown off during an event. For this round of quantification, tests were conducted at 50 mph and 70 mph with the wall with the soffit facing the wind, and at 50 mph for the quartering wind case.

The third test sequence focused on measuring water entry through the gable end vent. These tests were conducted with 30 mph and 50 mph wind-driven rain beating directly against the gable end. During these tests, soffits were covered with typical perforated vinyl soffit panel material.

Figure 7 - Photographs of the water entry quantification testing for the open soffit case with the wall facing the wind flow: top) whole duplex; and bottom) close-up of the open soffit area.

Following the soffit and gable end quantification test series, roof cover on the front of the duplex was blown off using high winds. Similar efforts were started for the roof surface at the back of the duplex, when a fan drive fault ended wind generation for that day. Because of schedule constraints, it was decided to remove roof cover from the back roof surface to expose the sealed and un-sealed roof decks above the same eave where soffit water entry testing was conducted. Removal of roof cover from the front and back surfaces exposed the gap at the top of the primary ridge, so it was fitted with a Florida Building Code High Velocity Hurricane Zone approved ridge vent.

The final sequence of quantification testing included wind speeds of 50 mph with the back of the duplex facing the wind flow. This configuration put the exposed sealed and un-sealed roof decks, shown in Figure 8, perpendicular to the wind-driven rain to allow a relative comparison in the amount of water entry in the attic for each half of the roof.

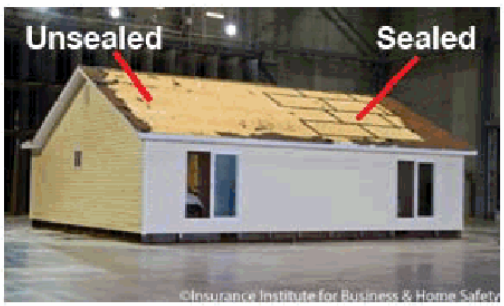

Figure 8 - Photograph of the back of the duplex after shingle and underlayment removal, illustrating the sealed roof deck (on the right) and the un-sealed roof deck (on the left).

Summary of Quantitative Test Results

Open Soffit Tests (simulating loss of soffit material during a high-wind event):

1. A wind speed of 30 mph produced a light sprinkling of drops on the water collection drainage pans within 8 feet of the open soffit. However, no water actually trickled down the drainage system to collection buckets.

2. A wind speed of 50 mph produced an overall water entry rate into the attic of about 1.3 inches per hour based on the open area of the soffit. This is about 15% of the rainfall deposited on the adjacent wall surface (8 inches per hour). Most water was within the first 10 feet of the attic space adjacent to the open soffit.

3. A wind speed of 70 mph produced an overall water entry rate into the attic of about 2.9 inches per hour based on the open area of the soffit. This is a little more than 33% of the deposition rate on the adjacent wall surface.

4. A quartering wind of 50 mph produced an uneven distribution of water in the attic, but still resulted in about 1.6 inches per hour based on the open area of the soffit. This is about 20% of the deposition rate on a wall surface that would have been facing the wind flow.

Covered Soffit Tests (where soffit material remains in place):

- A wind speed of 50 mph resulted in water accumulation in the attic space of approximately 6% of the amount of water that entered during the same test for the open soffit case.
- A wind of 70 mph produced about 9 times more water accumulation in the attic than the 50 mph test. This was about 25% of the amount of water that entered the attic during the same test (70 mph) for the open soffit case.
- A quartering wind of 50 mph produced very little accumulation of water in the attic. The amount was about 2.5% of the water entering during the same test for the open soffit case.

Gable End Vent Tests:

For winds of 30 mph and above, the water entry rate was about equal to the wind driven water deposition rate based on the area of the gable end vent. There was a slight indication of less water entry for higher wind speeds, but that likely was due to missed water that was blown farther into the attic and collected in the area around the access stairs where no collection pans were in place.

Exposed Roof Sheathing Tests:

The sealed roof deck side (where joints between the roof sheathing were sealed by applying a self adhesive modified bitumen tape) experienced about one-third of the water entry experienced by the side without tape. The amount of water entry through the roof deck was unprecedented in relation to tests conducted for soffit and gable end vents. The roof deck test actually had to be stopped at 16 minutes in duration, because the 3-gallon containers collecting water from each 10 foot by 2 foot collection area were overflowing. Some water entry on the sealed roof side was due to cuts in the tape that occurred when roof cover was removed. Even holes left by nails that pulled out when roof cover was removed led to steady drips of water into the attic. On the side where roof cover was blown off (shown in Figure 9), nails tended to stay in place, which would have reduced nail hole drips. Use of ring shank nails to fasten shingles and underlayment would likely help reduce these leaks, because they will be less likely to pull out, even if roof shingles are blown off. There was no sign of leaks through the Florida Building Code High Velocity Hurricane Zone approved ridge vent.

Consequences of Water Entry

Following quantitative testing, water collection devices were removed from the structure and the required drainage holes in the ceiling were patched. Furniture was placed in the duplex to model actual living spaces. The finished structure was then subjected to a series of wind-driven rain events modeled after Hurricane Dolly. These tests gave IBHS the opportunity to illustrate the consequences of water entry into attic spaces with compelling photos and video. Figure 10 shows photographs taken on the un-sealed roof deck side of the duplex during the demonstration testing, while Figure 11 (shown on page 9) shows a similar view on the sealed roof deck side.

Figure 9 - Photograph of the front of the duplex after shingle and underlayment removal using high winds, illustrating the sealed roof deck (on the left) and the un-sealed roof deck (on the right).

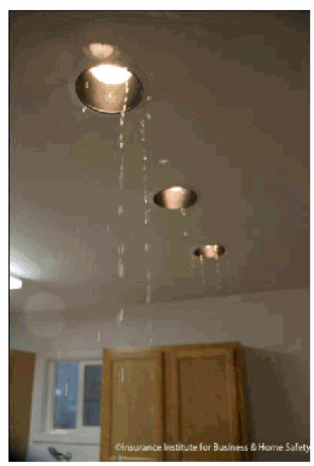

Figure 10 - Photograph of the water entry during the demonstration event on the un-sealed roof deck side of the duplex: close up of the recessed lighting in the kitchen.

Figure 11 - Photograph of the kitchen during the demonstration event on the sealed roof deck side of the duplex.

The amount of water streaming into the living space during the demonstration in the un-sealed roof deck side of the duplex, and the level of damage ultimately experienced on this half of the duplex, is typical of the level of water entry reported during real-world events. Within 45 minutes of the conclusion of testing, the kitchen ceiling in the un-sealed side of the duplex collapsed, as shown in Figure 12 and Figure 13. Shortly thereafter, the living room area ceiling also collapsed, as shown in Figure 14.

Figure 13 - Photograph of fallen portions of collapsed ceiling in the kitchen on the un-sealed roof deck side of the duplex.

Figure 12 - Photograph of collapsed ceiling in the kitchen on the un-sealed roof deck side of the duplex.

Figure 14 - Photograph of fallen portions of collapsed ceiling in the living room on the un-sealed roof deck side of the duplex.

Following the test, IBHS brought in an experienced property insurance claims adjuster to estimate the amount of damage each side of the duplex suffered. He assessed damage to the front three rooms on both sides of the duplex, including the kitchen, dining room, and family room. During a hurricane or high wind event, winds generally come from a relatively small range of directions after roof cover blows off, so damage confined to one area of a house would be typical of most people's experience. The difference between estimated repair costs on the two sides of the duplex was substantial. The loss estimate for the side without a sealed roof deck is more than three times the loss estimate for the side with the sealed roof deck. Of particular note: the furniture in the side without a sealed roof deck required replacement, while furnishings in the side with the sealed roof deck only required cleaning.

Conclusions and Recommendations

These preliminary tests clearly demonstrate that the areas addressed in the IBHS FORTIFIED Existing Homes™ and Roofing the Right Way guidance are important to reducing water entry in hurricanes and other storms where wind-driven rain is a factor. Clearly, sealing the roof deck is one of the most important protective measures that can be undertaken. However, the installer should be careful to make sure that seams are securely sealed and that the drip edge is attached using typical high-wind requirements for fasteners. It is likely that the High Velocity Hurricane Zone requirements for applying roofing cement around edges of the roof would also help reduce water entry if roof cover does suffer damage in a storm.

As a preliminary study, this work suggests that much more investigation is needed to quantify the amount of water entry that can be expected for normal construction, how much water entry is likely to be reduced with various water entry prevention measures, and how much water entry can be tolerated before costs of water entry remediation increase significantly.

Reason: This proposal will require sealing of the the roof deck that is consistent with the *IBHS Fortified Home Bronze* designation. When the primary roof covering is lost due to a wind event, water infiltration can cause extensive damage to interior finishes, furnishings and other contents, and can lead to ceiling collapse when insulation is saturated. Also, where power is lost and/or a building cannot otherwise be quickly dried out, mold growth is common.

While observations from recent hurricanes indicate buildings built to the Florida Building Code (FBC) are performing better than older buildings, significant roof covering loss is still occurring. Many of these buildings, while relatively undamaged structurally, experienced significant and costly damage to interior components due the loss of the primary roof covering. A sealed roof deck can significantly reduce the amount of water infiltration when the primary roof covering is lost. A demonstration test by IBHS on building with portion of the roof sealed and another portion unsealed showed significant reductions in water infiltration in the areas where the roof deck was sealed. (See attached support file Hurricane_Test_Wind_Driven_Water_Report.)

While underlayment requirements in the FBC have been strengthened recently, this proposal, if approved, will take them one step further to comply with the *IBHS Fortified Home Bronze* designation. From a practical standpoint, only two changes are proposed to the current underlayment requirements in the 6th Edition (2017) FBC. First, where felt underlayments are used without membrane/flashing strips applied over the joints in the roof deck, two layers would now be required. The lap requirements currently required for low slope roofs would be required for all slopes. Fasteners for felt underlayment are required to be annular ring or deformed shank fasteners. The number of fasteners and spacing of fasteners is consistent with current requirements.

The options for using adhered underlayments are unchanged from the 6th Edition (2017) FBC.

The requirements for synthetic underlayments have been revised to be consistent with the new standard for synthetic underlayments that is near completion and expected to be published in 2019.

Preliminary observations from Hurricane Michael are also indicating that newer buildings built to the FBC are performing better but water infiltration due to roof covering loss is still a problem. This proposal, if approved, will significantly reduce the amount of water infiltration through the roof deck when roof coverings are lost.

R7703

Date Submitted	12/10/2018	**Section**	1505	**Proponent**	Jon Roberts
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Chapter 35

Summary of Modification

The testing for photovoltaic panel systems are covered in both UL 1703 and UL 2703. This proposal adds two new UL standards to this section, UL 1703 and 2703, which are ANSI consensus standards. These standard provide the test method for testing panels and mounting systems.

Rationale

UL 1703 includes partial fire testing of the photovoltaic panel, which is one of the components of the photovoltaic panel system. UL 2703 uses the results of that component testing, and includes further evaluation and testing of the photovoltaic panel system (i.e. the photovoltaic panel and the rack support system) to establish the Fire Classification for the system. UL 1703 is referenced within UL 2703.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Fire classification of these systems are determined in accordance with UL 2703 currently so there is no significant impact on enforcement.

Impact to building and property owners relative to cost of compliance with code

Fire classification of these systems are determined in accordance with UL 2703 currently so there is no cost impact for compliance.

Impact to industry relative to the cost of compliance with code

Fire classification of these systems are determined in accordance with UL 2703 currently so there is no cost impact for compliance.

Impact to small business relative to the cost of compliance with code

Fire classification of these systems are determined in accordance with UL 2703 currently so there is no cost impact for compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Fire classification of these systems are determined in accordance with UL 2703 currently and adding this to the code will ensure a greater level of safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Since fire classification of these systems are determined in accordance with UL 2703 currently adding this to the code will improve the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This uses current practices and does not discriminate against other methods.

Does not degrade the effectiveness of the code

This improves the code it does not degrade it.

1505.9 ~~Photovoltaic panels and modules.~~ Rooftop mounted photovoltaic panel systems.

Rooftopmounted *photovoltaic panel systems* shall be tested, *listed* and identified with a fire classification in accordance with UL 1703 or UL2073. The fire classification shall comply with Table 1505.1 based on the type of construction of the building.

Chapter 35

Add new standard(s) as follows:

UL 2703-14, Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with FlatPlate Photovoltaic Modules and Panel

R7830

Date Submitted	12/10/2018	**Section**	1504	**Proponent**	Michael Silvers (FRSA)
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Changes to 1502, 1609.5 and Chapter 35 are included in this modification.

Summary of Modification

This modification moves ASCE 7 as it applies to roof coverings from Chapter 16 to Chapter 15

Rationale

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems by moving applicable portions of Chapter 16 to Chapter 15.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will help with enforcement by maintaining the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Impact to building and property owners relative to cost of compliance with code

This modification will not increase cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Impact to industry relative to the cost of compliance with code

This modification will not increase the cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems. It will reduce the cost of training and implementing the extremely complex provisions of ASCE 7-16 for roof coverings.

Impact to small business relative to the cost of compliance with code

Will not increase cost of compliance. It maintains the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems. It will reduce the cost of complying with the complex and burdensome provisions of ASCE 7-16 as it applies to roof coverings.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification provides equivalence by maintaining the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against materials, methods, or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. It remains effective by maintaining the codes familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems.

CHAPTER 15 ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

SECTION1502
DEFINITIONS AND NOTATIONS

NOTATIONS

V_{asd}
= Nominal design wind speed (3-second gust), miles per hour (mph) (km/hr) where applicable.

V_{ult}
= Ultimate design wind speeds (3-second gust), miles per hour (mph) (km/hr) determined from Figure 16509.3(1), 16509.3(2), 16509.3(3) or ASCE 7.

SECTION 1504
PERFORMANCE REQUIREMENTS

1504.1 Wind resistance of roofs.

Roof ~~decks and roof~~ coverings shall be designed for wind loads in accordance with Chapter 15 Sections 1504.1, 1504.2, 1504.3 and 1504.4.

1504.1.1 Wind resistance of asphalt shingles.

Asphalt shingles shall be designed for wind speeds in accordance with Section 1507.2.7.

1504.2 Wind resistance of clay and concrete tile.

Wind loads on clay and concrete tile roof coverings shall be in accordance with –Section ~~1609.5~~.

(Equation 15-34)

For SI:

where:

b = Exposed width, feet (mm) of the roof tile.

C_L = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1504.2.1.

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

L = Length, feet (mm) of the roof tile.

L_a = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width. For roof tiles with nails

or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

M_a = Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.

q_h = Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be ~~either loose laid on battens~~, mechanically fastened, mortar set or adhesive set.

The roof tiles shall be installed on solid sheathing that has been designed as components and cladding.

3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.

1504.2.1 Testing.

Testing of concrete and clay roof tiles shall be in accordance with Sections 1504.2.1.1 and 1504.2.1.2.

1504.2.1.1 Overturning resistance.

Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with SBCCI SSTD 11 and Chapter 15.

1504.2.1.2 Wind tunnel testing.

Where concrete and clay roof tiles do not satisfy the limitations in 1504.2 ~~Chapter 16~~ for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile roof covering in accordance with SBCCI SSTD 11 and Chapter 15.

1504.3 Wind resistance of nonballasted roofs.

Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for components and cladding in accordance with Section 1504.

1504.3.1 Other roof systems.

Built-up, modified bitumen, fully adhered or mechanically attached single-ply roof systems, metal panel roof systems applied to a solid or closely fitted deck and other types of membrane roof coverings shall be tested in accordance with FM 4474, UL 580 or UL 1897.

1504.3.2 Metal panel roof systems.

Metal panel roof system through fastened or standing seam shall be tested in accordance with UL 580 or ASTM E1592 or TAS 125.

Exceptions: Metal roofs constructed of cold-formed steel, where the roof deck acts as the roof covering and provides both weather protection and support for structural loads, shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2210.1.

1504.4 Ballasted low-slope roof systems.

Ballasted low-slope (roof slope < 2:12) single-ply roof system coverings installed in accordance with Sections 1507.12 and 1507.13 shall be designed in accordance with Section 1504.8 and ANSI/SPRI RP-4.

1504.5 Edge securement for low-slope roofs.

Low-slope built-up, modified bitumen and single-ply roof system metal edge securement, except gutters, shall be designed and installed for wind loads in accordance with Chapter 15 ~~16~~ and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, or RAS 111 except V_{ult} wind speed shall be determined from Figure Wind Maps in Chapter 15 1504.6(1), 1504.6 (2) or 1504.6 (3) as applicable.

1504.6 Wind Load Applications.

Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

1504.6.1 Determination of wind loads.

Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7 or provisions of the alternate all-heights method in Chapter 16. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. 1.Subject to the limitations of Section 1504.6.2 the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.
2. 2.Subject to the limitations of Section 1504.6.2 residential structures using the provisions of AWC WFCM.
3. 3.Subject to the limitations of Section 1504.6.2 residential structures using the provisions of AISI S230.
4. 4.Designs using NAAMM FP 1001.
5. Wind tunnel tests in accordance with ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.
6. 8.Exposed mechanical equipment or appliances fastened to a roof or installed on the ground in compliance with the code using rated stands, platforms, curbs, slabs, walls, or other means are deemed to comply with the wind resistance requirements of the 2007 Florida Building Code, as amended. Further support or enclosure of such mechanical equipment or appliances is not required by a state or local official having authority to enforce the *Florida Building Code*.

The wind speeds in Figures 1504.6(1),1504.6(2), and 1504.6 (3) are ultimate design wind speeds, V_{ult}, and shall be converted in accordance with Section 1609.3.1 to nominal design wind speeds, V_{asd}, when the provisions of the standards referenced in Exceptions 4 and 5 are used.

1504.6.2 Applicability.

The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1504.7. The provisions of ICC 600, AWC WFCM and AISI S230 shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. 1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C;

2. 2. The maximum average slope of the hill exceeds 10 percent; and

3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

1504.6.2 Ultimate design wind speed.

The ultimate design wind speed, V_{ult}, in mph, for the determination of the wind loads shall be determined by Figures 1609.3(1), 1609.3(2) and 1609.3(3). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category II buildings and structures shall be obtained from Figure 1609.3(1). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category III and IV buildings and structures shall be obtained from Figure 1609.3(2). The ultimate design wind speed, V_{ult}, for use in the design of Risk Category I buildings and structures shall be obtained from Figure 1609.3(3). The ultimate design wind speed, V_{ult}, for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The ultimate design wind speeds, V_{ult}, determined by the local jurisdiction shall be in accordance with Section 26.5.1 of ASCE 7. The exact location of wind speed lines shall be established by local ordinance using recognized physical landmarks such as major roads, canals, rivers and lake shores wherever possible.

In nonhurricane-prone regions, when the ultimate design wind speed, V_{ult}, is estimated from regional climatic data, the ultimate design wind speed, V_{ult}, shall be determined in accordance with Section 26.5.3 of ASCE 7.

FIGURE 1504.6(1)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES

FIGURE 1504.6(2)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY III AND IV BUILDINGS AND OTHER STRUCTURES

FIGURE 1504.6(3)

ULTIMATE DESIGN WIND SPEEDS, V_{ULT}, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES

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1504.6.3 Wind speed conversion.

When required, the ultimate design wind speeds of Figures ~~16~~1509.3(1), ~~16~~1509.3(2) and ~~16~~1509.3(3) shall be converted to nominal design wind speeds, V_{asd}, using Table ~~16~~1509.3.1 or Equation 16-33.

(Equation 15-01)

where:

V_{asd} = Nominal design wind speed applicable to methods specified in Exceptions 4 and 5 of Section 1504.6.1

V_{ult} = Ultimate design wind speeds determined from Figures 1504.6.3(1), 1504.6.3(2) or 1504.6.3(3).

TABLE 1504.6.3

WIND SPEED CONVERSIONS [a, b, c]

V_{ult}	100	110	120	130	140	150	160	170	180	190	200
V_{asd}	78	85	93	101	108	116	124	132	139	147	155

For SI: 1 mile per hour = 0.44 m/s.

1. a. Linear interpolation is permitted.
2. b. V_{asd} = nominal design wind speed applicable to method specified in Exceptions 1 through 4

   of Section 1504.6.1
3. c. V_{ult} = ultimate design wind speeds determined from Figure 1609.3(1), 1609.3(2) or 1609.3(3).

1504.6.4 Exposure category.

For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

1504.6.5 Wind directions and sectors.

For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1504.6.6 Surface roughness categories.

A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1504.6.7 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1504.6.7.

1. **Surface Roughness B.** Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

2. **Surface Roughness C.** Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands.
3. **Surface Roughness D.** Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.

1504.6.7 Exposure categories.

An exposure category shall be determined in accordance with the following:

1. **Exposure B.** For buildings with a mean roof height of less than or equal to 30 feet (9144 mm), Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.
2. **Exposure C.** Exposure C shall apply for all cases where Exposure B or D does not apply.
3. **Exposure D.** Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall also apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the building height, whichever is greater, from an Exposure D condition as defined in the previous sentence.

1504.~~6~~7 Physical properties.

Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall demonstrate physical integrity over the working life of the roof based upon 2,000 hours of exposure to accelerated weathering tests conducted in accordance with ASTM G152, ASTM G153, ASTM G154 or ASTM G155. Those roof coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

Remaining numbers to progress. Balance of text unchanged.

CHAPTER 16 STRUCTURAL DESIGN

1609.5 Roof systems.

Roof systems shall be designed and constructed in accordance with ~~Sections~~ Chapter 15 ~~1609.5.1~~ ~~through~~ ~~1609.5.3~~, ~~as applicable~~.

1609.5.1 Roof deck.

The roof deck shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

1609.5.2 Roof coverings.

Roof coverings shall comply with Section 1504. ~~1609.5.1.~~

~~**Exception:** Rigid tile roof coverings that are air permeable and installed over a roof deck complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.~~

Asphalt shingles installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.1.1.

1609.5.3Rigid tile.

Rigid tile installed over a roof deck complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.2

~~Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:~~

~~**(Equation 16-34)**~~

~~**For SI:**~~

~~**where:**~~

~~***b*** **= Exposed width, feet (mm) of the roof tile.**~~

~~C_L **= Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1504.2.1.**~~

~~GC_p **= Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.**~~

~~***L*** **= Length, feet (mm) of the roof tile.**~~

~~L_a **= Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76*L* from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.**~~

~~M_a **= Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.**~~

~~q_h **= Wind velocity pressure, psf (kN/m^2) determined from Section 27.3.2 of ASCE 7.**~~

~~Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.~~

~~The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.~~

~~The roof tiles shall be installed on solid sheathing that has been designed as components and cladding.~~

3. ~~An underlayment shall be installed in accordance with Chapter 15.~~
4. ~~The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).~~

5. ~~The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).~~
6. ~~The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).~~
7. ~~The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).~~
8. ~~Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.~~

Remaining text unchanged.

CHAPTER 35 REFERENCED STANDARDS

ASCE/SEI

American Society of Civil Engineers Structural Engineering Institute 1801 Alexander Bell Drive Reston, VA 20191-4400

Standard reference number	Title	Referenced in code section number

5—13

Building Code Requirements for Masonry Structures

1405.61405.6.11405.6.21405.101604.3.41807.1.6.31807.1.6.3.21808.92101.22105.12106.12107.12107.22107.32107.42107.62108.12108.22108.32108.42109.12109.1.12109.22109.2.12109.32110.12114.22122.12122.42122.52122.72122.8.22122.8.42122.10

6—13

Specification for Masonry Structures1405.6.11807.1.6.32103.12103.2.12103.32103.42104.12105.12107.12108.12121.62122.12122.2.32122.2.32122.42122.7.42122.8.12122.8.22122.8.32122.8.42122.8.62122.8.8

7—<u>10</u>

Minimum Design Loads for Buildings and Other Structures (with Errata dated January 11. 2011)

1504~~.8~~ 1514.4 1525

7—<u>16</u>

MinimumDesignLoadsforBuildingsandOtherStructures202449.4.2.2.6450.4.2.2.6453.4.7453.9.1453.25.4Table~~1504.81514.41525~~1602.11604.3Table 1604.51604.8.21604.101605.11605.2.11605.3.11605.3.1.21605.3.21605.3.2.11607.8.11607.8.1.11607.8.1.21607.8.31607.12.11608.11608.21608.31609.1.11609.1.21609.1.2.4.11609.1.2.4.21609.31609.5.11609.5.31609.61609.6.11609.6.1.11609.6.2Table 1609.6.21609.6.31609.6.4.11609.6.4.21609.6.4.4.11609.81611.21612.41613.11613.3.2Table 1613.3.3(1)Table 1613.3.3(2)1613.3.51613.3.5.11613.3.5.21613.41613.4.11613.5.11613.61614.11616.51620.11620.31620.61621.11621.21622.1.1Table1625.4 1626.1 Table 16261709.8.31803.5.121808.3.11810.3.6.11810.3.9.41810.3.11.21810.3.121905.1.11905.1.21905.1.822 05.2.1.12205.2.1.22205.2.22206.2.12209.12210.22304.6.12404.12505.12505.22506.2.13109.3.1

Remaining text unchanged.

Moving ASCE 7 as it applies roof coverings from Chapter 16 to Chapter 15 Rationale

This modification will maintain the current familiar and proven provisions of ASCE 7-10 as it pertains to roof coverings and roof systems by moving applicable portions of Chapter 16 to Chapter 15.

The increased pressure coefficients and complexities of ASCE 7-16 will have a disproportional effect on Florida. This standard was heavily debated and was passed by a narrow majority by the International Code Council (ICC). It faced strong opposition from jurisdictions throughout the country even though none of these areas will be impacted by the standard to the degree that Florida will. A majority of the Florida Building Commissioners voted to give its adoption further consideration, but the failure to reach a 75% threshold to allow further consideration thwarted this opportunity even though it was widely supported by the roofing industry.

Florida's roofing industry like many other construction disciplines is experiencing severe workforce shortages. Also like many other construction disciplines, much of Florida's required roofing skills are learned by experience in the field (this is in addition to classroom training that is a foundation but not the only knowledge that is needed). As described by engineers and others, ASCE 7-16 is exceptionally complex and implementation calls for more than a minor amount of training and added experience for construction contractors, construction workers and, importantly building code administrators and inspectors.

ASCE 7-10 has proven to be very effective and meaningfully compliant with Florida's strengthening and mitigation needs. A recent report titled "Rating the States" published by the Insurance Institute for Business & Home Safety (IBHS) states that Florida has the highest score of 18 states included in the report. Florida's score is also higher in 2018 than in 2015. Numerous other reports have touted how well buildings built in compliance with our current Florida Building Code – which includes ASCE 7-10 – performed. From our research and review as well as our observations of the ICC hearings on this subject, we are very concerned that the only reason for adopting ASCE 7-16 is change for the sake of change with very little real benefit, but some measurable, tangible and very real detrimental effects on roofing standards and fiscal impacts for building owners

Date Submitted	12/11/2018	**Section**	1505	**Proponent**	Jon Roberts
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Adds guidance by referencing table 501 for building integrated photovoltaic products to ensure that they have the proper fire classification.

Rationale

This assists the code official by providing guidance related to the fire classification of these types of products.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

These products are already in use. This will assist the code official and make enforcement easier.

Impact to building and property owners relative to cost of compliance with code

There is no cost impact related to this as these products are already in use today.

Impact to industry relative to the cost of compliance with code

There is no cost impact related to this as these products are already in use today.

Impact to small business relative to the cost of compliance with code

There is no cost impact related to this as these products are already in use today.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This ensures the proper fire classification of these integrated products and that can increase safety.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This improves the code by putting this information where it can readily be accessed by the code official.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This does not discriminate against other products.

Does not degrade the effectiveness of the code

This does not degrade the code.

1505.8 Building-integrated photovoltaic products.

Building-integrated photovoltaic products **installed as the roof covering shall be tested, *listed* and *labeled* for fire classification in accordance with Section 1505.1.**

R7878

Date Submitted 12/14/2018
Chapter 15
Section 1504
Affects HVHZ No
Proponent Andy Williams
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

New Section for Metal roof shingles that recognizes ASTM D3161 classification based on wind resistance code requirements.

Rationale

The proposal shows "wind resistance of metal roof shingles" as a separate item unlike asphalt shingles (1504.1.1) or other roof systems (1504.3.1) for non-ballasted roofs. Showing compliance with the FBC wind resistance requirements is necessary for proper evaluation.

UL580, UL1897, and FM4474 (used in "Other roof systems" including metal panel systems) are added test options for metal shingles. TAS 107, which directly states appropriateness for metal shingles, is added with ASTM equivalent D3161. UL has provided metal shingle wind classifications for many years and currently has D3161-related listings in the Online Certifications Directory.

D3161, created for asphalt shingles, was expanded in 2013 to include other discontinuous, air permeable, steep slope roofing products. This includes metal shingles (specifically identified in Section 1.3). UL was a proponent of the D3161 scope change showing support of D3161 to demonstrate wind resistance.

The proposal removes problems for metal shingle use by clarifying options to show compliance with the wind resistance code requirements. Included are uplift resistance methods used for many years (UL1897, UL580, FM4474), and accepted methods of fan-induced wind simulations (TAS 107, ASTM D3161) that are used for other discontinuous, air-permeable roof covers (asphalt shingles) and building integrated PV shingles. The fan-induced options provide alternatives for evaluation of air permeable metal shingles in a non-air-permeable manner via uplift resistance methods, which unfairly represents these products.

Table 1504.3.3 is added to establish recognition of metal shingles qualified via D3161. Classifications are equivalent to those for asphalt shingles (Table 1507.2.7.1). Shingles qualified via D3161 must to bear a label to show classification (Table 1504.3.3) - also required for asphalt shingles.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This alternate testing method should not impact the local enforcement entity

Impact to building and property owners relative to cost of compliance with code

This alternate testing method should not impact the property owner

Impact to industry relative to the cost of compliance with code

This alternate testing method will more accurately represent the performance of metal shingles and should eliminate non-representative testing costs.

Impact to small business relative to the cost of compliance with code

This alternate testing method should not impact small business and the cost of compliance

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This alternate testing method should not impact the health, safety, and welfare of the general public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This alternate testing method will provide a realistic indicator of the performance of metal shingles

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This alternate testing method is not specific to any one product type however it does recognize the value of this method of testing to obtain accurate results

Does not degrade the effectiveness of the code

This alternate testing method should not degrade the effectiveness of the code and should make the code parallel to these same criteria that have already been recognized by the IBC.

1504.3.3 Metal roof shingles.

Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with FM 4474, UL 580, UL 1897, ASTM D3161, or TAS 107. Metal roof shingles tested in accordance with ASTM D3161 shall meet the classification requirements of Table 1504.3.3 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table 1504.3.3.

TABLE 1504.3.3

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161

TABLE 1504.3.3

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161

MAXIMUM BASIC WIND SPEED FROM FIGURE 1609A, B, C or ASCE-7	V_{asd}	ASTM D3161
110	85	D or F
116	90	D or F
129	100	D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

R8061

23

Date Submitted	12/13/2018	Section	1507.1.1	Proponent	Greg Keeler
Chapter	15	Affects HVHZ	No	Attachments	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revision of requirements related to synthetic underlayment.

Rationale

ASTM D4533 is the most appropriate tear testing protocol for this category of products, and specifying two different protocols with the same minimum requirement doesn't make sense as the two protocols yield vastly different results. Additionally, testing indicates that synthetic underlayments are more resistant to fastener pull-through than D226 Type II felt. Thus, they should not be held to a more stringent requirement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

1507.1.1 Underlayment. Unless otherwise noted underlayment for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a label indicating compliance to the standard designation and, if applicable, type classification indicated in Table 1507.1.1. Underlayment shall be applied and attached in accordance with Table 1507.1.1.

Exception: A ~~reinforced~~ synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength in accordance with ASTM ~~D1970 or~~ ASTM D4533 of 20 pounds shall be permitted. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table R905.1.1 for the applicable roof covering and slope <u>and the underlayment manufacturer's installation instructions</u>~~, except metal cap nails shall be required where the ultimate design wind speed, V*ult*, equals or exceeds 150 mph~~.

R8063

Date Submitted	12/13/2018	**Section**	1507.1.1	**Proponent**	Greg Keeler
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

8061

Summary of Modification

Modifies table to include placeholder for proposed ASTM Polymeeric Underlayment Standard. This proposed standard is under ASTM Work Item #WK51913.

Rationale

This table corresponds with revised Section 1507.1.1 to include a placeholder for the proposed ASTM Polymeric Underlayment Standard. This proposed standard is under ASTM Work Item #WK51913. This proposal adds an ASTM standard that is currently under development. This would be the first ASTM Standard that applies specifically to synthetic underlayment. This proposed standard is under ASTM Work Item #WK51913. It is critical to reference a standard that applies exclusively to synthetic underlayment as many are currently qualified under standards that were intended for use only for asphaltic felt underlayment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

Please see attached PDF.

TABLE 1507.1.1
UNDERLAYMENT TABLE

Roof Covering Section	Roof Slope 2:12 and Less Than 4:12 Underlayment	Underlayment Attachment[1]	Roof Slope 4:12 and Greater Underlayment	Underlayment Attachment[1]
Asphalt Shingles R1507.2	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757		ASTM D6757	
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Concrete and Clay Tile 1507.3	See Section 1507.3.3			
Metal Roof Panels 1507.4	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Metal roof shingles 1507.5	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Mineral-surfaced roll roofing 1507.6	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM DXXXX		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Slate Shingles 1507.7	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Wood Shingles 1507.8	ASTM D226 Type I or II		ASTM D226 Type II	
	ASTM D4869 Type II, III, or IV	1	ASTM D4869 Type IV	2
	ASTM WK51913		ASTM WK51913	
Wood Shakes 1507.9	Not Permitted	Limited to roof slopes 4:12 and greater	ASTM D226 Type II	2
			ASTM D4869 Type IV	
			ASTM WK51913	
Photovoltaic Shingles 1507.17	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3

[a]Underlayment Attachment

1. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and less than four units vertical in 12 units horizontal (33-percent slope). Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
2. Roof slopes of four units vertical in 12 units horizontal (33-percent slope) or greater. Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope) and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

Exception: A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

R8080

Date Submitted	12/13/2018	**Section**	1507.3	**Proponent**	T Stafford
Chapter	15	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revises the roof tile section to clarify that wind loads on tile have to comply with ASCE 7-16.

Rationale

This proposal is primarily a correlation. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). In ASCE 7-16, the component and cladding loads and roof zones for roofs with a MRH of 60 feet and less have changed. The code currently refers to the FRSA/TRI manual for tile. However Table 1A (uplift loads for underlayment and hip/ridge tiles) and Tables 2A and 2B (aerodynamic uplift moment) are still based on ASCE 7-10. This proposal simply clarifies that these loads have to be determined in accordance with ASCE 7-16. Clarifying language has also been added with regards to the manufacturer's product approval installation instructions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Revise as follows:

1507.3.2 Deck slope. Clay and concrete roof tile shall be installed in ~~accordance~~ compliance with the manufacturer's product approval installation instructions in accordance with the recommendations of FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition where the Vasd as determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3 Underlayment. Unless otherwise noted, underlayment shall be applied according to the underlayment manufacturer's product approval installation instructions in accordance with ~~or~~ the recommendations of the FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition, except as modified in Section 1507.3.3.1, where the basic wind speed, V_{asd}, is determined in accordance with Section 1609.3.1 or the recommendations of RAS 118, 119 or 120.

1507.3.3.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Table 1A in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for underlayments for tile systems shall be determined in accordance with ASCE 7.

~~**1507.3.3.1 Slope and underlayment requirements.** Refer to FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition (2012) where the basic wind speed Vasd is determined in accordance with Section 1609.3.1 for underlayment and slope requirements for specific roof tile systems or the recommendations of RAS 118, 119 or 120.*~~

Revise as follows:

1507.3.7 Attachment. Clay and concrete roof tiles shall be fastened in compliance ~~accordance~~ with Section 1609 or the manufacturer's product approval installation instructions ~~or~~ in accordance with *FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition, except as modified in Section 1507.3.7.1, where the basic wind speed, *Vasd,* is determined in accordance with Section 1609.3.1.

1507.3.7.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Tables 2A and 2B in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. The required aerodynamic uplift moment shall be determined in accordance with Section 1504.2. Required design pressures for hip and ridge tiles shall be determined in accordance with ASCE 7.

R8158

Date Submitted 12/14/2018
Chapter 15
Section 1504.3.3
Affects HVHZ No
Proponent Ann Russo5
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

The proposal expands the definition of roofing beyond recognizing metal roof singles

Rationale

This proposal separates "metal roof shingles" as a separate line item product in Section 1504, specifically under the non-ballasted roof systems provisions. This proposal would create a separate line item for metal roof shingles based on the fact that metal shingles are not the same in all respects as either asphalt shingles (Section 1504.1.1) or the other roof systems (Section 1504.3.1) provisions.

One of the major considerations for this product type is the wind uplift testing which is addressed by several industry standards including FM, UL, and ASTM. The majority of manufacturers use one or more of these standards and we propose that the choice should remain with the manufacturer to demonstrate compliance. ASTM D3161M-15, is no longer constrained to asphalt shingles, but expanded to evaluate wind resistance of discontinuous, air permeable, steep slope roofing products that results from the product's rigidity, with or without contribution from sealant or other adhesive to help hold down the leading edge of the tabs, or mechanical interlocking, with or without contribution from sealant or other adhesive to hold down the leading edge of the tab, or any combination thereof." Inclusion of this standard as a compliance path for metal shingles would alleviate many of the difficulties experienced by metal shingle manufacturers.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies design and standard requirements making for clearer application and enforcement

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by improving definition of roofing covering options to correct standard(s)

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Add as follows:

1504.3.3 Metal roof shingles. Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with FM 4474, UL 580, UL 1897, or ASTM D 3161. Metal roof shingles tested in accordance with ASTM D 3161 shall meet the classification requirements of Table 1507.2.7.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D 3161 and the required classification in Table 1507.2.7.1.

R8161

Date Submitted	12/14/2018	**Section**	1507.2.7.1	**Proponent**	Ann Russo5
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The proposal expands the definition of roofing beyond recognizing metal roof singles

Rationale

This proposal separates "metal roof shingles" as a separate line item product in Section 1504, specifically under the non-ballasted roof systems provisions. This proposal would create a separate line item for metal roof shingles based on the fact that metal shingles are not the same in all respects as either asphalt shingles (Section 1504.1.1) or the other roof systems (Section 1504.3.1) provisions. It revises title of Table 1507.2.7.1 as well as adding additional parameter information.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies design and standard requirements making for clearer application and enforcement

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by improving definition of roofing covering options to correct standard(s)

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

TABLE 1507.2.7.1
CLASSIFICATION OF ~~ASPHALT~~ STEEP SLOPE ROOF SHINGLES TESTED IN ACCORDANCE TO WITH ASTM D7158 OR D 3161

For SI: 1 foot = 304.8 mm; 1 mph = 0.447 m/s.

a. The standard calculations contained in ASTM D 7158 assume Exposure Category B or C and building height of 60 feet or less. Additional calculations are required for conditions outside of theseassumptions.

R8164

Date Submitted	12/14/2018	**Section**	1507.2.7.1	**Proponent**	Ann Russo5
Chapter	15	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No | **Alternate Language** No

Related Modifications

Summary of Modification

The proposal expands the definition of roofing beyond recognizing metal roof singles

Rationale

The proposal clarifies the wider definition of shingles, updates standard references and includes proper wording for its expanded definition

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies design and standard requirements making for clearer application and enforcement

Impact to building and property owners relative to cost of compliance with code

None expected

Impact to industry relative to the cost of compliance with code

None expected

Impact to small business relative to the cost of compliance with code

None expected

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves safety by improving definition of roofing covering options to correct standard(s)

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves Code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not

Does not degrade the effectiveness of the code

Does not

Revise as follows:

1507.2.7.1 Wind resistance of ~~asphalt~~steep sloped shingles.

~~Asphalt shingles~~ Shingles shall be classified in accordance with ASTM D3161/D3161M-15, ASTM D7158 or TAS 107. Shingles classified as ASTM D3161/D3161M-15 Class D or ASTM D7158 Class G are acceptable for use where Vasd is equal to or less than 100 mph. Shingles classified as ASTM D3161/3161M-15 Class F, ASTM D7158 Class H or TAS 107 are acceptable for use for all wind speeds. ~~Asphalt shingle~~ Shingle wrappers shall indicate compliance with one of the required classifications, as shown in Table 1507.2.7.1.

Date Submitted	12/14/2018	**Section**	1510.2.5	**Proponent**	Paul Coats
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

7522, 7553, 7826, 8265, 8267, 8269, 8270, 8271

Summary of Modification

This is a correlation change with other modifications that reorganize the heavy timber provisions. It does not change requirements but improves terminology to distinguish between the use of the terms "heavy timber" and "Type IV construction."

Rationale

This modification was approved by the ICC committee and membership and appears in the 2018 edition of the International Building Code. This code change is related a reorganization of Type IV provisions in Section 602.4 and the heavy timber provisions in section 2304.11. The goal of this change (and similar changes to heavy timber terminology in other chapters) is to use the term "Type IV" or "Section 602.4" when the provisions are referring to the type of construction for the building, and "heavy timber complying with Section 2304.11" when the provisions are referring to a heavy timber element located in a building of any construction type. This and related changes are not intended to make technical changes to the code but rather to make the current requirements easier to apply.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Will make code application easier.

Impact to building and property owners relative to cost of compliance with code

No cost-related impact.

Impact to industry relative to the cost of compliance with code

No cost-related impact.

Impact to small business relative to the cost of compliance with code

No cost-related impact.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Will make code application easier.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by making its application easier.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

1. [BG]1510.2.5 Type of construction.

Penthouses shall be constructed with walls, floors and roofs as required for the type of construction of the building on which such penthouses are built.

Exceptions:

1. 1.On buildings of Type I construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating. The exterior walls and roofs of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall not be required to have a fire-resistance rating.
2. 2.On buildings of Type I construction two stories or less in height above grade plane or of Type II construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602 and be constructed of fire-retardant-treated wood. The exterior walls and roofs of penthouses with a *fire separation distance* of 20 feet (6096 mm) or greater shall be permitted to be constructed of fire-retardant-treated wood and shall not be required to have a fire-resistance rating. Interior framing and walls shall be permitted to be constructed of fire-retardant-treated wood.
3. 3.On buildings of Type III, IV or V construction, the exterior walls of penthouses with a fire separation distance greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602. On buildings of Type III, IV or VA construction, the exterior walls of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall be permitted to be of ~~Type IV~~ heavy timber construction complying with Sections 602.4 and 2304.11 or noncombustible construction or fire-retardant-treated wood and shall not be required to have a fire-resistance rating.

[BG]1510.3Tanks.

Tanks having a capacity of more than 500 gallons (1893 L) located on the roof deck of a building shall be supported on masonry, reinforced concrete, steel or ~~Type IV~~ heavy timber construction complying with Section 2304.11 provided that, where such supports are located in the building above the lowest *story*, the support shall be fire-resistance rated as required for Type IA construction.

G 180-15

406.7.2, TABLE 601, 603.1, 705.2.3, 803.3, 803.13.3, 1406.3, [BG] 1510.2.5, [BG] 1510.3, 3105.3, D102.2.8, 803.1

Proponent: Dennis Richardson, American Wood Council, representing American Wood Council (drichardson@awc.org)

2015 International Building Code

Revise as follows:

406.7.2 Canopies. Canopies under which fuels are dispensed shall have a clear, unobstructed height of not less than 13 feet 6 inches (4115 mm) to the lowest projecting element in the vehicle drive-through area. Canopies and their supports over pumps shall be of noncombustible materials, *fire-retardant-treated wood* complying with Chapter 23, ~~wood of Type IV sizes~~heavy timber complying with Section 2304.11 or of construction providing 1-hour *fire resistance*. Combustible materials used in or on a *canopy* shall comply with one of the following:

1. Shielded from the pumps by a noncombustible element of the *canopy*, or ~~wood of Type IV sizes~~heavy timber complying with Section 2304.11;
2. Plastics covered by aluminum facing having a thickness of not less than 0.010 inch (0.30 mm) or corrosion-resistant steel having a base metal thickness of not less than 0.016 inch (0.41 mm). The plastic shall have a *flame spread index* of 25 or less and a smokedeveloped index of 450 or less when tested in the form intended for use in accordance with ASTM E 84 or UL 723 and a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D 1929; or
3. Panels constructed of light-transmitting plastic materials shall be permitted to be installed in *canopies* erected over motor vehicle fuel-dispensing station fuel dispensers, provided the panels are located not less than 10 feet (3048 mm) from any building on the same *lot* and face *yards* or streets not less than 40 feet (12 192 mm) in width on the other sides. The aggregate areas of plastics shall be not greater than 1,000 square feet (93 m^2). The maximum area of any individual panel shall be not greater than 100 square feet (9.3 m^2).

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3[a]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	 3 3[a]	 2 2[a]	 1 1	 0 0	 2 1	 2 0	 2 1/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	See Section ~~602.4.6~~2304.11.2	0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members shall not be required, including protection of roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.

603.1 Allowable materials. Combustible materials shall be permitted in buildings of Type I or II construction in the following applications and in accordance with Sections 603.1.1 through 603.1.3:

1. *Fire-retardant-treated wood* shall be permitted in:
   1.1. Nonbearing partitions where the required *fire-resistance rating* is 2 hours or less.
   1.2. Nonbearing *exterior walls* where fire-resistance-rated construction is not required.
   1.3. Roof construction, including girders, trusses, framing and decking.
   Exception: In buildings of Type IA construction exceeding two *stories abovegrade plane*, *fire-retardant-treated wood* is not permitted in roof construction where the vertical distance from the upper floor to the roof is less than 20 feet (6096 mm).
2. Thermal and acoustical insulation, other than foam plastics, having a *flame spread index* of not more than 25.
   Exceptions:
   1. Insulation placed between two layers of noncombustible materials without an intervening airspace shall be allowed to have a *flame spread index* of not more than 100.
   2. Insulation installed between a finished floor and solid decking without intervening airspace shall be allowed to have a *flame spread index* of not more than 200.
3. Foam plastics in accordance with Chapter 26.
4. Roof coverings that have an A, B or C classification.
5. *Interior floor finish* and floor covering materials installed in accordance with Section 804.
6. Millwork such as doors, door frames, window sashes and frames.
7. *Interior wall and ceiling finishes* installed in accordance with Sections 801 and 803.
8. *Trim* installed in accordance with Section 806.
9. Where not installed greater than 15 feet (4572 mm) above grade, show windows, nailing or furring strips and wooden bulkheads below show windows, including their frames, aprons and show cases.
10. Finish flooring installed in accordance with Section 805.
11. Partitions dividing portions of stores, offices or similar places occupied by one tenant only and that do not establish a *corridor* serving an *occupant load* of 30 or more shall be permitted to be constructed of *fire-retardant-treated wood*, 1-hour fire-resistance-rated construction or of wood panels or similar light construction up to 6 feet (1829 mm) in height.
12. Stages and platforms constructed in accordance with Sections 410.3 and 410.4, respectively.
13. Combustible *exterior wallcoverings*, balconies and similar projections and bay or oriel windows in accordance with Chapter 14.
14. Blocking such as for handrails, millwork, cabinets and window and door frames.
15. Light-transmitting plastics as permitted by Chapter 26.
16. Mastics and caulking materials applied to provide flexible seals between components of *exterior wall* construction.
17. Exterior plastic veneer installed in accordance with Section 2605.2.
18. Nailing or furring strips as permitted by Section 803.11.
19. Heavy timber as permitted by Note c to Table 601 and Sections ~~602.4.7~~602.4.3 and 1406.3.
20. Aggregates, component materials and admixtures as permitted by Section 703.2.2.
21. Sprayed fire-resistant materials and intumescent and mastic fire-resistant coatings, determined on the basis of *fire resistance* tests in accordance with Section 703.2 and installed in accordance with Sections 1705.14 and 1705.15, respectively.
22. Materials used to protect penetrations in fire-resistance-rated assemblies in accordance with Section 714.
23. Materials used to protect joints in fire-resistance-rated assemblies in accordance with Section 715.
24. Materials allowed in the concealed spaces of buildings of Types I and II construction in accordance with Section 718.5.
25. Materials exposed within plenums complying with Section 602 of the *International Mechanical Code*.
26. Wall construction of freezers and coolers of less than 1,000 square feet (92.9 m^2), in size, lined on both sides with noncombustible materials and the building is protected throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

705.2.3 Combustible projections. Combustible projections extending to within 5 feet (1524 mm) of the line used to determine the *fire separation distance* shall be of not less than 1-hour fire-resistance-rated construction, ~~Type IV~~heavy timber construction complying with Section 2304.11, fire-retardant-treated wood or as required by Section 1406.3.

Exception: Type VB construction shall be allowed for combustible projections in Group R-3 and U occupancies with a fire separation distance greater than or equal to 5 feet (1524 mm).

803.3 Heavy timber exemption. Exposed portions of building elements complying with the requirements for buildings of ~~Type IV~~heavy timber construction in Section 602.4 or Section 2304.11 shall not be subject to *interior finish* requirements.

803.13.3 Heavy timber construction. Wall and ceiling finishes of all classes as permitted in this chapter that are installed directly against the wood decking or planking of ~~Type IV~~heavy timber construction in Sections 602.4.2 or 2304.11 or to wood furring strips applied directly to the wood decking or planking shall be fireblocked as specified in Section 803.13.1.1.

1406.3 Balconies and similar projections. Balconies and similar projections of combustible construction other than fire-retardant-treated wood shall be fire-resistance rated where required by Table 601 for floor construction or shall be of ~~Type IV~~heavy timber construction in accordance with Section ~~602.4~~2304.11. The aggregate length of the projections shall not exceed 50 percent of the building's perimeter on each floor.

Exceptions:
1. On buildings of Type I and II construction, three stories or less above *grade plane*, *fire-retardant-treated wood* shall be permitted for balconies, porches, decks and exterior stairways not used as required exits.
2. Untreated wood is permitted for pickets and rails or similar guardrail devices that are limited to 42 inches (1067 mm) in height.
3. Balconies and similar projections on buildings of Type III, IV and V construction shall be permitted to be of Type V construction, and shall not be required to have a *fire-resistance rating* where sprinkler protection is extended to these areas.
4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

[BG] 1510.2.5 Type of construction. Penthouses shall be constructed with walls, floors and roofs as required for the type of construction of the building on which such penthouses are built.

Exceptions:

1. On buildings of Type I construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating. The exterior walls and roofs of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall not be required to have a fire-resistance rating.
2. On buildings of Type I construction two stories or less in height above grade plane or of Type II construction, the exterior walls and roofs of penthouses with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602 and be constructed of fire-retardant-treated wood. The exterior walls and roofs of penthouses with a *fire separation distance* of 20 feet (6096 mm) or greater shall be permitted to be constructed of fire-retardant-treated wood and shall not be required to have a fire-resistance rating. Interior framing and walls shall be permitted to be constructed of fire-retardant-treated wood.
3. On buildings of Type III, IV or V construction, the exterior walls of penthouses with a fire separation distance greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour fire-resistance rating or a lesser fire-resistance rating as required by Table 602. On buildings of Type III, IV or VA construction, the exterior walls of penthouses with a fire separation distance of 20 feet (6096 mm) or greater shall be permitted to be of ~~Type IV~~heavy timber construction complying with Sections 602.4 and 2304.11 or noncombustible construction or fire-retardant-treated wood and shall not be required to have a fire-resistance rating.

[BG] 1510.3 Tanks. Tanks having a capacity of more than 500 gallons (1893 L) located on the roof deck of a building shall be supported on masonry, reinforced concrete, steel or ~~Type IV~~heavy timber construction complying with Section 2304.11 provided that, where such supports are located in the building above the lowest *story*, the support shall be fire-resistance rated as required for Type IA construction.

3105.3 Design and construction. *Awnings* and *canopies* shall be designed and constructed to withstand wind or other lateral loads and live loads as required by Chapter 16 with due allowance for shape, open construction and similar features that relieve the pressures or loads. Structural members shall be protected to prevent deterioration. *Awnings* shall have frames of noncombustible material, *fire-retardant-treated wood*, ~~wood of Type IV size~~heavy timber complying with Section 2304.11, or 1-hour construction with combustible or noncombustible covers and shall be either fixed, retractable, folding or collapsible.

D102.2.8 Permanent canopies. Permanent canopies are permitted to extend over adjacent open spaces provided all of the following are met:

1. The canopy and its supports shall be of noncombustible material, *fire-retardant-treated wood*, ~~Type IV construction~~heavy timber complying with Section 2304.11 or of 1-hour fire-resistance-rated construction.
   Exception: Any textile covering for the canopy shall be flame resistant as determined by tests conducted in accordance with NFPA 701 after both accelerated water leaching and accelerated weathering.
2. Any canopy covering, other than textiles, shall have a *flame spread index* not greater than 25 when tested in accordance with ASTM E 84 or UL 723 in the form intended for use.
3. The canopy shall have at least one long side open.
4. The maximum horizontal width of the canopy shall not exceed 15 feet (4572 mm).
5. The *fire resistance* of *exterior walls* shall not be reduced.

2015 International Fire Code

803.1 General. The provisions of this section shall limit the allowable fire performance and smoke development of interior wall and ceiling finishes and interior wall and ceiling trim in existing buildings based on location and occupancy classification. Interior wall and ceiling finishes shall be classified in accordance with Section 803 of the *International Building Code*. Such materials shall be grouped in accordance with ASTM E 84, as indicated in Section 803.1.1, or in accordance with NFPA 286, as indicated in Section 803.1.2.

Exceptions:

1. Materials having a thickness less than 0.036 inch (0.9 mm) applied directly to the surface of walls and ceilings.
2. Exposed portions of structural members complying with the requirements of ~~buildings of Type IV construction~~heavy timber in accordance with the *International Building Code* shall not be subject to interior finish requirements.

Reason: This code change is part 2 of a proposal to reorganize Type IV Section 602.4 and heavy timber section 2304.11. This part of the change includes references found throughout the IBC to either: Type IV construciton, Section 602.4, Section 2304.11, or "heavy timber". This change should follow directly after the 602.4 change and the reason for the change is included in that reason statement.
The references found in this part are generally changed to Type IV or Section 602.4 when the section of the code is referring to the type of construction associated with a structure. The references are generally changed to "heavy timber complying with Section 2304.11" when the code is referring to a heavy timber element found in a building of another type of construction. This change is a reorganization of two sections and is not intended to change the intent of the code.

Cost Impact: Will not increase the cost of construction
Since this is a reorganization of existing requirements, not the creation of new requirements, this code change will not increase the cost of construction.

G 180-15 : 406.7.2-RICHARDSON5276

G 180-15

Committee Action: Approved as Submitted

Committee Reason: This is a companion piece to G179-15. G179 reorganizes the heavy timber provisions. This change provides corrections to the various new section numbers resulting from G179-15.

R8291

Date Submitted	12/15/2018	**Section**	1504	**Proponent**	Chadwick Collins
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Updating to match currently applicable standards and references

Rationale

Updates language to reflect currently applicable standards and reflect referenced sections in revised referenced standards.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Update to current standards

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Requires compliance with most current applicable standards

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Consensus document standards remain in the text for reference.

Does not degrade the effectiveness of the code

Requires compliance with the currently applicable standards.

See attached file.

1504.7 Impact resistance. Roof coverings installed on low slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D3746, ASTM D4272, ~~CGSB 37-GP-52M~~ or the "Resistance to Foot Traffic Test" in Section ~~5.5~~ 4.6 of FM 4470. All structural metal roofing systems having a thickness equal to or greater than 22 gage and all nonstructural metal roof systems having a thickness equal to or greater than 26 gage shall be exempt from the tests listed above.

R8292

Date Submitted	12/15/2018	**Section**	1505	**Proponent**	Chadwick Collins
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Address inconsistency between FBC and FBC-R fire requirements.

Rationale

It stands to reason that the fire classification requirements in the FBC should not be less stringent than those in the FBC-R. All buildings permitted under the FBC-R require a Class A, B, or C classification. The above table, if left as written, would permit unclassified roof coverings on buildings of Use Group R-3, which can include two-family dwellings with up to 16 occupants.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Addresses possible risk to occupants as currently written.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code in regard to the systems called for in relation to possible occupancy.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Proposed change addresses a level of performance in regard to welfare of occupants and not any specific product or system.

Does not degrade the effectiveness of the code

Strengthens the intent of the code.

See attached file.

TABLE 1505.1[a, b]
MINIMUM ROOF COVERING CLASSIFICATION
FOR TYPES OF CONSTRUCTION

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C[c]	B	C[c]	B	B	C[c]

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m2.
a. Unless otherwise required in accordance with the International Wildland- Urban Interface Code or due to the location of the building within a fire district in accordance with Appendix D.
b. Nonclassified roof coverings shall be permitted on buildings of ~~Group R-3 and~~ Group U occupancies, where there is a minimum fire-separation distance of 6 feet measured from the leading edge of the roof.
c. Buildings that are not more than two stories above grade plane and having not more than 6,000 square feet of projected roof area and where there is a minimum 10-foot fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood
shakes and No. 1 shingles constructed in accordance with Section 1505.7.

R8293

Date Submitted 12/15/2018
Chapter 15
Section 1507
Affects HVHZ Yes
Proponent Chadwick Collins
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Updating language of section to reflect Chapter 2 definition

Rationale

Requiring labeling per the definition in Chapter 2 will provide a more stringent validation that the asphalt shingles meet the required wind resistance classification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Aligned labeling with intent of Chapter 2 to communicate the ability of the product to perform

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Brings code in more agreement with Chapter 2 definition

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

All asphalt shingles would have to meet this proposed modification.

Does not degrade the effectiveness of the code

Strengthens the code via agreement between proposed language and Chapter 2 definition

See attached file.

1507.2.7.1 Wind resistance of asphalt shingles. Asphalt shingles shall be classified in accordance with ASTM D3161, ASTM D7158 or TAS 107. Shingles classified as ASTM D3161 Class D or ASTM D7158 Class G are acceptable for use where V_{asd} is equal to or

less than 100 mph. Shingles classified as ASTM D3161 Class F, ASTM D7158 Class H or TAS 107 are acceptable for use for all wind speeds. Asphalt shingle wrappers shall be *labeled* to indicate compliance with one of the required classifications, as shown in Table 1507.2.7.1.

R8294

Date Submitted	12/15/2018	**Section**	1507	**Proponent**	Chadwick Collins
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarifies practice and prescriptive requirements

Rationale

This proposal clarifies the long-standing practice and prescriptive requirements from the IRC that drip edge on gables be installed over the underlayment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Addresses a condition that if not installed as proposed could lead to an inability of the roofing system to perform as expected in regard to the public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides clarity of a long-standing practice of construction

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Applies equally to currently referenced components in the section

Does not degrade the effectiveness of the code

Clarifies and strengthens the intent of the code in providing guidance for expected installation minimums.

See attached file.

1507.2.9.3 Drip edge. Provide drip edge at eaves and gables of shingle roofs. Overlap to be a minimum of 3 inches (76 mm). Eave drip edges shall extend 1/2 inch (13 mm) below sheathing and extend back on the roof a minimum of 2 inches (51 mm). <u>Drip edge at gables shall be installed over the underlayment.</u> Drip edge at eaves shall be permitted to be installed either over or under the underlayment. If installed over the underlayment, there shall be a minimum 4 inches (51 mm) width of roof cement installed over the drip edge flange. Drip edge shall be mechanically fastened a maximum of 12 inches (305 mm) on center. Where the V_{asd}, as determined in accordance with Section 1609.3.1, is 110 mph (177 km/h) or greater or the mean roof height exceeds 33 feet (10 058 mm), drip edges shall be mechanically fastened a maximum of 4 inches (102 mm) on center.

R8295

Date Submitted	12/15/2018	**Section**	1516	**Proponent**	Chadwick Collins
Chapter	15	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Alignment of fire classification between HVHZ and non-HVHZ (Section 1505)

Rationale

This proposal aligns the HVHZ fire classification requirements with those in the Non-HVHZ Section 1505 .

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Clarifies Class A assemblies for use

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides equivalency in fire classification between HVHZ and non-HVHZ

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Proposed language lists more systems than prior language

Does not degrade the effectiveness of the code

Aligns HVHZ to non-HVHZ while not lowering the threshold of Class A performance.

See attached file.

1516.2.1 Class A. Zero feet to 20 feet (0 to 6.1 m) distance separation measured horizontally from the closest point of any building edge to the nearest point to an adjoining structure, and all buildings with occupation greater than 300 persons.

~~**Exception:** Brick, masonry, slate, clay or concrete roof tile and exposed concrete roof deck are considered to meet Class A roof covering provisions without testing.~~

Exceptions:

1. Class A roof assemblies include those with coverings of brick, masonry or an exposed concrete roof deck.
2. Class A roof assemblies also include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile or slate installed on noncombustible decks or ferrous, copper or metal sheets installed without a roof deck on noncombustible framing.
3. Class A roof assemblies include minimum 16 ounce per square foot (0.0416 kg/m2) copper sheets installed over combustible decks.

R8397

Date Submitted	12/15/2018	**Section**	1503.1	**Proponent**	Michael Fischer
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial Change to general requirements

Rationale

This editorial proposal corrects scoping language.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

0

Impact to building and property owners relative to cost of compliance with code

0

Impact to industry relative to the cost of compliance with code

0

Impact to small business relative to the cost of compliance with code

0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

1503.1 General.

Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed in accordance with this code, and installed in accordance with this code and the ~~approved~~ manufacturer's approved instructions such that the roof covering shall serve to protect the building or structure.

FBC ARMA Code Proposals

1503.1 General.
Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed in accordance with this code, and installed in accordance with this code and the ~~approved~~ manufacturer's approved instructions such that the roof covering shall serve to protect the building or structure.

Reason: The proposal corrects design language and manufacturer's instructions reference. It is editorial.

R8399

Date Submitted	12/15/2018	**Section**	1504.7	**Proponent**	Michael Fischer
Chapter	15	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Also proposed for FBC-R

Summary of Modification

Removes withdrawn referenced standards.

Rationale

Removes withdrawn standards.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

0

Impact to building and property owners relative to cost of compliance with code

0

Impact to industry relative to the cost of compliance with code

0

Impact to small business relative to the cost of compliance with code

0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

1504.7 Impact resistance.
Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D3746, ASTM D4272, ~~CGSB 37-GP-52M~~ or the "Resistance to Foot Traffic Test" in Section 5.5 of FM 4470. All structural metal roofing systems having a thickness equal to or greater than 22 gage and all nonstructural metal roof systems having a thickness equal to or greater than 26 gage shall be exempt from the tests listed above.

1507.11.2 Material standards.
Modified bitumen roof coverings shall comply with ~~CGSB 37-GP-56M,~~ ASTM D6162, ASTM D6163, ASTM D6164, ASTM D6222, ASTM D6223, ASTM D6298 or ASTM D6509.

1507.12.2 Material standards.
Thermoset single-ply roof coverings shall comply with ASTM D4637, <u>or </u>ASTM D5019 ~~or CGSB 37-GP-52M~~.

1507.13.2 Material standards.
Thermoplastic single-ply roof coverings shall comply with ASTM D4434, ASTM D6754, <u>or </u>ASTM D6878 ~~or CGSB CAN/CGSB 37-54~~.

FBC ARMA Code Proposals

CGSB Standards

1504.7 Impact resistance.
Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D3746, ASTM D4272, ~~CGSB 37-GP-52M~~ or the “Resistance to Foot Traffic Test” in Section 5.5 of FM 4470. All structural metal roofing systems having a thickness equal to or greater than 22 gage and all nonstructural metal roof systems having a thickness equal to or greater than 26 gage shall be exempt from the tests listed above.

1507.11.2 Material standards.
Modified bitumen roof coverings shall comply with ~~CGSB 37-GP-56M,~~ ASTM D6162, ASTM D6163, ASTM D6164, ASTM D6222, ASTM D6223, ASTM D6298 or ASTM D6509.

1507.12.2 Material standards.
Thermoset single-ply roof coverings shall comply with ASTM D4637, or ASTM D5019 ~~or CGSB 37-GP-52M~~.

1507.13.2 Material standards.
Thermoplastic single-ply roof coverings shall comply with ASTM D4434, ASTM D6754, or ASTM D6878 ~~or CGSB-CAN/CGSB-37-54~~.

Reason: Proposal removes withdrawn Canadian Standards

R7365

Date Submitted	11/20/2018	**Section**	3111	**Proponent**	Bryan Holland
Chapter	31	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

7345, 7347, 7348

Summary of Modification

This proposed modification updates requirement for solar energy systems in the FBC-B.

Rationale

This proposed modification deletes the current requirements in Section 3111 and replaces them with the updated rules in 3111 of the 2018 IBC that have been correlated and harmonized with current industry standards and other applicable references. This change is similar to those proposed under Mods 7345, 7347, and 7348 for inclusion into the FBC-R. This change will also coordinate the FBC-B with the FFPC.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

Impact to small business relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed modification is directly connected to the health, safety, and welfare of the general public by coordinating the FBC-B with the FFPC for life, fire, and property safety related to solar energy system installations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed modification improves and strengthens the code by updating the rules for solar energy systems in the FBC-B.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposed modification does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

~~SECTION 3111~~

~~PHOTOVOLTAIC PANELS AND MODULES~~

~~3111.1 General. Photovoltaic panels and modules shall comply with the requirements of this code and the Florida Fire Prevention Code.~~

~~3111.1.1 Rooftop-mounted photovoltaic panels and modules. Photovoltaic panels and modules installed on a roof or as an integral part of a roof assembly shall comply with the requirements of Chapter 15 and the Florida Fire Prevention Code.~~

SECTION 3111

SOLAR ENERGY SYSTEMS

3111.1 General. Solar energy systems shall comply with the requirements of this section.

3111.1.1 Wind resistance. Rooftop-mounted photovoltaic panels and modules and solar thermal collectors shall be designed in accordance with Section 1609.

3111.1.2 Roof live load. Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.13.5.

3111.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with the Florida Building Code-Plumbing, the Florida Building Code-Mechanical, and the Florida Fire Prevention Code.

3111.2.1 Equipment. Solar thermal systems and components shall be listed and labeled in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

3111.3 Photovoltaic solar energy systems. Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the Florida Fire Prevention Code, NFPA 70 and the manufacturer's installation instructions.

3111.3.1 Equipment. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be listed and labeled in accordance with UL 1741. Systems connected to the utility grid shall use inverters listed for utility interaction.

3111.3.2 Fire classification. Rooftop-mounted photovoltaic systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic systems shall have a fire classification in accordance with Section 1505.8.

3111.3.3 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section 1507.18.

3111.3.4 Access and pathways. Roof access, pathways and spacing requirements shall be provided in accordance with Section 1204 of the Florida Fire Prevention Code.

3111.3.5 Ground-mounted photovoltaic systems. Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the Florida Fire Prevention Code.

3111.3.5.1 Fire separation distances. Ground-mounted photovoltaic systems shall be subject to the fire separation distance requirements determined by the local jurisdiction.

R7366

Date Submitted	11/20/2018	**Section**	35	**Proponent**	Michael Silvers (FRSA)
Chapter	35	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building Section 1507.3
Residential Section 905.3
Residential Chapter 46

Summary of Modification

This modification updates Referenced Standards: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Rationale

Updates Referenced Standard: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This change does not degrade the effectiveness of the code.

FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, ~~Fifth~~ Sixth Edition

FRSA

Florida Roofing Sheet Metal and Air Conditioning Contractors Association

~~4111 Metric Drive~~

P.O. Box 4850

Winter Park, FL327923

Standard
reference
number

FRSA/TRI

~~April 2012 (02-12)~~

September 2018(09–18)

-

Title

FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, ~~Fifth~~ Sixth Edition Revised

Referenced
in code
section number

1507.3.2, 1507.3.3, 1507.3.3.1, 1507.3.7, 1507.3.8, 1507.3.9

R7843

Date Submitted	12/10/2018	**Section**	35	**Proponent**	Gaspar Rodriguez
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No | **Alternate Language** No

Related Modifications

This proposal references a new standard indicated on Mod 7437; 7438; 7439.

Summary of Modification

Add ASTM E2140-01, Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head.

Rationale

This a new optional test standard that allows manufacturers to test their metal roof panel systems, to allow installation to a minimum 1:12 slope.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact, allows for optional roof systems to be installed on low-slope roofs.

Impact to building and property owners relative to cost of compliance with code

No impact, this is an optional roof system which many owners have requested.

Impact to industry relative to the cost of compliance with code

None, this is an optional roof system. The cost to industry will be absorbed by higher sales.

Impact to small business relative to the cost of compliance with code

None, this is an optional roof system. The cost to small business will be absorbed by higher sales.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This is an option the General Public is requesting.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides for proper testing for new roof systems which are being requested by the General Public.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against any products.

Does not degrade the effectiveness of the code

Does not degrade code, just adds an option for certain low-slope roofs.

ASTM Standard Reference Number Title Referenced in Code Section Number

E2072—10

Standard Specification for Photoluminescent (Phosphorescent) Safety Markings

1025.3

E2140-01

Standard Test Method for Water Penetration of Metal Roof Panel Systems by Static Water Pressure Head

Table 1515.2, 1523.6.5.2.4.1.1, TAS 110 Table 15.

E2174—10AE1

Standard Practice for On-Site Inspection of Installed Fire Stops

R8301

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update referenced standard

Rationale

Update D6083 to most current version.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates referenced standard

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Requires compliance with most current version of standard

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Standard is an ASTM consensus document

Does not degrade the effectiveness of the code

Requires compliance with most current version of standard

D6083—~~05e01~~18 Specification for Liquid Applied Acrylic Coating Used in Roofing

R8303

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	35	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update referenced standard

Rationale

Update D7158/D7158M to most current version

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates referenced standard

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Requires compliance with most current version of standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Standard is ASTM consensus document

Does not degrade the effectiveness of the code

Requires compliance with the most current version of standard.

D7158/D7158M—~~11~~19 Standard Test Method for Wind Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)

R7312

42

Date Submitted	11/19/2018	**Section**	202	**Proponent**	Michael Silvers (FRSA)
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments	**No**	**Alternate Language**	**No**

Related Modifications

Summary of Modification

The modification adds the definition of "Positive Roof Drainage" to the Existing Sub Code Chapter 2 which is currently only in the Building Code Chapter 2. The term only applies to existing buildings.

Rationale

The Existing Building Code in SECTION 706 EXISTING ROOFING, 706.1 General, Exception: deals specifically with roof slope that may or may not be required during re-roofing of existing buildings. Without the definition a user of this Sub Code has to access the Building Sub Code to fully understand the exception. This definition is an important part of this requirement. New construction is required to meet minimum slope requirements

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There is no cost impact for enforcement. Definition is currently in Building Chapter 2.

Impact to building and property owners relative to cost of compliance with code

There is no cost impact for compliance. Definition is currently in Building Chapter 2.

Impact to industry relative to the cost of compliance with code

There is no cost impact for compliance. Definition is currently in Building Chapter 2.

Impact to small business relative to the cost of compliance with code

There is no cost impact for compliance. Definition is currently in Building Chapter 2.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modification will make it easier for those using the Existing Sub Code, to comply with the requirement to achieve positive drainage that applies only to existing buildings.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The modification will make it easier for those using the Existing Sub Code, to comply with the requirement to achieve positive drainage that applies only to existing buildings.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

POSITIVE ROOF DRAINAGE. The drainage condition in which consideration has been made for all loading deflections of the roof deck, and additional slope has been provided to ensure drainage of the roof within 48 hours of precipitation.

R7219

Date Submitted	11/8/2018	**Section**	706.7.2.1	**Proponent**	Gaspar Rodriguez
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

The current language does not correctly describe the limitation on the width of the modified bitumen tape that can be used as a secondary water barrier.

Rationale

This modification indicates the limitation to the width of the modified bitumen tape. This allows for the user to easily understand the current code requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact. Provides language to properly indicate current code requirements.

Impact to building and property owners relative to cost of compliance with code

No impact. Provides language to properly indicate current code requirements.

Impact to industry relative to the cost of compliance with code

No impact. Provides language to properly indicate current code requirements.

Impact to small business relative to the cost of compliance with code

No impact. Provides language to properly indicate current code requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Allows the users of the code to more easily understand the current code requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the code by creating a more understandable document.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of products.

Does not degrade the effectiveness of the code

No, it does not degrade, it allows for a more precise interpretation.

706.7.2 Roof secondary water barrier for site-built single family residential structures. A secondary water barrier shall be installed using one of the following methods when roof covering is removed and replaced:

1. In High-Velocity Hurricane Zone regions:

a) All joints in structural panel roof sheathing or decking shall be covered with a ~~minimum~~ 4 inch (102 mm) to six inch (153 mm) wide strip of self-adhering polymer modified bitumen tape applied directly to the sheathing or decking. The deck and self-adhering polymer modified bitumen tape shall be covered with one of the underlayment systems approved for the particular roof covering to be applied to the roof.

R7314

Date Submitted	11/19/2018	**Section**	706	**Proponent**	Michael Silvers (FRSA)
Chapter	7	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building Code Section 1511 Existing Roofing

Summary of Modification

This modification adds language to clarify that salvaged slate, clay and concrete roof tile of a like kind can be used in certain applications.

Rationale

There are several sections of the code that indicate that some reuse of these materials are permitted: 104.9., 602.1 and 1506.2.1 all at least suggest acceptance. Section 1511.5 states that existing material may be reinstalled. It is not clear on when existing material quantities can be augmented. FS 553.842 allows reuse if the product approval requirements haven't changed. But it's not clear if the particular material never had product approval or the approval has changed if it can be used. The proposed change clarifies when the reuse of slate, clay and concrete roof tile may be acceptable when current product approvals or notice of acceptance are not available.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This modification will allow use of salvaged material that matches existing material. This will make maintenance and repair of existing tile roofs a good alternative to complete replacement.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

706.5 Reinstallation/Reuse of materials.

Existing or salvaged slate, clay or ~~cement~~ concrete tile shall be permitted for reinstallation or reuse, to repair an existing slate or tile roof, except that salvaged slate or tile shall be of like kind in both material and profile. D~~d~~amaged, cracked or broken slate or tile shall not be reinstalled. The building official may permit salvaged slate, clay and concrete tile to be installed on additions and new construction, when the tile is tested in compliance with the provisions of Section 1507 or 1523 (HVH shall comply with Section 1523) and installed in accordance with Section 1507 or 1518 (HVHZ shall comply with Section 1518). Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Aggregate surfacing materials shall not be reinstalled. (High-Velocity Hurricane Zones shall comply with Sections 1512 through 1525 of the Florida Building Code, Building).

R7525

Date Submitted 11/29/2018 | **Section** 706 | **Proponent** Michael Silvers (FRSA)
Chapter 7 | **Affects HVHZ** Yes | **Attachments** Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments Yes | **Alternate Language** No

Related Modifications

Changes to Section 707 and 403.8 are also included and shouldn't be considered separately.

Summary of Modification

Expands 706.7 Mitigation by eliminating "single family residential" thereby covering all applicable site built structures. It removes the "roofing materials are removed" trigger and replaces it with prescriptive methods already in code.

Rationale

Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm" which when you consider the 25% rule (Existing Building, 706.1.1) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural evaluation and mitigation is required. The owner must commit to an open ended contract with a no idea of the potential cost, what the scope of work might be or how many trades may be involved. Some older deck types that proceed uplift testing are deemed unacceptable for use as a substrate. This could necessitate complete deck replacement as well as reworking or replacement of the roof to wall connections. If the building is occupied there is additional cost. The cost of this work could very well make continued use of the building nonviable. This would apply to a building that conformed to the building code when it was built. Expanding the current prescriptive methods in 706.7 Mitigation will provide a clear, consistent and familiar approach to improving the wind resistance of applicable structures. Changing the trigger from "Where roofing materials are removed from more than 50 percent of the roof diaphragm" to "Where more than 25 percent of the roof diaphragm is repaired or replaced" will properly place the requirement for a roof diaphragm and roof to wall connection evaluation and possible repair or replacement in the structural scope as opposed to part of the routine building maintenance of a roof covering replacement. The 25% threshold mirrors existing requirements to bring the balance of the work into compliance with the code. See 706.1.1. This approach will address recommendations outlined in the FBC funded University of Florida report titled Cost Impacts of 2017 FBC-EB 707.3.2 Roof Diaphragm Reroofing Requirements. (Portions attached)

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification provides cost savings by reducing enforcement of requirements of 707.3.2 on all applicable roof replacement projects and replacing them with prescriptive methods currently in the code.

Impact to building and property owners relative to cost of compliance with code

This modification provides cost savings. See Support File.

Impact to industry relative to the cost of compliance with code

This modification provides cost savings. See Support File

Impact to small business relative to the cost of compliance with code

This modification provides cost savings. See Support File.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This modification eliminates the extremely burdensome requirements and associated cost of 707.3.2 on all applicable roof replacements. The change clarifies when the required engineering evaluation and related work needs to be done.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

It will allow a simple roof covering replacement without the burdensome roof diaphragm engineering evaluation currently required. The current requirements are ambiguous which creates wide spread confusion for contractors, engineers and code enforcement officials.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Current requirements of 707.3.2 are ambiguous and are typically ignored. The modification replaces the confusing and unenforced requirements with prescriptive requirements currently in the code for applicable structures

1st Comment Period History

R7525-G1

Proponent Gaspar Rodriguez | **Submitted** 1/16/2019 | **Attachments** No

Comment:

The code section referring to site-built single-family residential structure is derived from statutorily-mandated language. 553.844(2) (b) FS, specifically indicates "single-family residential structures." This proposed code mod will expand the statue, which I believe is beyond the scope of updating the code.
Also, the cost savings indicated on the support file only refers to the Cost Impact of Roof Diaphragm Reroofing Requirements. I would maintain that the cost impact of expanding FEBC 706.7 Mitigation Section, has an increase cost impact on enforcement cost.

1st Comment Period History

R7525-G2

Proponent Mo Madani **Submitted** 1/27/2019 **Attachments** No

Comment:

Mitigation techniques and requirements of the 2017 FBC are consistent with section 553.844 FS.

706.7 Mitigation.

When a roof covering on an existing site-built ~~single-family residential~~ structure is removed and replaced, the following procedures shall be permitted to be performed by the roofing contractor:

(a) Roof-decking attachment shall be as required by Section 706.7.1.

(b) A secondary water barrier shall be provided as required by Section 706.7.2.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.7.1 Roof decking attachment for site-built ~~singlefamily residential~~ structures.

For site-built ~~single-family residential~~ structures the fastening shall be in accordance with Section 706.7.1.1 or 706.7.1.2 as appropriate for the existing construction. 8d nails shall be a minimum of 0.113 inch (2.9 mm) in diameter and shall be a minimum of $2^1/_4$ inches (57 mm) long to qualify for the provisions of this section for existing nails regardless of head shape or head diameter.

Remaining text unchanged.

706.7.2 Roof secondary water barrier for site-built ~~singlefamily residential~~ structures.

706.8

When a roof covering on an existing site-built ~~single family residential~~ structure is removed and replaced on a building that is located in the wind-borne debris region as defined in the Florida Building Code, Building and that has an insured value of $300,000 or more or, if the building is uninsured or for which documentation of insured value is not presented, has a just valuation for the structure for purposes of ad valorem taxation of $300,000 or more:

(a) Roof to wall connections shall be improved as required by Section 706.8.1.

(b) Mandated retrofits of the roof-to-wall connection shall not be required beyond a 15 percent increase in the cost of reroofing.

Exception: ~~Single-family residential~~ structures permitted subject to the Florida Building Code are not required to comply with this section.

706.8.1 Roof-to-wall connections for site-built ~~singlefamily residential~~ structures.

Remaining text unchanged.

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.
Where ~~roofing materials are removed from~~ more than ~~50~~ <u>25</u> percent of the roof diaphragm ~~or section~~ ~~of~~ <u>is repaired or replaced on</u> a building located where the ultimate design wind speed, V_{ult}, is greater than 115 mph, as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the *Florida Building Code, Building*, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the *Florida Building Code, Building*, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the *Florida Building Code, Building*.

~~**Exceptions:**~~

~~1.This section does not apply to buildings permitted subject to the Florida Building Code.~~

~~2.This section does not apply to buildings permitted subject to the 1991 *Standard Building Code*, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~

~~3.Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~

~~4. This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

~~5. This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

SECTION 403

ALTERATIONS

403.8 Roof diaphragms resisting wind loads in highwind regions.

Where ~~the intended alteration requires a permit for reroofing and involves removal of roofing materials from~~ more than ~~50~~25 percent of the roof diaphragm is repaired or replaced on ~~of a building or section of~~ a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Remaining text unchanged.

Cost Impact of 2017 FBC-EB § 707.3.2 Roof Diaphragm Reroofing Requirements

RINKER-CR-2018-105

Final Report

1 June 2018

Submitted to

Mo Madani

Department of Business and Professional Regulation
1940 North Monroe Street
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Table 7. Bid Prices for A-F Roof type and A-C Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	1:$129,940 2:$109,688 3:$138,000	1: $128,540 2: $105,931 3: $139,000	1: $153,300 2: $128,773 3: $149,000	1:$129,940 2:$118,311 3:$143,000	1:$128,570 2:$118,311 3:$146,000	1:$128,540 2:$106,334 3:$141,000
Bid Line No.	1	1	1	1	1	1
A. Enhanced fastening of the roof deck	1:$134,440+ 2:$157,556 3:$164,400	NA	1:$156,800+ 2: $140,092 3: $163,425	NA	NA	1:$133,040+ 2:$118,753 3:$155,900
Bid Line Nos.	1,2,3,4 & 8	---------	1,2,3,4 & 8	---------	---------	1,2,3,4,5 & 9
B. Roof-to-wall connections enhanced fastening	1:$146,940+* 2:$128,208 3:$164,990	1: $131,040+ 2: $123,631 3: $158,560	1: $169,300+* 2: $147,293 3: $173,200	1:$145,940+ 2:$134,231 3:$134,575	1:$144,570+ 2:$134,231 3:$179,075	1:$145,540+* 2:$125,954 3:$165,675
Bid Line Nos.	1,2, 4,5 & 8	1, 2, 3 & 7	1,2,4,5 & 8	1,2,3,4 & 7	1,2,3,4 & 7	1,2,3,5,6 & 9
C. Entire roof deck replacement	1:$284,440+ 2:$265,188* 3:$173,790	1: $158,540+ 2: $148,431* 3: $196,600	1: $231,800+ 2: $219,273* 3: $230,150	1:$293,440+ 2:$226,211* 3:$207,795	1:$282,070+ 2:$226,211* 3:$246,815	1:$283,040+ 2:$252,934* 3:$235,075
Bid Line Nos.	1,2,4,7 & 8	1, 2, 6 &7	1,2, 4,7 & 8	1,2,3,6 & 7	1,2,3,6 & 7	1,2,3,5,8 & 9

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **1:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **2:** Cost for loss of business (Depends on use)
  - **3:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **4:** Cost to repair or replacing ceilings (Depends on use)
  - **5:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **6:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Table 8. Mean Bid Prices for A-F Roof type and A-B Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:** $129,940	**1:** $128,540	**3:** $149,000	**1:** $129,940	**1:** $128,570	**1:** $128,540
A. Enhanced fastening of the roof deck	**2:** $157,556	NA	**3:** $163,425	NA	NA	**1:** $133,040+
% Cost Increase over Base Bid	21.3 %	----	9.7%	----	----	3.5%
B. Roof-to-wall connections enhanced fastening	**1:** $146,940+*	**1:** $131,040+	**3:** $173,200	**1:** $134,575	**1:** $144,570+	**1:** $145,540+*
% Cost Increase over Base Bid	13.1%	1.9%	16.2%	3.6%	12.4%	13.2%
C. Entire roof deck replacement	**2:** $265,188*	**1:** $158,540+	**3:** $230,150	**2:** $226,211*	**3:** $246,815	**2:** $252,934*
% Cost Increase over Base Bid	104.1%	23.3%	54.5%	74.1%	92.0%	96.8%

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **7:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **8:** Cost for loss of business (Depends on use)
  - **9:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **10:** Cost to repair or replacing ceilings (Depends on use)
  - **11:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **12:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Conclusions

Roofing subcontractor bid data were collected for six roof types (A-F) covering the base bid and three repair scenarios (A-C). Unit costs were also collected for partial roof replacement options. The collected data was used to make cost comparisons between different replacement scenarios among three roofing subcontractors and determine mean base bid costs and repair/replacement costs for three scenarios: enhanced fastening of the roof deck; roof-to-wall connections enhanced fastening; and entire roof deck replacement. In general, based solely on the three bids received, the wood deck system was the least costly system to bring in compliance with 2017 FBC-EB § 707.3.2, while the LWC on bar joists was the most expensive

Future work should address the following:

a. Setting minimum deck attachment criteria (similar to wood decks) and standardizing this for all NOA/Product Approval tests. This will eliminate non-applicability of approved products for several field conditions and streamline the roofing permitting process.
b. On properties valued over a certain threshold (say $500,000), requiring scenario B (roof to wall connections and enhanced edge supports) up to a pre-set percentage (say 15%) of re-roofing cost.
c. Conducting a cost impact analysis for future code changes, before implementation, except in the case of life and/or fire safety requirements.

R7581

Date Submitted	11/29/2018	**Section**	707	**Proponent**	Michael Silvers (FRSA)
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Changes to Sections 403.8 and 202 Definitions are also included.

Summary of Modification

This modification changes the trigger from "where roofing materials are removed from more than 50% of the roof diaphragm" to a recognized trigger using a specific accumulated value of proposed work as a ratio of the value of the structure.

Rationale

Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm" which when you consider the 25% rule (Existing Building, 706.1.1) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural The existing language in 707.2.3 is ambiguous as it pertains to the "roof diaphragm". Engineers who can perform an evaluation can't agree when it applies, or what it requires. It states: "When roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building" which when you consider the 25% rule (Existing Building, 706.11) makes the 50% threshold actually 25%. It can be interpreted that during any roof replacement the structural evaluation and mitigation is required. The building owner must commit to an open ended contract with absolutely no idea of the potential cost, what the scope of work might be or how many trades may be involved. Some older deck types that proceed uplift testing are deemed unacceptable for use as a substrate for roof replacement. This would necessitate complete deck replacement as well as reworking or replacement of the roof to wall connections. If the building is occupied there is additional cost. The cost of this work could very well make continued use of the building unviable. This could easily apply to a building that conforms to the building code that was applicable when it was built. Using a trigger of "30 percent of the assessed value of the structure" as a cost threshold before requiring this work to be done aligns with other sections of the code. This basic method is currently used for energy and envelope improvements as well as certain improvements in coastal flood zones.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification provides cost savings by reducing enforcement of requirements of 707.3.2 on all applicable roof replacement projects and replacing them with prescriptive methods currently in the code.

Impact to building and property owners relative to cost of compliance with code

This modification provides cost savings. See Support File.

Impact to industry relative to the cost of compliance with code

This modification provides cost savings. See Support File

Impact to small business relative to the cost of compliance with code

This modification provides cost savings. See Support File

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Eliminates the burdensome requirements and excessive cost of 707.3.2. The change clarifies when the required evaluation needs to be done. It removes the current roof replacement trigger and uses an existing definition that triggers certain work to be done when a project reaches the 30% threshold.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Improves the requirements for a roof diaphragm evaluation. This change will allow roof covering replacement without the burdensome engineering evaluation currently required. The current ambiguous requirements creates confusion for contractors, engineers and code enforcement officials.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Current requirements of 707.3.2 are ambiguous and are typically ignored. The modification replaces the confusing and unenforced requirements with prescriptive requirements currently in the code for applicable structures

SECTION 707
STRUCTURAL

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.

Where a renovated building alteration includes roof replacement ~~roofing materials are removed from more than 50 percent of the roof diaphragm or section of a building located~~ where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the Florida Building Code, Building, is greater than 115 mph (51 m/s), as defined in Section 1609 (the High-Velocity Hurricane Zone be evaluated for the wind loads specified in the Florida Building Code, Building, including shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the Florida Building Code, Building

Remaining text unchanged.

403.8 Roof diaphragms resisting wind loads in highwind regions.

Where ~~the intended~~ a renovated building alteration requires a permit for reroofing ~~and involves removal of roofing materials from more than 50 percent of the roof diaphragm of a building or section of a building located~~ where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of the Florida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

Remaining text unchanged.

CHAPTER 2

DEFINITIONS

SECTION 202
GENERAL DEFINITIONS

RENOVATED BUILDING. A residential or nonresidential building undergoing alteration that varies or changes insulation, HVAC systems, water heating systems or exterior envelope conditions, provided the estimated cost of renovation exceeds 30 percent of the assessed value of the structure

Cost Impact of 2017 FBC-EB § 707.3.2 Roof Diaphragm Reroofing Requirements

RINKER-CR-2018-105

Final Report

1 June 2018

Submitted to

Mo Madani

Department of Business and Professional Regulation
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Table 7. Bid Prices for A-F Roof type and A-C Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:**$129,940 **2:**$109,688 **3:**$138,000	**1:** $128,540 **2:** $105,931 **3:** $139,000	**1:** $153,300 **2:** $128,773 **3:** $149,000	**1:**$129,940 **2:**$118,311 **3:**$143,000	**1:**$128,570 **2:**$118,311 **3:**$146,000	**1:**$128,540 **2:**$106,334 **3:**$141,000
Bid Line No.	1	1	1	1	1	1
A. Enhanced fastening of the roof deck	**1:**$134,440+ **2:**$157,556 **3:**$164,400	NA	**1:**$156,800+ **2:** $140,092 **3:** $163,425	NA	NA	**1:**$133,040+ **2:**$118,753 **3:**$155,900
Bid Line Nos.	1,2,3,4 & 8	---------	1,2,3,4 & 8	---------	---------	1,2,3,4,5 & 9
B. Roof-to-wall connections enhanced fastening	**1:**$146,940+* **2:**$128,208 **3:**$164,990	**1:** $131,040+ **2:** $123,631 **3:** $158,560	**1:** $169,300+* **2:** $147,293 **3:** $173,200	**1:**$145,940+ **2:**$134,231 **3:**$134,575	**1:**$144,570+ **2:**$134,231 **3:**$179,075	**1:**$145,540+* **2:**$125,954 **3:**$165,675
Bid Line Nos.	1,2, 4,5 & 8	1, 2, 3 & 7	1,2,4,5 & 8	1,2,3,4 & 7	1,2,3,4 & 7	1,2,3,5,6 & 9
C. Entire roof deck replacement	**1:**$284,440+ **2:**$265,188* **3:**$173,790	**1:** $158,540+ **2:** $148,431* **3:** $196,600	**1:** $231,800+ **2:** $219,273* **3:** $230,150	**1:**$293,440+ **2:**$226,211* **3:**$207,795	**1:**$282,070+ **2:**$226,211* **3:**$246,815	**1:**$283,040+ **2:**$252,934* **3:**$235,075
Bid Line Nos.	1,2,4,7 & 8	1, 2, 6 &7	1,2, 4,7 & 8	1,2,3,6 & 7	1,2,3,6 & 7	1,2,3,5,8 & 9

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  - **1:** Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  - **2:** Cost for loss of business (Depends on use)
  - **3:** Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  - **4:** Cost to repair or replacing ceilings (Depends on use)
  - **5:** Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  - **6:** Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Table 8. Mean Bid Prices for A-F Roof type and A-B Repair Scenarios+*

Repair	LWC on Bar Joists	Wood Deck System	Metal on Steel Bar Joists	Gypsum on Spaced Joists	Tectum on Spaced Joists	LWEC Deck System
Base Bid (incl. in A-C Repair Scenarios)	**1:** $129,940	**1:** $128,540	**3:** $149,000	**1:** $129,940	**1:** $128,570	**1:** $128,540
A. Enhanced fastening of the roof deck	**2:** $157,556	NA	**3:** $163,425	NA	NA	**1:** $133,040+
% Cost Increase over Base Bid	21.3 %	----	9.7%	----	----	3.5%
B. Roof-to-wall connections enhanced fastening	**1:** $146,940+*	**1:** $131,040+	**3:** $173,200	**1:** $134,575	**1:** $144,570+	**1:** $145,540+*
% Cost Increase over Base Bid	13.1%	1.9%	16.2%	3.6%	12.4%	13.2%
C. Entire roof deck replacement	**2:** $265,188*	**1:** $158,540+	**3:** $230,150	**2:** $226,211*	**3:** $246,815	**2:** $252,934*
% Cost Increase over Base Bid	104.1%	23.3%	54.5%	74.1%	92.0%	96.8%

+ = No Bid Items; * = Condition/Exclusions

COST NOTES:

- For all 6 deck types the following cost items need to be also taken into consideration:
  7: Cost for relocation if needed of occupants, contents, etc. (Depends on use)
  8: Cost for loss of business (Depends on use)
  9: Cost for isolating dust from occupied area if contents are not relocated (Depends on use)
  10: Cost to repair or replacing ceilings (Depends on use)
  11: Cost to keep temporarily watertight or phasing of work to do the same (Factored in Bid)
  12: Cost of engineering for each protocol ($8,250).
- For deck types with rigid insulation for replacement (A, B, D, E & F) the Cost for the cover board that is required over the polyisocyanurate insulation is factored in bid and cost if replacement triggers energy code requirements would apply across the boards regardless of diaphragm frame.
- For light weight insulating concrete deck type (A) the cost for required tapered insulation for replacement of LWIC fill is factored in bid.
- For gypsum deck type (D) cost for relocation (mandatory) depends on building use type and the cost for removal and replacement of ceiling, ductwork, wiring etc. depends on building use type and cannot all be pinned on diaphragm roof type.

Conclusions

Roofing subcontractor bid data were collected for six roof types (A-F) covering the base bid and three repair scenarios (A-C). Unit costs were also collected for partial roof replacement options. The collected data was used to make cost comparisons between different replacement scenarios among three roofing subcontractors and determine mean base bid costs and repair/replacement costs for three scenarios: enhanced fastening of the roof deck; roof-to-wall connections enhanced fastening; and entire roof deck replacement. In general, based solely on the three bids received, the wood deck system was the least costly system to bring in compliance with 2017 FBC-EB § 707.3.2, while the LWC on bar joists was the most expensive

Future work should address the following:

a. Setting minimum deck attachment criteria (similar to wood decks) and standardizing this for all NOA/Product Approval tests. This will eliminate non-applicability of approved products for several field conditions and streamline the roofing permitting process.
b. On properties valued over a certain threshold (say $500,000), requiring scenario B (roof to wall connections and enhanced edge supports) up to a pre-set percentage (say 15%) of re-roofing cost.
c. Conducting a cost impact analysis for future code changes, before implementation, except in the case of life and/or fire safety requirements.

R7960

Date Submitted	12/13/2018	**Section**	707.3.2	**Proponent**	Gaspar Rodriguez
Chapter	7	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Section 403.8 also modified.

Summary of Modification

Resolves the issue of a routine maintenance activity (i.e. reroofing) establishing a burdensome requirement that is contemplated in Chapter 9 of the Florida Building Code Existing Building, when an Alteration Level Three is reached.

Rationale

Resolves the issue of a routine maintenance activity (i.e. reroofing) establishing a burdensome requirement that is contemplated in Chapter 9 of the Florida Building Code Existing Building, when an Alteration Level Three is reached. Realizes that quite often removal of roof covering does not expose the structural attachment of all existing elements of the lateral force-resisting system.

Section 907.4, FBCEB, indicates the requirements for an engineering evaluation and analysis when more than 30 percent of the roof area is involved in a structural alteration. Removal of roof covering should be considered non-structural alteration.

Provide clarity that it is the structural alteration that initiates when an engineering evaluation and analysis is required.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Reduces the burden of enforcement, by properly placing the condition of this requirement at the more proper level of alteration.

Impact to building and property owners relative to cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Impact to industry relative to the cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Impact to small business relative to the cost of compliance with code

Will save cost by eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The welfare of the public will benefit with the cost savings from eliminating the excessive cost of evaluating a structure during a routine reroof. The evaluation should occur during a more extensive alteration.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides equivalent protection by focusing the enforcement of the code on buildings that are being altered at an alteration level where the evaluation is warranted.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code. Could be argued that it makes the code more effective by focusing the enforcement of the code on buildings that are being altered at an alteration level where the evaluation is warranted.

707.3.2 Roof diaphragms resisting wind loads in high-wind regions.

Where ~~roofing materials are~~the structural roof deck is removed from more than ~~50~~30 percent of the ~~roof~~structural diaphragm of a building or section of a building located where the ultimate design wind speed, V_{ult}, determined in accordance with Figure 1609.3(1) of the Florida Building Code, Building, is greater than 115 mph (51 m/s), as defined in Section 1609(the High-Velocity Hurricane Zone shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in the Florida Building Code, Building.

~~Exceptions:~~

1. ~~This section does not apply to buildings permitted subject to the Florida Building Code.~~
2. ~~This section does not apply to buildings permitted subject to the 1991 Standard Building Code, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~
3. ~~Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~
4. ~~This section does not apply to site-built singlefamily dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~
5. ~~This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

403.8 Roof diaphragms resisting wind loads in high-wind regions.

Where the ~~intended alteration requires a permit for reroofing and involves removal of roofing materials~~structural roof deck is removedfrom more than~~50~~30 percent of the~~roof~~structural diaphragm of a building or section of a building located where the ultimate design wind speed is greater than 115 mph (51 m/s) in accordance with Figure 1609.3(1) of theFlorida Building Code, Building as defined in Section 1609 (the HVHZ shall comply with Section 1620) of the Florida Building Code, Building, roof diaphragms, connections of the roof diaphragm to roof framing members, and roof-to-wall connections shall be evaluated for the wind loads specified in Section 1609 of the Florida Building Code, Building, including wind uplift. If the diaphragms and connections in their current condition are not capable of resisting at least 75 percent of those wind loads, they shall be replaced or strengthened in accordance with the loads specified in Section 1609 of the Florida Building Code, Building.

~~**Exceptions:**~~

1. ~~This section does not apply to buildings permitted subject to the Florida Building Code.~~
2. ~~This section does not apply to buildings permitted subject to the 1991 Standard Building Code, or later edition, or designed to the wind loading requirements of the ASCE 7-88 or later editions, where an evaluation is performed by a registered design professional to confirm the roof diaphragm, connections of the roof diaphragm to roof framing members, and roof-to-wall connections are in compliance with the wind loading requirements of either of these standards or later editions.~~
3. ~~Buildings with steel or concrete moment resisting frames shall only be required to have the roof diaphragm panels and diaphragm connections to framing members evaluated for wind uplift.~~
4. ~~This section does not apply to site-built single-family dwellings. Site-built single-family dwellings shall comply with Sections 706.7 and 706.8.~~

5. ~~This section does not apply to buildings permitted within the HVHZ after January 1, 1994 subject to the 1994 South Florida Building Code, or later editions, or where the building's wind design is based on the wind loading requirements of ASCE 7-88 or later editions.~~

R8083

Date Submitted 12/13/2018
Chapter 7
Section 706.1
Affects HVHZ No
Proponent Harold Barrineau
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Section: [BS] 706.3, 706.3 (New), 706.3.1 (New), 706.3.1.1 (New)

Summary of Modification

[BS] 706.1 General. [BS] 706.2 Structural and construction loads. 706.3 Roof replacement. 706.3.1 Roof recover. 706.3.1.1 Exceptions

Rationale

This proposal is simply editorial and matches the FBC Existing Reroofing sections with the FBC Building.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal does not impact local entity relative to enforcement.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction

Since this proposal is intended to be editorial to coordinate the FBC Existing reroofing sections with the FBC Building. There will be no increase in the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction

Since this proposal is intended to be editorial to coordinate the FBC Existing reroofing sections with the FBC Building. There will be no increase in the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction

Since this proposal is intended to be editorial to coordinate the FBC Existing reroofing sections with the FBC Building. There will be no increase in the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal improves the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens or improves the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

1st Comment Period History

R8083-G1

Proponent Gaspar Rodriguez **Submitted** 1/17/2019 **Attachments** No

Comment:

This proposed mod indicates it does not affect HVHZ, however, this mod does affect the HVHZ. If the mod is recommended for approval it must contain language to indicate Reroofing in the HVHZ shall comply with Section 1521 FBC.

The rationale indicates that this proposal is simply editorial, however, I see that an exception is added that is not part of the current code. Also, my reading and comparing of the proposed mod's language, compared to Section 1511 FBC does not match. Actually, the current Section 706.3 FEBC is almost identical to Section 1511.3 FBC and in my opinion needs no modification.

Revise as follows:

[BS] 706.1 General. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 15 of the Florida Building Code, Building, or Chapter 9 of the Florida Building Code, Residential. Roof repairs to existing roofs and roof coverings shall comply with the provisions of this code.

~~**Exception**~~ **Exceptions**: ~~Reroofing~~

1. Roof replacement or roof recover of existing low slope roof coverings hall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 of the Florida Building Code, Building for roofs that provide positive roof drainage (High-Velocity Hurricane Zones shall comply with Sections 1515.2.2.1 and 1516.2.4 of the Florida Building Code, Building).

2. Recovering or replacing an existing roof covering shall not be required to meet the requirement for secondary (emergency overflow) drains or scuppers in Section 1503.4 of the International Building Code for roofs that provide for positive roof drainage. For the purposes of this exception, existing secondary drainage or scupper systems required in accordance with this code shall not be removed unless they are replaced by secondary drains or scuppers designed and installed in accordance with Section 1503.4 of the Florida Building Code, Building.

-

[BS] 706.2 Structural and construction loads.

Structural roof components shall be capable of supporting the roof-covering system and the material and equipment loads that will be encountered during installation of the system.

Delete without substitution:

~~**BS] 706.3 Recovering versus replacement.** New roof coverings shall not be installed without first removing all exist-ing layers of roof coverings down to the roof deck where any of the following conditions occur:~~

~~1. Where the existing roof or roof covering is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for addi-tional roofing.~~

~~2. Where the existing roof covering is wood shake, slate, clay, cement or asbestos-cement tile.~~

~~3. Where the existing roof has two or more applications of any type of roof covering.~~

~~4. When blisters exist in any roofing, unless blisters are cut or scraped open and remaining materials secured down before applying additional roofing.~~

~~5. Where the existing roof is to be used for attachment for a new roof system and compliance with the securement provisions of Section 1504.1 of the Florida Building Code, Building cannot be met.~~

~~**Exceptions:**~~

~~Building and structures located within the High-Velocity Hurricane Zone shall comply with the provisions of Sections 1512 through 1525 of the Florida Building Code, Building.~~

~~Complete and separate roofing systems, such as standing-seam metal roof systems, that are designed to transmit the roof loads directly to the building's structural system and that do not rely on existing roofs and roof coverings for support, shall not require the removal of existing roof coverings.~~

~~The application of a new protective coating over an existing spray polyurethane foam roofing system shall be permitted without tear-off of existing roof coverings.~~

~~Roof Coating. Application of elastomeric and or maintenance coating systems over existing asphalt shingles shall be in accordance with the shingle manufacturer's approved installation instructions.~~

-

Add new text as follows:

706.3 Roof replacement. Roof replacement shall include the removal of all existing layers of roof coverings down to the roof deck.

Exception: Where the existing roof assembly includes an ice barrier membrane that is adhered to the roof deck, the existing ice barrier membrane shall be permitted to remain in place and covered with an additional

706.3.1 Roof recover. The installation of a new roof covering over an existing roof covering shall be permitted where any of the following conditions occur:

Where the new roof covering is installed in accordance with the roof covering manufacturer's approved instructions.

Complete and separate roofing systems, such as standing-seam metal roof panel systems, that are designed to transmit the roof loads directly to the building's structural system and that do not rely on existing roofs and roof coverings for support, shall not require the removal of existing roof coverings.

Metal panel, metal shingle and concrete and clay tile roof coverings shall be permitted to be installed over existing wood shake roofs when applied in accordance with Section 706.4.

The application of a new protective coating over an existing spray polyurethane foam roofing system shall be permitted without tear off of existing roof coverings.

706.3.1.1 Exceptions. A roof recover shall not be permitted where any of the following conditions occur:

Where the existing roof or roof covering is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for additional roofing.

Where the existing roof covering is slate, clay, cement or asbestos-cement tile.

Where the existing roof has two or more applications of any type of roof covering.

R8177

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Date Submitted	12/14/2018	**Section**	202	**Proponent**	Ann Russo1
Chapter	2	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Add definition to the building-integrated photovoltaic roof panel

Rationale

This proposal adds definition and will provide clarity to the application of this type of roof covering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds another type of roof covering and will provide clarity to the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal has reasonable and substantial connection with the health, safety and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code and will provide equivalent or better products, methods and systems of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Add text as follows:

SECTION 202

DEFINITIONS

BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL. A photovoltaic panel that functions as a component of the building envelope.

Date Submitted 12/3/2018
Chapter 3
Section 324
Affects HVHZ No
Proponent John Hall
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments Yes
Alternate Language No

Related Modifications

The location and numbering of this modification will be dependent upon any action taken on modification #7475.

Summary of Modification

The modification provides for solar ready features to facilitate the instalation of solar PV and solar thermal systems without resort to destructive methods.

Rationale

Solar photovoltaic and solar thermal systems are becoming more cost competitive in the marketplace. Adoption of this technology has many societal benefits. A serious hindrance to the adoption of solar technology is the destructive means required to install them on existing structures. This mod seeks to overcome this hindrance.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There will be no cost impact relative to enforcement of the code due to this proposed modification. The inspection activity will be performed during already required inspections that are regularly scheduled.

Impact to building and property owners relative to cost of compliance with code

There will be a cost impact to building and property owners for compliance. The requirements are minimal and the associated cost is negligible.

Impact to industry relative to the cost of compliance with code

There will be no cost impact to industry for compliance. The modification is only applicable to one- and two-family dwellings and townhouses.

Impact to small business relative to the cost of compliance with code

There will be no cost impact to small business for compliance. The modification is only applicable to one- and two-family dwellings and townhouses.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The proposed modification has a reasonable and substantial connection with the health, safety, and welfare of the general public by fostering adoption of solar technology that will reduce harmful emissions from use of fossil fuels.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The proposed modification improves the code by making provision for non-destructive installation of solar systems on existing structures.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposed modification does not discriminate against any materials, products, methods, or systems of construction as none are specified. The modification allows use of any existing code approved methods and materials for compliance.

Does not degrade the effectiveness of the code

The proposed modification does not degrade the effectiveness of the code. The implementation of the code is enhanced through the provision of features that simplify addition of solar systems to existing structures.

1st Comment Period History

R7645-G1

Proponent Stevie Freeman-Monte **Submitted** 1/29/2019 **Attachments** No

Comment:

I support this proposed code modification.

SECTION 324

SOLAR ENERGY SYSTEMS

R324.1 General. Solar energy systems shall comply with the provisions of this section.

R324.2 Solar thermal systems. Solar thermal systems shall be designed and installed in accordance with Chapter 23 and the *Florida Fire Prevention Code.*

R324.3 Photovoltaic systems. Photovoltaic systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.1, NFPA 70 and the manufacturer's installation instructions.

R324.3.1 Equipment listings. Photovoltaic panels and modules shall be listed and labeled in accordance with UL 1703. Inverters shall be *listed* and *labeled* in accordance with UL 1741. Systems connected to the utility grid shall use inverters *listed* for utility interaction.

R324.4 Rooftop-mounted photovoltaic systems. Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be designed and installed in accordance with this section.

R324.4.1 Structural requirements. Rooftop-mounted *photovoltaic panel systems* shall be designed to structurally support the system and withstand applicable gravity loads in accordance with Chapter 3. The roof on which these systems are installed shall be designed and constructed to support loads imposed by such systems in accordance with Chapter 8.

R324.5 Building-integrated photovoltaic systems. Building-integrated photovoltaic systems that serve as roof coverings shall be designed and installed in accordance with Section R905.

R324.5.1 Photovoltaic shingles. Photovoltaic shingles shall comply with Section R905.16.

R324.5.2 Fire Classification. *Building-integrated photovoltaic systems* shall have a fire classification in accordance with Section R902.3.

R324.6 Ground-mounted photovoltaic systems. Groundmounted photovoltaic systems shall be designed and installed in accordance with Section R301.

R324.6.1 Fire separation distances.

Ground-mounted photovoltaic systems shall be subject to the *fire separation distance* requirements determined by the local *jurisdiction*.

<u>**R324.7 Solar-ready zone.** New detached one- and two-family dwellings, and townhouses with not less than 600 square feet (55.74 m2) of roof area oriented between 90 degrees and 270 degrees of true north shall comply with Sections R324.9 through R324.17.</u>

<u>**Exceptions:**</u>

New residential buildings with a permanently installed on-site renewable energy system.

A building where all areas of the roof that would otherwise meet the requirements of Section R324.8 are in full or partial shade for more than 70 percent of daylight hours annually.

Solar-ready zone. A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

R324.7.1 Construction document requirements for solar ready zone. Construction documents shall indicate the solar-ready zone.

R324.7.2 Solar-ready zone area. The total solar ready zone area shall be not less than 300 square feet (27.87m2) exclusive of mandatory access or set back areas as required by the *Florida Fire Prevention Code*. New townhouses three stories or less in height above grade plane shall have a solar-ready zone area of not less than 150 square feet (13.94 m2). The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m2) exclusive of access or set back areas as required by the *Florida Fire Prevention Code*.

R324.7.3 Obstructions. Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

R324.7.4 Shading. The solar-ready zone shall be set back from any existing or new, permanently affixed object on the building or site that is located south, east or west of the solar zone a distance not less than two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees and roof plantings.

R324.7.5 Capped roof penetration sleeve. A capped roof penetration sleeve shall be provided adjacent to a solar-ready zone. The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit, but shall have an inside diameter of not less than 11/4 inches (32 mm).

R324.7.6 Roof load documentation. The structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

R324.7.7 Interconnection pathway. Construction documents shall indicate pathways for routing of conduit or plumbing from the solar-ready zone to the electrical service panel or service hot water system.

R324.7.8 Electrical service reserved space. The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit breaker location.

> **Exception.** A listed enclosure on the supply side of the electrical service main disconnecting means providing access for future interconnection of a solar photovoltaic power production source shall be permitted. The listed enclosure shall be labeled "For Future Solar Electric." The label shall comply with NFPA 70 110.21(B).

R324.7.9 Construction documentation certificate. A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.

Fiscal Impact Assumptions Mod 7645

1. Electrical inspections will be required during the course of construction of a new dwelling. The inspections required by this modification will be performed during the regularly scheduled rough inspection.
2. The modification will result in negligible cost to the owner. The modification requires only three physical items to be installed, a capped roof penetration sleeve of a minimum inside diameter of 1.25 inches, a two pole space in the electrical panel, and labels indicating the location of the solar ready roof zone and the electrical panel space or supply side enclosure if provided.
3. The space in the electrical panel can be substituted with a listed enclosure on the supply side of the service main disconnecting means. This option would eliminate the need for additional space in the electrical panel.
4. All remaining requirements are for location of items to allow clear space on the roof for the system.

LUND UNIVERSITY

Residential solar photovoltaics deployment: barriers and drivers in space

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2017

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List of abbreviations:

IRR = Internal rate of return

PPA = Power purchase agreement

PV = (Solar) photovoltaics

TGC = tradable green certificates

TIS = Technological innovation system

TPO = Third-party ownership

Keywords: Solar photovoltaics (PV), renewable energy, sustainability transitions, technology deployment, diffusion of innovations, barriers, drivers, space, technological innovation system (TIS), technology adoption, business model, peer effects

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As regards financial support, I am very grateful to the Swedish Energy Agency (project: "Policy intervention for a competitive green energy economy"), the Swedish Research Council Formas (project: "Solenergi i stadsplanering") and the IIIEE Foundation.

Abstract

In order to support a sustainability transition in the energy sector, actors need knowledge about barriers and drivers to the deployment of clean energy technologies. Solar photovoltaics (PV) is a renewable energy technology that is technically mature and on the verge of becoming economically competitive in numerous regions around the world. Not least in the residential segment, PV has considerable potential. Even after residential PV has reached economic competitiveness, however, the technology might still face important barriers in the sociotechnical system in which it is to be deployed.

This thesis aims at adding knowledge about barriers and drivers to the deployment of residential PV systems. The research takes a sociotechnical systems perspective and demonstrates how the *technological innovation systems* (TIS) framework can be amended by the *business models* and the *diffusion of innovations* frameworks to study the deployment of a mature technology in a catching-up market, treating technology development and production as a 'black box'. The research is largely based on case studies and uses various modes of data collection and analysis. The bulk of the research was performed in Swedish settings on the national and local levels, although the United States, Germany and Japan were also studied. Studying these different contexts, the thesis builds knowledge about barriers and drivers on different spatial scales. The researched focused on the period between 2009 and 2014.

The results highlight various barriers and drivers in the studied contexts. On the national level, the Swedish sociotechnical system for PV deployment has been immature and infested by various institutional barriers. Swedish subsidies for PV deployment have been flawed with uncertainties, complexities and discontinuations, and there have been important uncertainties regarding the future development of the institutional set-up. The results also demonstrate how barriers in different national contexts have been decisive for what kinds of business models for PV deployment that have been viable. On the local level in Sweden, the results show how actors such as local electric utilities and private individuals have influenced homeowners to adopt PV through information dissemination and social influence (peer effects). The results can inform policymakers, firms and other actors as to how to support PV deployment.

Populärvetenskaplig sammanfattning

Klimatförändringarna är en av vår tids största utmaningar. För att utsläppen av koldioxid ska minska behöver teknologier för förnybar energi snabbt ersätta energi baserad på fossila bränslen. För att olika aktörer – såsom lagstiftare, företag, ideella organisationer och privatpersoner – ska kunna stödja en sådan omställning behövs kunskap om olika hinder och drivkrafter som motverkar respektive främjar (eller skulle kunna främja) spridningen av teknologi för förnybar energi.

Denna avhandling handlar om spridning av *solceller*. Avhandlingens mål är att identifiera och utvärdera hinder och drivkrafter som påverkar hur mycket solceller som installeras. Fokus ligger främst på solcellsanläggningar för privatpersoner i Sverige, vilket i regel innebär solceller placerade på villatak. Trots Sveriges geografiska läge på förhållandevis solfattiga breddgrader finns god potential för användning av solceller även i Sverige. Avhandlingen tar ett sociotekniskt systemperspektiv och analyserar samtida hinder och drivkrafter relaterade till regelverk, styrmedel, affärsmodeller, social påverkan och ekonomi. En rad fallstudier genomfördes, och data samlades in genom bland annat enkäter och intervjuer med nyckelaktörer. Genom fallstudier fokuserade på såväl det nationella som det lokala planet bygger avhandlingen kunskap om hinder och drivkrafter på olika geografiska nivåer.

Arbetet genomfördes som fyra delstudier, vilka har publicerats (eller ska publiceras) i vetenskapliga tidskrifter. Den första delstudien tog ett helhetsperspektiv på hinder och drivkrafter på nationell nivå i Sverige. Analysen återger ett underutvecklat sociotekniskt system för byggnadsanknutna solceller i Sverige och pekar på en rad problem vad gäller den institutionella stabiliteten. Brister i de ekonomiska styrmedlen har medfört osäkerheter och försämrad investeringsvilja inom installatörsbranschen samt en lång kö för privatpersoner att få ansökningar om bidrag beviljade. Stora osäkerheter har rått vad gäller den framtida utformningen av styrmedel och skatteregler. I vissa fall har det varit oklart hur befintliga regler ska tillämpas då dessa inte varit anpassade för mikroproduktion av elektricitet utan utvecklats för centraliserad storskalig elproduktion.

I den andra delstudien analyserades olika typer av affärsmodeller som nått framgång på tre stora solcellsmarknader (USA, Tyskland och Japan). En affärsmodell är det sätt på vilket företag skapar värde åt sig själva och sina kunder. Studien gick ut på att identifiera faktorer som skiljer sig åt mellan marknaderna och som skulle kunna förklara varför en viss affärsmodell nått framgång på en marknad men inte på en annan. De studerade marknaderna skiljer sig åt markant vad gäller vilka typer av affärsmodeller som nått framgång. Till exempel har leasing av solcellssystem varit mycket populärt i USA men nästintill obefintligt i Tyskland och Japan. Resultaten visade på att faktorer som husägares tillgång till kapital, sparkvoter, flyttmönster, egenskaper hos den nationella byggsektorn samt utformning av bidragssystem kan ha ett stort förklaringsvärde. Resultaten kan användas för att stödja spridning av solceller i Sverige och annorstädes, t.ex. genom att informera lagstiftare om hur institutionella hinder mot vissa typer av affärsmodeller kan avlägsnas, eller genom att informera entreprenörer om hur affärsmodeller kan anpassas för olika nationella kontexter.

Den tredje delstudien gick ut på att förklara skillnader i antalet solcellsinstallationer per capita mellan svenska kommuner. Intervjuer med lokala aktörer samt en enkät skickad till personer som skaffat solceller användes för att identifiera lokala faktorer i fem kommuner med särskilt hög solcellstäthet (antal installationer per capita). Resultaten pekar på att den troligen enskilt viktigaste förklaringen till den höga solcellstätheten i de studerade kommunerna är att lokala aktörer aktivt främjat solceller. Framförallt verkar lokala elnätsbolag som marknadsfört och spridit information kring solceller ha haft en stor effekt.

Den fjärde delstudien handlade om social påverkan mellan privatpersoner. En rad utländska studier har tidigare visat att varje ny solcellsinstallation ökar sannolikheten för ytterligare installationer i dess absoluta närhet, vilket indikerar att grannar påverkar varandra att skaffa solceller. Kunskapen om *hur* denna påverkan gått till har dock varit låg. En enkät skickades till solcellsägare, och uppföljande intervjuer genomfördes med utvalda respondenter. Resultaten tydde på att påverkan främst skett genom förhållandevis nära sociala nätverk (mellan släkt och vänner snarare än mellan grannar utan någon närmare relation), samt att den information som förmedlats och som ansetts viktig främst varit en *bekräftelse* på att anläggningen är enkel att använda, levererar elektricitet som förväntat och är driftsäker, samt att inga obehagliga överraskningar är att vänta. Kontakt mellan privatpersoner har således fungerat som ett komplement till professionell rådgivning, där solcellsägande privatpersoner förmedlat en trygghet som ökat deltagarnas benägenhet att skaffa solceller trots att de saknat proffsens detaljkunskaper.

I sin helhet visar avhandlingen på en rad viktiga hinder och drivkrafter för spridning av solceller. Dessa hinder och drivkrafter kopplar till såväl nationella styrmedel och regelverk som till lokala informationsinsatser och social påverkan. Genom att öka kunskaperna om hinder och drivkrafter på olika geografiska nivåer bidrar avhandlingen till bättre förutsättningar för olika aktörer att underlätta spridning av solceller.

List of papers

This thesis is based on the following four research papers (articles). The full papers can be found at the end of the thesis.

Paper 1:

Palm, A., 2015. An emerging innovation system for deployment of building-sited solar photovoltaics in Sweden. Environmental Innovation and Societal Transitions 15, 140-157.

Paper 2:

Strupeit, L., Palm, A., 2016. Overcoming barriers to renewable energy diffusion: business models for customer-sited solar photovoltaics in Japan, Germany and the United States. Journal of Cleaner Production 123, 124-136.

This paper was produced by my colleague Lars Strupeit and me in close collaboration. As regards research design, the credit goes mainly to Lars. Data collection was split between us, with me responsible for one case (Japan) and Lars for the other two cases. The literature review, data analysis and writing were performed by the two of us in close collaboration.

Paper 3:

Palm, A., 2016. Local factors driving the diffusion of solar photovoltaics in Sweden: A case study of five municipalities in an early market. Energy Research & Social Science 14, 1-12.

Paper 4:

Palm, A., 2016. Peer effects in residential solar photovoltaics adoption – a mixed methods study of Swedish users. Submitted to Energy Research & Social Science.

Content

1. Introduction

To cope with the challenge of climate change, the need for a transition to a low-carbon energy system is urgent (IPCC, 2014). Such a transition is likely to not only involve the introduction of new energy technologies, but also changes of a more social character, involving institutions, consumption behaviour, knowledge and business models (Geels, 2002; Grübler, 2003; IPCC, 2014; Kemp et al., 1998). Sociotechnical transitions of this kind have occurred several times throughout history in different sectors, but they normally take decades (Grübler, 1996), not only because of the time required to develop and refine new technological artefacts, but also because of various barriers in the sociotechnical environment in which the technology is to be deployed. Not least in the energy sector, such barriers are often severe (Unruh, 2000).

Common barriers to the dissemination of new technology include high costs, technical flaws and poor compatibility with existing infrastructure (Geels, 2002; Grübler, 1996; Kemp et al., 1998). Key reasons that new technology tends to be expensive are that production typically takes place on a relatively small scale, and that processes of learning regarding efficient production are yet to occur (Grübler, 2003; Kemp and Soete, 1992). Long periods of experimentation and learning are typically required to bring down costs and refine the performance of a new technology (Grübler, 2012; Kemp and Soete, 1992; Rosenberg, 1994).

Even after a new technology has reached economic and technical competitiveness, important barriers of a more social character typically remain, obstructing deployment of the technology. Organisational and institutional support for new energy technologies is often lacking, while existing (competing) technologies have built up such support over a long period (Bergek et al., 2008a; Geels, 2002; Grübler, 2012; Hekkert et al., 2007; Unruh, 2000). Existing institutions are often poorly aligned to new, radical innovations as the institutions were often adapted for another technological regime, and incumbent companies with vested interests in preserving the status quo will often use their (superior) financial resources and networks to hold new competitors back, e.g. through lobbying (Unruh, 2000). Besides, consumers tend to be somewhat suspicious of new technologies, and complexities and uncertainties (perceived or real, technical or institutional) can often deter potential adopters (Kemp et al., 1998; Rogers, 1983).

There is also an important spatial dimension to the dissemination of innovations. Understanding the preconditions for a transition requires an understanding of how different phenomena relate to geographical places and scales (Coenen et al., 2012; Hansen and Coenen, 2015). The spatial dimension of sustainability transitions has, nevertheless, remained underexplored (Coenen et al., 2012; Hansen and Coenen, 2015). For example, local aspects related to consumers and market formation have only been sporadically considered in the transitions literature (Hansen and Coenen, 2015).

There are various strategies that different actors can use to facilitate a transition. Various policy interventions can be used, based on economic instruments, regulatory approaches or information dissemination (IPCC, 2014). Firms can develop innovative business models that fit certain characteristics of a new technology (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013). Information campaigns and lobbying can be run by non-profit organisations or others. Individuals can influence each other through social networks. Such activities can make a new technology disseminate more quickly. To enable different actors to facilitate a transition in an informed manner, a thorough understanding of the sociotechnical system in which the technology is to be deployed is needed.

This thesis is about the deployment of one specific renewable energy technology, namely *solar photovoltaics* (PV). The aim is to identify and assess *barriers* and *drivers* that obstruct and facilitate PV deployment. The thesis takes the *spatial* dimension into consideration, recognising that geographical place and scale might matter in different ways for different barriers and drivers. The scope is limited to the residential sector, i.e. to PV systems situated on the premises of private homeowners. Only grid-connected applications are considered. The thesis adopts a systemic, sociotechnical view of technology deployment, recognising that deployment depends on an interplay between aspects such as institutions, perceptions, social influence, economy infrastructure and artefacts (Bergek et al., 2008a; Geels, 2002; Grübler, 2003; Hekkert et al., 2007; Hughes, 1993; Markard et al., 2012; Unruh, 2000).

The research behind the thesis has been presented to the research community in four papers. Three of them have been published in different peer-reviewed academic journals, and the fourth is under revision. The papers are summarised one by one in section 3, and the full papers are provided as appendices.

Box 1. Background: PV technology

What is a PV system?

A PV system consists of a number of PV modules and any necessary mounting device, wiring, power inverters etc. Each module consists of a series of solar cells encapsulated into a weather-resistant shell with a transparent surface. PV systems take advantage of the photovoltaic effect, which occurs as the semiconductive material of solar cells is exposed to sunlight.

PV development and dissemination: a brief history

After its invention in the mid-1900s, PV technology found its first significant commercial market in the space industry, where the then high cost of PV was of minor concern. Subsequent niche markets include pocket calculators, early mobile phones, remote transmission stations, parking meters and holiday cottages. As a result of cost reductions and subsidies, the residential rooftop segment gained relevance in the 1990s. Global PV installations came to be dominated by a handful of countries with ambitious subsidy schemes, including Japan, Germany and the United States. In the most recent years, the global PV market has become increasingly geographically diverse.

Technical benefits and challenges of PV

Rooftop PV systems allow adopters to produce and use their own electricity. As the production is close to the user, transmission losses are kept at a minimum. PV technology is highly modular, and PV can feasibly be applied on vastly different scales (from pocket calculators to ground-mounted solar parks). A challenge of PV is intermittency (electricity is produced only when the sun shines), and an increasing share of PV in the power systems might eventually increase the need for load management.

The efficiency of most commercial PV modules in converting solar energy into electricity is around 15%, a figure that has gradually increased from around 6% in the earliest years of PV technology. This figure might not appear too impressive at first glance, but, considering the large amounts of solar energy entering the Earth, it is more than enough from a technical perspective. The global technical potential for electricity generation is several times larger for PV than for biomass or wind power (de Vries et al., 2007).

Although solar cells can be made from a variety of different materials, the world market has been dominated by cells made of silicon, which is the Earth's second most abundant element. The lifecycle greenhouse gas emissions and other externalities of PV systems are normally small in comparison to fossil fuel based electricity generation systems. The energy payback time of silicon-based PV systems under average United States and Southern European conditions is typically around two to three years (Fthenakis and Kim, 2011), and the lifetime of PV modules can be assumed to be 25 years or more (Bazilian et al., 2013).

1.1. PV deployment: barriers, drivers and space – previous knowledge and gaps in the literature

1.1.1. Barriers and drivers to PV deployment

Residential PV deployment faces substantial challenges, including issues that are general to the deployment of new technologies as well as issues that are more specific to PV, the electricity system and the built environment. While barriers are present throughout the PV value chain, this thesis focuses on barriers at work in the *deployment* phase. Deployment is defined here as the process of putting the technology into use, involving activities occurring at and around the very end of the value chain (see section 1.3 for a more detailed definition).

From a purely technical point of view, PV has been a rather mature technology for decades, performing well in various applications (Jacobsson et al., 2004). However, PV is a radical innovation in the context of national electricity systems and the built environment (Awerbuch, 2000; Schleicher-Tappeser, 2012). Compared to established electricity generation technologies, PV is a disruptive technology as it (a) can be distributed at many points in the electrical grid rather than concentrated to a few large plants, (b) can be located at the user side of the electricity meter, and (c) produces electricity intermittently (only when the sun shines). As a radical technology that requires compatibility with other systems, PV can be expected to face substantial challenges regarding compatibility with existing institutions, practices and infrastructures when deployed in a new context (cf. Kemp et al., 1998). Although there is a fair amount of literature on barriers and drivers to PV deployment, there are various relevant research gaps, of which this thesis addresses a few.

Historically, high costs of PV-generated electricity compared to electricity bought from the grid have been a dominant barrier to residential PV and other grid-connected PV applications (Arvizu et al., 2011; Jacobsson et al., 2004). Only recently have costs of PV technology become low enough for PV to compete in grid-connected applications without subsidies. These cost reductions have largely been the result of learning and economies of scale in the production of solar cells, including input materials (Candelise et al., 2013; de La Tour et al., 2013; Jacobsson et al., 2004; Neij, 2008; Nemet, 2006; Zheng and Kammen, 2014). However, this thesis mainly studies a context (Sweden) in which limited economic profitability has remained a substantial barrier.

To overcome the cost barrier, subsidies to deployment have been a common strategy and an important driver. However, not only the sheer size of subsidies is important, but also various other design aspects. For example, the remuneration can be based on the electricity production, total cost or installed capacity of a PV system, creating somewhat different incentive structures (Haas, 2003). Regardless of which strategy is chosen, the literature stresses the importance of keeping subsidies predictable (to reduce uncertainty), user-friendly (to reduce complexity) and dynamic (to be adaptable to external changes). It is crucial to keep the economic profitability (measured for example as the ***internal rate of return***, IRR) of investing in a PV system predictable. Remuneration levels should thus be continuously monitored and adapted to changing prices of PV systems (Haas, 2004, 2003; Sandén, 2005). Throughout Europe, insufficient guarantees regarding the continuation of subsidies have been a common problem (Dusonchet and Telaretti, 2010). The potential of subsidies for PV adoption to drive down costs of PV technology has also been stressed, as the subsidies provide the industry with a market in which it can sell its products and thus learn how to produce and deploy PV more efficiently (Jacobsson et al., 2004; Sandén, 2005). There has, however, been a large variation in how subsidies for PV deployment have actually been designed.

An economic barrier that is particularly tangible for PV is the relatively high ***upfront*** cost. That is, the total lifecycle cost of PV systems is typically highly concentrated to the initial investment. The 'fuel' is free and maintenance costs are low, and although a PV system might be a beneficial long-term investment, prospective adopters might not be able to purchase a PV system due to difficulties in raising the necessary capital (Rosoff and Sinclair, 2009; Yang, 2010). This issue can also deter potential adopters that use a high (explicit or implicit) discount rate.

As costs of PV systems have decreased over time, other barriers than poor economic profitability have gained in relative importance. For example, various complexities and uncertainties (institutional, financial, technical) will often deter potential PV adopters (Karteris and Papadopoulos, 2012; Rai et al., 2016; Rosoff and Sinclair, 2009; Shih and Chou, 2011; Simpson and Clifton, 2015). Examples of specific institutional barriers to PV deployment that have been pinpointed in the literature are a lack of reliable installer certification and standards for technical components and grid-connection (Shrimali and Jenner, 2013; Simpson and Clifton, 2015; Zhang et al., 2015), and long turnaround times and high fees in permitting (Dong and Wiser, 2013; Li and Yi, 2014). Incumbent actors in the electricity sector that have seen their revenues being threatened by the dissemination of residential PV have often tried to influence institutions to counteract PV dissemination, with some (albeit limited) success (Hess, 2016).

Barriers to PV deployment may often be rooted in the electricity and housing systems. Barriers to new technologies tend to be most severe for "systemic technologies that require change in the outside world" (Kemp et al., 1998). For PV to achieve compatibility with buildings and electricity systems, technical and institutional change in these systems might be required. Housing and energy are also typically highly regulated, meaning that various legislative barriers might be present (cf. Unruh, 2000). Systems for electricity generation and distribution can be understood as 'large technical systems' of high complexity and inertia (Hughes, 1993). In such systems, existing institutions and infrastructures often interact to obstruct the deployment of new technologies. Legislation and other institutions in the electricity sector have typically been adapted for a technological regime (cf. Geels, 2002) of centralised large-scale facilities (Unruh, 2000). Current energy systems can be understood as being in a state of 'carbon lock-in' caused by "technological and institutional co-evolution driven by path-dependent increasing returns to scale" (Unruh, 2000), impeding radical innovation in the energy sector and conserving the status quo. Furthermore, technological change is typically slower in sectors of long-lived structures (Grübler, 1996). Only rarely does new energy technology replace existing technology through the premature retiring of existing capital stock; thus, the longevity of plants and infrastructures in incumbent energy systems holds back the dissemination of new energy technologies (Grübler, 2012).

In understanding barriers and drivers to PV deployment, it is important to understand the motives for adopting a residential PV system. In developed countries, motives have mainly related to electricity bill savings, reduced environmental impact, energy independence and a general interest in new technology (Rai et al., 2016; Schelly, 2014; Zhai and Williams, 2012). In markets where PV adoption has been a poor economic investment, concern for the environment and an interest in the technology have often been important driving forces for those few adopting PV (e.g. Palm and Tengvard, 2011).

It is recognised that business model innovation (the development of new business models or the adaptation of existing ones) could serve to overcome certain barriers to PV deployment. For example, third-party ownership (TPO) business models can address the high upfront cost of PV systems, bureaucratic hassle and concerns related to operation and maintenance (Overholm, 2015). Research on how different business models for PV deployment relate to different contextual factors has, however, been scarce.

1.1.2. The spatial dimension of PV deployment

Barriers and drivers to PV deployment can be rooted in different places and extend over different geographical scales. The production of PV system components has mainly taken place in other parts of the world than where the technology has been deployed (Huang et al., 2016; Quitzow, 2015), and the part of the value chain where development and production occur has been more global by nature than have processes of deployment. Processes occurring 'upstream' in the PV value chain, such as silicon purification and wafer production, are technologically advanced and take place in a global arena. In this part of the value chain, skilled staff has been recruited from around the world and production equipment and produced goods have been traded internationally (de la Tour et al., 2011; Huang et al., 2016). The development of institutions governing the global PV industry has been shaped by an interplay between governments and firms across national borders (Bohnsack et al., 2016). Although the actual production of PV system components and input materials has been concentrated to certain places, the sociotechnical system for the generation of PV system components has thus been rather global by nature. At the subsequent steps down the value chain too, solar cells and modules are traded globally nearly as commodities. As a consequence, cost reduction and technological improvements of PV system components have been globally pervasive, thus directly reducing barriers to PV deployment around the world.

PV deployment is an inherently more local process. Installations must be performed on-site, and the geographical focus of the actors involved typically range from the local to the national scale. Deployment in any given place is typically strongly dependent on formal institutions applying to a limited geographical area (Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015), including subsidies, tax rules, building permits and rules for grid-connection.

The cost and technical performance of PV technology have thus been determined to a great extent by factors beyond the deployment context, operating at other geographical places and scales.

Although PV system installation is in itself a rather straightforward procedure, PV deployment is a complex and systemic procedure involving interaction between various actors, institutions and artefacts (Quitzow, 2015). PV deployment and production could indeed be understood as being different sociotechnical systems with different spatial characteristics, interconnected through certain linkages (cf. Bergek et al., 2015; Markard et al., 2015; Quitzow, 2015; Sandén et al., 2008). For small national deployment markets, the global PV industry could be seen as an 'external force' (cf. Sandén et al., 2008). Deployment could thus be characterised as taking place in sociotechnical 'sub-systems' (national or regional PV markets) to a global sociotechnical system for PV technology. The geographical reach of these sub-systems is presumably defined to a great extent by national borders, as the nation state is a natural upholder and enforcer of formal institutions. Although the aggregate of these sub-systems is what fuels (and is fuelled by) the global production system for PV system components, the individual sub-systems are often too small to substantially influence the global system (a counterexample is the domination of the German PV market on global demand in the early 2000s (Quitzow, 2015)).

Conventional methods for analysing technological transitions have suffered from a lack of attention to geographical aspects of the kinds described above (Coenen et al., 2012; Raven et al., 2012). The most widely used sociotechnical system approaches to understanding sustainability transitions are *technological innovation systems* (TIS) and the *multi-level perspective* (MLP) (Coenen et al., 2012; Coenen and Díaz López, 2010; Markard et al., 2012; Markard and Truffer, 2008; Weber and Rohracher, 2012). These approaches have been developed and conventionally applied to consider processes of technology development and deployment together as belonging to one and the same system. However, neither of them has been very explicit on how to deal with spatial division of labour of the kind occurring in the PV value chain (Coenen et al., 2012), although some development has occurred in this regard in parallel to the work with this thesis (Hansen and Coenen, 2015).

As stated, PV technology is mature regarding technical performance, and is reaching cost competitiveness in an increasing number of regions. Meanwhile, there are numerous potential national and regional markets around the world where PV penetration is (still) very low. These markets can be seen as potential catching-up markets, into which PV technology could be imported and deployed relatively swiftly if their internal barriers to deployment are not too severe. The potential global aggregate for PV uptake in such markets is huge, and it is thus important to understand barriers and drivers to deployment in these markets. Research on barriers and drivers to PV deployment in catching-up markets has, however, been scarce.

Various factors of a more local nature have been found to influence PV adoption rates, such as local variations in solar insolation, electricity prices (Kwan, 2012) and rules and procedures for permits, grants and grid-connection (Brudermann et al., 2013; Dong and Wiser, 2013). There is also some evidence that local organisations can overcome barriers to deployment by promoting PV through campaigns, information provision, lobbying or demonstration projects (Brudermann et al., 2013; Dewald and Truffer, 2012; Noll et al., 2014; Owen et al., 2014). As argued by Noll et al. (2014), such local initiatives are likely to have the largest impact on PV adoption rates if residential PV adoption is neither highly profitable nor clearly unprofitable. As financial aspects are neither the dominant driver nor a major barrier in such situations, the argument goes, there is more opportunity for information campaigns or seminars to make a relative difference in driving adoption rates. However, the understanding of what factors can explain local variation in PV adoption rates has been limited.

A driver with an often inherently large local component is social influence between peers, also referred to as *peer effects*. Positive word of mouth often plays an important role in overcoming barriers to the diffusion of innovations (Rogers, 1983). This is particularly true in situations where the support of a strong brand or strong marketing resources are lacking, which is often the case for small companies marketing radical innovations (Mazzarol, 2011). A number of recent studies have attempted to quantify local peer effects in terms of increased probability of additional nearby PV adoptions following previous adoptions (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). The results indicate that peer effects are stronger down to the zip code or street level (e.g. Bollinger and Gillingham, 2012). Some early attempts have also been made to separate *active* (through direct interpersonal contact) and *passive* (through passively observing PV systems) peer effects, although the results have remained rather inconclusive (e.g. Rai and Robinson, 2013). Pre-existing research on peer effects in PV adoption has focused on estimating the sheer magnitude of the effects, and the qualitative perspective has been lacking. The actual mechanisms underlying the peer effects have thus remained poorly understood.

There is some evidence that local organisations can take advantage of peer effects to reduce barriers to adoption. The findings of Noll et al. (2014) suggest that local non-profit organisations promoting residential PV in the U.S. have managed to leverage the impact of their activities through peer effects by engaging local individuals. A better understanding of how peer effects actually work could potentially inform organisations in how to exploit peer effects to boost PV uptake.

1.2. Objective

The objective of this thesis is to advance the knowledge on *the deployment of residential PV systems*. More specifically, the thesis aims at identifying and assessing *barriers* and *drivers* that obstruct or facilitate PV deployment in different geographical settings, taking the spatial dimension into account. Barriers include any factors in the sociotechnical system surrounding PV deployment that obstruct the deployment process, thus reducing the rate of PV adoptions. Correspondingly, drivers are sociotechnical factors that facilitate PV deployment, thus increasing adoption rates. Such barriers and drivers may relate to for example institutions, firms, economy, human behaviour, infrastructure or technology. Studying different national and local contexts, the thesis aims at building knowledge on barriers and drivers on different spatial scales. The thesis aims at answering four different research questions, one for each paper:

- RQ1 (paper 1): What barriers are present in the Swedish sociotechnical system for residential PV deployment?

- RQ2 (paper 2): How have different kinds of business models been successfully designed by firms to overcome country-specific barriers to residential PV deployment in different national contexts?
- RQ3 (paper 3): What local factors can explain geographically uneven adoption rates (as measured on the municipal level) of residential PV systems within Sweden?
- RQ4 (paper 4): How has social influence between peers (peer effects) reduced barriers to PV adoption among Swedish homeowners?

The thesis is largely based on case study methodology. Important modes of data collection were interviews and surveys, although data were gathered in various other ways as well. Both qualitative and quantitative methods were used.

The target audience includes actors that might have an interest in stimulating PV dissemination. These include policymakers, firms and non-profit organisations.

1.3. Scope

This thesis focuses on a particular part of the PV value chain, namely on *deployment*. Deployment is defined here as the process of putting the technology into use, and involves various activities taking place at and around the very end of the PV value chain, such as PV system marketing, sales, installation and adoption decision making among (potential) users. Deployment is thus the last set of processes in a series of events that lead to a PV system being commissioned. Processes taking place further upstream in the value chain, such as technology production and development, are outside the scope.

Although the terms 'deployment' and 'dissemination' are often used interchangeably, 'deployment' is in this thesis used to signal that it is activities at the end of the value chain that are alluded to. The term 'dissemination' is used here to describe the increased uptake of an innovation (e.g. the number of PV systems per capita) without alluding to any particular part(s) of the value chain. Dissemination is thus regarded here as an outcome of the combination of technology development, production and deployment.

With a focus on deployment, there is little reason to delimit the scope to PV systems based on any particular kind of solar cells. Although crystalline silicon solar cells dominate PV markets worldwide, other kinds of solar cells are in principle not excluded from the analysis. Other cell types can be produced with very different methods using different materials, but once encapsulated into modules they can typically be treated more or less as equivalents for residential applications. The deployment focus thus allows the researcher to regard PV modules as 'black boxes' converting sunlight into electricity regardless of the characteristics of its internal processes.

As regards different applications, the focus is on the *residential* segment, i.e. on systems situated in connection to and providing electricity to a particular household. Thus, larger ground-mounted installations, industrial applications and most applications on multi-family dwellings are not considered. Although people renting their homes are in principle not excluded, the current state of affairs in PV markets around the world (including the studied contexts) implies that the adopter category of interest is that of private homeowners.

Regarding *geography*, most of the research focused on Sweden, either the whole country (paper 1) or more local entities (papers 3 and 4). Only in paper 2 was the focus on markets outside Sweden, namely Germany, Japan and the United States. Paper 2 does, nevertheless, provide important lessons for Swedish actors regarding the future development of the Swedish market as this paper studies more developed markets. Papers 3 and 4 differ from the other papers in that they have a *local* focus. All research was conducted in developed countries only. Practically all households in the studied contexts are connected to the electrical grid, and the thesis thus considers grid-connected PV applications only.

Sweden was chosen as the main setting for three key reasons. First, residential PV as an investment in Sweden has been neither clearly unprofitable nor very profitable in recent years. When PV adoption offers limited (but not too poor) prospects of economic gains, various non-economic factors are presumably more likely to have a relatively high impact on adoption rates (cf. Noll et al., 2014), which makes such factors more easily observable. This makes Sweden a potentially fruitful case for studying non-economic barriers to deployment. Second, there has been a lack of research on barriers to PV deployment in catching-up markets. The aggregate of (potential) catching-up PV markets around the world offers a huge potential for PV uptake, and understanding barriers in such contexts is thus of utmost importance. Third, data for Sweden were relatively accessible as the researcher was based there and is a native speaker of the language. Paper 2 went outside the Swedish context because there was not enough empirical data to be found on the topic of interest (business models for PV deployment) within Sweden. A better understanding of business models can nevertheless be useful to support PV deployment in Sweden and other catching-up markets.

Regarding *time*, the research focuses mainly on phenomena that occurred between 2009 (when a subsidy for residential PV was launched in Sweden) and 2014. During that period and up until the time of writing this chapeau (late 2016), the studied PV markets, as well as other PV markets around the world and the global PV industry, have developed substantially. There is, nevertheless, little reason to believe that the findings of this thesis (with perhaps some minor exceptions) are less relevant at the time of finishing the thesis than a few years earlier. First, as observed by the researcher, most of the barriers to deployment in Sweden identified throughout the research remain at the time of finishing the thesis and are thus still relevant targets for policy. Second, even if the studied contexts have changed, there are numerous markets around the world that will likely face challenges similar to those encountered in the studied cases, and that can learn important lessons from them.

All papers except paper 4 adopt a systemic perspective in their respective context, considering a variety of interacting factors in PV deployment. Paper 4, being narrower in scope, focuses exclusively on social influence between peers in PV adoption.

1.4. Limitations

Some limitations of this thesis need to be recognised. First, the generalisability (external validity) of the findings is limited by the fact that the bulk of the research was focused on the Swedish context. Generalisability might be largest to similar cases, e.g. to developed countries with PV markets that are in an early stage of development and where the economic profitability of adopting a PV system is limited.

Second, the perspectives of all relevant actors are not always present. Due to restrictions in time available to the researcher, primary data could not be collected through interviews or surveys for all actors but were collected only from actors that were deemed the most relevant. In paper 1, the actors interviewed were general experts, installers and electricity companies, while primary data were not gathered for adopters and policymakers. In paper 2, primary data were obtained from companies using the business models of interest and from industry experts, but not from the companies' customers or from companies using other business models. Also in paper 3, a deeper understanding could possibly have been obtained through interviews with adopters that responded to the survey.

Third, the number of cases in the comparative case studies (papers 2 and 3) was constrained by limitations in the amount of time available to the researcher rather than by theoretical saturation (cf. Glaser and Strauss, 1967). With more cases added, the internal and external validity could have been increased, and additional insights could potentially have been reached.

Fourth, data could have been gathered to support more elaborate statistical analyses. For paper 3, data could have been collected to perform statistical analyses comparing a larger number of municipalities with regard to how various aspects correlate with PV adoption rates. For paper 4, a larger sample with secured representativeness would have made more elaborate statistical analyses possible.

2. Methodology

This section starts with a description of three theoretical frameworks that were used to guide the research. Then, the overall research design, which is based on case studies and various methods for data collection and analysis, is presented. Lastly, the interdisciplinary nature of the research is discussed briefly.

2.1. Theoretical frameworks

The research conducted for this thesis was guided by a variety of theoretical frameworks and concepts. However, three theoretical frameworks were particularly important. The rationale for choosing these frameworks is described below, after which the frameworks are outlined one by one.

As the thesis aims at identifying barriers and drivers throughout sociotechnical systems for PV deployment, the theoretical framework, or set of frameworks, used must reflect the 'whole' system. There are existing frameworks that fit this purpose quite well. In particular, the *technological innovation systems* (TIS) framework (e.g. Bergek et al., 2008a; Hekkert et al., 2007) and the *multi-level perspective* (MLP) (e.g. Geels, 2002) have been developed to analyse the development and deployment of new technologies from a sociotechnical systems perspective. These two frameworks have become dominant as analytical tools to understand (various barriers and drivers to) sustainability transitions, and, even though they have been developed rather independently of each other, they are largely focused on the same real-world phenomena and share several key concepts (Coenen et al., 2012; Markard and Truffer, 2008). Although these frameworks were not developed for any particular technology or sector, they have very often been applied to renewable technologies in the energy sector (Markard et al., 2012; Markard and Truffer, 2008).

Yet, there are differences between these two frameworks. The TIS framework is apt for studying barriers and drivers at different stages of a technology's development (Bergek et al., 2015, 2008a; Markard et al., 2012), while the MLP framework is relatively more focused on niche applications *or* regimes and less so on intermediate stages of development (Markard and Truffer, 2008). The MLP framework is more apt to explain broader transformative changes than the TIS framework, which is more focused on technology-specific matters (Markard et al., 2015; Weber and Rohracher, 2012). These differences hint that the TIS framework might be a more appropriate choice for the purpose of studying the deployment of a mature technology (PV) in an application that is not to be considered a niche (the residential application) but that has become mainstream in other geographical contexts and is expected to become mainstream also in the country or region of interest. Thus, the thesis uses the TIS framework as a starting point to analyse barriers to PV deployment (paper 1).

The wide scope of the TIS framework implies that it is not as detailed in all parts of the studied sociotechnical system. To further understand barriers and drivers to PV deployment, papers 2-4 analyse specific parts of the deployment systems. The research designs of papers 2-4 thus required the identification of the most relevant parts of these systems, as well as the identification or construction of theoretical frameworks that zoomed in on these parts.

Ideally, the TIS framework would provide adequate guidance to other frameworks that could be applied when studying certain phenomena in greater depth. This is the case for some phenomena that are within the scope of the TIS framework; for example, the TIS framework assigns significant importance to institutions, and accordingly the TIS literature refers to central literature on institutional theory, particularly to literature that deals with relationships between institutions and technological change. However, when it comes to other phenomena that occur in the TIS framework, such as the different actors involved in technology deployment and some of the 'functions' (key processes), the TIS literature does not connect as well to other literature streams. Neither does it provide guidance to any subsystems that might be analysed.

A useful analysis has, nevertheless, been performed by Foxon (2011), who identified a set of key coevolving systems relevant when analysing sustainability transitions, namely *ecosystems*, *technologies*, *institutions*, *business strategies* and *user practices*. Of these systems, *ecosystems* are regarded as external in this thesis. Also *technologies* are largely regarded as an external force, as the focus is on the deployment of artefacts that are in themselves technically mature and imported from another system. *Institutions* are crucial to a systemic analysis of barriers to deployment but are, as stated, quite well covered by the TIS framework, and paper 1 accordingly provides a thorough institutional analysis. Thus, potential areas for further studies remaining after the completion of paper 1 are *business strategies* and *user practices*. Business strategies have also been identified as crucial in bringing sustainable products to the market within the *business models* literature (Bocken et al., 2014; Boons and Lüdeke-Freund, 2013; Mont et al., 2006; Reim et al., 2015; Tukker, 2004). Furthermore, Schot et al. (2016) have made a strong case for dealing in greater depth with the role of users in the technological transitions literature.

Suitable frameworks for studying business strategies and user practices are the *business models framework* (Amit and Zott, 2001; Shafer et al., 2005) and Rogers' (1983) *diffusion of innovations* framework, respectively. Thus, these frameworks were used for papers 2-4. These frameworks fit within the scope of the TIS framework as they zoom in on real-world phenomena covered by the TIS literature. Both frameworks could be positioned relatively easily within the TIS literature as they clearly relate to core TIS concepts. What the TIS framework intends to capture by stressing the importance of firms and the function 'entrepreneurial experimentation' has a large overlap with what is described in the business models literature. The business models literature, being solely devoted to this topic, is nevertheless much more detailed on the phenomena of interest. In a similar manner, the role of users and the functions 'legitimation', 'knowledge development and diffusion' and 'market formation' of the TIS framework have a large overlap with what is dealt with in Rogers' diffusion of innovations framework.

2.1.1. Framework 1: Technological innovation systems (TIS)

The technological innovation systems (TIS) framework was developed to analyse the development, production and deployment of new technologies from a sociotechnical systems perspective (Bergek et al., 2008a; Hekkert et al., 2007). Its most common application has been to identify and assess barriers and drivers to technology dissemination in order to derive policy recommendations, often with the purpose of understanding how increased uptake of renewable energy technologies could be supported (e.g. Dewald and Truffer, 2011; Dewald and Fromhold-Eisebith, 2015; Jacobsson and Bergek, 2011; Quitzow, 2015; Sandén et al., 2008; Suurs, 2009; Suurs and Hekkert, 2009).

The TIS literature is a branch of a wider innovation systems literature, including other innovation systems approaches such as *national*, *regional* and *sectoral* innovation systems. An innovation system belonging to any of these categories can be understood as a complex system of actors and institutions involved in the development, production and deployment of new technology. Originally, the innovation systems literature focused on *national* innovation systems, which are not restricted to one particular technology but deal with the general innovative capability of a country (Lundvall, 2010). Subsequently, literature emerged on sector-specific innovation systems (Malerba, 2009) and, narrowing down, on innovation systems for specific technologies – that is, on TISs. The innovation systems literature emerged largely as a result of a frustration among certain scholars regarding how (mainstream) economics dealt with economic development; the argument was that it neglected processes of learning, institutions and technological change, and wrongfully assumed a static equilibrium (Sharif, 2006).

The rate and direction of technological change can be understood as being determined more by competition between innovation systems than between technologies (Hekkert et al., 2007). A major external force of a TIS for PV deployment is the incumbent system for electricity production, which could be understood as a sectoral innovation system, or as a sociotechnical *regime* (Geels, 2002). As stated, such incumbent systems/regimes could be expected to be locked in through various technological and institutional mechanisms, making it difficult for new and competing technologies to gain ground (Unruh, 2000).

In this thesis (paper 1), the TIS approach was used somewhat differently than in most previous TIS studies as it was applied to the *deployment* phase exclusively. Earlier TIS studies (as most other innovation system studies) have been predominantly used to study processes of development, production and deployment together as occurring in one and the same system, or they have paid less attention to deployment than to development and production (Dewald and Truffer, 2011). However, due to spatially different characteristics between different parts of the PV value chain (see section 1.1.2), a pure deployment focus was deemed the most appropriate for the present research (see also section 2.1.1.3).

In recent (post-2007/2008) TIS literature (Bergek et al., 2008a; Hekkert et al., 2007), a TIS is normally divided into one 'structural' and one 'functional' (more dynamic) part. These are outlined below, and it is briefly explained how they may relate to technology deployment. A brief account of how to think about geographical system boundaries in relation to the value chain follows, as this was an important issue in paper 1.

2.1.1.1. The structure of a TIS

The 'structure' of a TIS is normally thought of in terms of the following three categories of elements:

- *Actors*: Any organisations or individuals relevant for the development or deployment of the technology. With a deployment focus, core actors include, for example, installers and suppliers of turnkey systems and components, policymakers and (potential) adopters.
- *Networks*: Linkages between actors through which information is exchanged. In deployment, associations for installers and suppliers are frequently of high importance, as well as informal networks between adopters. Advocacy coalitions may attempt to influence policy though political networks (Bergek et al., 2008b).
- *Institutions:* Any humanly devised rules (formal or informal) affecting the development or deployment of the technology, such as laws, standards, practices or collective mind frames. For deployment, technology standards

(Ma, 2010) and popular perceptions (legitimacy) (Jacobsson and Bergek, 2004) are examples of institutions that are often important. Although institutions often facilitate deployment, pre-existing institutions may also prohibit or complicate the deployment of a new technology, often unintentionally.

While a TIS is in its early stages, the institutional set-up is usually badly aligned to the emerging technology as institutions are either not in place or are maladapted to the technology. The alignment of institutions to new technology is, however, notoriously an arduous process (Unruh, 2000), further complicated by the fact that firms "compete not only in the market but also over the nature of the institutional set-up" (Bergek et al., 2008a), a competition in which incumbent firms are often in a stronger position than the small newcomers that might represent the new technology. Furthermore, key actors might be missing or might not have gained the relevant knowledge, and networks are often lacking.

With a focus on deployment, these three categories of structural components are all likely to be as important as when the TIS framework is used to study development and deployment together. However, the deployment focus allows the researcher to focus his or her resources on those actors, networks and institutions that are the most relevant for deployment, thus creating room for a more in-depth analysis of those elements.

2.1.1.2. Functions of a TIS

Functions represent key processes that should occur in a TIS in order for the system to perform well. Functions have been described as constituting "an intermediate level between the components of a [TIS] and the performance of the system" (Jacobsson and Bergek, 2004) and as "emergent properties of the interplay between actors and institutions" (Markard and Truffer, 2008). The exact number of functions that should occur is somewhat arbitrary, and various sets of functions have been presented. The following set has (with some variation) gained recognition in the recent TIS literature (Bergek et al., 2008a; Hekkert et al., 2007):

- *Knowledge development and diffusion*, encompassing different processes of learning among key actors. As regards deployment, firms, policy makers and (potential) adopters need to gain an understanding of how to install, market, regulate, support and use the technology.
- *Guidance of the search*, capturing incentives for firms and other organisations to enter and participate in the TIS. The strength of this function is to a great extent determined by present and future *market formation* (see below) as perceived by relevant actors, not least when it comes to the deployment phase.

- *Entrepreneurial experimentation*, including various creative activities of firms. As regards deployment, innovation and variation regarding what applications and business models are employed can be important indicators of the strength of this function.
- *Market formation*, referring to activities that contribute to the creation of demand for the technology. Market formation is a crucial part of the deployment process and a prerequisite for dissemination. Barriers to market formation are often found in the institutional set-up (for example as a lack of standards or misaligned legislation) or in a poor price/performance.
- *Legitimation*, referring to changes in the social acceptance of a technology, or how good or desirable the technology is perceived to be. Legitimation through lobbying performed by activists and interest organisations was decisive for the implementation of deployment supporting schemes for PV in Germany (Bergek et al., 2008a; Jacobsson and Lauber, 2006).
- *Resource mobilisation*, reflecting the availability of human and financial capital necessary for the TIS to perform well. As regards the deployment of renewable energy technologies, the mobilisation of capital for subsidy schemes has often been crucial.

By identifying and strengthening poorly performing functions, policy interventions can facilitate the dissemination of a desirable technology (e.g. a renewable energy technology). This can be achieved by strengthening or adding drivers, or by weakening or removing barriers (Bergek et al., 2008a).

The functions have often been used to study feedback loops between production and deployment. When the TIS framework is applied to the deployment phase exclusively, such feedback loops will not be made visible. With a deployment focus, there is also a possibility that the relative importance between functions might differ from when the TIS framework is applied to a larger part of the value chain, as some functions might be more directly related to earlier stages of the value chain and others to deployment processes (e.g. 'market formation').

2.1.1.3. The spatial dimension and the case for deployment-focused TIS studies

Setting spatial system boundaries in TIS studies can be more or less complicated depending on the case at hand. While some technologies have their value chain assembled more or less entirely within one single country, others have their value chain distributed over different geographical places and scales. As stated by Hekkert et al. (2007), a technology is "hardly ever embedded in just the institutional infrastructure of a single nation or region, since – especially in modern society – the relevant knowledge base for most technologies originates from various geographical areas all over the world". The question of what part(s) of the value chain that are in focus thus has implications for the choice of spatial scope of the study.

A need for more elaborate approaches to geographical system boundary setting and spatial differentiation in TIS studies has been identified in recent publications (Binz et al., 2014; Coenen et al., 2012). The general trend towards increased global division of labour and specialisation in value chains (Antràs et al., 2012; Baldwin and Robert-Nicoud, 2014; Hummels et al., 2001; Los et al., 2015; Timmer et al., 2013) suggests that this need, if anything, will increase as technologies increasingly have their value chains distributed over different geographical places and scales. In parallel to the work with this thesis, empirical and conceptual work has been carried out by other scholars to make the TIS framework more elaborate regarding spatial differentiation (Bergek et al., 2015; Binz et al., 2014; Dewald and Fromhold-Eisebith, 2015; Gosens et al., 2015; Huang et al., 2016; Quitzow, 2015; Wieczorek et al., 2015). Empirical studies using geographically differentiated TIS approaches have been performed for PV (Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015), membrane bioreactors (Binz et al., 2014) and wind power (Wieczorek et al., 2015). A spatially differentiated TIS analysis, in which deployment and production are treated as (partly) different sociotechnical systems between which linkages exist, has been proposed in recent publications (Bergek et al., 2015; Dewald and Fromhold-Eisebith, 2015; Quitzow, 2015). Such analyses could often be useful, but they are resource-intensive as the researcher has to gather and analyse data from different contexts. It is thus important that the researcher knows what to focus his or her resources on and what can be left out of the analysis. Thus, there is a case for elaborating upon whether and under what circumstances the TIS framework can be applied to deployment exclusively, treating technology development and production as a 'black box'.

PV is an example of a technology whose whole value chain does not naturally fit into one and the same geographically defined TIS. As described in section 1.1.2, the development and production of PV system components take place in a global arena, and this part of the value chain is thus better understood as pertaining to a global TIS (although it might, for pragmatic reasons, make sense to define a national TIS for these processes if the purpose is to derive policy recommendations for a particular government), while the deployment of PV is an inherently much more local activity. This can make it somewhat problematic to attempt to squeeze development, production and deployment of PV into one and the same TIS, although the TIS framework is originally intended to study all these processes together. In paper 1, this dilemma was elaborated upon, and it was demonstrated that the TIS framework is useful to study deployment separately in cases where it does not make sense to include more upstream parts of the value chain in the same TIS as deployment.

Two macro trends hint that TIS analyses focused on deployment will be increasingly needed. First, an increasing global division of labour and specialisation suggests that the production and trade of artefacts will increasingly take place in a global arena, while processes of deployment may remain more localised (which has been the case for PV, see section 1.1.2). In those cases, individual end user markets will often be small in relation to the global production system, and a pure deployment focus in TIS studies may be feasible. Second, there is an increasing availability of mature renewable energy technologies that can be deployed in new regions. This availability creates a case for more deployment-focused TIS analyses to study barriers and drivers in these catching-up markets, thus informing actors in how to facilitate a sustainability transition. Furthermore, as technologies mature, their global production systems are likely to increase in size in both absolute terms and in relation to more localised deployment systems, in which case it can be feasible to treat technology development and production as a 'black box' in relation to deployment.

2.1.2. Framework 2: Business models

In order for a technological transition to take place, not only technical but also organisational innovation is required. Not least *firms*, who are usually key actors in technology deployment, might need new strategies to overcome barriers to the deployment of radical innovations. In order to profit from a new technology, firms will often need new strategies for how to provide value for their customers and capture value for themselves – that is, new ***business models*** are needed. In paper 2, an analysis was made of why different kinds of business models for PV deployment have reached success in different national contexts.

A business model is, simply put, a representation of how firms create value for themselves and their customers. Customers may be private individuals, other firms or other organisations, and value may be provided in the form of services, products or a combination of both. In two widely cited papers, business models have been described as "the design of transaction content, structure, and governance so as to create value through the exploitation of business opportunities" (Amit and Zott, 2001), and the "firm's underlying core logic and strategic choices for creating and capturing value within a value network" (Shafer et al., 2005). The business models concept became prevalent around the mid-1990s in connection with the rise of the Internet (Shafer et al., 2005; Zott et al., 2011). A deployment focus is common in business model analyses, although focus can equally well be on products that are to be further processed before a finished product can be deployed.

Although there is no precise, agreed definition of a business model, the following elements are central to most definitions (M. Richter, 2013):

- *Value proposition:* the products or services offered to customers.
- *Customer interface:* the overall interaction with customers, including customer relations, customer segmentation and distribution channels.
- *Infrastructure:* the company's inner structure for value creation, including assets, know-how and partnerships.
- *Revenue model:* the relationship between the costs and revenues of the value proposition.

It is recognised in the literature that business model innovation (the development of new business models or the adaptation of existing ones) can facilitate the deployment of new technologies (Boons and Lüdeke-Freund, 2013). A new technology might not only come with some inherent attributes that call for a new or changed business model, but also the newness in itself might entail barriers that could be addressed through business model innovation. Uncertainties and incompatibilities with existing institutions could potentially be addressed through business models designed to transfer risks and transaction costs from the customer to the company, or to neutralise particular institutional barriers.

In the present thesis (paper 2), the analysis went beyond the conventional business models framework to also consider various contextual country-specific factors. This allowed the research to identify how various barriers have influenced the viability of different business models for PV deployment in different geographical contexts.

2.1.3. Framework 3: Diffusion of innovations

In the *diffusion of innovations* literature, the (potential) adopters are in focus, as well as those influencing or trying to influence their decision to adopt or reject an innovation. Thus, this framework is deployment-focused by nature, although it does not capture the full set of actors (or other factors) relevant for deployment. This section outlines the diffusion of innovations framework as presented by Rogers (1983). Rogers' framework gathers insights from a broad set of literature and has gained wide recognition. His main contribution was to put existing research together into a comprehensible yet robust package. The framework is by no means restricted to sustainability innovations or innovations in the energy sector, but is general to innovations that are or can be adopted by individuals. Elements of the diffusion of innovations framework were used throughout this thesis, particularly in papers 3 and 4.

Rogers (1983, p. 5) defined diffusion as *"the process by which an innovation is communicated through certain channels over time among the members of a social system"*. The framework focuses on processes of decision making, how different personality types relate to the inclination to adopt an innovation, and how different attributes of innovations might influence their adoption rates. Rogers used the terms 'diffusion' and 'dissemination' interchangeably. In this thesis, 'dissemination' is used as a general term for the uptake of an innovation (e.g. in terms of adoption rates), while 'diffusion' is used for processes more specifically related to communication or exchange of ideas, or to signal adherence to the work of Rogers. In this thesis, 'diffusion' differs from 'deployment' in that 'deployment' involves more aspects than just interpersonal communication (the difference between 'dissemination' and 'deployment' has been accounted for in section 1.3).

A key feature of the framework is the categorisation of potential adopters by some key characteristics and their role in diffusion processes. Rogers promotes a categorisation of potential adopters into five ideal types (although he concedes that in reality there are no sharp boundaries between these groups):

- *Innovators* are the first to adopt innovations. The innovator is venturesome and eager to try new ideas, leading him or her to seek social relationships with other like-minded outside their local peer group. Innovators are often seen upon with some suspicion by their peers, being perceived as 'too' innovative, but they can still facilitate the diffusion process by bringing new ideas into their social system.
- *Early adopters* are somewhat less innovative than innovators. They are more integrated into their local social system than innovators, and are more influential on the attitudes of their local peers. Being both relatively respected and innovative (but not *too* innovative), they are effective role models and have the highest level of *opinion leadership* (see below) among the categories.
- The *early majority* adopts innovations just slightly earlier than the average individual. This group is an important link between early and late adopters, providing interconnectedness supporting the diffusion process. Once a person belonging to this category has started contemplating adoption, his or her decision period is longer than that of earlier adopters.
- The *late majority* adopts innovations slightly later than the average individual. Adoption often comes as the result of economic necessity or social pressure. Persons in this category tend to maintain a sceptical attitude towards new ideas in general, and practically all uncertainty about the innovation must have disappeared before they choose to adopt.
- *Laggards* are the last to adopt an innovation. They are suspicious of new ideas, and their attitudes are often aligned with the practices of previous generations. Often, however, a precarious economic situation is a partial reason for the late adoption.

The decision to adopt (and keep using) an innovation is described by Rogers as an *innovation-decision process* consisting of the following five stages:

- *Knowledge,* in which awareness of the existence of the innovation and understanding of how it works are gained.
- *Persuasion*, in which a favourable or unfavourable attitude towards the innovation is formed.
- *Decision*, involving activities leading to a choice regarding whether to adopt or reject the innovation.
- *Implementation*, in which the innovation is put into use.
- *Confirmation*, in which reinforcement of an earlier adoption decision is sought, sometimes leading to a reversal of the adoption.

Innovations have different *attributes*, which are highly influential on the rate at which they diffuse in a social system. Attributes can be generalised into the following five categories, which, according to Rogers, taken together normally explain most of the variance in the rate of adoption between innovations:

- *Relative advantage* as compared to existing alternatives. In the case of residential PV, the existing alternative would for most prospective adopters be electricity from another source or another financial investment.
- *Compatibility* with for example norms, beliefs and infrastructure. As an example, residential PV benefits from a widespread belief in the perils of climate change, but may be in conflict with permitting or tax rules.
- *Complexity* as perceived by potential adopters. Although residential PV systems are typically relatively easy to acquire and use (at least from a technical point of view), potential adopters might perceive adoption and use as potentially complicated.
- *Trialability*, reflecting the possibility of testing the technology before adopting it. Residential PV suffers from low trialability, as a PV system cannot easily be installed and uninstalled for testing on a rooftop.
- *Observability*, being the extent to which members of a social system can observe the results of an adoption. While residential PV has a high observability in terms of *awareness* (neighbours will normally notice when someone has installed a rooftop PV system), lower observability of the actual results of PV adoption (production, economy, reliability) might be a disadvantage.

A key concept in papers 3 and 4 is that of ‘peer effects’, which captures social influence between peers (e.g. neighbours, co-workers or friends) in the adoption decision process. Although Rogers did not use this particular term, much of his framework is, as should be evident from the above account, dedicated to this topic. Peer effects can be *active* (occurring through direct communication between peers) or *passive* (occurring without direct communication, for example when someone observes a new PV installation in their neighbourhood) (e.g. Rai and Robinson, 2013). Peer effects have been observed in the adoption of a variety of technologies, such as menstrual cups among Nepalese adolescents (Oster and Thornton, 2009), electric vehicles (Axsen et al., 2009), information and communication technologies (e.g. Stewart, 2007), housing renovation (Helms, 2012) and various kinds of farming equipment (Rogers, 1983). Peer effects are often highly localised (Rode and Weber, 2013), and local peer effects for residential PV systems have been quantified in a number of recent studies (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). There has, nevertheless, been a lack of qualitative research on peer effects in PV adoption, and consequently the understanding of the underlying mechanisms of peer effects in PV adoption has remained poor. This gap was addressed in paper 4.

2.2. Research design

The research was mainly based on case studies carried out using qualitative methods. Data were collected through a variety of methods, including interviews (all papers), surveys (papers 3 and 4) and comprehensive internet searches (all papers). Both primary and secondary data (academic and non-academic) were used (secondary data were relatively more important for papers 1 and 2). In this section, the case study approach(es) adopted and the methods for data collection and analysis are outlined. (For a more detailed account of the research designs of each paper, see section 3 or the appended papers.)

2.2.1. Case studies

The thesis is largely based on *case studies*, i.e. empirical in-depth inquiries in single settings (Eisenhardt, 1989; Yin, 2009). Case studies are suitable to shed light on 'how'- or 'why'-questions regarding contemporary phenomena over which the researcher has little or no control (Yin, 2009). Case studies can be based on qualitative or quantitative methods, or a combination of both, and they normally make use of a variety of evidence, including documents, artefacts, interviews, and observations (Eisenhardt, 1989; Yin, 2009). Case studies are generalisable to theoretical propositions rather than to populations, and one of their important strengths is to explain causal links in complex situations (Yin, 2009).

Case studies can be based on one or more cases, which should be selected on the basis of their expected ability to provide useful information rather than to provide a representative sample of a larger universe (Eisenhardt, 1989; Yin, 2009). If the number of candidates for cases to study exceeds about a dozen, quantitative data should be collected about the cases and pre-defined criteria should be specified to select a smaller number (Yin, 2009). This strategy was adopted for paper 3.

For papers 1-3, a clear-cut case study approach was adopted, while paper 4 employed elements of case study methodology. Paper 1 was carried out as a single-case study to identify and assess barriers and drivers within one particular setting (Sweden as a whole). Papers 2 and 3, on the other hand, used multiple-case approaches to support generalisations by means of comparison between different settings.

2.2.2. Data collection and analysis

In line with the interdisciplinary nature of the research and with case study methodology, data were collected and analysed using a variety of sources and methods (Table 1). This allowed for knowledge to be added regarding various aspects of the posed research questions. The variety also allowed for triangulation, i.e. for increasing the internal validity of the findings using evidence derived from different datasets and methods (Richards, 2007). While papers 1 and 2 were exclusively qualitative, papers 3 and 4 used a mix of qualitative and quantitative methods. Paper 4 used a narrower set of data sources than the other papers. Both primary and secondary data were used. Primary data were collected mainly from interviews and surveys. See Table 1, section 3 or the appended papers for more detailed information on the data used for each paper.

Participants (interviewees and survey respondents) were selected through *purposeful sampling*, i.e. they were selected based on their expected ability to provide useful information rather than to achieve a representative sample of a larger population. Purposeful sampling is generally adequate in qualitative research (Maxwell, 2008).

Interviews were carried out in a semi-structured manner, meaning that a set of questions (an interview guide) was prepared in advance but was not necessarily followed strictly. Thus, any unforeseen and interesting matters surging during the interview could be addressed. In total, 59 interviews were performed. In addition, numerous shorter or less structured communications were performed with various actors, mainly through telephone or email. The main function of these shorter contacts was to guide the research towards relevant data sources or topics.

The interviews were analysed differently between the papers, mostly depending on their relative importance for the respective paper. For papers 1-3, interviews were not recorded but notes were taken during the interviews. For paper 4, in which interviews were relatively more important, not only notes were taken but the interviews were also recorded and (whenever the notes were not considered detailed enough) revisited and partly transcribed. Simple coding techniques were used to analyse the interviews, through which themes were identified and put into categories. This allowed the researcher to keep track of how many interviewees had made certain statements or expressed certain considerations. Some degree of interview coding was performed for all papers, although it was done most systematically for paper 4.

Two surveys were performed to collect data for papers 3 and 4, respectively. Questionnaires (see appendices A and B) were sent by postal mail to Swedish PV adopters. The response rates were 74-80% (which is to be regarded as high) and in total 130 valid responses were obtained. The data obtained through the surveys were used mainly for descriptive statistics and to guide the further research, although some inferential statistics were also performed.

Table 1. Data systematically collected for the four papers, by type and quantity. In addition to what is shown in this table, systematic Internet searches were important for papers 1-3, leading to the use of various secondary data.

Paper	Data		
	Type	Actor/source	Quantity
1	Interviews (duration 0.5-1 h)	PV installers	9
		Electricity companies	9
		Experts	4
2	Interviews, marketing material	Companies (Japan)	5
	Websites	Companies (U.S, Germany)	70
3	Survey questionnaire (appendix A)	Adopters	65 valid responses (80% response rate)
	Interviews (duration 0.25-0.5 h)	Local actors (e.g. PV installers, electric utilities, municipal energy advisers)	16
4	Survey questionnaire (appendix B)	PV adopters	65 valid responses (74% response rate)
	Interviews (appendix C) (duration 0.25-0.75 h)	PV adopters	16

Secondary data were collected from various sources. Documents such as industry reports, academic publications, newspaper articles and the websites of firms and other organisations were used. For papers 1-3, comprehensive Internet searches were an important tool to identify and gather data. An important data source and tool was the Swedish Energy Agency's register of applications and approvals for an investment subsidy scheme that has been available to PV adopters since 2009. The names and addresses of PV adopters obtained from this register allowed for analysis of geographical differences in PV adoption rates within Sweden, and made it possible for the researcher to contact adopters for the surveys and interviews. This register was used for papers 3 and 4.

When feasible, data were collected until theoretical saturation (Glaser and Strauss, 1967) was approached, i.e. until the marginal gain in insights obtained through additional data collection was not large enough to motivate the effort of collecting more data. There were, nevertheless, restrictions regarding the extent to which theoretical saturation could be applied (see section 1.4).

2.3. Interdisciplinarity

The research behind this thesis is *interdisciplinary* by nature. Interdisciplinarity is the combination and (partial) integration of elements from two or more academic disciplines (Boden, 1999; Klein, 2010, 1990). A broad scope alone does not necessarily imply interdisciplinarity, and neither does the mere juxtaposition of different disciplines (Klein, 1990). For interdisciplinarity to be meaningful, the strengths of different disciplines should contribute to address one and the same issue and, ideally, the disciplines should enrich each other (Boden, 1999). Although interdisciplinarity is often confused with *multidisciplinarity*, the latter term refers to the juxtaposition of disciplines without any requirements on integration (Klein, 1990). Distinctions between different branches of social science are to a large extent arbitrary and historically forged (Calhoun and Rhoten, 2010), meaning that that interdisciplinary approaches are often no more intrinsically wide-scoped or integrative than research within established disciplines.

Interdisciplinary approaches are often useful to study phenomena that are complex or that do not fit into one particular discipline (Calhoun and Rhoten, 2010; Klein, 1990; Krohn, 2010), including many policy challenges facing humanity, such as climate change and sustainability transitions in the energy sector (Bhaskar et al., 2010; Miller, 2010). The present research made use of two theoretical frameworks (TIS and business models) that are in themselves pronouncedly interdisciplinary (Pateli and Giaglis, 2007; Sharif, 2006). In addition, theories originating in sociology (the diffusion of innovations framework) were used to understand the role of adopters in PV deployment. Although these three frameworks were used largely in parallel rather than integrated with each other in the four papers, this chapeau ties the findings more closely together, thus strengthening the interdisciplinarity of the research.

3. Key findings organised by papers

The four papers studied barriers and drivers to PV deployment in different geographical contexts and using different approaches. In paper 1, a sociotechnical systems approach was used to identify and assess various barriers and drivers to PV deployment in Sweden. In paper 2, business models for PV deployment that have been successful in three important PV markets (the United States, Germany and Japan) were analysed regarding their ability to overcome country-specific barriers. In paper 3, drivers that could explain the relatively high adoption rates observed in certain Swedish municipalities were identified and assessed using a multiple-case study approach. In paper 4, social influence between peers (peer effects) was studied regarding how Swedish PV adopters have increased the willingness of their peers to adopt PV. In the following, the four papers are summarised one by one.

3.1. Paper 1 – Systems perspective on barriers and drivers to PV deployment (Sweden)

3.1.1. Background

The Swedish government has an outspoken ambition to increase the share of solar energy and other renewables in the country's energy system, and subsidies for PV deployment have been available for a number of years. As previously stated, the deployment of radical energy technologies is however a complex process that may encounter several unforeseen barriers. This calls for a systematic review of the overall conditions for PV deployment within the country. Such an analysis has previously been performed by Sandén et al. (2008), who included not only deployment but also development and production in their study. This thesis provides an updated study devoted solely to the deployment phase.

3.1.2. Objective and approach

The objective of this paper was to identify and assess barriers and drivers to the deployment of residential PV systems in Sweden. Such an analysis could result in information useful to policymakers. A technological innovation systems (TIS) approach was adopted, which is a sociotechnical systems perspective developed to analyse the dynamics of technology development, production and deployment, and to identify and assess barriers and drivers throughout a technology's value chain (see section 2.1.1). In the present thesis, however, the TIS framework was applied to the deployment phase exclusively, allowing for a more robust analysis of this phase.

Methods for data collection were comprehensive Internet searches, 22 interviews with experts, installation firms and electricity companies, as well as a number of brief communications with various actors. A large amount of secondary data, mainly identified through the Internet searches, was reviewed, including legislative texts, debate articles, organisations' websites, statistics from governmental organisations, governmental reports, etc.

The Swedish national borders were set as the geographical system boundary because they coincide with the reach of several important institutions and because a purpose of the study was to inform Swedish policymakers. Timewise, the study focused on the early 2010s.

3.1.3. Results

The analysis revealed that the Swedish TIS for PV deployment was small and underdeveloped, although the market was (in relative terms) in a state of rapid growth. Commercial actors involved in PV deployment were largely restricted to small installation companies, although electric utilities[1] and electricity retailers had also shown an increasing interest in PV systems sales and trade in solar electricity. Installation firms were typically small and with a local focus. They were often not exclusively devoted to PV technology, thus lacking the benefit of specialisation. Potentially important actors such as architects or construction companies were not

[1] In this thesis, an *electric utility* is defined as an organisation that operates an electrical distribution grid. Although the legal entity that is most directly responsible for operating the grid is not allowed by Swedish law to trade in electricity or appliances such as PV systems, a grid-operating entity and an electricity-trading entity can be (and are often) gathered within the same group of companies. The group of companies can then sell PV systems though the electricity-trading entity, while it runs the grid through its grid-operating entity. In this thesis, the term *utility* may refer to such groups of entities or to pure grid-operators. For companies engaged in electricity-trading but not in grid-operation, the term *electricity retailer* will be used.

engaged in PV deployment more than marginally. PV systems were almost exclusively purchased by the adopters, meaning that third-party ownership business models that have been common in some more developed markets were practically non-existent in Sweden. This lack of alternative business models could be a barrier to some potential adopters who would prefer to adopt PV without purchasing a system.

Overall, the most important barrier to PV deployment was found to be the poor economic profitability of investing in a PV system. This was not only because of expensive PV systems and relatively low amounts of solar influx, but also because electricity prices in Sweden have generally been relatively low by international standards. Thus, the Swedish PV market had been created and upheld by subsidies. However, the subsidy schemes in place were sub-optimally designed, impaired by uncertainties and complexities.

The most important subsidy for PV deployment has been an investment subsidy scheme available for residential PV since 2009. Through this subsidy, adopters have been reimbursed for a fixed share of their expenses for purchasing a PV system. The scheme has repeatedly reached its budget cap, after which no more applications have been approved until more funding has been added through political decisions. As the PV market was very dependent on this subsidy scheme, the reaching of the cap has led to discontinuations not only in the scheme but in the whole PV market. This has created severe problems for installation firms that have suddenly and repeatedly lost their source of revenue. It has most often been unknown to the actors if and when new funding was to be added to the scheme. The interviews revealed that, as a result of these uncertainties, installation firms have often postponed decisions regarding the recruitment of new employees, purchasing of equipment or acquiring of a more appropriate office.

Furthermore, whenever the cap had been reached, additional applications were placed in a queue to be considered if and when new funding was added through political decisions. This led to waiting times for getting applications approved gradually increasing to more than a year, creating complications not only for adopters but also for firms. The delays have resulted in extra transaction costs for installers who have often had the feeling that they have been forced to ‘sell the PV system twice’, once when the adopter contacts them before filing an application for the subsidy and again after the application has been approved.

In parallel to the investment subsidy scheme, a tradable green certificates (TGC) scheme has been in place since 2003. Through the TGC scheme, owners of PV systems and a number of other renewable electricity technologies have been granted tradable certificates for their electricity production (one certificate per megawatt-hour). Certificates have been sellable on a ‘free’ market, demand being created by legal obligations on other actors to acquire certificates in proportion to their production or use of electricity.

The TGC scheme was launched as the main Swedish policy instrument to support renewable electricity, and an important feature was its alleged 'technology neutrality'. It has been an important driver of the dissemination of renewable electricity technologies, mainly for wind power (Swedenergy, 2012). The scheme has, however, been poorly adapted for micro-generation of electricity (e.g. in residential PV systems). Trading small quantities of certificates has been complicated, and although PV owners have formally been entitled certificates corresponding to their whole production, hassle and extra costs have made it unattractive to acquire certificates for the self-consumed part of the production. Perhaps most importantly, expensive metering equipment has had to be installed by the PV owner for certificates to be granted for self-consumed electricity. The misalignment of the TGC scheme to micro-generation is illustrated by the fact that only a fraction of the Swedish PV adopters had found it worthwhile to apply for TGCs at the time of the study. For example, by the end of 2012 a mere 10% of all grid-connected PV systems in Sweden were benefiting from the scheme (Stridh et al., 2013).

As regards the institutional set-up beyond subsidies, existing institutions were found to be fairly well-aligned to residential PV deployment in the sense that no particular barriers of prohibitive magnitude could be identified. An important barrier was removed in 2010 when PV adopters were given the legal right to connect their system to the grid at no cost. Building permits for PV systems have usually been granted without prohibitive costs or hassle, and even though there has been some variation between municipalities' building permit policies, national regulation has kept these costs and restrictions within certain limits.

There have, however, been some barriers related to tax rules. Most of the existing tax rules of relevance were designed decades ago for a regime of centralised large-scale electricity generation, and have not always been straightforwardly applicable to micro-generation. For example, there have been uncertainties regarding whether micro-producers selling their surplus electricity to an electricity retailer are to be regarded as 'professional' and thereby subject to extra taxation and paper work. According to the tax agency, tax rules on the EU and Swedish levels have also prohibited net metering (the practice of subtracting any electricity fed into the grid from the consumption before applying taxes), although the tax agency's interpretation of the rules on this point has been opposed by some actors.

A large problem has been uncertainties regarding the future development of the institutional set-up. Most importantly, future taxes and subsidies have been unpredictable, both regarding their design and at what times they would be in operation. Apart from the aforementioned uncertainties regarding the investment subsidy, there were important uncertainties regarding the planned introduction of a tax reduction scheme for PV owners[2], for example regarding the compatibility of the tax reduction with existing tax rules.

The functional analysis revealed a linear chain reaction driving deployment. 'Legitimation' had been necessary for 'resource mobilisation' of the funding used for the investment subsidy scheme. This caused 'market formation' to take off, which in turn provided 'guidance of the search' for entrepreneurs to get involved in the PV installation business. The functions not mentioned in this chain reaction ('knowledge development and diffusion' and 'entrepreneurial experimentation') were excluded because little evidence was found that these functions operated on more than a basic level. Most installation had taken place in a rather traditional manner both technically and organisationally, and the experimentation of electric utilities and other commercial actors had remained a rather marginal phenomenon. The knowledge employed by actors involved in PV deployment was rather basic (add-on PV installation is in itself not a very complicated process), and the awareness of consumers necessary for their propensity to adopt PV was rather captured by the legitimation function. Because of the deployment focus, functional feedback mechanisms from deployment to production that are often analysed in TIS studies were not made visible in this case. However, the Swedish PV market was too small to significantly affect the global PV production system and such feedback mechanisms could thus be neglected.

3.2. Paper 2 – Business models for PV deployment (Germany, United States, Japan)

3.2.1. Background

In overcoming barriers to PV deployment, firms may play an important role through organisational innovation. The development and adaptation of new and existing business models have historically often been crucial in technological transitions. As PV is a radical technology in the electricity and housing sectors, business model innovation will most likely be key to coping with various barriers. Barriers, not least related to these sectors, can vary substantially between different geographical contexts, and there is thus a need to analyse how different business models can address barriers in different PV markets. Insights into how business models can

[2] After the publication of the paper, the tax reduction has been implemented in parallel to the other schemes, meaning that there are now (December 2016) three overlapping subsidy schemes.

counteract barriers to PV deployment could be useful to support deployment in Sweden and other emerging PV markets around the world. As revealed in paper 1, the TIS function 'entrepreneurial experimentation' was rather weak in Swedish PV deployment as practically all installation companies offered the same basic sales of turnkey PV systems. In other markets around the world, however, a variety of PV business models with rather different characteristics has emerged lately. Thus, paper 2 went beyond the Swedish setting to find empirical evidence on alternative business models.

3.2.2. Objective and approach

This study aimed at analysing how different business models for PV deployment can overcome barriers in different national contexts, and how different barriers and other contextual factors affect which kind of business models that will emerge and succeed in different settings. The study compared three distinctively different business models for PV deployment that have achieved success in three important PV markets, namely in Japan, Germany and the United States. In Germany, PV systems have been purchased and owned by the user as a financial investment. In the United States, third-party ownership (TPO) business models have proliferated. In Japan, the building industry has taken a leading role by integrating PV systems into prefabricated homes. An in-depth analysis was performed regarding the characteristics of each business model and the national contexts in which they thrive. How context has mattered for the success of the different business models, and implications for policymakers and firms, were then elaborated upon.

Based on theoretical sampling (Eisenhardt, 1989), the cases were selected for three key reasons. First, distinctively different business models have succeeded in the three countries, which allows for the identification of contextual factors that might explain why a certain business model thrives in a certain context. Second, the three countries together accounted for about 45% of the cumulative global installed PV capacity at the time of the study being performed (REN 21, 2014), making them important cases to learn from regarding successful PV deployment. Third, the extensive experience of PV deployment in the three countries was instrumental for data access.

Key data sources included firms' own material, such as websites, marketing material and annual reports. Also, legislative texts, standards, research reports, academic literature, trade journals etc. were used. In the case of Japan, the possibilities to use secondary data were more restricted due to the language barrier, and interviews were thus carried out with five companies in the prefabricated housing sector and with a number of experts, using an interpreter.

3.2.3. Results

Below, a case-by-case account of the different business models and their respective contexts is given. The conclusions are then accounted for.

3.2.3.1. United States

In the United States, business models based on third-party ownership (TPO) have been highly successful, accounting for 70-90% of residential installations in important sub-markets such as California, Arizona and Colorado. In these business models, the adopter is not the owner of the PV system. Instead, the system is owned by a firm providing a full-service solution including planning, installation and maintenance. Financing is obtained through an arrangement in which firms package several projects into funds that are sold to investors.

TPO models are commonly based on either a power purchase agreement (PPA) or a lease. In a PPA, adopters purchase the electricity that the PV system generates. Certain criteria are set for the price so that it is highly predictable over a period of 15-20 years. At the end of this term, the adopter can purchase the PV system, have it removed by the PPA provider or renew the agreement. In a lease, the adopter instead pays a time-based fee for using the system, and gets to use the produced electricity without additional payments. PV leasing has been common in states in which PPA has not been allowed.

The TPO models used in the United States have successfully addressed several common barriers to PV adoption. First, they have minimised consumer transaction costs. The adopter's only point of contact has typically been the firm providing the TPO model, rather than numerous actors such as installation and maintenance firms, banks, insurers and government agencies. The TPO firm has also taken care of any administrative tasks related to subsidies, permits and grid-connection. Second, risks related to the ownership have been shifted from the adopter towards the firm. Third, the adopter has not had to raise capital to finance the system.

TPO models have addressed barriers that have been particularly prevalent in the Unites States. Homeowners in the United States have had lower savings rates than homeowners in Japan or Germany, and potential adopters in the United States have thus been less likely to be able to finance a PV system upfront without a mortgage. Furthermore, access to home equity loans has been severely restricted in the wake of the financial crisis of 2008, which has left many homeowners 'underwater' (their home mortgage being larger than the value of their home), further restricting potential adopters' ability to finance a PV system purchase. People in the United States also tend to move relatively frequently, which for many potential adopters has likely increased the relative attractiveness of immediate electricity bill savings compared to a long-term investment in their home. Lastly, transaction costs in PV deployment have been higher in the United States than in Japan or Germany, which has made it more attractive for adopters to impose them on a third party.

3.2.3.2. Germany

In Germany, PV systems have mainly been financed and owned by the adopters themselves. In the business model dominating German PV deployment, the value proposition has been based on PV adoption as a low-risk financial investment fully competitive with other investment alternatives. Adopters have been guaranteed stable revenues for 20-21 years through a feed-in tariff scheme backed up by national legislation. Policymakers have regularly monitored the cost development of PV systems and adapted the feed-in tariffs to keep the IRR of PV adoption at around 7%.

Transaction costs in PV deployment have been relatively low in Germany. Institutional alignment and local learning among practitioners since the early 1990s have led to a relatively smooth deployment process, and legal-administrative processes related to PV deployment have become among the least complicated in Europe. The absence of high transaction costs has made the third-party owner somewhat redundant as a key function of a third-party owner is otherwise to absorb transaction costs. This is likely a partial explanation for German PV adopters' preference for purchasing and owning PV systems without the involvement of a third-party owner.

As German adopters have fully financed the upfront cost, the German business model has benefited from the availability of low-interest loans especially dedicated to PV. These loans have been provided through a government-owned bank since 1999. The loans have often been supplemented by equity from the customers, and the relatively high savings rates of German homeowners have thus facilitated the business model.

Just like firms in the United States, German firms have been offering a variety of services and features to reduce uncertainties and complexity. These include comprehensive insurance packages, long-term warranties for durability and performance, as well as certification of PV system components and installers through reputable organisations.

3.2.3.3. Japan

In Japan, the cross-selling of PV systems together with other products has been widespread, particularly in the construction sector. The *prefabricated homes industry* has been leading in this regard and, as early as 2011, about 60% of all new prefabricated homes came with a PV system. The prefabricated homes sector has held around 20% of the market for new homes and 10-15% of the residential PV market. The prefabrication of homes has been dominated by around ten large companies.

The value proposition has had several advantages compared to value propositions based on add-on PV systems. PV systems sold with new homes have been less expensive for the adopter than add-on systems, and roof integration has allowed for aesthetically appealing solutions. As the adopter has already established a contact with the supplier for the purpose of purchasing a home, transaction costs have been reduced for both parties. In Japan, PV adopters who have purchased their PV system together with a new home have typically been more satisfied with the adoption than have other PV adopters (Mukai et al., 2011).

The expenses for the PV system have generally been integrated into the home mortgage, reducing transaction costs and interest rates. As a mortgage needs to be issued for the home in any case, it has been easy to expand this loan to include the PV system. From the perspective of the financial institution issuing the loan, the income generated through the PV system has enhanced the adopter's creditworthiness. Building-integration has also been a benefit in this regard as a system physically integrated into the roof cannot as easily come adrift.

A key contextual factor explaining the success of this business model is the pre-existence of a highly industrialised prefabrication sector. Built upon large volumes, automation and advanced logistics systems, Japan's prefabrication industry has seemingly been the most industrialised house-building industry in the world. Industrialisation has brought about a high degree of standardisation, benefitting PV integration. The high level of industrialisation has, in turn, sprung out of a 'scrap and rebuild' culture in which almost 90% of all homes sold have been newly produced. Homes in Japan have typically depreciated very rapidly as they have increased in age.

Unlike in Western countries, prefabricated homes in Japan have been considered to be of higher quality than site-built homes, and they have typically been more expensive and equipped with more features. The cost savings achieved through industrialisation and mass-production have generally been used to add more features to the homes rather than to reduce consumer prices. Through this so called *mass customisation*, consumers have been offered a wide variety of choices between mass-produced components, including energy devices such as batteries, fuel cells, heat pumps and home energy management systems. PV systems have neatly fitted into this pattern.

Another relevant contextual factor has been the domestic PV industry, which has been dominated by large electronics companies keeping large parts of the PV value chain within their own organisation. The Japanese PV industry has played a key role in making prefabricated PV homes become common in Japan by marketing their products intensely towards the prefabrication industry rather than directly to consumers. They have also been seeking collaboration with prefabrication companies, something that, as revealed by the interviews, the prefabrication companies have often perceived as valuable and helpful. The interviews also revealed that house producers have tended to prioritise stable long-term partnerships with PV module suppliers over lower prices or higher efficiency of the modules. Although Japanese modules have been substantially more expensive than for example Chinese modules, all house producers interviewed used Japanese modules. They motivated this choice by explaining that communication with and reliability of the module producer and its products are crucial when modules are to be customised to fit the roofs.

Also, assurances of the national government that subsidies were to be present for an extended period have been important for the prefabrication industry to work with PV integration. Changing production lines is expensive, and the house-building industry has preferred certainty that PV systems were to remain attractive for their customers before making such investments.

3.2.3.4. Conclusions

In all three cases, the studied business models for PV deployment have enabled firms to overcome typical barriers faced by prospective PV adopters, such as complexity, transaction costs, risks and access to finance. Yet, the business models have been distinctively different. The analysis suggests that the differences between them have to a large extent been the result of differences in the national contexts in which they have occurred. The importance of context implies that business models for PV deployment cannot necessarily be viably transferred from one setting to another. (For example, recent attempts to implement TPO business models in Germany have not been very successful.)

The strong presence of TPO models in the United States and their absence in Germany and Japan is not likely to only be the result of differences in consumer preferences, but also of other contextual factors. TPO models have effectively addressed issues that have been particularly prevalent in the Unites States, such as low savings rates, restricted access to capital, high mobility on the housing market and high transaction costs. In Germany and Japan, on the other hand, higher savings rates, better access to low-interest loans, lower mobility on the housing market and lower transaction costs have made PV adopters more prone to purchase and finance the PV systems themselves.

TPO models for PV deployment may gradually lose their relevance for most adopters as PV markets mature. Market maturation usually entails a reduction in transaction costs and risks, which might make it more attractive for adopters to finance and own PV systems themselves. As TPO models require more middle-men capturing their share of the lifecycle economic gains of a PV system, business models based on self-ownership have the potential to become more financially beneficial for adopters. Once other barriers disappear, self-ownership could thus become the most viable option for most adopters also in markets such as the United States. A high proliferation of TPO models could perhaps even serve as an indicator for policymakers that there are barriers that should be dealt with. TPO models could, however, still prevail in mature markets to serve certain market segments, as some adopters might value the simplicity of TPO models more than the prospects of higher long-term financial gains.

3.3. Paper 3 – Local factors and information channels influencing PV deployment (Sweden)

3.3.1. Background

On the surface, the conditions for PV deployment seem to be rather homogenous throughout Sweden, as economic and institutional conditions do not differ much between different parts of the country. Yet, PV adoption rates vary between municipalities to an extent that is beyond what could be explained by local factors such as building stock characteristics, solar influx or average income. This raises the question of whether there are unknown local drivers present in these high-dissemination municipalities that have increased local adoption rates.

3.3.2. Objective and approach

This paper aimed at identifying and assessing factors that could explain high localised adoption rates of residential PV systems in Swedish municipalities. An explorative multiple-case study approach was used (Yin, 2009). Five municipalities that stood out in terms of high PV adoption rates were studied in depth. These main cases were then compared to 50 municipalities with low PV adoption rates, which were studied in less depth. Triangulation of quantitative and qualitative methods and different data sources was used to enhance the robustness of the findings.

The main cases were selected as follows. All Swedish municipalities were ranked by their per capita PV density and by their PV density in terms of number of PV systems per detached home. Those five municipalities that occurred in the top ten in *both* these rankings were selected. As comparison cases, the 50 municipalities with the lowest per capita PV adoption rates were selected (except for one municipality that was excluded because it had very few detached homes). The case selection was thus a combination of replication (cases with the same outcome on a key variable) and a 'two tail' design (cases on either extreme of a key variable) (Yin, 2009).

Data were collected by three main methods. First, a survey questionnaire (see appendix A) was sent by postal mail to all presumed PV adopters that could be identified in the five main case municipalities. The survey yielded 65 valid responses at a response rate of 80%. The aim of the survey was to assess various local information channels that might have affected the respondents' decision to adopt PV. Second, 16 interviews, as well as a number of shorter communications, were performed with local installers, electric utilities and other key actors. Third, comprehensive Internet searches were performed to identify actors and gather other relevant information about the cases.

The data necessary to estimate municipalities' adoption rates and to contact adopters were obtained from the Swedish Energy Agency. More specifically, a register of applications and approvals for the national investment subsidy scheme (this scheme has been described in section 3.1.3) was used, containing the names and addresses of adopters. Since few PV systems had been installed outside this scheme, these data were assumed to provide a good representation of the actual number of installations.

3.3.3. Results

The results pointed to local actors promoting PV as an important explanatory factor behind the relatively high adoption rates in the five main case municipalities. This finding was corroborated through triangulation, as the three main sources of data (survey, interviews and Internet searches) pointed largely to the same explanatory factors. Common to the five municipalities was the presence of local organisations promoting solar energy from an early stage, mainly electric utilities and installation firms selling PV systems and disseminating information. The survey respondents recognised that they had been influenced to a substantial extent by these activities. Overall, the respondents rated local information channels as slightly more influential than common non-local information channels such as nation-wide media, websites with a non-local focus and non-local acquaintances. The survey results indicated that the local factors had not only *raised the respondents' interest* in PV but also *influenced their final decision* to adopt, suggesting that these factors operated throughout a substantial portion of the innovation-decision process (cf. Rogers, 1983).

The relative importance of different factors varied between the studied municipalities. Regarding this variation, the survey results were largely in line with the results obtained through the interviews and Internet searches (factors that were found to be of high relative importance in a municipality using one method were also found to be of high relative importance using the other methods). For instance, in the two municipalities with the most active local utilities, the respondents regarded utilities as more important than respondents in the other three main case municipalities did. In one municipality where installations had been largely concentrated to one zip code area in which an installation company was based, peer effects and PV installers were recognised by the respondents as relatively important. In another municipality, where a local association has realised a number of larger ground-mounted PV installations, the presence of ground-mounted PV was recognised by the respondents as important in inspiring them to adopt PV.

Local electric utilities supporting PV appeared to have been a particularly important driver elevating local PV adoption rates. Local utilities promoting PV during the period studied were found in four of the five main case municipalities, while none of the local utilities in the 50 comparison municipalities were found to have engaged in PV promotion during or before the period studied. The local utilities supporting PV in the main case municipalities had started their promotion of PV *before* the PV market started taking off, indicating causation in the direction from utilities towards increased adoption rates. The importance of utilities was also recognised by the survey respondents. Seminars attended by the respondents had (as reported by the respondents) been arranged mainly by local utilities, and 54% and 24% of the respondents agreed that their final decision to adopt PV had to some or to a large extent, respectively, been due to their utility purchasing PV electricity.

The results also indicated some causality going in the other direction. During the interviews, some representatives of PV-promoting utilities acknowledged that their organisations had been influenced to some extent by customers adopting PV or contacting them for information on grid-connection of PV, thus pushing them towards developing strategies for PV. This reveals the presence of a positive feedback loop: customers influence their utilities, which in turn influence other customers to adopt. The interviews also revealed that the utilities' engagement in PV promotion had in most cases started largely as the result of one devoted staff member (usually the CEO). These persons had, for one reason or the other, adopted a positive attitude towards PV, and had had the personal drive to win their organisation over to promoting PV.

Lastly, respondents in all municipalities recognised having been influenced by PV adopters in their proximity (peer effects), both through direct communication with adopters and by observing PV systems in their neighbourhood. These findings were strengthened by the interviews with installation companies, which largely agreed that after installing a PV system at a particular place, they would often shortly thereafter get additional requests from homeowners in the same area. These homeowners had, according to the interviewees, often been inspired by the first installation. On average, the survey respondents considered local acquaintances to have been about as influential on their adoption decision as installation firms. However, local peers whom the respondents categorised as 'neighbours' were seen as having had a rather minor influence, indicating that the peer effects had been mediated through other kinds of social relations than those between people regarding each other primarily as neighbours.

3.4. Paper 4 – Peer effects in PV adoption (Sweden)

3.4.1. Background

The results of paper 3 suggested that peer effects (social influence between peers) have been a factor in reducing barriers to PV adoption in Sweden. A number of previous studies have also quantified peer effects in PV adoption in other settings, mainly Germany and the United States (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). This research has mainly been concerned with estimating the increased probability of PV adoptions occurring within a small geographical area as the result of previous adoptions in the vicinity. Little, however, has been known about the inner workings of peer effects in PV adoption. Thus, in paper 4, a closer look was taken at the role of peer effects among Swedish PV adopters.

3.4.2. Objective and approach

The study took a mixed-methods approach (combining quantitative and qualitative methods) to add knowledge of the inner workings of peer effects among Swedish PV adopters. More specifically, the research aimed at shedding light on what kinds of social relations mediate peer effects, what kind of information is transferred between the peers and what emotions are evoked leading to the adoption of a PV system.

Data were collected through a survey questionnaire (see appendix B) and interviews (see appendix C) with selected survey respondents. The survey was sent by postal mail to Swedish PV adopters. To maximise the occurrence of peer effects among the respondents, adopters living in zip code areas with high adoption rates were targeted. Just like for paper 3, data for estimating local adoption rates and addresses of adopters were obtained from the Swedish Energy Agency's register of applications and approvals for the national investment subsidy scheme. All Swedish zip code areas were ranked by their number of PV systems per capita, and the survey was sent to all 92 individuals that had had their applications for the subsidy approved in the 25 zip code areas with the highest adoption rates (except for five areas that were located in the municipalities studied in paper 3, which were excluded because the adopters on those areas had recently been sent a similar questionnaire). The survey yielded 65 valid responses at a response rate of 74% (four presumed adopters returned the questionnaire informing that they had in fact not adopted). The survey was mainly built upon five-point rating scales of both unipolar and Likert type, in which the respondents were asked to rate how they perceived that seeing PV systems or talking to PV adopters in or outside their neighbourhood had influenced their perceptions of PV technology.

Telephone interviews were performed with selected survey respondents. Those 22 respondents who reported having been in contact with at least one PV adopter in their neighbourhood prior to taking a final decision to adopt (and who had provided their telephone number) were selected, and full interviews were carried out with 16 of them. The interviews were recorded, and whenever the notes taken during the interviews were not considered detailed enough, the recordings were used to complement the notes. Key data were coded in a spreadsheet.

Considering that people tend to consistently underestimate the impact of social influence on their decision making (Nolan et al., 2008), the risk of overestimating peer effects using the chosen methodology, which relied on participants' self-estimation, was assumed to be small.

3.4.3. Results

As in paper 3, the presence of peer effects was widely recognised by the participating PV adopters. Among the survey respondents, 38% reported that contact with a peer (local or non-local) had been highly important ("4" or "5" in the rating scales) for raising their interest in PV. The corresponding figure for the final decision to adopt was 35%. Among respondents who had been in contact with an adopter in their neighbourhood before they decided to adopt (28 respondents), half agreed that the contact had been highly important for raising their interest in PV, and almost half did so regarding their final decision to adopt.

The interviews revealed that the contacts had almost exclusively occurred through pre-existing and rather close social networks, such as friends and family. Contacts with PV-using neighbours to whom the respondent had no deeper relationship had been rare and of minor importance (this was also suggested by the survey carried out for paper 3). This contrasts somewhat to what has been previously believed about peer effects in PV adoption, where the role of neighbour relations has (more or less implicitly) been assumed to be important. Furthermore, even though the sample was selected based on a presumed high occurrence of *local* peer effects, almost as many respondents reported having been highly influenced ("4" or "5" in the rating scales) by someone living *outside* as *inside* their neighbourhood.

The main function of the peer effects appears to have been a confirmation that PV works as intended and without hassle, rather than the procreation of unexpected insights or the provision of more advanced information. The confirmation was strengthened by the trustworthiness of the peers, who (apart from being known by the participants) as private homeowners were in a situation similar to that of the participants, and who (as opposed to PV installers) lacked economic incentives to recommend PV adoption. The information transferred had generally not been of a very advanced character, and had mainly related to ease of use and economic performance – that PV systems worked as intended and without hassle, and that they delivered as much electricity as expected. This information had, nevertheless, been perceived as useful by the interviewees; it had contributed to reducing a general uncertainty about PV as a new and 'unknown' technology, and had increased the participants' determination to adopt. Overall, few of the contact persons had recommended PV adoption outright – rather, they had provided more 'neutral' accounts of their experiences as adopters. Almost all interviewees had seriously contemplated PV adoption and acquired some knowledge of PV before any contact with previous adopters took place, and the contacts did thus not evoke much unexpected insight.

When it comes to the role of *passive* peer effects (influence of *seeing* PV), the results indicated that these had been of minor importance. As in the survey carried out for paper 3, seeing PV systems was regarded as a relatively important influential factor. However, a closer look at the data revealed that respondents who had seen a PV system in their neighbourhood tended to regard this as influential only if they had also been in contact with an adopter. The interviews confirmed that it was when a PV system had been seen in connection with adopter contact that it had been influential, for example when visiting a PV owner that demonstrated his or her PV system.

Contacts between the interviewees and previous adopters had come about in two principal ways: either the interviewee had approached the PV adopter with the purpose of acquiring information from him or her, or the topic had come up as they had met for another purpose. Only in one case had the interviewee experienced being approached by an adopter (other than a salesperson) who appeared to have had the purpose of talking about PV. In the previous literature, it has sometimes been assumed that seeing local PV systems tend to induce people to contact the systems' owners to get more information. However, the findings of the present study did not support that such an order of events had been common in the studied setting, as almost no contacts had come about as the result (partly or fully) of the interviewee first seeing the contact person's PV system.

4. Concluding discussion

In this section, a synthesis of the findings of the four papers will first be presented. The methodological contributions of the thesis will then be discussed. Based on the findings, some recommendations for policy will also be provided, both specific advice for reforms of Swedish policy and more general advice. Lastly, some pathways for further research will be suggested.

4.1. Synthesis of findings

The objective of this thesis was to identify and assess barriers and drivers to residential PV deployment in different geographical settings, taking the spatial dimension into account. The findings of each paper have been accounted for separately in section 3. The added value of this synthesis is that it builds a larger and more coherent picture of barriers and drivers on different spatial levels, thus contributing to an improved understanding of the geography of sustainability transitions (cf. Coenen et al., 2012; Hansen and Coenen, 2015).

While the price and performance of PV technology have been largely determined on the international level, the thesis goes into depth with barriers and drivers rooted in national and local settings. By studying altogether four national PV markets, papers 1 and 2 identify and assess barriers and drivers mainly rooted on the national level, providing various examples of how institutions, industry, culture and financial aspects have affected PV deployment. On the local level, papers 3 and 4 show how local organisations and private individuals have driven PV deployment through information provision and social influence. Together, barriers and drivers rooted on all these levels determine the conditions for PV deployment at any given location. Thus, an understanding of barriers and drivers on all levels is important.

Paper 1 took a systemic perspective to identify and assess barriers and drivers in Sweden. The analysis was facilitated by the technological innovation systems (TIS) framework, which guided the research to relevant actors, networks, institutions and processes. The analysis depicts a small, underdeveloped Swedish TIS for PV deployment, albeit in rapid growth in relative terms. Limited economic profitability in PV adoption was a crucial barrier during the period studied (also including subsidies). The results reveal that the Swedish policy environment has been uncertain and complex, creating problems for different actors. The institutional barriers in Swedish PV deployment (which have been described in more detail in section 3.1.3) could be coarsely summarised as follows: First, the fact that more than one subsidy scheme for PV deployment have been running in parallel is a complexity in itself. Second, there have been uncertainties regarding when different subsidies were to be available, and on what conditions. Third, important rules, mainly related to taxes, have been unpredictable.

Even though the institutions affecting PV deployment in Sweden have mainly been national, they have not always been fully controlled by the national government. For example, Swedish rules for taxes and building permits affecting PV deployment have partly been determined on the EU and the municipal levels, respectively. Paper 1 reveals that institutions on the EU level have restricted the ability of the Swedish government to adapt rules to PV and other micro-generation technologies, resulting in institutional rigidity that has contributed to a lock-in of the incumbent energy system (cf. Unruh, 2000).

The thesis also demonstrates that country-specific characteristics of a domestic industrial sector can be important for PV deployment. Paper 2 reveals that certain characteristics of the Japanese construction sector, such as a high degree of industrialisation and standardisation, have been important for the physical and organisational integration of PV into the construction of new buildings in Japan. Those factors are rather unique to the Japanese construction sector compared to other domestic construction sectors around the world. This is likely an important explanation of why the Japanese construction sector has been highly involved in PV deployment as compared to construction sectors in other important PV markets.

The thesis also identifies barriers and drivers that vary between countries but are less confined to administrative borders. Such factors include cultural and behavioural aspects such as savings rates, homeowner mobility (how often people move), accustomedness to TPO business models (not only for PV) and priorities regarding long-term versus immediate cost savings. As suggested by paper 2, these aspects will influence what kind of business models will be most viable within a certain context, as different business models are suited to overcome different barriers to deployment. Perhaps most importantly, this relates to the ability of potential adopters to raise capital and to their preferences regarding whether to own the PV system or consult a TPO firm. Another example is real estate prices, which have developed rather differently between countries and regions, influencing homeowners' ability to finance a PV system. If the value of a home substantially exceeds the mortgage for the same home, the homeowner can often quite easily get a home equity loan to finance a PV system. This will be the situation for most homeowners in regions where the prices of homes have increased substantially in recent years. On the other hand, there are many regions around the world in which the values of homes have decreased dramatically in the wake of the financial crisis of 2008. In these regions, homeowners will typically have less opportunity of getting a home equity loan, and many of them will be 'underwater', meaning that the value of their home is lower than their mortgage. These homeowners will often find it difficult to finance a PV system, and TPO business models might then be a viable option. As argued in paper 2, this is likely a contributing factor to the success of TPO business models in California, where housing prices declined substantially after the financial crisis.

Paper 2 illustrates that certain business models can successfully overcome complexities and uncertainties faced by prospective PV adopters on the national level. It is thus noteworthy that Sweden, with its complex and uncertain policy environment, has (as was found in paper 1) lacked alternative business models such as TPO even though these have been successful in addressing complexities and uncertainties in other countries. As argued in paper 2, a lack of alternative business models (such as TPO) could be a barrier for some categories of potential adopters, and trying to explain the absence of TPO models in Sweden is thus justified. Drawing on papers 1 and 2, this synthesis allows for some remarks in this regard. A first reason for the absence of TPO models in Sweden could be the low economic profitability of PV investments; TPO models require a middle-man taking a share of the life cycle economic gains of a PV system, and the total economic gains might simply have been too small in Sweden for TPO to be viable. Second, the small size of the Swedish PV market might have decreased the likelihood of TPO models occurring as they require a higher level of organisational sophistication. Third, the Swedish institutional uncertainties have created risks of events that would affect all installations simultaneously. This contrasts to risks of events that occur independently of one another for each installation. While TPO models do not address the former kind of risk (events affecting all installations simultaneously could ruin a TPO firm), they successfully address the latter kind by spreading the risks over a large number of installations. Fourth, the Swedish housing market has withstood the global financial crisis remarkably well from an international perspective, and the prices of homes have increased rather consistently during the last decade, which has made it easier for Swedish homeowners in general to finance PV systems themselves without the need for a TPO model.

When it comes to the local level, papers 3 and 4 point to local sources of information as being an important driver of PV deployment. Local information seminars organised by electric utilities seem to have had a substantial effect in increasing adoption rates in Swedish municipalities (paper 3), and basic information transferred between peers appears to have been important in convincing Swedish homeowners to adopt PV (paper 4). Even though information channels operating on a higher geographical level, such as websites directed towards a national or international audience and media with a national coverage, were important for the decision making of the participating adopters, the findings of paper 3 suggest that local sources of information were of equal or higher importance. A substantial function of the information appears to have related to raising the interest in PV among potential adopters, indicating a lack of basic awareness.

Even though the geographical entity studied in paper 3 was the municipality, the findings point to another geographical entity of relevance, namely the area covered by the electrical grid operated by a certain utility. Different utilities have developed different strategies and attitudes regarding PV, and the results of paper 3 strongly suggest that a local utility's supportive attitude can substantially increase local PV adoption rates. Even though these effects are surely not strictly confined to the area covered by the utility's grid, the reach of the grid is likely to be of significant importance as everyone connected to the grid is a customer of the utility and thus subject to its communication. While utilities might have different roles in different countries, previous research on local sources of market formation (Dewald and Truffer, 2012) has not acknowledged the role of utilities, which might be relevant in some (though likely not all) other countries as well.

A driver with an inherently large local component is *peer effects* (social influence between peers resulting in PV adoptions). Previous research has identified substantial localised peer effects in PV deployment using quantitative research methods (Bollinger and Gillingham, 2012; Graziano and Atkinson, 2014; Graziano and Gillingham, 2014; Müller and Rode, 2013; Rai and Robinson, 2013; L.-L. Richter, 2013; Rode and Weber, 2013). Little has been known, however, about the inner workings of peer effects in PV deployment. Together, papers 3 and 4 contribute to deepening the understanding of peer effects by surveying in total 130 PV adopters and interviewing 16 of them, thus introducing a qualitative perspective that has been lacking in the previous research. Paper 3 confirms that peer effects in PV adoption also exist in the Swedish setting, and the paper provides some tentative findings regarding their underlying mechanisms. In paper 4, the mechanisms behind the peer effects were investigated more deeply. The two papers used data from different sets of participants (one set for each paper) and, as some survey items were identical or very similar for the sets, they together provide a larger sample on some aspects.

Paper 4 suggests that the main function of the peer effects was a *confirmation* from a trustworthy source that PV adoption would be a sound choice. The information transferred was generally not of a very advanced character, and related mainly to ease of use and economic performance – that the technology worked as intended and without hassle, and that it delivered as much electricity as expected. This information was perceived as useful by the interviewees, and it contributed to reducing a general uncertainty regarding PV as a new and 'unknown' technology, thus reducing barriers to adoption. Paper 4 was unique not only to the Swedish context, but also globally, as peer effects in PV adoption had not previously been studied through interviews with adopters.

The results of papers 3 and 4 suggest that the main reason (at least in the studied setting) for peer effects having a large local component is that people who are family and friends tend to live close to one another, rather than people influencing one another through more superficial neighbour relations. Both papers reveal that relations with people who the adopters perceived as ‘neighbours’ were perceived to have been of minor importance – instead, the influence had taken place through closer and more established social networks. The high degree of localisation in peer effects has led to an assumption in the previous literature that neighbour relations and passive influence (through passively observing neighbours’ PV systems) have been important mediators of peer effects. However, paper 4 suggests that passive peer effects played but a minor role in the studied context. One implication of these results relates to the fruitfulness of different computational models of peer effects in PV deployment. Two different approaches to such models are based on social networks and geography, respectively (Bale et al., 2013; Rode and Weber, 2013). The results of this thesis indicate that the former approach might more accurately reflect the underlying processes at work.

Lastly, the thesis demonstrates how the local nature of PV deployment can create inefficiencies, at least in a small and early market such as the Swedish one. Paper 1 reveals that the installation of PV systems in Sweden has been dominated by small, local firms that have often not been exclusively devoted to PV technology, thus lacking the benefit of specialisation. This can be seen as a consequence of the fact that PV systems need to be installed on-site by the firm’s staff, in combination with a small market size. Several of the installers interviewed for paper 1 expressed the ambition to become more specialised, claiming that the small market size within their catchment area would not support specialisation. With limited demand for PV systems within a reasonable travelling distance, a full-time job cannot be sustained by the demand for PV installations only. This leads to poor economies of scale on the local level, and to a lack of competition as the number of installers offering their services in any given place will be limited.

4.2. Methodological contribution

The thesis makes some contributions regarding research methodology, which will be discussed below. A first contribution relates to the application of the TIS framework. In paper 1, this framework was used to study PV deployment separately from processes occurring earlier in the PV value chain. Paper 1 demonstrates that it is meaningful to apply the TIS framework to study deployment separately in order to identify and assess barriers and drivers, and that deployment taken on its own is a complex and systemic process that motivates the use of a holistic analysis tool such as the TIS framework. The thesis argues that in cases where a mature technology is to be deployed in a catching-up market that is small in relation to the international production system for the technology in question, a pure deployment focus is motivated in TIS analyses. The value of this contribution is made evident by the fact that a pure deployment focus allows the researcher to focus his or her resources on the deployment phase, thus avoiding spending valuable time studying technology development and production, and saving him or her the effort of doing an international and spatially differentiated TIS analysis. Furthermore, increasing global specialisation and division of labour, as well as an increasing availability of mature renewable energy technologies that can be deployed in new regions, can be expected to create an increasing need for deployment-focused TIS studies (see section 2.1.1.3).

The thesis also demonstrates how the TIS framework, the business models framework and Rogers' diffusion of innovations framework can be combined to study technology deployment (see section 2.1). The latter two frameworks fit within the scope of the TIS framework and are appropriate choices when zooming in on selected parts of a TIS that relate to technology deployment. The thesis argues that the latter frameworks connect well to certain phenomena described in the TIS literature, such as certain categories of actors and the functions 'entrepreneurial experimentation', 'knowledge development and diffusion', 'legitimation' and 'market formation'. Thus, the latter frameworks could well be positioned within the TIS framework – the very concept of a 'business model', as well as various core concepts within both the frameworks, could be incorporated into the TIS framework, in some cases perhaps by replacing existing terminology. This would, nevertheless, require a deeper analysis, which is beyond the scope of the present thesis.

Another methodological contribution relates more directly to the application of the business models framework. In paper 2, the viability of different business models for PV deployment in different countries was studied. Previous literature on business models had elaborated upon how business model innovation can bring new (sustainable) technologies to the market (Bocken et al., 2014; Boons and Lüdeke-

Freund, 2013; Mont et al., 2006; Reim et al., 2015; Tukker, 2004) and upon the role of the wider sociotechnical context for shaping business models (Birkin et al., 2009; Budde Christensen et al., 2012; Casper and Kettler, 2001; Linder and Cantrell, 2000; Provance et al., 2011). The methodological uniqueness of paper 2 was that it combined the business models framework with a comparative case study approach to pinpoint contextual factors in different geographical settings. This had not previously been done for PV technology and, to the best knowledge of the authors, it had not been done for the deployment of any other technology either. The approach proved useful in understanding how different business models can overcome contextual barriers (see section 3.2.3) to technology deployment and thereby create value for adopters and firms.

Also some contributions regarding methodology to study local variations in PV adoption rates were made. For paper 3, an approach based on comparative case studies was developed to identify and assess local drivers in Swedish municipalities. A combination of a replication and a 'two tail' design (Yin, 2009) was used. Five 'main cases' (municipalities with the highest adoption rates) and 50 'comparison cases' (municipalities with the lowest adoption rates) were studied. The number of comparison cases was larger because data were scarcer for this category. The comparative element of the approach was two-fold. First, the main cases were compared to one another. Second, the two categories of cases were compared to each other. The method proved useful to pinpoint local drivers that could explain why certain municipalities have stood out in terms of high PV adoption rates. To the best knowledge of the author, there has not previously been any research on local variations in technology adoption rates using an approach including the elements described above.

Furthermore, paper 3 introduced a novel approach for dealing with differences in building stock when selecting cases for comparative case studies of geographical differences in PV adoption rates. There is often a need to take building stock into consideration when studying causal factors behind PV adoption rates, as the characteristics of the built environment (e.g. the share of detached homes) may otherwise become an important confounding variable. For paper 3, all Swedish municipalities were ranked by their PV-density using two measures: the number of PV systems *per capita* and *per detached home*. Municipalities that occurred at the top or bottom of *both* these rankings were selected. The inclusion of the latter criteria served as a control mechanism, reducing the risk of local building stock characteristics confounding the selection process (see section 3.3.2).

Lastly, for paper 4, a mixed-methods approach was developed to study peer effects in PV adoption, combining qualitative and quantitative research methods through a survey and follow-up interviews with selected respondents. Thus, a qualitative perspective that had hitherto been lacking in studies of peer effects in PV adoption was introduced. As peer effects are by nature closely related to the adopters' own thoughts and emotions, survey data arguably need to be complemented with interviews – particularly in a stage where the understanding of the effects is limited – to make sure that the survey data have been interpreted correctly and to increase the chances of identifying any important matters not identified through the survey. The method proved useful to nuance the previous understanding of peer effects in PV adoption, and continued research using this or similar approaches may be fruitful in achieving a deeper understanding of peer effects in the adoption of PV or other technologies.

4.3. Implications for policymakers, firms and others

Based on the findings of this thesis, some recommendations can be derived for policymakers, firms and other actors aiming to support PV dissemination. Below, a set of general advice will first be provided. Then, a number of more specific recommendations for reforms of existing Swedish policy will follow.

A first set of advice relates to *business models* for PV deployment (paper 2). The findings regarding the relationship between business models and their surrounding context may be useful to both policymakers and firms. Even though the research on business models was not carried out in Sweden (as was the rest of the research), the findings might prove useful to overcome barriers in Sweden and other catching-up markets.

One piece of advice for policymakers is to remove any institutional barriers that might obstruct the use of certain business models, or to provide enabling legislation for business models that have proven viable in other contexts. Preferences vary between consumer groups, and a variety of business models for prospective adopters to choose from could thus increase the overall adoption rates by satisfying the preferences of a larger number of consumers. Furthermore, a substantial number of the potential adopters will, in many contexts, find it difficult to finance and own a PV system even if a purchase would be their first choice. Any institutions hindering TPO business models may thus impose a barrier to PV deployment. This does not necessarily mean that policy has failed if all business models that have proven successful in other markets are not present in the market of interest, as it might simply be the case that the market has selected against certain business models due to differences in consumer preferences or other contextual differences that are beyond the direct control of policymakers.

When it comes to firms, the findings on business models could be informative when planning to enter new markets or targeting certain consumer segments. The findings could also guide firms in how to respond to a changing context.

A second set of advice relates to *electric utilities* (organisations operating electrical grids). Paper 3 strongly suggests that local utilities can elevate PV uptake in their area by supporting PV. Policymakers could exploit this by influencing utilities to take a supportive attitude towards residential PV. Such influence could be exercised by informing utilities about PV technology and about how other organisations have worked with PV, for instance by offering utilities' staff training as to how to best support PV deployment. A web-based platform for the provision and exchange of information directed towards utilities could be implemented (perhaps as part of a larger platform for PV information directed to a broader audience). Educating utilities might both increase the chance of them choosing to support PV deployment, and make utilities perform better in providing their customers with relevant information. In cases where a government owns a utility (Swedish utilities are, for example, often owned by local governments), the government could steer the utility towards promoting PV. Utilities could also be regulated to take a more active role in PV deployment.

Another piece of advice is to arrange *information seminars* targeting private homeowners. Such seminars could be arranged by any actor (such as utilities, non-profit organisations, local governments and installation firms) interested in supporting PV deployment. Paper 3 suggests that local information seminars have been an effective strategy to convince homeowners to adopt PV in Sweden. The effectiveness of seminars might, nevertheless, depend on context-specific factors. Two key characteristics of the Swedish PV market are that it is in an early stage of development and that there is limited economic profitability in residential PV adoption. As convincingly argued by Noll et al. (2014), there are reasons to believe that information provision has the highest prospects of being effective in markets where PV is neither very profitable nor clearly unprofitable. Awareness of PV might also be lower in early markets, in which case there is a higher need for information dissemination. The generalisability this advice might thus be more or less limited to markets that are similar to Sweden in these respects.

A last piece of advice relates to *peer effects* (papers 3 and 4). Actors with a goal to increase PV uptake could seek to make use of peer effects by involving existing PV adopters in information campaigns or marketing. This might prove a cost-effective strategy for policy and businesses even if the existing adopters are economically compensated for their involvement.

Paper 4 reveals that information obtained from peers plays a partly different and complementary role compared to other information sources, such as the advice of professionals. Peers (at least in the context studied) seem to convince each other to adopt PV by giving reassurance that adoption is indeed a sound choice, rather than through the provision of more factual information (which can be found in written sources or obtained through professional advisers). Trust is not only gained through established social relations, but also through peers being in a similar situation (as private homeowners), having actual experience as adopters, and (as opposed to firms) lacking economic incentives to portray PV in an excessively positive manner. The participation of PV adopters in information campaigns or marketing could thus be effective as a complement to other means of information provision.

There are various conceivable strategies for making use of peer effects. One suggestion is to include sessions in information seminars where visitors get the opportunity to talk to adopters, for example in Q&A sessions or group discussions. Study visits could also be organised by firms or policymakers to the premises of adopters to let attendants see their PV system and talk to them. Another option would be to have local energy advisors provide citizens with contact information to local adopters. Policymakers might even want to target certain individuals to become PV adopters if these individuals could be expected to be particularly likely to create further adoptions through peer effects. If so, the findings of paper 4 suggest that socially well-connected individuals should be targeted rather than individuals who have the most visible rooftops.

4.3.1. Reforms of existing Swedish policy

A substantial portion of the research behind this thesis relates to existing Swedish institutions, and the results thus lend themselves to some Sweden-specific policy advice. This advice does not involve increased subsidisation, but rather changes in the design of existing subsidy schemes or other advice that does not require increased public spending. The advice relates to issues that were identified in the research *and* that are still present at the time of finishing the thesis (December 2016), which includes the majority of the issues identified in the research.

Paper 1 points to several uncertainties and complexities in the Swedish policy framework that could be addressed. First, the circumstance that more than one subsidy schemes for PV deployment have been running in parallel is an unnecessary complication that creates extra administration and transaction costs for adopters, installation firms and authorities, and that makes it more difficult for (potential) adopters to estimate the economic consequences of PV adoption. At the time of writing (December 2016), three subsidy schemes are running in parallel, as the proposed tax reduction was implemented after the completion of paper 1. Second, it was – and still is – unclear for how long the different subsidy schemes will run. The total budget for PV within these schemes should thus preferably be gathered within one coherent long-term strategy with high predictability and transparency.

The most important Swedish subsidy scheme for PV deployment – the investment subsidy launched in 2009 – has been flawed with uncertainties. This issue could be addressed through some relatively straightforward reforms. First, the scheme's duration and future remuneration levels should be planned and made transparent. This could be done through the setting of certain conditions to determine the future development of the scheme. For example, it could be decided that investing in a residential PV should yield a certain economic profitability, e.g. an IRR of around 5%. Factors that influence this figure (most importantly the cost development of PV systems) should then be monitored continuously so that remuneration levels can be adapted to keep the profitability at the desired level. Once the profitability reaches the desired level without the need for subsidies, the scheme has served its purpose and should be terminated. Second, measures should be taken to mitigate the long queue of applications awaiting approval. Even though the remuneration level has been reduced to 20% since paper 1 was finished while a substantial amount of long-term funding has been added, the long queue has persisted, resulting in waiting times of up to two years as of November 2016 (Svensk Solenergi, 2016). As regards the market fluctuations caused by discontinuations in the scheme, this problem appears to have been resolved. Even if new discontinuations in the scheme would occur, the current remuneration level of only 20% in combination with reduced prices of PV systems have induced an increased share of the new adopters to purchase the system *before* their application is approved, hoping to get the subsidy retroactively. This secures a more evenly distributed demand for PV systems regardless of any discontinuations in the scheme.

Paper 1 also shows that the tradable green certificates (TGC) scheme, which has been available for PV and other renewables since 2003, has been poorly adapted to residential PV and other modes of micro-production of electricity. To adapt this scheme, the selling of small quantities of certificates could be made easier. This could be achieved for example through the provision of a user-friendly web-based trading platform, or by authorities purchasing certificates at market rates from micro-producers using an automated system (the authorities could then re-sell the certificates in bulk to other actors). Another issue is the high cost for micro-producers of acquiring certificates for self-consumed electricity, as this requires the installation of additional metering equipment. This could – if the TGC scheme is to be intended for micro-producers in the future – be solved through for example relaxed requirements on metering, certificates for self-consumption being granted on the basis of a template, or by providing PV adopters with free metering equipment. However, a burning issue is whether the TGC scheme should be intended at all for micro-production. If so, the scheme should be adapted accordingly. If not, micro-production should be formally excluded from the TGC system (any subsidisation should then be carried out by other means).

The building permit system could also be reformed. To reduce complexity, rules could be standardised between municipalities. Building permits for residential PV could also be abolished if certain criteria are fulfilled (e.g. that the panels follow the inclination of the roof). Fees could be abolished, or only be due once a permit has been approved (thus reducing uncertainty and risk for prospective adopters). Information on building permits regarding fees, requirements, administration time etc. could be provided on municipalities' websites.

As regards uncertainties regarding tax rules, it was recently (after the completion of paper 1) established that residential PV adopters are under most circumstances indeed not subject to extra taxation and related administration. Any remaining uncertainties could be mitigated by adaptation of rules in a planned, transparent manner, by clear and official statements regarding the intended direction of future reform, or by clarifying official statements regarding how existing rules should be applied.

4.4. Suggestions for further research

In this section, some possible lines of research that could be addressed subsequent to this thesis will be identified. Four potential areas of research will be discussed, one following each paper.

4.4.1. Technological innovation systems (TIS)

As argued in this thesis, there will likely be an increasing need for TIS studies focusing exclusively on the deployment phase of PV (as was done in paper 1) and other technologies. Although this thesis makes some methodological contributions in how to perform such studies (see section 4.2), further methodological development is needed. For example, methods need to be developed regarding how to set system boundaries for geography and value chain based on what phenomena interact in a systemic manner and how different phenomena relate to space. A deployment focus is also likely to have implications regarding the functional dynamics of TISs. The relative importance of different functions might change in some generalisable ways and there might be differences in which functions are important on different geographical scales. New empirical research, or re-analysis of existing TIS literature with a 'new lens', might shed light on these issues.

Conceptual work could also be done regarding how the TIS framework connects to other streams of literature. As observed in this thesis (see section 2.1), the business models framework as well as Rogers' diffusion of innovations framework both fit within the scope of the TIS framework and are useful when zooming in on certain key parts of a TIS. These, and perhaps other, frameworks could be more elaborately positioned within the TIS framework in future conceptual work.

4.4.2. Business models and their context

Paper 2 served as a first step in analysing how business models for PV deployment depend on barriers and other contextual factors in different geographical settings. The findings pointed towards a number of factors that appeared to have influenced the success of different business models in the studied markets. However, more research is needed in order to gain a deeper understanding of how and to what extent these and other factors influence the viability of different business models. As an increasing number of PV markets become mature enough to host more elaborate business models, there will be more potential cases to study. Paper 2 could also be complemented through data collection from adopters (surveys, interviews) in the studied markets or in other markets. This could shed light on adopters' motives for preferring a certain business model, and on whether any particular contextual factors influenced their preferences. Furthermore, business models for the deployment of other technologies than PV could be studied in relation to their context. This could yield valuable technology-specific as well as generalisable knowledge regarding the relationship between business models and their context.

4.4.3. Local barriers and drivers

Paper 3 was and early attempt to identify causes of locally elevated adoption rates of residential PV. There are several ways to continue this line of research. First, the adopter perspective could be further explored, e.g. through interviews with adopters in municipalities with high adoption rates. This way, a deeper understanding of factors influencing the different stages of their adoption decision process could be gained. Approaches similar to that developed for paper 3 could also be used to study other settings than the Swedish one. This could reveal to what extent the findings of paper 3 are generalisable; for example, the findings might be specific for early PV markets or for some other characteristic that Sweden shares with certain other settings. Another possibility would be to use statistical regression analyses to compare municipalities or other geographical entities with each other, using PV adoption rates as the dependent variable. This could reveal correlations not visible through case study methodology.

One finding of paper 3 was that local electric utilities supporting PV appeared to have had a substantial positive effect on adoption rates. This could be further explored in different ways. For example, it could be investigated why some utilities choose to engage in PV promotion and sales. From a purely economic perspective, promoting PV might appear as a bad decision for utilities as increased PV penetration undermines their source of revenue. Furthermore, PV sales are arguably beyond their core business. Research on incumbent companies in the offshore oil and gas sector that have diversified into wind power suggests that a key reason for this diversification has been to attract the most talented staff for use in their core business (Hansen and Steen, 2015). However, there is as yet little research on the reasons for energy incumbents to engage in renewables, and on whether and under what circumstances such engagement might be economically rational for such organisations.

Furthermore, the role (current and potential) of utilities might differ between countries. For example, utilities are typically highly regulated on the national level, which might create rather different opportunities for utilities in different countries to act beyond their core tasks (and thus to support PV). This could be researched.

Lastly, more research could be done on the role of local information in increasing PV adoption rates. The findings of paper 3 indicated that information seminars have been important in the cases studied, but little is known about what defines successful information dissemination on the local level (e.g. how an information seminar should be designed in order to spur PV adoptions). As information dissemination can be a low-cost intervention, it can (if effective) be a cost-effective way to increase PV uptake. For example, it has been argued that information dissemination has the highest potential to be effective in early markets in which PV is neither very profitable nor clearly unprofitable (Noll et al., 2014), but there is currently little empirical evidence to support this.

4.4.4. Peer effects

This thesis offers an initial attempt to understand the inner workings of peer effects in PV adoption. To build a more solid understanding of the mechanisms behind these peer effects, more qualitative empirical research is needed. Using the approach developed for paper 4 or a similar methodology combining survey and interviews appears to be a fruitful way of moving this research forward. Data could be collected from adopters, non-adopters, or potential adopters in different settings.

Depending on the exact research question and on the expected occurrence of useful information among adopters, representative or purposeful sampling could be used. For example, peer effects could often be expected to be more common in areas with high adoption rates. Thus, any given sample size could yield more useful information through purposeful sampling in such areas. As large samples are costly to manage, purposeful sampling could be beneficial in situations where a representative sample is not necessary. Future research could in those cases imitate or be inspired by the sampling strategy developed for the present thesis.

Research could also be done to find out whether and how the characteristics of peer effects vary between different contexts, such as between early and more mature markets. For example, as early adopters are generally more cosmopolite than later adopters (Rogers, 1983), peer effects might be less localised in early markets (as was the case in the studied Swedish early market).

The findings of this thesis raise some doubt as to the role of passive peer effects in PV adoption. In previous literature, these have often been assumed to be an important part of the 'total' peer effects. The importance of the passive component could be assessed by investigating the impact of PV systems' visibility. If, for example, rooftop PV systems facing roads generate substantially larger increases in local adoption rates than PV systems facing backyards, this could indicate a large passive component.

Lastly, the possibilities of utilising peer effects in campaigns could be explored. Is, for example, information provision (e.g. seminars) more effective when adopters are involved? How should they be engaged to make the highest impact: should they give lectures, be available for Q&A sessions, or take part in conversation groups? (As anecdotal evidence, small conversation groups among seminar participants were described as a very important influential factor by one of the interviewees.) Would it be cost-effective to pay them to participate? Are organised study visits to PV adopters' premises a viable strategy? Such alternatives could be investigated, for example through experiments.

5. Conclusions

This thesis identifies and assesses various barriers and drivers to the deployment of residential PV systems in different geographical contexts. Using a sociotechnical systems approach, the thesis demonstrates how the *technological innovation systems* TIS framework can be amended by the *business models* and the *diffusion of innovations* frameworks to study the deployment of a mature technology (in this case PV) in a catching-up market, treating the development and production of the technology as a 'black box'. On the national level, the analysis shows that the Swedish sociotechnical system for residential PV deployment has been immature and infested by various institutional barriers. Most notably, the Swedish subsidy schemes for PV deployment have been flawed with uncertainties and complexities, and there have been important uncertainties regarding the future development of the Swedish institutional set-up. The results also demonstrate how barriers in different national contexts have affected what kinds of business models for PV deployment that have been viable. On the local level, the results demonstrate how actors such as local electric utilities and private individuals have influenced homeowners to adopt PV through information dissemination and social influence (peer effects). The findings can inform policymakers, firms and other actors as to how to better support PV deployment.

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R7726

Date Submitted	12/6/2018	**Section**	806.5	**Proponent**	Ann Russo1
Chapter	8	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Editorial improvement.

Rationale

This is an editorial improvement, which makes the code clearer. There is no change in the requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No negative impact to local entity relative to enforcement of code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is simply an editorial improvement which makes the code clearer.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will make to code clearer which will improve the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows to make the code clearer:

R806.5 Unvented attic and unvented enclosed rafter assemblies.

(no change to the text in between)

5.1.2 Where air-permeable insulation is ~~provided inside the building thermal envelope, it shall be installed in accordance withSection 5.1.1. In addition to the air-permeable insulation~~ installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the R-values in Table R806.5 for condensation control.

(no change to the text below)

R7347

Date Submitted 11/20/2018
Chapter 9
Section 907
Affects HVHZ No
Proponent Bryan Holland
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**
Alternate Language **No**

Related Modifications

7345

Summary of Modification

This proposed modification deletes unneeded "reserved" sections and adds pointers to other applicable rules or standards related to solar energy systems.

Rationale

This proposed modification simply adds pointers to the R324 (Mod 7345), the NFPA 70, and the FFPC for rules related to rooftop solar energy systems. The proposal also deletes unneeded sections placed in a "reserve" status in the current code.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

Impact to small business relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed modification is directly connected to the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed modification improves and strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposed modification does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

SECTION R907

ROOFTOP-MOUNTED PHOTOVOLTAIC SYSTEMS

R907.1 Rooftop-mounted photovoltaic systems. Rooftop-mounted photovoltaic panel systems shall be designed and installed in accordance with Section R324, NFPA 70 and the Florida Fire Prevention Code.

~~Reserved.~~

~~R907.2 Wind resistance.~~

~~Reserved.~~

~~R907.3 Fire classification.~~

~~Reserved.~~

~~R907.4 Installation.~~

~~Reserved.~~

~~R907.5 Photovoltaic panels and modules.~~

~~Reserved.~~

R7348

Date Submitted	11/20/2018	**Section**	909	**Proponent**	Bryan Holland
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

7345, 7347

Summary of Modification

This proposed modification deletes R909 as it is no longer needed with the updated information in R324 (Mod 7345) and R907 (Mod 7347).

Rationale

This proposed modification completely deletes all of Section 909 as these requirements are found in R907 and R324. There is no need to keep a section of "reserved" rules in the updated code.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposed modification will not impact the local entity relative to code enforcement.

Impact to building and property owners relative to cost of compliance with code

This proposed modification will not change the cost of compliance to building and property owners.

Impact to industry relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact industry.

Impact to small business relative to the cost of compliance with code

This proposed modification will not change the cost of compliance or impact small business.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposed modification is directly connected to the health, safety, and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposed modification improves and strengthens the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposed modification does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposed modification enhances the effectiveness of the code.

~~SECTIONR 909~~

~~ROOFTOP-MOUNTED PHOTOVOLTAIC PANEL SYSTEMS~~

~~R909.1 General.~~

~~Reserved.~~

~~R909.2 Structural requirements.~~

~~Reserved.~~

~~R909.3 Installation.~~

~~Reserved.~~

R7353

Date Submitted	11/20/2018	**Section**	905.3	**Proponent**	Michael Silvers (FRSA)
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building Code Sections 1507.3

Summary of Modification

This modification updates Referenced Standard: FRSA/TRI High Wind Concrete and Clay Roof Tile Manual from the Fifth to the Sixth Edition

Rationale

Updates Referenced Standard: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with enforcement of the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This change modification does not discriminate any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

905.3.2 Clay and concrete roof tile shall be installed on roof slopes in accordance with the recommendations of FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

905.3.3 Underlayment.

Required underlayment shall comply with the underlayment manufacturer's installation instructions in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or

905.3.3.1 Slope and underlayment requirements.

Refer to manufacturer's installation instructions, FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or RAS 118, 119 or 120 for underlayment and slope requirements for specific roof tile systems.

905.3.6 Fasteners.

Nails shall be corrosion resistant and not less than 11 gage, $^5/_{16}$-inch (11 mm) head, and of sufficient length to penetrate the deck not less than $^3/_4$inch (19 mm) or through the thickness of the deck, whichever is less or in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or in accordance with the recommendations of RAS 118, 119 or 120. Attaching wire for clay or concrete tile shall not be smaller than 0.083 inch (2.1 mm).

905.3.7 Application.

Tile shall be applied in accordance with this chapter and the manufacturer's installation instructions, recommendations of the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition or the recommendations of RAS 118, 119 or 120.

905.3.7.1 Hip and ridge tiles.

Hip and ridge tiles shall be installed in accordance with FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

905.3.8 Flashing.

At the juncture of roof vertical surfaces, flashing and counterflashing shall be provided in accordance with this chapter and the manufacturer's installation instructions, recommendations of the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* ~~Fifth~~ Sixth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 111, 118, 119 or 120.

R7426

Date Submitted	11/25/2018	**Section**	905.17.1	**Proponent**	T Stafford
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Correlates the wind loading requirements in the code for rooftop PV with ASCE 7-16.

Rationale

This proposal correlates the wind loading requirements on roof mounted photovoltaic systems with the newly referenced ASCE 7-16. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). ASCE 7-16 contains two new methods for wind loads on photovoltaic systems. One method is based on the component and cladding loads applicable to the roof. The other method is based on entirely different criteria and research. Therefore, for clarification, this proposal simply references ASCE 7 for wind loads on rooftop PV systems.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to building and property owners relative to the cost of compliance with the code. This code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

R905.17.1 Wind resistance. Rooftop mounted photovoltaic systems shall be designed for wind loads in accordance with ASCE 7 ~~for component and cladding in accordance with Chapter 16 of the *Florida Building Code, Building* using an effective wind area based on the dimensions of a single unit frame~~.

R7571

Date Submitted	11/29/2018	**Section**	905	**Proponent**	Michael Silvers (FRSA)
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Building 1507.1.1

Summary of Modification

This modification adds an exception to underlayment attachment that provides for an existing self-adhering membrane to act as a secondary water barrier similar to the 4" wide strip in the current exception.

Rationale

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They usually cannot be removed. A new self-adhering membrane cannot be adhered to an existing membrane. This change provides a clear method to properly incorporate the membrane into the new roof system. It uses a similar approach to one that already is in code. It recognizes that the existing membrane provides similar protection to a 4" strip over the joints in the roof decking.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification will not impact enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification will reduce the cost of roof replacement when a self-adhering membrane has been previously applied to the entire roof deck.

Impact to industry relative to the cost of compliance with code

This modification will not add to cost of compliance.

Impact to small business relative to the cost of compliance with code

This modification will not add to cost of compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They cannot be removed. This provides a clear method to properly incorporate the membrane into the new roof system.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Self-adhering membranes applied to the entire deck are being encountered during roof replacement more often. They cannot be removed. This provides a clear method to properly incorporate the membrane into the new roof system.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against materials, methods, or systems of construction.

Does not degrade the effectiveness of the code

This modification does not degrade the effectiveness of the code.

TABLE R905.1.1

UNDERLAYMENT TABLE

Underlayment Attachment

3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

Exceptions:

1. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table 1507.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.
2. An existing self-adhering modified bitumen underlayment complying with Underlayment Attachment 3. above has been previously installed over the roof decking and where it is required, re-nailing off the roof sheathing in accordance with 706.7.1 of the Florida Building Code, Existing Building can be confirmed or verified.An approved underlayment in accordance with Table R905.1.1 for the applicable roof covering shall be applied over the entire roof over the existing self-adhered modified bitumen underlayment.

R7665

Date Submitted	12/4/2018	**Section**	905.1.1	**Proponent**	Greg Keeler
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Residential R905.1.1 Unknown This is a back-up proposal in the event the proposal related to the new ASTM Polymeric Underlayment Standard is not approved.

Summary of Modification

This proposal clarifies requirements related to use of synthetic underlayment.

Rationale

ASTM D4533 is the most appropriate tear testing protocol for this category of products, and specifying two different protocols with the same minimum requirement doesn't make sense as the two protocols yield vastly different results. Additionally, testing indicates that synthetic underlayments are more resistant to fastener pull-through than D226 Type II felt. Thus, they should not be held to a more stringent requirement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

R905.1.1 Underlayment. Unless otherwise noted underlayment for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a label indicating compliance to the standard designation and, if applicable, type classification indicated in Table R905.1.1. Underlayment shall be applied and attached in accordance with Table R905.1.1.

Exception: A ~~reinforced~~ synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength in accordance with ASTM ~~D1970 or~~ ASTM D4533 of 20 pounds shall be permitted. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table R905.1.1 for the applicable roof covering and slope <u>and the underlayment manufacturer's installation instructions</u>~~, except metal cap nails shall be required where the ultimate design wind speed, V*ult*, equals or exceeds 150 mph~~.

R7694

Date Submitted	12/5/2018	**Section**	905.1.1	**Proponent**	T Stafford
Chapter	9	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

This proposal will require a sealed roof deck consistent with the IBHS Fortified Bronze designation.

Rationale

This proposal will require sealing of the the roof deck that is consistent with the IBHS Fortified Home Bronze designation. See uploaded support file for the rationale and justification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This proposal will slightly increase cost. For roof slopes 4:12 and greater, the cost increase for a typical 2000 square foot roof will be approximately $220. For roof slopes less than 4:12, the cost increase for a typical 2000 square foot roof will be approximately $440.

Impact to industry relative to the cost of compliance with code

No impact to industry relative to cost of compliance with the code.

Impact to small business relative to the cost of compliance with code

No impact to small business relative to cost of compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal will reduce the amount of water infiltration through the roof deck when roof coverings are lost due to a wind event.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal strengthens the code by requiring a sealed roof deck to reduce the amount of water infiltration through the roof deck when roof coverings are lost due to a wind event.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not degrade the effectiveness of the code

This proposal does not degrade the effectiveness of the code.

Revise as follows:

R905.1.1 Underlayment. ~~Unless otherwise noted u~~Underlayment ~~for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels~~ shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a label indicating compliance to the standard designation and, if applicable, type classification indicated ~~in Table R905.1.1~~. Underlayment shall be applied and attached in accordance with Section R905.1.1.1, R905.1.1.2, or R905.1.1.3 as applicable ~~Table R905.1.1~~.

R905.1.1.1 Underlayment for asphalt, metal, mineral surfaced, slate and slate-type roof coverings. Underlayment for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels shall comply with one of the following methods:

1. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

2. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

> **Exception:** A reinforced synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength of 15 lbf in accordance with ~~ASTM D1970 or~~ ASTM D4533 ~~of 20 pounds~~ and a minimum tensile strength of 20 lbf/inch in accordance with ASTM D5035 shall be permitted to be applied over the entire roof over the 4-inch wide (102 mm) membrane strips. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table R905.1.1.1 for the applicable roof covering and slope~~, except metal cap nails shall be required where the ultimate design wind speed, V_{ult}, equals or exceeds 150 mph~~.

3. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C)), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

> **Exception:** A reinforced synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength of 15 lbf in accordance with ASTM D4533 and a minimum tensile strength of 20 lbf/inch in accordance with ASTM D5035 shall be permitted to be applied over the entire roof over the 4-inch wide (102 mm) membrane strips. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table R905.1.1.1 for the applicable roof covering and slope.

4. Two layers of ASTM D226 Type II or ASTM D4869 Type III or Type IV underlayment shall be installed as follows: Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.

> **Exception:** Compliance with Section R905.1.1.1 is not required for structural metal panels that do not require a substrate or underlayment.

TABLE R905.1.1.1
UNDERLAYMENT WITH SELF-ADHERING STRIPS OVER ROOF DECKING JOINTS

Roof Covering	Underlayment Type	Underlayment Attachment

		2:12 = Roof Slope < 4:12	Roof Slope > 4:12
Asphalt Shingles, Metal Roof Panels, Photovoltaic Shingles	ASTM D226 Type II ASTM D4869 Type III or IV ASTM D 6757	Apply in accordance with Section R905.1.1.1 Item 4 or Section R905.1.1.3 Item 3 as applicable to the type of roof covering.	Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
Metal Roof Shingles, Mineral-Surface Roll Roofing, Slate and Slate-type Shingles, Wood Shingles, Wood Shakes	ASTM D226 Type II ASTM D4869 Type III or IV		

~~TABLE R905.1.1~~
~~UNDERLAYMENT TABLE~~

~~Roof Covering Section~~	~~Roof Slope 2:12 and Less Than 4:12 Underlayment~~	~~Underlayment Attachment[a]~~	~~Roof Slope 4:12 and Greater Underlayment~~	~~Underlayment Attachment[a]~~
~~Asphalt shingles R905.2~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV ASTM D6757~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type III or IV ASTM D 6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D 1970~~	~~3~~
~~Concrete and Clay Tile R905.3~~	~~See Section R905.3.3~~			
~~Metal roof shingles R905.4~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV ASTM D6757~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~
~~Mineral-surfaced roll roofing R905.5~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTMD 1970~~	~~3~~
~~Slate and slate type shingles R905.6~~	~~ASTM D226 Type I or II ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II ASTM D4869 Type IV~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~

~~**Wood shingles R905.7**~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~	~~2~~
~~**Wood shakes R905.8**~~	~~Limited to roof slopes 4:12 and Greater~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~	~~2~~	
~~**Metal roof panels R905.10**~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~ ~~ASTM D6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~
~~**Photovoltaic Shingles R905.17**~~	~~ASTM D226 Type I or II~~ ~~ASTM D4869 Type II, III or IV~~ ~~ASTM D6757~~	~~1~~	~~ASTM D226 Type II~~ ~~ASTM D4869 Type IV~~ ~~ASTM D6757~~	~~2~~
	~~ASTM D1970~~	~~3~~	~~ASTM D1970~~	~~3~~

~~[a]Underlayment Attachment~~

~~1. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and less than four units vertical in 12 units horizontal (33-percent slope). Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.~~

~~2. Roof slopes of four units vertical in 12 units horizontal (33-percent slope) or greater. Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.~~

~~3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope) and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970(2015a) installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.~~

~~**Exception:** A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970(2015a), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.~~

R905.1.1.2 Underlayment for concrete and clay tile. Underlayment for concrete and clay tile shall comply with one of the following methods:

1. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

2. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Section R905.3.3 shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

3. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Section R905.3.3 shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

> **Exception:** Compliance with Section R905.1.1.2 is not required where a fully adhered underlayment is applied in accordance with Section R905.3.3.

R905.1.1.3 Underlayment for wood shakes and shingles. Underlayment for wood shakes and shingles shall comply with one of the following methods:

1. A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

2. A minimum 3 ¾-inch wide (96 mm) strip of self-adhering flexible flashing tape complying with AAMA 711-13, Level 3 (for exposure up to 176° F (80° C)), installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An underlayment complying with Table R905.1.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) flashing strips.

3. Two layers of ASTM D226 Type II or ASTM D4869 Type III or Type IV underlayment shall be installed as follows: Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using annular ring or deformed shank nails with metal or plastic caps with a nominal cap diameter of not less than 1 inch. Metal caps are required where the ultimate design wind speed, V_{ult}, equals or exceeds 170 mph. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.

Insurance Institute for Business & Home Safety

Where building science leads to real-world solutions.

Hurricane Demonstration Testing

Insights on Wind-Driven Water Entry

The Insurance Institute for Business & Home Safety (IBHS) Research Center 2011 hurricane season demonstration test offered an opportunity to gain insight into roof and ventilation system wind-driven water entry issues.

This unique, full-scale study of how wind-driven water penetrates openings in residential roof systems was modeled on real world, post-event damage assessments in areas where hurricane winds were strong enough to rip off roof cover, but not strong enough to blow off roof sheathing. In such instances, significant property damage and extended occupant displacement routinely occur due to water intrusion. In addition to wind-driven water pouring in – or being blown through – cracks between roof sheathing elements when primary roof cover is damaged and the underlayment is lost, water intrusion through residential roofs can originate from attic ventilation elements (e.g., ridge vents, gable end vents, and soffit vents).

Such damage is particularly common in inland areas, where hurricane-strength winds occur, but building codes and standards are not as stringent as in coastal jurisdictions. For example, when 2005's Hurricane Wilma crossed the southern tip of Florida as a Category 2 hurricane with peak wind speed gusts of about 110 mph, she caused more than $10 billion of damage, most of which related to roof damage and resulting water intrusion. Much of this damage occurred far inland. Other hurricanes have caused catastrophic damage as they moved well inland. For example, after Hurricane Ike made landfall in Texas, it remained strong for two days, creating Category 1 hurricane force winds as far away as Ohio (and causing more than $1.5 billion of losses there).

Water penetration can cause extensive damage to interior finishes, furnishings and other contents, and can lead to ceiling collapse when insulation is saturated. Also, where power is lost and/or a house cannot otherwise be quickly dried out, mold growth is common. IBHS believes that the tremendous human and financial costs associated with water penetration during hurricanes could be substantially reduced through widespread adoption of relatively simple, inexpensive changes to residential roofing systems, such as sealing the roof deck (which only costs about $500 for an average-sized home).

Objectives for IBHS' first wind-driven water research program included:

- quantifying the relative volume of water penetration through different roof openings;
- cataloguing types of water penetration damage to different parts of a house;
- demonstrating effective individual damage mitigation techniques, such as sealing the roof deck; and,
- illustrating why sealed roof decks are core components of the IBHS FORTIFIED for Existing Homes™ and FORTIFIED for Safer Living® program requirements for hurricane-prone regions.

The building specimen designed and constructed for the demonstration was a duplex, where sheathing joints on one half of the roof deck were sealed prior to installing roofing materials and the other half was not sealed. Both halves of the roof were then covered with simple felt paper underlayment prior to installing the asphalt shingles. The building included gable ends fitted with gable end vents and one foot wide soffits at the eaves. The roof sheathing stopped short along the primary ridge so it was possible to install a ridge vent during one set of tests.

All of these features have been addressed in the IBHS FORTIFIED Existing Homes™ bronze designation, which incorporates current best practices in a systems based approach to reducing water entry related losses in high wind events. These recommendations are also incorporated in the IBHS Roofing the Right Way guide.

Figure 1 -Test duplex moving into the large test chamber at the IBHS Research Center.

The basic recommendations in the IBHS FORTIFIED Existing Homes ™ bronze brochure and the IBHS Roofing the Right Way guide related to preventing or reducing wind-driven water entry include:

1. Sealing the roof deck (joints or the entire surface) to prevent water from running into the attic through the gaps between the roof sheathing panels.

2. Ensuring that soffit panels (the flat panels installed between the bottom of the eaves at the roof edge and the wall of the house) are well attached to the house so they do not blow off in high winds, thereby creating an opening through which wind-driven water could enter the attic.

3. Covering gable end vents with flat shutter panels (plywood or some other flat material) when a hurricane threatens, to keep water from being blown into the attic.

4. Ensuring that ridge vents are products that have been tested and approved for resisting wind driven water entry and that they are adequately attached using the manufacturer's recommendations for high wind installations.

The 2011 hurricane demonstration test gave IBHS its first opportunity to illustrate the relative success and importance of taking these steps to reduce the potential for water entry using high-definition photos and videos of the consequences of water entry into attic spaces during the demonstration testing. Quantitative measurements of water entry were obtained by researchers opportunistically during this demonstration testing to provide preliminary measurements and insight into the quantity of water entering into an attic through vents and between sheathing joints.

Establishing Wind-Driven Rain Capabilities

Planning and research leading to the development of wind-driven rain capabilities at the IBHS Research Center have been ongoing for several years. IBHS provided support to the University of Florida (UF) to assist with deployment of a research disdrometer (an instrument that quantifies droplet size and rain fall rates, shown in Figure 2 on page 3) in Hurricane Ike.

IBHS followed up with partial support for a Ph.D. student to analyze rain droplet size distribution based on Hurricane Ike data, and then to use the UF wind simulator to select a commercially available spray nozzle to produce a similar distribution of rain droplet sizes in the IBHS Research Center test chamber. Thus, a realistic distribution of droplet sizes is required to achieve the same wetting patterns on buildings that occur during real world storms.

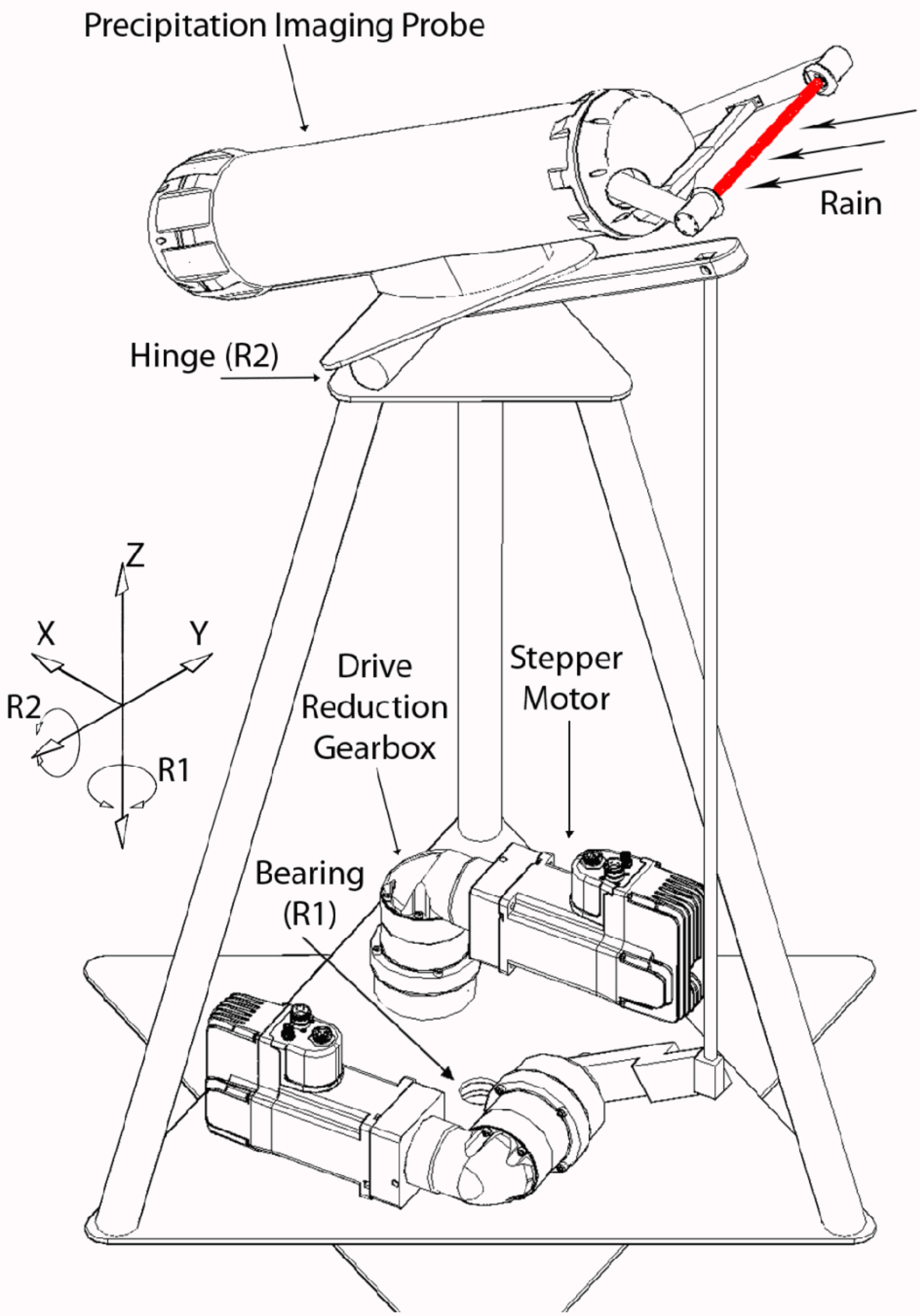


Figure 2 - Precipitation Imaging Probe (PIP) style disdrometer mounted on Florida Coastal Monitoring Program (FCMP) portable weather station for Hurricane Ike data collection by University of Florida.

This summer, the student brought the research disdrometer to the IBHS lab to conduct tests of the completed system. The validation tests demonstrated that target rain deposition rates (8 inches per hour in American Society of Testing and Materials and Florida Building Code test standards) and droplet size distributions were properly reproduced. NOTE: A Ph.D. dissertation is being written on this research and should be completed by the end of 2011.

Measuring Water Entry Rates

When the duplex was completed, including installation of wall board and ceiling drywall, drainage panels and tracks (DrySpaceTM) were installed to create water collection channels between the ceiling trusses, as shown in Figure 3. These channels were outfitted with drains and pipes that allowed collected water to be captured in plastic containers arranged throughout the interior (non-attic) space in the two halves of the duplex. The drainage system was installed in a modular system that allowed the collection of water in ceiling areas roughly 10 feet long by 2 feet wide. The trusses ran from front to back of the house and the 22½ inch space between the trusses was divided into three sections, each about 10 feet long. Each drainage channel directed water to a separate numbered plastic container. Typical drain and collection locations are shown in Figure 4, Figure 5, and Figure 6 (shown on page 6). Tests were typically conducted for a 20-minute period, during which a constant wind speed was maintained and rainfall rate was set to produce 8 inches per hour on the test building (i.e., horizontally driven rain). At the completion of each test, water in the buckets was measured and quantity was recorded.

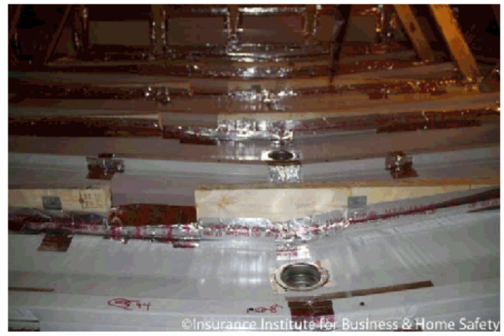


Figure 3 - Photograph of water collection channels between ceiling trusses in duplex.

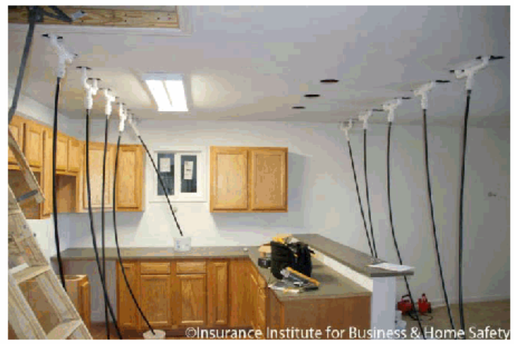


Figure 4 - Photograph of water collection drains to collection buckets in the duplex.

Figure 5 - Photograph of water collection drains to collection buckets in the duplex.

Figure 6 - Photograph of water collection drains to collection buckets in the duplex.

Quantitative Test Program Summary

A series of quantitative tests was conducted during the time available before the scheduled hurricane demonstration. The first test sequence involved measuring water entry rates when the soffit cover was missing along the entire length of the back eave of the duplex. The opening of approximately 8.5 sq. ft. under the eave of the roof where wind and wind-driven rain could enter the attic caused by the missing soffit is typical of the observed loss of the soffit cover in strong winds. Tests were conducted for wind speeds of 30 mph, 50 mph and 70 mph, during which the wall with the open soffit faced the wind flow, as shown in Figure 7. A quartering wind test (i.e., the wall with the open soffit was oriented at 45 degrees off perpendicular to the wind direction) was also conducted with a 50 mph wind speed.

The second test sequence involved repeating soffit tests with a typical perforated vinyl soffit panel intact, thus quantifying differences in water entry for typical soffits that remain undamaged vs. soffit material blown off during an event. For this round of quantification, tests were conducted at 50 mph and 70 mph with the wall with the soffit facing the wind, and at 50 mph for the quartering wind case.

The third test sequence focused on measuring water entry through the gable end vent. These tests were conducted with 30 mph and 50 mph wind-driven rain beating directly against the gable end. During these tests, soffits were covered with typical perforated vinyl soffit panel material.

Figure 7 - Photographs of the water entry quantification testing for the open soffit case with the wall facing the wind flow: top) whole duplex; and bottom) close-up of the open soffit area.

Following the soffit and gable end quantification test series, roof cover on the front of the duplex was blown off using high winds. Similar efforts were started for the roof surface at the back of the duplex, when a fan drive fault ended wind generation for that day. Because of schedule constraints, it was decided to remove roof cover from the back roof surface to expose the sealed and un-sealed roof decks above the same eave where soffit water entry testing was conducted. Removal of roof cover from the front and back surfaces exposed the gap at the top of the primary ridge, so it was fitted with a Florida Building Code High Velocity Hurricane Zone approved ridge vent.

The final sequence of quantification testing included wind speeds of 50 mph with the back of the duplex facing the wind flow. This configuration put the exposed sealed and un-sealed roof decks, shown in Figure 8, perpendicular to the wind-driven rain to allow a relative comparison in the amount of water entry in the attic for each half of the roof.

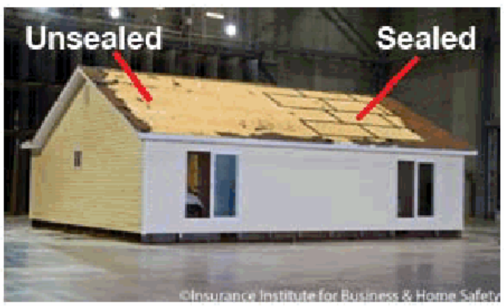


Figure 8 - Photograph of the back of the duplex after shingle and underlayment removal, illustrating the sealed roof deck (on the right) and the un-sealed roof deck (on the left).

Summary of Quantitative Test Results

Open Soffit Tests (simulating loss of soffit material during a high-wind event):

1. A wind speed of 30 mph produced a light sprinkling of drops on the water collection drainage pans within 8 feet of the open soffit. However, no water actually trickled down the drainage system to collection buckets.

2. A wind speed of 50 mph produced an overall water entry rate into the attic of about 1.3 inches per hour based on the open area of the soffit. This is about 15% of the rainfall deposited on the adjacent wall surface (8 inches per hour). Most water was within the first 10 feet of the attic space adjacent to the open soffit.

3. A wind speed of 70 mph produced an overall water entry rate into the attic of about 2.9 inches per hour based on the open area of the soffit. This is a little more than 33% of the deposition rate on the adjacent wall surface.

4. A quartering wind of 50 mph produced an uneven distribution of water in the attic, but still resulted in about 1.6 inches per hour based on the open area of the soffit. This is about 20% of the deposition rate on a wall surface that would have been facing the wind flow.

Covered Soffit Tests (where soffit material remains in place):

- A wind speed of 50 mph resulted in water accumulation in the attic space of approximately 6% of the amount of water that entered during the same test for the open soffit case.
- A wind of 70 mph produced about 9 times more water accumulation in the attic than the 50 mph test. This was about 25% of the amount of water that entered the attic during the same test (70 mph) for the open soffit case.
- A quartering wind of 50 mph produced very little accumulation of water in the attic. The amount was about 2.5% of the water entering during the same test for the open soffit case.

Gable End Vent Tests:

For winds of 30 mph and above, the water entry rate was about equal to the wind driven water deposition rate based on the area of the gable end vent. There was a slight indication of less water entry for higher wind speeds, but that likely was due to missed water that was blown farther into the attic and collected in the area around the access stairs where no collection pans were in place.

Exposed Roof Sheathing Tests:

The sealed roof deck side (where joints between the roof sheathing were sealed by applying a self adhesive modified bitumen tape) experienced about one-third of the water entry experienced by the side without tape. The amount of water entry through the roof deck was unprecedented in relation to tests conducted for soffit and gable end vents. The roof deck test actually had to be stopped at 16 minutes in duration, because the 3-gallon containers collecting water from each 10 foot by 2 foot collection area were overflowing. Some water entry on the sealed roof side was due to cuts in the tape that occurred when roof cover was removed. Even holes left by nails that pulled out when roof cover was removed led to steady drips of water into the attic. On the side where roof cover was blown off (shown in Figure 9), nails tended to stay in place, which would have reduced nail hole drips. Use of ring shank nails to fasten shingles and underlayment would likely help reduce these leaks, because they will be less likely to pull out, even if roof shingles are blown off. There was no sign of leaks through the Florida Building Code High Velocity Hurricane Zone approved ridge vent.

Consequences of Water Entry

Following quantitative testing, water collection devices were removed from the structure and the required drainage holes in the ceiling were patched. Furniture was placed in the duplex to model actual living spaces. The finished structure was then subjected to a series of wind-driven rain events modeled after Hurricane Dolly. These tests gave IBHS the opportunity to illustrate the consequences of water entry into attic spaces with compelling photos and video. Figure 10 shows photographs taken on the un-sealed roof deck side of the duplex during the demonstration testing, while Figure 11 (shown on page 9) shows a similar view on the sealed roof deck side.

Figure 9 - Photograph of the front of the duplex after shingle and underlayment removal using high winds, illustrating the sealed roof deck (on the left) and the un-sealed roof deck (on the right).

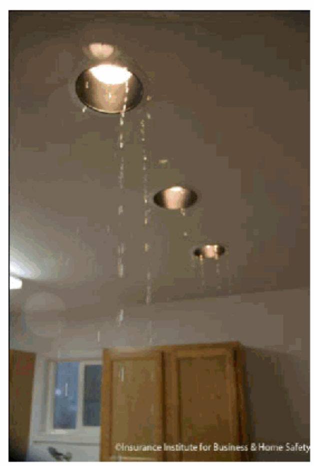


Figure 10 - Photograph of the water entry during the demonstration event on the un-sealed roof deck side of the duplex: close up of the recessed lighting in the kitchen.

Figure 11 - Photograph of the kitchen during the demonstration event on the sealed roof deck side of the duplex.

The amount of water streaming into the living space during the demonstration in the un-sealed roof deck side of the duplex, and the level of damage ultimately experienced on this half of the duplex, is typical of the level of water entry reported during real-world events. Within 45 minutes of the conclusion of testing, the kitchen ceiling in the un-sealed side of the duplex collapsed, as shown in Figure 12 and Figure 13. Shortly thereafter, the living room area ceiling also collapsed, as shown in Figure 14.

Figure 13 - Photograph of fallen portions of collapsed ceiling in the kitchen on the un-sealed roof deck side of the duplex.

Figure 12 - Photograph of collapsed ceiling in the kitchen on the un-sealed roof deck side of the duplex.

Figure 14 - Photograph of fallen portions of collapsed ceiling in the living room on the un-sealed roof deck side of the duplex.

Following the test, IBHS brought in an experienced property insurance claims adjuster to estimate the amount of damage each side of the duplex suffered. He assessed damage to the front three rooms on both sides of the duplex, including the kitchen, dining room, and family room. During a hurricane or high wind event, winds generally come from a relatively small range of directions after roof cover blows off, so damage confined to one area of a house would be typical of most people's experience. The difference between estimated repair costs on the two sides of the duplex was substantial. The loss estimate for the side without a sealed roof deck is more than three times the loss estimate for the side with the sealed roof deck. Of particular note: the furniture in the side without a sealed roof deck required replacement, while furnishings in the side with the sealed roof deck only required cleaning.

Conclusions and Recommendations

These preliminary tests clearly demonstrate that the areas addressed in the IBHS FORTIFIED Existing Homes™ and Roofing the Right Way guidance are important to reducing water entry in hurricanes and other storms where wind-driven rain is a factor. Clearly, sealing the roof deck is one of the most important protective measures that can be undertaken. However, the installer should be careful to make sure that seams are securely sealed and that the drip edge is attached using typical high-wind requirements for fasteners. It is likely that the High Velocity Hurricane Zone requirements for applying roofing cement around edges of the roof would also help reduce water entry if roof cover does suffer damage in a storm.

As a preliminary study, this work suggests that much more investigation is needed to quantify the amount of water entry that can be expected for normal construction, how much water entry is likely to be reduced with various water entry prevention measures, and how much water entry can be tolerated before costs of water entry remediation increase significantly.

Reason: This proposal will require sealing of the the roof deck that is consistent with the *IBHS Fortified Home Bronze* designation. When the primary roof covering is lost due to a wind event, water infiltration can cause extensive damage to interior finishes, furnishings and other contents, and can lead to ceiling collapse when insulation is saturated. Also, where power is lost and/or a building cannot otherwise be quickly dried out, mold growth is common.

While observations from recent hurricanes indicate buildings built to the Florida Building Code (FBC) are performing better than older buildings, significant roof covering loss is still occurring. Many of these buildings, while relatively undamaged structurally, experienced significant and costly damage to interior components due the loss of the primary roof covering. A sealed roof deck can significantly reduce the amount of water infiltration when the primary roof covering is lost. A demonstration test by IBHS on building with portion of the roof sealed and another portion unsealed showed significant reductions in water infiltration in the areas where the roof deck was sealed. (See attached support file Hurricane_Test_Wind_Driven_Water_Report.)

While underlayment requirements in the FBC have been strengthened recently, this proposal, if approved, will take them one step further to comply with the *IBHS Fortified Home Bronze* designation. From a practical standpoint, only two changes are proposed to the current underlayment requirements in the 6th Edition (2017) FBC. First, where felt underlayments are used without membrane/flashing strips applied over the joints in the roof deck, two layers would now be required. The lap requirements currently required for low slope roofs would be required for all slopes. Fasteners for felt underlayment are required to be annular ring or deformed shank fasteners. The number of fasteners and spacing of fasteners is consistent with current requirements.

The options for using adhered underlayments are unchanged from the 6th Edition (2017) FBC.

The requirements for synthetic underlayments have been revised to be consistent with the new standard for synthetic underlayments that is near completion and expected to be published in 2019.

Preliminary observations from Hurricane Michael are also indicating that newer buildings built to the FBC are performing better but water infiltration due to roof covering loss is still a problem. This proposal, if approved, will significantly reduce the amount of water infiltration through the roof deck when roof coverings are lost.

R7730

Date Submitted	12/6/2018	**Section**	905.15.3	**Proponent**	Ann Russo1
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Add necessary language for the application of roof coatings.

Rationale

This proposal adds necessary language so that the application of roof coatings follows manufacturer's approved installation instructions. This proposal adds clarity and does not change code requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds clarity and does not change code requirements.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal adds necessary language so that the application of roof coatings follows manufacturer's approved installation instructions.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal adds clarity and improves the application of the code.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal does not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will improve the effectiveness of the code.

Revise as follows:

R905.15.3 Application.

Liquid-applied roofing shall be installed in accordance with this chapter and the manufacturer's <u>approved installation </u>instructions. The approved allowable uplift resistance for the liquid-applied coatings shall be equal to or greater than the uplift resistance for the roof based on Table R301.2(2).

R7782

Date Submitted 12/8/2018
Chapter 9
Section 905.8.5
Affects HVHZ No
Proponent Scott McAdam
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No
Alternate Language No

Related Modifications

RB154-16 New Mod 7737
Table R905.8.5

Summary of Modification

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Rationale

The existing text was outdated, requiring clarification and updates to current AWPA section numbering.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

clarification with wording of standard no impact

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction
These changes merely clarify and update the existing text without any impact on the required specifications for materials used.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

clarification

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

clarifies

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

does not discriminate

Does not degrade the effectiveness of the code

no effect

TABLE R905.8.5

WOOD SHAKE MATERIAL REQUIREMENTS

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shakes of naturally durable wood	1	Cedar Shake and Shingle Bureau
Tapersawn shakes of naturally durable wood	1 or 2	Cedar Shake and Shingle Bureau
Preservative-treated shakes and shingles of naturally durable wood	1	Cedar Shake and Shingle Bureau
Fire-retardant-treated shakes and shingles of naturally durable wood	1	Cedar Shake and Shingle Bureau
Preservative-treated tapersawn shakes of Southern pine treated in accordance with AWPA Standard U1 (Commodity Specification A, Special Requirement 4.6 ~~Use Category 3B and Section 5.6~~)	1 or 2	Forest Products Laboratory of the Texas Forest Services

R7806

Date Submitted	12/9/2018	**Section**	906.2	**Proponent**	Scott McAdam
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB352-16

add appropriate standard for mineral wool roof insulation board and add to Table 906.2

Summary of Modification

This proposal will add reference to the appropriate ASTM Standard specification for mineral wool roof insulation and make Table R906.2 consistent with IBC Table 1508.2.

Rationale

ASTM C726-12 Standard Specification for Mineral Wool Roof Insulation Board

Reason: This proposal will add reference to the appropriate ASTM Standard specification for mineral wool roof insulation and make Table R906.2 consistent with IBC Table 1508.2. This will help to ensure that roofing systems designed using mineral wool roof insulation will perform as intended by the IRC. This standard has been referenced in the IBC since the 2012 edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

no impact provide additional information

Impact to building and property owners relative to cost of compliance with code

No cost impact adds standard which will provide consistent regulation

Impact to industry relative to the cost of compliance with code

No cost impact adds standard which will provide consistent regulation

Impact to small business relative to the cost of compliance with code

No cost impact adds standard which will provide consistent regulation

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

provides consistency with added standard helping the public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

strengthens and improves the code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

will not discriminate

Does not degrade the effectiveness of the code

enhances the effectiveness of the code

Revise as follows:

TABLE R906.2

MATERIAL STANDARDS FOR ROOF INSULATION

Cellular glass board	ASTM C 552
Mineral wool board	ASTM C 726
Composite boards	ASTM C 1289, Type III, IV, V or VI
Expanded polystyrene	ASTM C 578
Extruded polystyrene board	ASTM C 578
Perlite board	ASTM C 728
Polyisocyanurate board	ASTM C 1289, Type I or II
Wood fiberboard	ASTM C 208
Fiber-reinforced gypsum board	ASTM C 1278
Glass-faced gypsum board	ASTM C 1177

R7865

Date Submitted	12/10/2018	**Section**	902	**Proponent**	Jon Roberts
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

This proposal adds a section to the code related to rooftop mounted photovoltaic panel systems. It requires rooftop mounted panel systems to be listed and identified with a fire classification in accordance with UL 1703 and UL 2703.

Rationale

This code change simply provides the appropriate method for testing photovoltaic panel systems for fire classification, as required by the ANSI standards. This method is already in use within the industry.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This method is already in use within the industry therefore there is no impact to the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This method is already in use within the industry therefore there is no additional cost to construction.

Impact to industry relative to the cost of compliance with code

This method is already in use within the industry therefore there is no additional cost to construction.

Impact to small business relative to the cost of compliance with code

This method is already in use within the industry therefore there is no additional cost to construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This method is already in use and helps to maintain the safety of these systems.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This improves the code by adding additional language for use by the building official relative to roof top mounted solar panel systems.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This does not discriminate against other equivalent methods.

Does not degrade the effectiveness of the code

This method is already in use within the industry therefore there is no degradation of the code.

R902.4 Rooftop-mounted photovoltaic ~~panels and modules~~ panel systems.

Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be tested, listed and identified with a fire classification in accordance with UL 1703 and UL 2703. Class A, B or C *photovoltaic panel systems* and modules shall be installed in jurisdictions designated by law as requiring their use or where the edge of the roof is less than 3 feet (914 mm) from a lot line.

R7967

Date Submitted 12/14/2018
Chapter 9
Section 905
Affects HVHZ No
Proponent Andy Williams
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

R301.2.1

Summary of Modification

Addition of Wind Resistance testing ASTM D3161 to measure metal roof shingle wind resistance performance

Rationale

This proposal recognizes wind resistance of metal roof shingles as a separate item, R905.4.4.1. These items are not the same as asphalt shingles, R905.2.4.1. Showing compliance with the FRC wind resistance requirements is necessary for proper evaluation. UL580, UL1897, and FM4474, currently recognized in the FBC for “Other roof systems,” including metal panel systems, are added as options for metal shingles. TAS 107, which directly states its appropriateness for metal shingles, is added with ASTM equivalent D3161. UL has provided metal shingle wind classifications for many years and currently has D3161-related listings in the Online Certifications Directory.

D3161, created for asphalt shingles, was expanded in 2013 to include other discontinuous, air permeable, steep slope roofing products. This includes metal shingles (specifically identified in Section 1.3). UL was a proponent of the D3161 scope change showing support of D3161 to demonstrate wind resistance.

This proposal removes problems for metal shingle use by clarifying options to show compliance with the wind resistance code requirements. Included are uplift resistance methods used in the FBC for many years (UL1897, UL580, FM4474), and accepted methods of fan-induced wind simulations (TAS 107, ASTM D3161) that are used for other discontinuous, air-permeable roof covers (asphalt shingles) and building integrated PV shingles. The fan-induced options provide alternatives for evaluation of air permeable metal shingles in a non-air-permeable manner via the uplift resistance methods, which unfairly represents the products.

Table R905.4.4.1 is added to establish recognition of metal shingles qualified via D3161. Classifications are equivalent to those for asphalt shingles (Table R905.2.6.1). Like asphalt, metal shingles qualified via D3161 must to bear a label and classification (Table R905.4.4.1).

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal should have no additional impact on enforcement of the code

Impact to building and property owners relative to cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Impact to industry relative to the cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Impact to small business relative to the cost of compliance with code

This proposal should have no additional cost impact for compliance with the code

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal should provide realistic performance information to better ensure safety through code compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal provides more accurate performance information on this type of roofing system.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal provides more accurate performance information on this type of roofing system.

Does not degrade the effectiveness of the code

This proposal provides more accurate performance information on this type of roofing system.

Mod 7967

Add new text as follows

R905.4.4.1

R905.4.4.1 Wind Resistance of Metal roof shingles. Metal roof shingles applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580, UL 1897 or TAS 107. Metal roof shingles tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.2.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table R905.4.4.1.

Add new table as follows:

TABLE R905.4.4.1

CLASSIFICATION OF METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161

MAXIMUM BASIC WIND SPEED FROM FIGURE 1609A, B, C or ASCE-7	V_{asd}	ASTM D3161
110	85	D or F
116	90	D or F
129	100	D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

Modify existing text as follows

R301.2.1 Wind design criteria.

Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2(1) as determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, and exterior doors (other than garage doors). Where loads for garage doors are not otherwise specified, the loads listed in Table R301.2(4) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. Metal roof shingles shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces from the roof assembly to the foundation.

R8060

Date Submitted	12/13/2018	**Section**	905.1.1	**Proponent**	Greg Keeler
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

R7665

Summary of Modification

Placeholder for proposed ASTM Polymeric Underlayment Standard. This proposed standard is under ASTM Work Item #WK51913.

Rationale

This proposal adds an ASTM standard that is currently under development. This would be the first ASTM Standard that applies specifically to synthetic underlayment. This proposed standard is under ASTM Work Item #WK51913. It is critical to reference a standard that applies exclusively to synthetic underlayment as many are currently qualified under standards that were intended for use only for asphaltic felt underlayment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

R905.1.1 Underlayment. Unless otherwise noted underlayment for asphalt shingles, metal roof shingles, mineral surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes and metal roof panels shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869, ~~and~~ D6757, and ASTM WK51913 shall bear a label indicating compliance to the standard designation and, if applicable, type classification indicated in Table R905.1.1. Underlayment shall be applied and attached in accordance with Table R905.1.1.

~~**Exception:** A reinforced synthetic underlayment that is approved as an alternate to underlayment complying with ASTM D226 Type II and having a minimum tear strength in accordance with ASTM D1970 or ASTM D4533 of 20 pounds shall be permitted. This underlayment shall be installed and attached in accordance with the underlayment attachment methods of Table R905.1.1 for the applicable roof covering, slope, except metal cap nails shall be required where the ultimate design wind speed, V*ult*, equals or exceeds 150 mph~~.

R8062

Date Submitted	12/13/2018	**Section**	905.1.1	**Proponent**	Greg Keeler
Chapter	9	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

R8060

Summary of Modification

Modifies table to include placeholder for proposed ASTM Polymeric Underlayment Standard. This proposed standard is under ASTM Work Item #WK51913.

Rationale

This table corresponds with revised Section R905.1.1 to include a placeholder for the proposed ASTM Polymeric Underlayment Standard. This proposal adds an ASTM standard that is currently under development. This would be the first ASTM Standard that applies specifically to synthetic underlayment. This proposed standard is under ASTM Work Item #WK51913. It is critical to reference a standard that applies exclusively to synthetic underlayment as many are currently qualified under standards that were intended for use only for asphaltic felt underlayment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None

Impact to building and property owners relative to cost of compliance with code

None

Impact to industry relative to the cost of compliance with code

None

Impact to small business relative to the cost of compliance with code

None

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

Please see attached PDF.

TABLE R905.1.1
UNDERLAYMENT TABLE

Roof Covering Section	Roof Slope 2:12 and Less Than 4:12 Underlayment	Underlayment Attachment[1]	Roof Slope 4:12 and Greater Underlayment	Underlayment Attachment[1]
Asphalt Shingles R905.2	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757		ASTM D6757	
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Concrete and Clay Tile R905.3	See Section 1507.3.3			
Metal roof shingles R905.4	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Mineral-surfaced roll roofing R905.5	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Slate and Slate-Type Shingles R905.6	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Wood Shingles R905.7	ASTM D226 Type I or II		ASTM D226 Type II	
	ASTM D4869 Type II, III, or IV	1	ASTM D4869 Type IV	2
	ASTM WK51913		ASTM WK51913	
Wood Shakes R905.8	Not Permitted	Limited to roof slopes 4:12 and greater	ASTM D226 Type II	2
			ASTM D4869 Type IV	
			ASTM WK51913	
Metal Roof Panels R905.10	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3
Photovoltaic Shingles R905.17	ASTM D226 Type I or II	1	ASTM D226 Type II	2
	ASTM D4869 Type II, III, or IV		ASTM D4869 Type IV	
	ASTM D6757			
	ASTM WK51913		ASTM WK51913	
	ASTM D1970	3	ASTM D1970	3

[a]Underlayment Attachment

1. Roof slopes from two units vertical in 12 units horizontal (17-percent slope), and less than four units vertical in 12 units horizontal (33-percent slope). Apply a 19-inch (483 mm) strip of underlayment felt parallel to and starting at the eaves, fastened sufficiently to hold in place. Starting at the eave, apply 36-inchwide (914 mm) sheets of underlayment, overlapping successive sheets 19 inches (483 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with corrosion-resistant fasteners with one row centered in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
2. Roof slopes of four units vertical in 12 units horizontal (33-percent slope) or greater. Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches (51 mm), end laps shall be 6 inches and shall be offset by 6 feet. The underlayment shall be attached to a nailable deck with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 inches (305 mm) o.c., and one row at the end and side laps fastened 6 inches (152 mm) o.c. Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than 3/4 inch into the roof sheathing.
3. Roof slopes from two units vertical in 12 units horizontal (17-percent slope) and greater. The entire roof deck shall be covered with an approved self-adhering polymer modified bitumen underlayment complying with ASTM D1970 installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's installation instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed.

Exception: A minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane complying with ASTM D1970, installed in accordance with the manufacturer's instructions for the deck material, shall be applied over all joints in the roof decking. An approved underlayment in accordance with Table R905.1.1 for the applicable roof covering shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips.

Date Submitted	12/13/2018	**Section**	905.3	**Proponent**	T Stafford
Chapter	9	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Revises the roof tile section to clarify that wind loads on tile have to comply with ASCE 7-16.

Rationale

This proposal is primarily a correlation. During Phase I of the 2020 update of the FBC, the Commission voted to update ASCE 7 from the 2010 edition to the 2016 edition (ASCE 7-16). In ASCE 7-16, the component and cladding loads and roof zones for roofs with a MRH of 60 feet and less have changed. The code currently refers to the FRSA/TRI manual for tile. However Table 1A (uplift loads for underlayment and hip/ridge tiles) and Tables 2A and 2B (aerodynamic uplift moment) are still based on ASCE 7-10. This proposal simply clarifies that these loads have to be determined in accordance with ASCE 7-16. Clarifying language has also been added with regards to the manufacturer's product approval installation instructions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

No impact to local entities relative to enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

No impact to building and property owners. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to industry relative to the cost of compliance with code

No impact to industry. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Impact to small business relative to the cost of compliance with code

No impact to small business. While there may be cost impacts for certain buildings due to the adoption of ASCE 7-16, this code change simply correlates the code with the previous action by the commission to update ASCE 7 to the 2016 edition (ASCE 7-16).

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This code change correlates the code with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This code change improves the code by providing correlation with the previous action by the Commission to update reference standard ASCE 7 to the 2016 edition (ASCE 7-16).

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This code change dos not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

This code change does not degrade the effectiveness of the code.

Revise as follows:

R905.3 Clay and concrete tile. The installation of clay and concrete tile shall ~~be in~~ comply ~~accordance~~ with the manufacturer's product approval installation instructions~~, or~~ in accordance with the recommendations of FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

Revise as follows:

R905.3.2 Deck slope. Clay and concrete roof tile shall be installed on roof slopes in ~~accordance~~ compliance with the manufacturer's product approval installation instructions in accordance with therecommendations of FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.3 Underlayment. Required underlayment shall comply with the underlayment manufacturer's product approval installation instructions in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition, except as modified in Section R905.3.3.1, where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.3.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Table 1A in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for underlayments for tile systems shall be determined in accordance with ASCE 7.

~~**R905.3.3.1 Slope and underlayment requirements.**Refer to manufacturer's installation instructions, FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition where the V_{asd} is determined in accordance with Section R301.2.1.3 or RAS 118, 119 or 120 for underlayment and slope requirements for specific roof tile systems.~~

Revise as follows:

~~Table~~ R905.3.7 Wind resistance of Clay and Concrete Tile ~~Attachment.~~ ~~Reserved.~~ Wind loads on clay and concrete tile roof coverings shall be determined in accordance with Section 1504.2 of the *Florida Building Code, Building.*

R905.3.7.1 Hip and ridge tiles. Hip and ridge tiles shall be installed in compliance ~~accordance~~ with the manufacturer's product approval installation instructions in accordance with the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition, except as modified in Section R905.3.7.1, where the V_{asd} is determined in accordance with Section R301.2.1.3 or the recommendations of RAS 118, 119 or 120.

R905.3.7.1.1 FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual,* Fifth Edition. Delete Tables 2A and 2B in the FRSA/TRI *Florida High Wind Concrete and Clay Roof Tile Installation Manual*, Fifth Edition. Required design pressures for hip and ridge tiles shall be determined in accordance with ASCE 7.

R8170

Date Submitted	12/14/2018	**Section**	905.16	**Proponent**	Ann Russo1
Chapter	9	**Affects HVHZ**	No	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Expanding the requirements for Building-integrated Photovoltaic roof panels.

Rationale

This proposal adds new sections to address Building-integrated photovoltaic (BIPV) roof panels. These products form part of the roof assembly and are subject to the same requirements as any other roof covering. These BIPV panels are larger and the wind resistance is determined by UL 1897 Uplift Tests for Roof Covering System

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This proposal adds another type of roof covering and will provide clarity to the enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

Will not increase the cost of construction.

Impact to industry relative to the cost of compliance with code

Will not increase the cost of construction.

Impact to small business relative to the cost of compliance with code

Will not increase the cost of construction.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal has reasonable and substantial connection with the health, safety and welfare of the general public.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal will improve the application of the code and will provide equivalent or better products, methods and systems of construction.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This proposal will not discriminate against materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This proposal will not degrade the effectiveness of the code.

Revise as follows:

R905.16 Building-integrated photovoltaic ~~roofing modules/shingles~~roof panels applied directly to the roof deck.

(no change to the text below)

R905.16.1 Deck requirements.

~~Reserved~~Building-integrated photovoltaic roof panels shall be applied to a solid or closely-fitted deck, except where the roof covering is specifically designed to be applied over spaced sheathing.

R905.16.2 Deck slope.

~~Reserved~~Building-integrated photovoltaic roof panels shall be used only on roof slopes of two units vertical in 12 units horizontal (17-percent slope) or greater.

R905.16.3 Underlayment.

Underlayment shall comply ~~and be installed in accordance~~ with Section R905.1.1.

R905.16.3.1 Ice barrier.

Where required, an ice barrier shall comply with Section R905.1.2.

R905.16.4 ~~Underlayment application~~Ice barrier.

~~Reserved~~In areas where there has been a history of ice forming along the eaves causing a backup of water, as designated in Table R301.2(1), an ice barrier that consists of not less than two layers of underlayment cemented together or of a self-adhering polymer-modified bitumen sheet shall be used in lieu of normal underlayment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building.

Exception: Detached accessory structures that do not contain conditioned floor area.

~~**R905.16.4.1 Ice barrier.**~~

~~Reserved.~~

~~**R905.16.4.2 Underlayment and high winds.**~~

~~Reserved.~~

R905.16.5 Material standards.

Building-integrated photovoltaic ~~roofing modules/shingles~~roof panels shall be listed and labeled in accordance with UL 1703.

R905.16.6 Attachment.

Building-integrated photovoltaic ~~roofing modules/shingles~~roof panels shall be attached in accordance with the manufacturer's installation instructions.

R905.16.7 Wind resistance.

~~Building-integrated photovoltaic roofing modules/shingles shall be tested in accordance with procedures and acceptance criteria in ASTM D3161 or TAS 107. Building-integrated photovoltaic roofing modules/shingles shall comply with the classification requirements of Table R905.2.6.1 for the appropriate maximum basic wind speed. Building-integrated photovoltaic roofing modules/shingles packaging shall bear a label to indicate compliance with the procedures in ASTM D3161 or TAS 107 and the required classification from Table R905.2.6.1~~Building-integrated photovoltaic roof panels shall be tested in accordance with UL 1897. Building-integrated photovoltaic roof panels packaging shall bear a label to indicate compliance with UL 1897.

R8288

Date Submitted	12/15/2018	**Section**	905	**Proponent**	Chadwick Collins
Chapter	9	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Update to meet intent of code definition

Rationale

Requiring labeling per the definition in Chapter 2 will provide a more stringent validation that the asphalt shingles meet the required wind resistance classification.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates requirement with intent of the code

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes any ambiguity between this section and the chapter 2 definition

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Places requirement on all products.

Does not degrade the effectiveness of the code

Brings section into compliance with Chapter 2.

See attached file

R905.2.6.1 Classification of asphalt shingles. Asphalt shingles shall be classified in accordance with ASTM D3161, TAS 107 or ASTM D7158 to resist the basic wind speed per Figure R301.2(4). Shingles classified as ASTM D3161 Class D or classified as ASTM D7158 Class G are acceptable for use where V_{asd} is equal to or less than 100 mph. Shingles classified as ASTM D3161 Class F, TAS 107 or ASTM D7158 Class H are acceptable for use for all wind speeds. Asphalt shingle wrappers shall be *labeled* to indicate compliance with one of the required classifications, as shown in Table R905.2.6.1.

R8290

Date Submitted 12/15/2018
Chapter 9
Section 905
Affects HVHZ Yes
Proponent Chadwick Collins
Attachments Yes
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Clarifies practice and prescriptive requirements

Rationale

This proposal clarifies the long-standing practice and prescriptive requirements from the IRC that drip edge on gables be installed over the underlayment.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Addresses a condition that if not installed as proposed could lead to an inability of the roofing system to perform as expected in regard to the public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Provides clarity of a long-standing practice of construction

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Applies equally to currently referenced components in the section

Does not degrade the effectiveness of the code

Clarifies and strengthens the intent of the code in providing guidance for expected installation minimums.

See attached file

R905.2.8.5 Drip edge. Provide drip edge at eaves and gables of shingle roofs. Overlap to be a minimum of 3 inches (76 mm). Eave drip edges shall extend 1/2 inch (13 mm) below sheathing and extend back on the roof a minimum of 2 inches (51 mm). <u>Drip edge at gables shall be installed over the underlayment.</u> Drip edge at eaves shall be permitted to be installed either over or under the underlayment. If installed over the underlayment, there shall be a minimum 4 inch (51 mm) width of roof cement installed over the drip edge flange. Drip edge shall be mechanically fastened a maximum of 12 inches (305 mm) on center. Where the V_{asd} as determined in accordance with Section R301.2.1.3 is 110 mph (177 km/h) or greater or the mean roof height exceeds 33 feet (10 058 mm), drip edges shall be mechanically fastened a maximum of 4 inches (102 mm) on center.

R8400

Date Submitted	12/15/2018	**Section**	905.11.2	**Proponent**	Michael Fischer
Chapter	9	**Affects HVHZ**	No	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

8399

Summary of Modification

Removes withdrawn standards

Rationale

Remove withdrawn standards

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

0

Impact to building and property owners relative to cost of compliance with code

0

Impact to industry relative to the cost of compliance with code

0

Impact to small business relative to the cost of compliance with code

0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Yes

Does not degrade the effectiveness of the code

Yes

Table R905.11.2
Remove Standard CGSB 37-GP-56M from Modified Bitumen Roof Membrane Standards

R905.12.2 Material standards.
Thermoset single-ply roof coverings shall comply with ASTM D4637, or ASTM D5019 ~~or CGSB 37-GP-52M~~.

R905.13.2 Material standards.
Thermoplastic single-ply roof coverings shall comply with ASTM D4434, ASTM D6754, or ASTM D6878 ~~or CGSB CAN/CGSB 37.54~~.

FBC ARMA Code Proposals

CGSB Standards

Table R905.11.2
Remove Standard CGSB 37-GP-56M from Modified Bitumen Roof Membrane Standards

R905.12.2 Material standards.
Thermoset single-ply roof coverings shall comply with ASTM D4637, or ASTM D5019 ~~or CGSB 37-GP-52M~~.

R905.13.2 Material standards.
Thermoplastic single-ply roof coverings shall comply with ASTM D4434, ASTM D6754, or ASTM D6878 ~~or CGSB CAN/CGSB 37.54~~.

Reason: Proposal removes withdrawn Canadian Standards

R7463

Date Submitted	11/27/2018	**Section**	103	**Proponent**	Richard Schauland
Chapter	Appendix U	**Affects HVHZ**	No	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **Yes** **Alternate Language** **No**

Related Modifications

Summary of Modification

Please refer to the attached file. The documentation for this proposal exceeds the 300 character limit.

Rationale

The modifications proposed are designed to provide clarification and strengthen the existing Solar-ready Appendix U.

In Section U103.1, the roof area orientation has been modified from 110 degrees to 90 in order to maximize the roof slopes that maximize solar technology effectiveness. For similar reasons, Section U103.3 now precludes any portion of the solar zone from being located on a roof slope greater than 2:12 that faces within 45 degrees of true north.

New Section U103.5 clarifies the term "shading" used in Section U103.1, Exception #2, by clarifying how far the designated solar-ready zone should be set back from permanently affixed objects.

If necessary for the system, it is considerably cheaper to provide a path for future wiring from the solar panel to the meter at the time of new construction than after, so roofs with a slope of 2:12 or less must provide a pipe sleeve penetration. There are other design options for roofs with greater slopes, so a penetration is not necessary.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

There may be little to no impact to local entities relative to the enforcement of the code. Local entities would have to verify the shading limitations and verify the penetration sleeve during already conducted inspections.

Impact to building and property owners relative to cost of compliance with code

This proposal will increase the cost of construction only in roofs with a slope of 2:12 or less. In any other projects, there will not be an increase in the cost.

Impact to industry relative to the cost of compliance with code

This proposal will increase the cost of construction only in roofs with a slope of 2:12 or less. In any other projects, there will not be an increase in the cost.

Impact to small business relative to the cost of compliance with code

There will no impact to small business because this proposal is for residential buildings only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

This proposal is about maximizing the solar technology effectiveness. It provides clarity to the code.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

This proposal does strengthen the Code, it ensures maximum effectiveness of the solar technology.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The proposal does not discriminate against materials, products, methods, or systems of construction.

Does not degrade the effectiveness of the code

This proposal helps the effectiveness of the code by providing clarity to the code.

1st Comment Period History

R7463-G1

Proponent Stevie Freeman-Monte **Submitted** 1/29/2019 **Attachments** No

Comment:

I support this proposed code modification.

U103.1 General. New detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 square feet (55.74 m2) of roof area oriented between ~~110~~ 90 degrees and 270 degrees of true north shall comply with sections U103.2 through ~~U103.8~~ U103.10.

Exceptions:

1. New residential buildings with a permanently installed on-site renewable energy system.
2. A building ~~with a solar-ready zone~~ where all areas of the roof that ~~is shaded~~ would otherwise meet the requirements of Section U103 are in full or partial shade for more than 70 percent of daylight hours annually.

U103.2 Construction document requirements for solar ready zone. Construction documents shall indicate the solar- ready *zone*.

U103.3 Solar-ready zone area. The total solar-ready *zone* area shall be not less than 300 square feet (27.87 m2) exclusive of mandatory access or set back areas as required by the *Florida Fire Prevention Code*. New multiple single-family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (185.8 m2) per dwelling shall have a solar- ready zone area of not less than 150 square feet (13.94 m2). The solar-ready zone shall be composed of areas not less than 5 feet (1.52 m) in width and not less than 80 square feet (7.44 m2) exclusive of access or set back areas as required by the *Florida Fire Prevention Code*.

U103.4 Obstructions. Solar-ready *zones* shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

Add new text as follows:

U103.5 Shading The *solar-ready zone* shall be set back from any existing or new permanently affixed object on the building or site that is located south, east, or west of the solar zone a distance at least two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees, and roof plantings.

U103.6 Capped roof penetration sleeve A capped roof penetration sleeve shall be provided adjacent to a *solar-ready zone* located on a roof slope of 2:12 or less. The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit, but shall have an inside diameter of not less than 1 ¼ inches.

Revise as follows:

~~U103.5~~ U103.7 Roof load documentation. *No change to text.*

~~U103.6~~ U103.8 **Interconnection pathway.** *No change to text.*

~~U103.7~~ U103.9 **Electrical service reserved space.** *No change to text.*

~~U103.8~~ U103.10 **Construction documentation certificate.** *No change to text.*

Code Change No: RB371-16

Original Proposal

Section: U103, U103.1, U103.2, U103.3, U103.4, U103.5, U103.5 (New), U103.6, U103.6 (New), U103.7, U103.8

Proponent: Kathleen Petrie, City of Seattle, Department of Construction and Inspections, representing City of Seattle, Department of Construction and Inspections (kathleen.petrie@seattle.gov)

Revise as follows:

U103.1 General. New detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 square feet (55.74 m^2) of roof area oriented between ~~110~~ 90 degrees and 270 degrees of true north shall comply with sections U103.2 through ~~U103.8~~ U103.10.

Exceptions:

1. New residential buildings with a permanently installed on-site renewable energy system.
2. A building ~~with a solar-ready zone~~ where all areas of the roof that ~~is shaded~~ would otherwise meet the requirements of Section U103 are in full or partial shade for more than 70 percent of daylight hours annually.

U103.2 Construction document requirements for solar ready zone. Construction documents shall indicate the solar- ready *zone*.

U103.3 Solar-ready zone area. The total solar-ready *zone* area shall be not less than 300 square feet (27.87 m^2) exclusive of mandatory access or set back areas as required by the *International Fire Code*. New multiple single-family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (185.8 m^2) per dwelling shall have a solar-ready *zone* area of not less than 150 square feet (13.94 m^2). The solar-ready *zone* shall be composed of areas not less than 5 feet (1.52 m) in width and not less than 80 square feet (7.44 m^2) exclusive of access or set back areas as required by the *International Fire Code*.

U103.4 Obstructions. Solar-ready *zones* shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

Add new text as follows:

U103.5 Shading The *solar-ready zone* shall be set back from any existing or new permanently affixed object on the building or site that is located south, east, or west of the solar zone a distance at least two times the object's height above the nearest point on the roof surface. Such objects include, but are not limited to, taller portions of the building itself, parapets, chimneys, antennas, signage, rooftop equipment, trees, and roof plantings.

U103.6 Capped roof penetration sleeve A capped roof penetration sleeve shall be provided adjacent to a *solar-ready zone* located on a roof slope of 2:12 or less. The capped roof penetration sleeve shall be sized to accommodate the future photovoltaic system conduit, but shall have an inside diameter of not less than 1 ¼ inches.

Revise as follows:

~~U103.5~~ U103.7 Roof load documentation. *No change to text.*

~~U103.6~~ U103.8 Interconnection pathway. *No change to text.*

~~U103.7~~ U103.9 Electrical service reserved space. *No change to text.*

~~U103.8~~ U103.10 Construction documentation certificate. *No change to text.*

Reason: The modifications proposed are designed to provide clarification and strengthen the existing Solar-ready Appendix U.

In Section U103.1, the roof area orientation has been modified from 110 degrees to 90 in order to maximize the roof slopes that maximize solar technology effectiveness. For similar reasons, Section U103.3 now precludes any portion of the solar zone from being located on a roof slope greater than 2:12 that faces within 45 degrees of true north.

New Section U103.5 clarifies the term "shading" used in Section U103.1, Exception #2, by clarifying how far the designated solar-ready zone should be set back from permanently affixed objects.

If necessary for the system, it is considerably cheaper to provide a path for future wiring from the solar panel to the meter at the time of new construction than after, so roofs with a slope of 2:12 or less must provide a pipe sleeve penetration. There are other design options for roofs with greater slopes, so a penetration is not necessary.

Cost Impact: Will increase the cost of construction
Only in roofs with a slope of 2:12 or less will this proposal increase the cost of construction by $100. In all other projects it will not increase the cost of construction.

Report of Committee Action Hearings

Committee Action: **Approved as Submitted**

Committee Reason: The new language takes shading into account, clarifies the code and adds flexibility for builders.

Assembly Action: **None**

Final Action Results

RB371-16	**AS**

R7367

Date Submitted	11/20/2018	**Section**	46	**Proponent**	Michael Silvers (FRSA)
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Residential Section 905.3
Building Section 1507.3
Building Chapter 35

Summary of Modification

This modification updates Referenced Standards: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Rationale

Updates Referenced Standard: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the Fifth to the Sixth Edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

This modification does not impact cost associated with enforcement of the code.

Impact to building and property owners relative to cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to industry relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Impact to small business relative to the cost of compliance with code

This modification does not impact cost associated with compliance with the code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The manuals use as a referenced standard has led to improvement with the application of roof tile in Florida. The latest edition is has been updated with better information and illustrations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

This modification does not discriminate against any materials, products, methods or systems of construction.

Does not degrade the effectiveness of the code

This change does not degrade the effectiveness of the code.

Updates Referenced Standard: FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual from the ~~Fifth~~ to the Sixth Edition.

FRSA

Florida Roofing Sheet Metal and Air Conditioning Contractors Association

~~4111 Metric Drive~~

P.O. Box 4850

Winter Park, FL32792~~2~~3

Standard reference number

FRSA/TRI

~~April 2012 (02-12)~~

September 2018(09–18)

-

Title

FRSA/TRI Florida High Wind Concrete and Clay Roof Tile Installation Manual, ~~Fifth~~ Sixth Edition Revised

Referenced in code section number

905.3.2, 905.3.3, 905.3.3.1, 905.3.6, 905.3.7, 905.3.7.1, 905.3.8

R7808

Date Submitted	12/9/2018	**Section**	906.2	**Proponent**	Scott McAdam
Chapter	46	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RB352-16
add appropriate standard for mineral wool roof insulation board and add to Table 906.2

Summary of Modification

This proposal will add reference to the appropriate ASTM C726 Standard specification for mineral wool roof insulation and make Table R906.2 consistent with IBC Table 1508.2.

Rationale

ASTM C726-12 Standard Specification for Mineral Wool Roof Insulation Board

Reason: This proposal will add reference to the appropriate ASTM Standard specification for mineral wool roof insulation and make Table R906.2 consistent with IBC Table 1508.2. This will help to ensure that roofing systems designed using mineral wool roof insulation will perform as intended by the IRC. This standard has been referenced in the IBC since the 2012 edition.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code
no impact provide additional information

Impact to building and property owners relative to cost of compliance with code
No cost impact adds standard which will provide consistent regulation

Impact to industry relative to the cost of compliance with code
No cost impact adds standard which will provide consistent regulation

Impact to small business relative to the cost of compliance with code
No cost impact adds standard which will provide consistent regulation

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public
provides consistency with added standard helping the public

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction
strengthens and improves the code

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities
will not discriminate

Does not degrade the effectiveness of the code
enhances the effectiveness of the code

Add Standard:

ASTM

ASTM International100 Barr Harbor DriveWest Conshohocken PA19428

Standard reference number	Title	Refer in section n
C726—12	Standard Specification for Mineral Roof Insulation Board	TR906.2

Table included for reference only

TABLE R906.2

MATERIAL STANDARDS FOR ROOF INSULATION

Mineral wool board	ASTM C 726

R8302

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	46	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update referenced standard

Rationale

Update D6083 to most current version.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates referenced standard

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Requires compliance with most current version of standard

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Standard is an ASTM consensus document

Does not degrade the effectiveness of the code

Requires compliance with most current version of standard

D6083—~~05e01~~18 Specification for Liquid Applied Acrylic Coating Used in Roofing

R8305

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	46	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update referenced standard

Rationale

Update D7158/D7158M to most current version

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates referenced standard

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Requires compliance with most current version of standard.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Standard is ASTM consensus document

Does not degrade the effectiveness of the code

Requires compliance with the most current version of standard.

D7158/D7158M—~~11~~19 Standard Test Method for Wind Resistance of Sealed Asphalt Shingles (Uplift Force/Uplift Resistance Method)

R7191

76

Date Submitted	11/6/2018	**Section**	3.3	**Proponent**	Michael Goolsby
Chapter	RAS 111	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No

Alternate Language No

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16, update preservative standard and clarify Table 2 requirements.

Rationale

The RAS 111 modification is needed to align the rooftop elevated pressure zones with ASCE 7-16. Also, to revise the wood preservative standard which has been updated. The note in Table 2 has been improved to eliminate confusion regarding when a hook strip/cleat is required. Finally, a scrivener's error has been corrected.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforcement by providing proper guidance the relevant standard and clarifies eave metal requirements.

Impact to building and property owners relative to cost of compliance with code

No cost impact, merely provides proper guidance the relevant standard and clarifies eave metal requirements.

Impact to industry relative to the cost of compliance with code

No cost impact, merely provides proper guidance the relevant standard and clarifies eave metal requirements.

Impact to small business relative to the cost of compliance with code

No cost impact, merely provides proper guidance the relevant standard and clarifies eave metal requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modifications reinforces path to compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is strengthened by clarification of the correct standard providing more clear explanatory language in Table 2.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The modification improves the effectiveness of the code by providing a more clear path for achieving compliance.

ROOFING APPLICATION STANDARD (RAS) No. 111-20

STANDARD REQUIREMENTS FOR ATTACHMENT OF PERIMETER WOODBLOCKING AND METAL FLASHING

3.3 Woodblocking Fastener Spacing

3.3.1 The attachment criteria for woodblocking shall be 250 plf for Zone 2 ~~perimeter~~ areas and 300 plf for Zone 3 ~~corner~~ areas.

3.4.5 All woodblocking, shall be only ~~salt pressure~~ preservative treatedinaccordancewiththe American Wood Preservers Association, AWPA U-1, Use Category 2 or higher ~~C-2orC-9~~,oranydecayresistant species.

TABLE 2 HOOK STRIP/CONTINUOUS CLEAT THICKNESS REQUIREMENTS FOR EDGE METAL AND COPINGS FACE DIMENSIONS						
GALVANIZED METAL OR STAINLESS STEEL						
Min. Component Gage		26 ga	24 ga	22 ga	20 ga	18 ga
Max. Vertical (Face) Flange		4 in.	6 in.	8 in.	10 in.	12 in.
Min. Hook Strip/Cleat Gage[1]		24 ga	22 ga	20 ga	18 ga	16 ga
ALUMINUM						
Min. Component Gage	0.032 in.	0.032 in.	0.040 in.	0.050 in.	0.060 in.	0.070 in.
Max. Vertical (Face) Flange	< 3 in.	3 in.	4 in.	6 in.	8 in.	10 in.
Min. Hook Strip/Cleat Gage	Not Required	0.040 in.	0.050 in.	0.060 in.	0.070 in.	0.080 in.
COPPER						
Min. Component Gage			16 oz	20 oz.	24 oz.	32 oz
Max. Vertical (Face) Flange			3.5 in.	6 in.	8 in.	10 in.
Min. Hook Strip/Cleat Weight[1]			20 oz.	24 oz.	32 oz	48 oz

For SI: 1 inch = 25.4 mm.

[1]When utilizing the maximum vertical (face) flange a hook strip/cleat is required. The h~~H~~ook strip/cleat shall be one thickness greater than that of the metal profile material, as commercially available.

5.2.3 When a continuous cleat (hook strip) is required and the vertical flange exceeds 7 in. the "butt-joint" method shall be utilized and a cover plate shall be installed.

NOTE: All metal surfaces receiving hot bitumen or approved flashing cement shall be fully primed with ASTM D41 or ASTM D43, as required, primer. Primer which is in a quick dry formulation is acceptable. All fasteners shall be covered with either:

R7221

Date Submitted	11/8/2018	**Section**	5.3	**Proponent**	Gaspar Rodriguez
Chapter	RAS 115	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** | **Alternate Language** **No**

Related Modifications

Summary of Modification

Clearly indicate that drip edge metal shall be installed over anchor/base sheet. This is a current code requirement and needs to be precisely specified. Eliminate unnecessary requirement to coat joints of metals.

Rationale

This is a current code requirement which somehow has never been clearly indicated. We have had some users question where this requirement is indicated. This modification clearly indicates the current requirement.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Adds language to more precisely define current code requirements and delete unnecessary requirements.

Impact to building and property owners relative to cost of compliance with code

None. Adds language to more precisely define current code requirements and delete unnecessary requirements .

Impact to industry relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements and delete unnecessary requirements.

Impact to small business relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements and delete unnecessary requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes. Adds language to more precisely define current code requirements and delete unnecessary requirements .

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes. Adds language to more precisely define current code requirements and delete unnecessary requirements .

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require any specific material, product, method or system of construction.

Does not degrade the effectiveness of the code

Does not degrade code, actually makes code more easily understandable.

5.3 Eave and gable drip metal shall be installed over the anchor/base sheet, ~~joined by a~~ lapped ~~of~~ a minimum of 4 inches. ~~and the entire interior of the joints shall be coated with approved flashing cement.~~ Eave and gable drip metal shall be fastened with minimum 12 gauge annular ring shank nails at a maximum spacing of 4 in. o.c. The nails shall be manufactured from similar and compatible material to the termination profile. All composite materials shall be fastened with nonferrous nails. All metal profiles shall be installed in compliance with RAS 111.

R7349

Date Submitted	11/20/2018	**Section**	4.2	**Proponent**	Gaspar Rodriguez
Chapter	RAS 115	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Add language to more correctly reflect code requirements for recently approved products.

Rationale

Some new underlayments come in widths wider than 36 inches. Current code language contemplates a 36 inch wide sheet of underlayment. Proposed language takes in account the wider underlayments currently available.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Adds language to more precisely define current code requirements.

Impact to building and property owners relative to cost of compliance with code

None. Adds language to more precisely define current code requirements.

Impact to industry relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements.

Impact to small business relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes. Adds language to more precisely define current code requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes. Adds language to more precisely define current code requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate. Adds language to more precisely define current code requirements.

Does not degrade the effectiveness of the code

Correct. Adds language to more precisely define current code requirements.

4.2 All underlayments shall be fastened with approved minimum 12 gage by 11/4 in. corrosion-resistant annular ring shank roofing nails fastened through minimum 32 gage by 1 5/8 in. diameter approved tin caps. ~~Maximum fastener spacing shall be 6 in. o.c. at the laps with two additional rows in the field at a maximum spacing of 12 in. o.c.~~Underlayment shall be attached to a nailable deck in a grid pattern of 12 inches (305 mm) between the overlaps, with 6-inch (152 mm) spacing at the overlaps.Nails shall be of sufficient length to penetrate through the sheathing or wood plank a minimum of 3/16 in. or penetrate 1 inch (25 mm) or greater thickness of lumber a minimum of 1 in., except where architectural appearance is to be preserved, in which case a minimum of 3/4 in. nail may be used.

R7297

Date Submitted	11/16/2018	**Section**	3.10	**Proponent**	Jorge Acebo
Chapter	RAS 117	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarifies how tapered insulation should be used when substituting standard insulation.

Rationale

Clarifies the use of tapered insulation and specifies minimum thickness.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates to HVHZ requirements to improve building performance

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Clarified existing requirements

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates current understanding of component use.

Does not degrade the effectiveness of the code

Improves code effectiveness by clarifying current requirements

RAS 117 Section 3.10

Tapered insulation may be substitutedfor any flat stock type listed in the Roof SystemAssemblyProductApproval.The fastening requirements shall remain the sameand have a minimum thickness as specified in the Roof System Assembly Product Approval. ~~Polyisocyanurate tapered insulation systems shall have a minimum aver- age thickness per panel of 1 in.~~

R7198

Date Submitted	11/6/2018	**Section** 2		**Proponent**	Michael Goolsby
Chapter	RAS 118	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update standard for treated wood and clarify coastal building zone.

Rationale

The RAS 118 modification is needed to revise the wood preservative standard which has been updated and to provide geographic guidance where the definition of "coastal building zone" no longer is provided in Chapter 16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforcement by providing proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to building and property owners relative to cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to industry relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to small business relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modification strengthens the code by providing a clearer path to compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is strengthened by clarification of the correct standard and providing a more clear location of a zone no longer defined.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The modification improves the effectiveness of the code by providing clarification of the correct standard and providing a more clear location of a zone no longer defined.

ROOFING APPLICATION STANDARD (RAS) No. 118-20 INSTALLATION OF MECHANICALLY FASTENED ROOF TILE SYSTEMS

Direct Deck & Counter Battens Only

2.01 Fasteners:

A. Tile Fasteners

1. All roof tile nails or fasteners, except those made of copper, monel, aluminum, or stainless steel, shall be tested for corrosion in compliance with TAS 114, Appendix E, Section 2 (ASTM G85), for salt spray for 1,000 hours. Tile fasteners used within 1500 feet landward of the reach of the mean high tide ~~in coastal building zones, as define in Chapter 16 (High-Velocity Hurricane Zones)~~, shall be copper, monel, aluminum or stainless steel.

2.07 Sheathing material shall conform to APA-rated sheathing, in compliance with Chapter 23 (High-Velocity Hurricane Zones) of the Florida Building Code, Building.

A. Battens – material to be decay resistant species or ~~pressure~~ preservative treated in compliance with American Wood Preservers Association, AWPA U-1, Use Category 2 or higher, or any decay resistant species ~~C2~~.

1. Battens shall not be bowed or twisted.

2. Vertical battens shall be a minimum of nominal 1 in. by 4 in., horizontal battens shall be a minimum of nominal 1 in. by 2 in.

R7351

Date Submitted	11/20/2018	**Section**	3.06	**Proponent**	Gaspar Rodriguez
Chapter	RAS 118	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Indicate the minimum requirements for height vent pipes, need to extend above roof.

Rationale

The minimum height vent pipes need to extend above roof tiles is not indicated in the code. This proposed change indicates to the user of the code the minimum requirements.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Adds language to more precisely define current code requirements.

Impact to building and property owners relative to cost of compliance with code

None. Adds language to more precisely define current code requirements.

Impact to industry relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements.

Impact to small business relative to the cost of compliance with code

None. Adds language to more precisely define current code requirements.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes. Adds language to more precisely define current code requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes. Adds language to more precisely define current code requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate. Adds language to more precisely define current code requirements.

Does not degrade the effectiveness of the code

Correct. Adds language to more precisely define current code requirements.

3.06 Pipes, Stacks, Vents, etc., (see Drawings 8 & 9).

A. Apply approved plastic roof cement around base of protrusion and on the bottom side of metal flanges sealing unit base flashing to the underlayment.

B. Nail all sides within 1 in. of outside edge of base flashing 6 in. on center. Make certain base is flush to deck.

C. Pipes, vents, stacks shall terminate a minimum 2 in. above upper most adjacent finished tile surface.

R7200

Date Submitted	11/6/2018	**Section**	2	**Proponent**	Michael Goolsby
Chapter	RAS 119	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Update standard for treated wood and clarify coastal building zone.

Rationale

The RAS 119 modification is needed to revise the wood preservative standard which has been updated and to provide geographic guidance where the definition of "coastal building zone" no longer is provided in Chapter 16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforcement by providing proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to building and property owners relative to cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to industry relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to small business relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modification strengthens the code by providing a clearer path to compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

The code is strengthened by clarification of the correct standard and providing a more clear location of a zone no longer defined.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The modification improves the effectiveness of the code by providing clarification of the correct standard and providing a more clear location of a zone no longer defined.

ROOFING APPLICATION STANDARD (RAS) No. 119-20 INSTALLATION OF MECHANICALLY FASTENED ROOF TILE SYSTEMS

Direct Deck & Horizontal Battens Only

(Preformed Metals With Edge Returns)

2.01 Fasteners:

A. TileFasteners

1. All roof tile nails or fasteners, except those made of copper, monel, aluminum, or stainless steel, shall be tested for corrosion in compliance with TAS 114, Appendix E, Section 2 (ASTM G85), for salt spray for 1,000 hours. Tile fasteners used within 1500 feet landward of the reach of the mean high tide ~~in coastal building zones, as define in Chapter 16 (High-Velocity Hurricane Zones)~~, shall be copper, monel,aluminumorstainlesssteel.

2.07 Sheathing material shall conform to APA-rated sheathing, in compliance with Chapter 23 (High-Velocity Hurricane Zones) of the Florida Building Code, Building.

A. Battens – material to be decay resistant species or ~~pressure~~ preservative treated in compliance with American Wood Preservers Association,AWPA U-1, Use Category 2 or higher, or any decay resistant species ~~C2~~.

1. Battensshallnotbebowed or twisted.

2. Vertical battens shall be a minimum of nominal 1in. by4in.,horizontal battens shall be a minimum of nominal 1 in. by 2 in.

R7201

Date Submitted	11/6/2018	**Section**	2	**Proponent**	Michael Goolsby
Chapter	RAS 120	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Update standard for treated wood and clarify coastal building zone.

Rationale

The RAS 120 modification is needed to revise the wood preservative standard which has been updated and to provide geographic guidance where the definition of “coastal building zone” no longer is provided in Chapter 16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Improves enforcement by providing proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to building and property owners relative to cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to industry relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Impact to small business relative to the cost of compliance with code

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The modifications reinforces path to compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

No cost impact, merely provides proper guidance to the relevant standard and clarifies location of zone no longer defined.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against materials, products, methods or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

The modification improves the effectiveness of the code by providing clarification of the correct standard and providing a more clear location of a zone no longer defined.

ROOFING APPLICATION STANDARD (RAS) No. 120-20 MORTAR AND ADHESIVE SET TILE APPLICATION

2.01 Fasteners:

A. TileFasteners

1. All roof tile nails or fasteners, except those made of copper, monel, aluminum, or stainless steel, shall be tested for corrosion in compliance with TAS 114, Appendix E, Section 2 (ASTM G85), for salt spray for 1,000 hours. Tile fasteners used within 1500 feet landward of the reach of the mean high tide ~~in coastal building zones, as define in Chapter 16 (High-Velocity Hurricane Zones)~~, shall be copper, monel,aluminumorstainlesssteel.

2.07 Sheathing material shall conform to APA-rated sheathing, in compliance with Chapter 23 (High-Velocity Hurricane Zones) of the Florida Building Code, Building.

A. Battens – material to be decay resistant species or ~~pressure~~ preservative treated in compliance with American Wood Preservers Association,AWPA U-1, Use Category 2 or higher, or any decay resistant species ~~C2~~.

1. Battensshallnotbebowed or twisted.

2. Vertical battens shall be a minimum of nominal 1in. by4in.,horizontal battens shall be a minimum of nominal 1 in. by 2 in.

R7592

Date Submitted	11/30/2018	**Section**	3	**Proponent**	Gaspar Rodriguez
Chapter	RAS 120	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation	Pending Review
Commission Action	Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clearly indicate current code requirements, specifically back-nailing of underlayment and minimum height of vent pipes.

Rationale

These two current code requirements are not clearly indicated in the code. This addition language will allow for easier code interpretation.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Allows for easier interpretation of current code.

Impact to building and property owners relative to cost of compliance with code

Allows for easier interpretation of current code.

Impact to industry relative to the cost of compliance with code

Allows for easier interpretation of current code.

Impact to small business relative to the cost of compliance with code

Should allow for less cost to comply with code, due to easier interpretation of code.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Makes current code requirements easier to understand.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Makes current code requirements easier to understand.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not change or degrade current code requirements.

3.01Underlayment Applications - CHOOSE ONE of the following:

D.Product Approved Anchor/Base Sheet/Self - Adhered Underlayment System. The roof cover is terminated at approved metal flashings. Any approved anchor/base sheet as listed in the Product Approval shall be mechanically attached to the wood deck with approved fasteners spaced in a 12 in. grid staggered in two~~0ws~~ rows in the field and 6 in. on center at the laps or as specified in the underlayment manufacturers Product Approval. Anchor/base sheet end laps shall be a minimum of 6 in. and head laps shall be a minimum of 4 in. Over anchor/base sheet, apply one layer of any Product approved, self-adhered underlayment in compliance with the self-adhered underlayment manufacturers' Approval/Requirements. Head laps shall be backnailed 12 in. on center with approved nails through tincaps or by prefrabricated fasteners in accordance with Section 1517.5.1 and 1517.5.2 Florida Building Code, Building.

3.06 Pipes, Stacks, Vents, etc., (see Drawings 8 & 9).

A. Apply approved plastic roof cement around base of protrusion and on the bottom side of metal flanges sealing unit base flashing to the underlayment.

B. Nail all sides within 1 in. of outside edge of base flashing 6 in. on center. Make certain base is flush to deck.

C. Pipes, vents, stacks shall terminate a minimum 2 in. above upper most adjacent finished tile surface.

R7384

Date Submitted	11/21/2018	**Section**	4	**Proponent**	Michael Goolsby
Chapter	RAS 130	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Establish consistency with industry standard for installation of wood shingles and wood shakes.

Rationale

The modification clarifies underlayment and interlayment requirements for wood shingle and wood shake installations.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None. Clarification only.

Impact to building and property owners relative to cost of compliance with code

May decrease the cost of installations by removing the necessity for interlayment installations for wood shingles.

Impact to industry relative to the cost of compliance with code

May decrease the cost of installations by removing the necessity for interlayment installations for wood shingles.

Impact to small business relative to the cost of compliance with code

None. Clarification only.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Ensures a more durable roof system by eliminating interlayments for wood shingles, which otherwise encourages decay and deformation of shingles and subsequent premature roof failure and by specifying the minimum interlayment for wood shakes.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Ensures a more durable roof system by eliminating interlayments for wood shingles, which otherwise encourages decay and deformation of shingles and subsequent premature roof failure and by specifying the minimum interlayment for wood shakes.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate against product of demonstrated capabilities.

Does not degrade the effectiveness of the code

Improves the effectiveness of the building code by enhancing installation requirements for wood shingles and wood shakes.

ROOFING APPLICATION STANDARD (RAS) No.130-20
INSTALLATION CRITERIA FOR ROOF SHINGLES AND SHAKES APPLICATION

4. Wood Shingles

4.1 Underlayment

Solid Sheathing:	Two plies of ASTM D226, Type 1 felt overlapped 19 in., or a single layer of ASTM D226 Type II felt overlapped a minimum of 4 in. on side laps, and 6 in. on the end laps. Fastened with corrosion resistant 12 ga. roofing nails through tin caps. Fasten with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 in. o.c., and one row at the laps fastened 6 in. o.c.
Spaced Sheathing:	Underlayment shall be installed at a minimum of 36 in. wide sheet at the eave line~~, and shall be a minimum of two plies of ASTM D226, Type I felt overlapped 19 in., or a single layer of ASTM D226 Type II felt overlapped a minimum of 4 in. on side laps, and 6 in. on the end laps~~. Fastened with corrosion resistant 12 ga. roofing nails through tin caps. Fasten with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 in. o.c~~., and one row at the laps fastened 6 in. o.c., at a minimum of 36 in. from the eave of the roof~~.
	Roofing nails shall be of sufficient length to penetrate through the plywood panel or wood plank decking not less than $^{3}/_{16}$ in., or to penetrate into a 1 in., or greater, thickness of lumber not less than 1 in.

4.3 Valleys may be installed open or closed. A 36 in. wide sheet of minimum ASTM D226 Type II organic felt shall be installed ~~over the underlayment and~~ centered in the valley, fastened 6 in. o.c. through tin-caps at each edge of the sheet. Minimum end laps shall be 12 in. and fully adhered with approved flashing cement.

4.7 Reserved. ~~An optional interlayment sheet may be installed between wood shingles in solid sheathing applications. Interlayment shall be required in all spaced sheathing applications. Interlayment shall be a minimum of ASTM D226, Type I felt with a minimum width of 18 in. and shall be applied between each succeeding course of wood shingles. Interlayment shall be fastened on the upper edge of the sheet. The bottom edge of the interlayment shall be positioned above the butt edge of each course of wood shingles, a distance equal to triple the weather exposure of the wood shingles. Extend interlayment up vertical surfaces a minimum of 4 in. No felt shall be exposed.~~

4.8 The beginning or starter course of wood shingles at the eave line shall be doubled as a minimum. The wood shingles shall ~~be~~ project a minimum $^3/_4$ in. to a maximum of 2 in. beyond the drip edge at both eaves and rakes. Spacing between shingles (joints or key ways) shall be a minimum of $^1/_4$ in. and a maximum of $^3/_8$ in. Shingles shall be positioned so that they cover the joints in the preceding course and adjacent courses shall be offset a minimum of $1^1/_2$ in. In any three courses (adjacent), no two joints should be directly aligned (see Detail B).

4.10 Hip and ridges may be installed from pre-manufactured units or field assembled units from manufacturer's shingles. The exposed juncture of the roof hip and ridge areas shall be covered with a minimum 6 in. wide strip of ASTM D226 Type II organic felt, prior to installing the hip and ridge units. No felt shall be left exposed. Lay alternate overlapping hip and ridge units, starting with a double starter course. <u>The weather exposure of the hip and ridge units shall be the same exposure as the field shingles.</u> Each side of the hip and ridge units shall be a minimum of 4 in. wide. Each hip and ridge unit shall be fastened to the roof with two fasteners of the same type as that used for the field shingles. Fasteners shall be of sufficient length to penetrate the plywood panel or wood plank decking not less than $^3/_{16}$ in.; or to penetrate into a 1 in., or greater, thickness of lumber not less than 1 in. Nails shall be driven straight and flush. Nails shall not be overdriven (see Detail C).

5. Wood Shakes

5.1 Underlayments:

Solid Sheathing:	<u>Underlayment shall be installed at a minimum of 36 in. wide sheet at the eave line</u> ~~Two plies of ASTM D226, Type I felt overlapped 19 in., or a single layer of ASTM D226 Type II felt overlapped a minimum of 4 in. on side laps and 6 in. on the end laps.~~ Fasten with corrosion resistant 12 ga. roofing nails through tin caps. Fasten with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 in. o.c~~., and one row at the laps fastened 6 in. o.c., at a minimum of 36 in. from the eave of the roof~~.
Spaced Sheathing:	Underlayment shall be installed at a minimum of 36 in. wide <u>sheet</u> at the eave line~~, and shall be a minimum of two plies of ASTM D226, Type I felt overlapped 19 in., or a single layer of ASTM D226 Type II felt overlapped a minimum of 4 in. on side laps, and 6 in. on the end laps~~. Fastened with corrosion resistant 12 ga. roofing nails through tin caps. Fasten with two staggered rows in the field of the sheet with a maximum fastener spacing of 12 in. o.c~~., and one row at the laps fastened 6 in. o.c., at a minimum of 36 in. from the eave of the roof~~.
	Roofing nails shall be of sufficient length to penetrate through the plywood panel or wood plank decking not less than $^3/_{16}$ in., or to penetrate into a 1 in., or greater, thickness of

lumber not less than 1 in.

5.8 Spacing between shakes (joints or key ways) shall be a minimum ~~$^{1}/_{4}$~~ 3/8 in. and a maximum of $^{5}/_{8}$ in. Shakes shall be positioned so that they cover the joints in the preceding course. Adjacent courses shall be offset a minimum of $1^{1}/_{2}$ in. In any three courses (adjacent), no two joints should be directly aligned (see Detail D).

5.10 Hip and ridges may be installed from pre-manufactured units or field assembled units from manufacturer's shakes. The exposed juncture of the roof hip and ridge areas shall be covered with a minimum 6 in. wide strip of ASTM D226 Type II organic felt, prior to installing the hip and ridge units. No felt shall be left exposed. Lay alternate overlapping hip and ridge units, starting with a double starter course. The weather exposure of the hip and ridge units shall be the same exposure as the field shingles. Each side of the hip and ridge units shall be a minimum of 4 in. wide. Each hip and ridge unit shall be fastened to the roof with two fasteners of the same type as that used for the field shakes. Fasteners shall be of sufficient length to penetrate the plywood panel or wood plank decking not less than $^{3}/_{16}$ in.; or to penetrate into a 1 in., or greater, thickness of lumber not less than 1 in. Nails shall be driven straight and flush. Nails shall not be overdriven. (see Detail C).

R8282

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 103	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ Roofing Updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS) No. 103-~~95~~ 20
TEST PROCEDURE FOR SELF-ADHERED UNDERLAYMENTS FOR USE IN ~~DISCONTINUOUS~~ TILE ROOF SYSTEMS

1. Scope

1.1 This Protocol covers procedures for testing self-adhering, prefabricated~~, reinforced~~, polymer modified bituminous, and solid thermoplastic sheet roofing materials intended for use as underlayment in ~~Discontinuous~~ Tile Roof Systems to assist in the waterproofing to function in combination with a Prepared Roof Covering. These products may employ granular or particulate surfacing materials on one side. The Granular Adhesion test shall be required for all granular surfaced materials used as a bonding surface for mortar or adhesive set tile systems.

1.2 The test procedures outlined in this Protocol cover the determination of the Wind Uplift Resistance; the Thickness; the Dimensional Stability; the Tear Resistance; the Breaking Strength; the Elongation; ~~the Water Absorption;~~ the Low Temperature Flexibility; the Ultraviolet Resistance; the Accelerated Aging Performance; the Cyclic Elongation Performance; the Water Vapor Transmission; the Compound Stability; the Puncture Resistance; the Tile Slippage Resistance; ~~the Crack Cycling Resistance; and~~ the Peel Resistance; the Accelerated Weathering Performance of an underlayment material; the Tensile Adhesion properties of the exposed surface of the underlayment; and Granular Adhesion ~~of a mineral~~ for granular surfaced ~~roll roofing material, for use as an~~ underlayment.

1.3 These test methods appear in the following order:

	Section
Conditioning	5
Thickness	6
Wind Uplift	7
Dimensional Stability	8
Tear Resistance	9
Breaking Strength and Elongation	10
Reserved	11
Low Temperature Flexibility	12
Ultraviolet Resistance	13
Accelerated Aging	14
Cyclic Elongation	15
Water Vapor Transmission	16
Compound Stability	17
Puncture Resistance	18
Tile Slippage Resistance	19
~~Crack Cycling~~ Reserved	20
Peel Resistance	21
Granule Adhesion	22
Tensile Adhesion	23
Accelerated Weathering	24

2. Referenced Documents

2.1 *ASTM Test Standards:*

~~C 794 Adhesion in Peel of Elastomeric Joint Sealants~~
~~D 570 Water Absorption of Plastics~~
D 1079 Standard Definitions and Terms Relating to Roofing, Waterproofing and Bituminous Materials
~~D 1938 Tear Propagation Resistance of Plastic Film and Thin Sheeting by a Single-Tear Method~~
D 4073 Standard Test Method For Tensile Tear Strength of Bituminous Roofing Membranes
D 1970 Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection (Low Temperature Flexibility)
D 2523 Testing Load-Strain Properties of Roofing Membranes
D 1623 Standard Test Method For Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
D 5147 Sampling and Testing Modified Bituminous Sheet Materials
E 96 Water Vapor Transmission of Materials
E 380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *Reserved*

2.3 *Reserved*

2.4 *The Florida Building Code, Building*.

2.5 *Application Standards*

TAS 124 Test Procedure for Field Uplift Testing of Existing Membrane Roof Systems

2.6 *Reserved*

3. Terminology & Units

3.1 Definitions - For definitions of terms used in this Protocol, refer to ASTM D 1079; Chapters 2 and 15 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. The definitions from the *Florida Building Code, Building* shall take precedence.

3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E 380.

4. Significance and Use

4.1 The test procedures outlined in this Protocol provide a means of determining whether a self-adhering roofing material, intended for use as an underlayment in a Discontinuous Roof System~~,~~ for use in the High-Velocity Hurricane Zones, meets the requirements of the *Florida Building Code, Building*.

5. Conditioning

5.1 Specimens shall be selected in accordance with ASTM D5147. Unless otherwise specified, condition test specimens for a minimum of four (4) hours at 73.4 ± 3.6°F and 50 ± 5% relative humidity prior to testing. Note separate conditioning requirements for cold bend testing in Section 12.1.

6. Thickness

6.1 Materials shall be checked at five points across the roll width. Measurements shall be made at two points, each being 6 ± 0.5 inches from each edge, and at three points equally spaced between these two points.

6.2 Compute the average thickness and the standard deviation of the thicknesses, in mils, based on the total number of point measurements from all of the rolls taken.

6.3 Report the individual point measurements, average, and standard deviation in mils.

6.4 Any modified bitumen and bituminous membrane test specimen which exhibits an average thickness less than sixty (60) mils shall be considered as failing the thickness test. For granular surfaced products, thickness measurements shall be at the selvage edge, not at a granular surface.

6.5 Nonbituminous membranes shall not have a thickness minimum. Performance shall be based on physical property testing.

7. Wind Uplift

7.1 This test covers the determination of the wind uplift resistance of materials specified in Section 1 of this Protocol in accordance with TAS 124 except as noted below.

7.1.1 Test Deck Construction

7.1.1.1 Test is being conducted on materials noted in Section 1 of this Protocol; therefore, any reference to “roof membrane” in TAS 124 shall be regarded as ‘underlayment.’

7.1.1.2 Four (4) 8' x 8' test decks shall be constructed of 40/20 $^{19}/_{32}$ in. APA Rated Plywood Sheathing attached to wood joists spaced 24 o.c. Each test deck shall consist of four (4) panels of said sheathing, the corners of which shall meet at the center of each test deck, leaving a $^{1}/_{8}$ in. gap between panels.

7.1.1.3 Adhere one (1) layer of underlayment to each test deck.

7.1.2 Procedure

7.1.2.1 Test shall be a laboratory test not a field test; therefore, any instruction in TAS 124 which references “building or outdoor conditions” shall be regarded as “laboratory conditions.”

7.1.2.2 Regulate the negative pressure in the chamber. Begin by raising the negative pressure in the chamber to 30 lbf/ft^2 and holding this pressure for one (1) minute. Thereafter, raise the negative pressure in increments of 15 lbf/ft^2, holding each incremented pressure for one (1) minute, until the negative pressure has been held at 90 lbf/ft^2 for one (1) minute.

7.1.3 Report

7.1.3.1 Any test specimen which exhibits any significant separation between the membrane and tested substrate deflection or significant blistering from the sheathing surface-shall be considered as failing the wind uplift test.

8. Dimensional Stability

8.1 Prepare five (5) 2 foot wide x 6 foot long specimens with a 4 inch overlap seam across the center of the 6 foot length. Prepare the specimens: one from each edge of the roll and three from random places in the roll. The length of each specimen should be in the “machine direction” of the roll.

8.2 The substrate shall be APA 32/16 span rated sheathing of a $^{15}/_{32}$ in. thickness that has been reinforced on the back side with two angle irons.

8.3 Adhere the underlayment specimen on the substrate and install a $1^{1}/_{2}$ in. x $1^{1}/_{2}$ in. x 2' wood termination batten to one "free" end of the underlayment using three (3) equally spaced #12 wood screws to secure the batten through the underlayment and the sheathing. Mechanically attach the other "free" end of the underlayment using three (3) equally spaced ~~10d~~ roofing nails, located two (2) inches from the "free" end, with one nail at one inch from each edge, penetrating the sheathing a minimum of $^{1}/_{2}$ inch.

8.4 Condition each specimen in an oven or under heat lamps maintained at 180 ± 5°F for a minimum of six (6) hours.

8.5 Report any tears or "tear drop" conditions which arise at fastener penetrations during and/or after conditioning is complete. Report any shrinking or wrinkling which appears to have compromised the lapped area of underlayment.

8.6 Any test specimen which exhibits conditions noted in Section 8.5 of this Protocol shall be considered as failing the dimensional stability test.

8.7 Provide before and after photographs of each specimen in the final test report.

9. Tear Resistance

9.1 This test covers the determination of the tear propagation resistance of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 4073, except as noted below.

9.1.1 The prescribed Test Method shall be run in both the machine and the cross-machine direction of the roll material.

9.1.2 The final test report shall include average tear propagation force values and standard deviations of these value for both the machine and the cross-machine direction of the material.

9.1.3 Any test specimen which exhibits a tear propagation value less than 20 lbf (88.5 N) in either the machine or cross-machine directions shall be considered as failing the tear strength test.

10. Breaking Strength and Elongation

10.1 This test covers the determination of the breaking strength and elongation of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 2523, except as noted below.

10.1.1 Sampling

10.1.1.1 Ten specimens; five in the machine direction and five in the cross-machine direction of the roll, shall be cut to dimensions of 1 in. x 6 in.

10.1.2 Conditioning

10.1.2.1 Heat Aging, shall consist of seven (7) days in an air circulating oven at a controlled temperature of 149 ± 5°F.

10.1.2.2 UV Exposure shall consist of 460 hours of continuous ultraviolet light exposure in accordance with the apparatus and configuration in 13.1.2.1 herein.

10.1.3 Procedure

10.1.3.1 Each set of samples, as specified in 10.1.1.1 herein, shall be tested “as received”, after heat aging, and after UV exposure, as specified in 10.1.2.1 and 10.1.2.2 herein.

10.1.3.2 Grip separation rate shall be 20 ± 0.2 inches per minute for all tests conducted.

10.1.3.3 Temperatures of specimens and test grips during conditioning and testing shall ~~comply with ASTM D 2523~~ be 73.4 ± 3.6°F.

10.1.4 Report

10.1.4.1 Report the grip separation rate used.

10.1.4.2 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of “as received,” after heat conditioning, and after UV exposure. The~~se grouping~~ test specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits a breaking strength value less than those listed in Table 1 shall be considered as failing the breaking strength test.

TABLE 1 MINIMUM BREAKING STRENGTH VALUES

SPECIMEN	BREAKING STRENGTH
	(Machine Direction or Cross-Machine Direction)
As Received	25 lbf/inch of width (35 N/cm of width)
After Heat Aging	25 lbf/inch of width (35 N/cm of width)
After UV Exposure	25 lbf/inch of width (35 N/cm of width)

10.1.4.3 Elongation shall be reported, in (%), for all test specimens and shall be itemized in groupings of “as received,” after heat conditioning, and after UV exposure. These groupings shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits elongation values at ultimate load condition less than those listed in Table 2 shall be considered as failing the elongation test.

TABLE 2 MINIMUM ELONGATION VALUES (%)

SPECIMEN	ORGANIC REINFORCEMENT	FIBERGLASS REINFORCED	POLYESTER OR POLYPROPYLENE REINFORCED	SOLID THERMOPLASTIC ~~SHEATHING~~ SHEETS
As Received	6%	3%	25%	225%
After Heat Aging	5%	2.5%	21%	191%
After UV Exposure	5%	2.5%	21%	191%

11. Reserved

12. Low Temperature Flexibility

12.1 This test covers the determination of the low temperature flexibility of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 1970 except as noted below. Membranes shall be tested at a maximum of -10°F.

12.1.1 Procedure

12.1.1.1 Each set of specimens shall be tested “as received” and after conditioning, as specified in ASTM D 1970 (7.4.2).

12.1.2 Report

12.1.2.1 Low temperature flexibility results shall be reported on a pass/fail basis, for all test specimens and shall be itemized in grouping of “as received” and after conditioning. No cracking at -10°F shall be considered as passing the low temperature flexibility test.

13. Ultraviolet Resistance

13.1 This test covers the determination of the ultraviolet resistance performance of materials specified in Section 1.

13.1.1 Sampling - Two 18 in. x ~~18~~48 in. specimens are to be cut.

13.1.2 Conditioning

13.1.2.1 Ultraviolet light shall be produced by four 275 watt UV lamps in an enclosure in accordance with Figure 1. Recommended lamps are: Ultra-Vitalux, 275 watt, 220-230 V, #E27; Osram 275 W lamps, or; equivalent bulbs providing UV characteristics of 5.0 W/m2/nm irradiance at a wavelength of 315 to 400 nm at one meter.

13.1.2.2 Specimens to be exposed for ~~200~~ 460 (± 2) continuous hours ~~(10 hours per day for 20 days)~~.

13.1.2.3 Specimen temperature to be maintained at 135-140°F throughout the ~~UV exposure portion of the~~ test period. ~~Specimens shall be maintained between 70°F +/- 15°F when not exposed to UV during the test period.~~

13.1.3 Report & Conditions of Acceptance

13.1.3.1 Report any visible peeling, chipping, cracking, flaking, pitting or other damage, under 5x magnification, which resulted from the ultraviolet conditioning. Report the type and location of the damage (if any).

13.1.3.2 Report the type of UV lamps used to condition the samples.

13.1.3.3 Any test specimen which exhibits damage as defined in Section 13.1.3.1 of this Protocol shall be considered as failing the ultraviolet resistance test.

14. Accelerated Aging

14.1 This test covers the determination of the accelerated aging performance of materials specified in Section 1 of this Protocol.

14.2 ~~Sampling~~ Specimen Preparation - -Six (6) 12 in. x 12 in. specimens shall be prepared with three (3) in the machine direction and three (3) in the cross-machine direction of the roll. Specimens shall be marked to indicate machine direction.

14.3 Accelerated Aging – The specimens prepared per Section 14.2 are aged by the following cyclic process. Twenty-five cycles are required, with each cycle consisting of the following:

1. Oven dry at 120°F for three hours with all surfaces exposed.
2. Immerse in water maintained at room temperature for three hours, with all surfaces exposed.
3. Remove from water and blot dry, then air dry for 18 hours at room temperature for eighteen hours with all surfaces exposed.

Samples shall be in the air dry period over weekends and holidays, which shall be confirmed in the test log. The room temperature shall be maintained at 73 ± 5°F (22.8 ± 2.8°C).

14.3.1 Conditions of Acceptance – No visible damage to the specimens, such as chipping, cracking, or delamination.

14.3.2 Breaking strength and elongation tests of aged specimens shall be conducted in accordance with Section 10 of this Protocol, except as noted below.

14.3.2.1 Sampling - After the six (6) 12 in. x 12 in. aged specimens have been examined for visible damage, prepare ten (10) 1 in. x 6 in. specimens from the aged material; five in the machine direction and five in the cross-machine direction of the roll. In addition to these ten aged specimens, prepare ten "as received" specimens of the same dimensions; five in the machine direction and five in the cross-machine direction of the roll.

14.3.2.2 Conditioning - No further conditioning is to be incurred on the aged specimens.

14.3.2.3 Procedure - Each set of samples, as specified in ~~13.1.3.1~~ 14.2 herein, shall be tested "as received" and after accelerated aging.

14.3.2.4 Report

14.3.2.4.1 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of "as received" and after accelerated aging. These ~~grouping~~ specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits a breaking strength less than the value listed in Table 2 shall be considered as failing the accelerated aging test.

14.3.2.4.2 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of 'as received' and after accelerated aging. These ~~grouping~~ specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits an elongation value less than the applicable value listed in Table 2 shall be considered as failing the accelerated aging test.

15. Cyclic Elongation

15.1 This test covers the determination of the cyclic elongation performance of materials specified in Section 1 of this Protocol.

15.1.1 Three specimens are prepared with $^{15}/_{32}$-inch-thick (12.7 mm), 3-inch-by-6-inch (76 mm by 152 mm) APA Rated A-C plywood. Each specimen includes two plywood pieces aligned so that the 6-inch (152 mm) edges are parallel and separated by 1/8 inch (3.2 mm). One~~e~~ piece of underlayment, 5 inches by 5 inches is attached to the plywood pieces across the joint and rolled 3 times back and forth (2-3s per direction) using a 26 lb. (11.8 kg) roller. The specimens are then conditioned at 73 ± 4°F (22.8 ± 2.2°C) for seven days. After conditioning, specimens are placed in a cold box, which is maintained at –20°F (–28.9°C) for ~~48~~ 24 hours ± 1 hour. Specimens are then cycled between a 1/8-inch (3.2 mm) and 1/4-inch (6.4 mm) plywood edge separation for 100 cycles while maintaining the temperature at –20°F (–28.9°C). The rate of movement shall be 1/8 inch (3.2 mm) per hour.

15.1.2 Conditions of Acceptance - Any test specimen which exhibits cracking of material shall be considered as failing the cyclic elongation test.

16. Water Vapor Transmission

16.1 This test covers the determination of the water vapor transmission of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method E96, procedure B.

16.2 The water vapor transmission of the membrane shall not be greater than 1.0 g/m^2 in 24 hours.

17. Compound Stability

17.1 This test covers the determination of the high temperature stability of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 5147, Section 15, except as noted below.

17.1.1 Any test specimen which exhibits flowing, dripping or drop formation at a temperature less than 220°F shall be considered as failing the compound stability test.

18. Puncture Resistance

18.1 This test covers the determination of the puncture resistance of materials specified in Section 1 of this Protocol as noted below.

18.1.1 Two 12 in. x 25 in. specimens shall be prepared; one ultraviolet light conditioned and one accelerated aging conditioned, as specified in Sections 13 and 14 of this Protocol, respectively.

18.1.2 The puncture point shall be affixed to any shaft and have a right angle triangular pyramid shape that is 1 inch in height with rounded leading edges of 0.062 ± .002 inch radius. The point should be honed to a 0.062 inch radius and the base edges left sharp. The weight of the puncture point and shaft shall be 1.0lb ± 0.1lb.

18.1.2.1 Attach each specimen to a frame consisting of nominal wood members spaced 24 inches on center.

18.1.2.2 The test specimens shall have a maximum sag of 1 inch measured from the top of the framing member.

18.1.2.3 Drop the puncture point from a height of 30 inches above the top of the framing in five different locations.

18.1.3~~2~~ Any test specimen which exhibits any sign of puncture shall be considered as failing the puncture test.

19. Tile Slippage Resistance

19.1 Prepare three (3) 4 foot ~~wide~~ x 8 foot ~~long~~ test frames using min. 2 inch by 4 inch nominal lumber spaced at 24 inches on center. ~~specimens with a 4 inch overlap seam across the center of the 8 foot length. Prepare the specimens: one from one edge of the roll and one from the center of the roll. The length of each specimen should be in the "machine direction" of the roll.~~

19.2 ~~The substrate shall be~~ Install ~~32/16~~ $^{15}/_{32}$ in. APA 32/16 span rated sheathing on the test frames ~~that has been reinforced on the back side with two angle irons~~.

19.3 Adhere the underlayment to the substrate with a side lap and back nailed per the manufacturer's installation instructions. The side lap width and back nailing details shall be included in the final test report.

19.4 Condition each test deck in an oven or under heat lamps maintained at 165 ± 5°F for a minimum of four (4) hours. Thereafter, the deck shall be cooled for minimum three hours at 75° ± 5°F.

19.5 After conditioning, position one test deck at a slope of 4 in:12 in.; one at a slope of 5 in:12 in.; and the third at a slope of 6 in:12 in. The 5 in:12 in. test deck may be omitted if requested by the client.

19.6 Onto each sloped test deck, place one (1) stack of 10 flat concrete tiles and one (1) stack of 10 profiled tiles manufactured with "lugs" on the underside of each tile. Allow the tile stacks to sit on the underlayment surface for ~~72~~ minimum 36 hours while maintaining a controlled surface temperature of 165 ± 5°F. Temperature to be maintained by a ~~surface mounted~~ thermocouple mounted on the surface of the underlayment.

19.7 Report any of the following: ~~tears or tile slippage on any portion of the underlayment. Report any tile sliding which has damaged any portion of the top surface of the underlayment.~~

- Any tile slippage on any portion of the underlayment

- Any tears in the underlayment
- Any tears in the underlayment surfacing
- Any delamination of the underlayment facing from the adhesive layer

19.8 Any test specimen which exhibits conditions noted in Section 19.7 of this Protocol shall be considered as failing the tile slippage resistance test.

19.9 Provide before and after photographs of each specimen in the final test report.

19.10 Alternate stacking configurations shall be permitted to be approved as part of a Product Approval. Details of such stacking configurations shall be included in the final test report.

20. ~~Crack Cycling~~ Reserved

~~20.1 This test covers the determination of the crack cycling performance of materials specified in Section 1 of this Protocol in accordance with the ICBO Acceptance Criteria For Roof Underlayment For Use In Severe Climate Areas (Section IV, F), except as noted below.~~

~~20.1.1 Three specimens are prepared with $^{15}/_{32}$-inch-thick (12.7 mm), 3-inch-by-6-inch (76 mm by 152 mm) APA Rated A-C plywood. Each specimen includes two plywood pieces aligned so that the 6-inch (152 mm) edges are parallel and separated by 1/8 inch (3.2 mm). The underlayment is attached to the plywood pieces across the joint and rolled 3 times back and forth (2-3s per direction) using a 26 lb. (11.8 kg) roller. The specimens are then conditioned at 73 ± 4°F (22.8 ± 2.2°C) for seven days. After conditioning, specimens are placed in an oven which is maintained at 180 ± 5°F and 55 ± 5% relative humidity for 48 hours ± 1 hour. Specimens are then cycled between a 1/8-inch (3.2 mm) and 1/4 inch (6.4 mm) plywood edge separation for 100 cycles while maintaining the temperature at 180°F and 55 ± 5% relative humidity. The rate of movement shall be 1/8 inch (3.2 mm) per hour.~~
~~Specimens shall be adhered over the two pieces of sheathing.~~

~~20.1.2 The three specimens shall be prepared with 32/16 $^{15}/_{32}$ in. x 3 in. x 6 in. APA span rated plywood sheathing.~~

~~20.1.3 Conditioning shall consist of exposure to a controlled temperature of 180 ± 5°F and 55 ± 5% relative humidity for a period of seven (7) days.~~

~~20.1.42 Conditions of Acceptance - Any test specimen which exhibits cracking of material shall be considered as failing the cyclic elongation test.~~

21. Peel Adhesion

21.1 This test covers the determination of the peel adhesion to substrate performance of materials specified in Section 1 of this Protocol in accordance with the applicable provisions of ASTM Test Method D 1970 and as noted below.

21.1.1 Specimen Preparation

21.1.1.1 The substrate shall be APA 32/16 span rated plywood sheathing of a $^{15}/_{32}$ in. thickness.

21.1.2 Conditioning

21.1.2.1 One set of samples shall be conditioned at 73.4~~5~~ ± ~~2~~3.6°F for four (4) hours; a second and third set shall be conditioned per Sections 13 and 14 of this protocol for accelerated aging and ultraviolet resistance, respectively.

21.1.1 Report

21.1.3.1 Peel Adhesion shall be reported, in lbf/foot of width, for all test specimens and shall be itemized in grouping of "conditioned at 73.4~~5~~°F," "after accelerated aging" and "after ultraviolet conditioning."

21.1.3.2 Any "conditioned" specimen which exhibits a peel strength less than 6.5 lbf/foot of width shall be considered as failing the peel adhesion test.

21.1.3.3 Any aged or ultraviolet conditioned specimen which exhibits a peel strength less than 4.9 lbf/foot of width shall be considered as failing the peel adhesion test.

FOR MINERAL SURFACED ~~ROLL~~ MATERIAL TO BE USED AS A MORTAR OR ADHESIVE SET TILE UNDERLAYMENT

22. Granule Adhesion

22.1 This test covers the determination of granule loss of materials specified in Section 1 of this Protocol, which employ a fine or granular surfacing on one side, in accordance with ASTM Test Method D 5147 except as noted below.

22.1.1 Any test specimen which exhibits an average granule loss greater than 0.75 grams shall be considered as failing the granule adhesion test.

FOR UNDERLAYMENTS TO BE USED WITH ADHESIVE SET TILE SYSTEMS

23. Tensile Adhesion of Tile Adhesives

23.1This test covers the determination of the tensile adhesion bond between a tile adhesive and the underlayment surface.

23.2 This test is required to be performed on all adhesives for which approval is sought.

23.3 Sample Preparation and Testing

23.3.1 Prepare 20 (5 each) specimens for testing at 0 days (control), 14 days, 60 days, and 120 days:

23.3.1.1 Bond a 2 inch wide by 24 inch long piece of underlayment to a 2 inch wide by 24 inch long piece of 23/32" B-C APA rated plywood. Take care that the method of bonding does not interfere with or otherwise alter the surface of the underlayment to which the tile adhesive is to be applied. Prepare (6) underlayment/plywood strips in this fashion.

23.3.1.2 Place 2 prepared specimens with the long edge horizontal in a jig such that there is a max. ¾ inches between specimens and the specimens are braced to prevent expansion. The exposed surface of the specimens should be facing each other.

23.3.1.3 Apply foam adhesive in the void between specimens in a manner specified by the adhesive manufacturer's instructions.

23.3.1.4 Allow the adhesive to cure for min. two hours.

23.3.1.5 Remove the adhered specimens from the jig and trim excess adhesive from all edges.

23.3.1.6 Cut each adhered specimen into 2 inch by 2 inch squares.

23.3.2 Condition the 2 inch by 2 inch specimens as follows:

23.3.2.1 Control specimens shall be conditioned at 73.4 ± 3.6°F and 50% relative humidity for 4 hours.

23.3.2.2 All remaining specimens shall be conditioned at 180 ± 2°F and 65% relative humidity. Six specimens each shall be conditioned for 14, 60, and 120 days.

23.3.3 Test all samples in accordance with ASTM D1623. Testing shall be performed after a stabilization at 73.4 ± 3.6°F and 50% relative humidity.

23.4 The average tensile adhesion of (5) specimens after 0, 14, 60, and 120 days shall be min. 15 psi. Any set of specimens with an average tensile adhesion below 15 psi will be considered as having failed this test.

24. Accelerated Weathering

24.1 Underlayments for which an outdoor exposure greater than 30 days is desired must comply with the requirements of this section.

24.2 Underlayments shall be exposed to accelerated weathering in accordance with ASTM D4798, Cycle A-1.

24.2.1 Exposure Limitations shall be established per Table 24.1.

24.2.2 At the conclusion of the required accelerated weathering, the weathered underlayment shall be tested per Table 24.2. Any product not achieving the values therein will be considered as having failed the test.

24.3 Report the results of testing per Table 24.2 and the duration of Accelerated Weathering exposure.

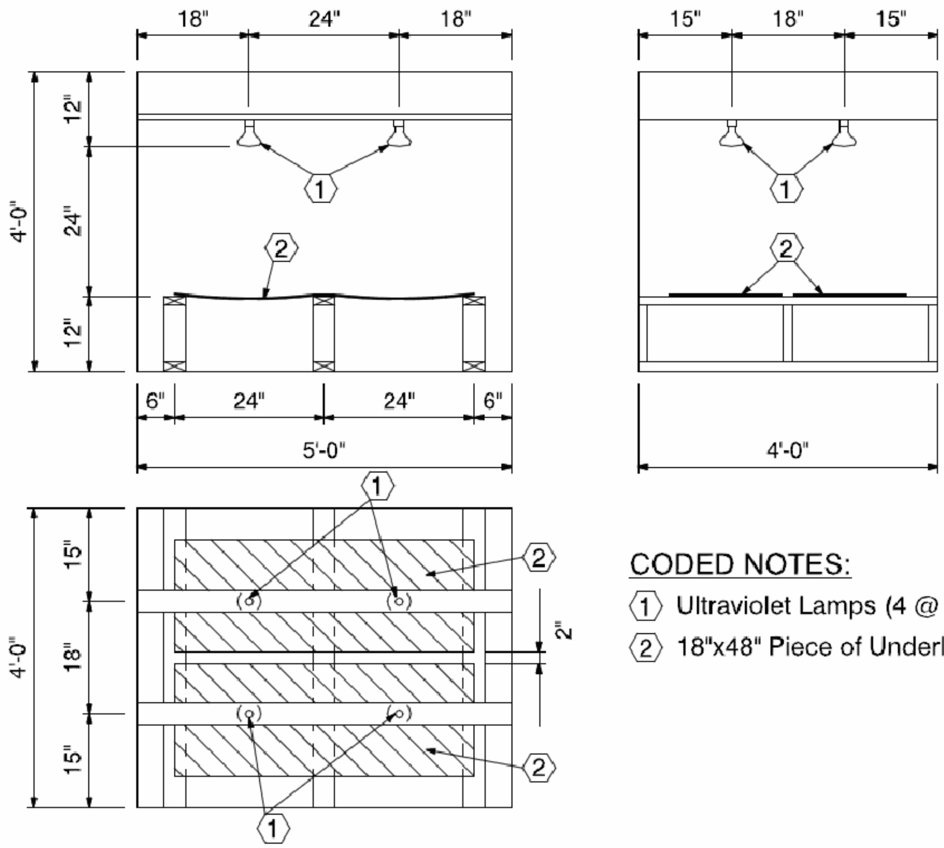
TABLE 24.1

Days of Allowable Outdoor Exposure	Accelerated Weathering Duration (Hours)

45	250
60	333
90	500
120	666
150	833
180	1,000

TABLE 24.2

Property Tested	Section Number	Minimum Requirement (MD & CD)			
Breaking Strength	10	25 lbf/in			
Elongation	10	Organic Reinforcement	Fiberglass Reinforcement	Polyester or Polypropylene Reinforced	Solid Thermoplastic Sheeting
		6%	3%	25%	225%
Low Temperature Flexibilty	12	No Cracking			



CODED NOTES:

1 Ultraviolet Lamps (4 @ 275W Each)

2 18"x48" Piece of Underlayment

FIGURE 1

R8283

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 104	**Affects HVHZ**	Yes	**Attachments**	Yes

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS) No. 104-~~95~~20
TEST PROCEDURE FOR NAIL-ON UNDERLAYMENT FOR USE IN ~~DISCONTINUOUS~~ TILE ROOF SYSTEMS

1. Scope

1.1 This Protocol covers procedures for testing mechanically attached, prefabricated, ~~reinforced,~~ polymer modified bituminous, and solid thermoplastic sheet roofing materials intended for use as underlayment in ~~Discontinuous~~ Tile Roof Systems to assist in the waterproofing to function in combination with a Prepared Roof Covering. These products may employ fine or granular surfacing materials on one side in which case the "Granular Adhesion" test, as specified herein, shall also be conducted. The Granular Adhesion test shall be required for all granular surfaced materials used as a bonding surface for mortar or adhesive set tile.

1.2 The test procedures outlined in this Protocol cover the determination of the Thickness; the Dimensional Stability; the Tear Resistance; the Breaking Strength; the Elongation; ~~the Water Absorption;~~ the Low Temperature Flexibility; the Ultraviolet Resistance; the Accelerated Aging Performance; the Cyclic Elongation Performance; the Water Vapor Transmission; the Puncture Resistance; and the Tile Slippage Resistance of an underlayment material; the Accelerated Weathering Performance of an underlayment material; the Tensile Adhesion properties of the exposed surface of the underlayment; and Granular Adhesion ~~of a mineral~~ for granular surfaced ~~roll roofing material, for use as an~~ underlayment.

1.3 These test methods appear in the following order:

	Section
Conditioning	5
Thickness	6
Dimensional Stability	7
Tear Resistance	8
Breaking Strength and Elongation	9
Reserved	10
Low Temperature Flexibility	11
Ultraviolet Resistance	12
Accelerated Aging	13
Cyclic Elongation	14
Water Vapor Transmission	15
Puncture Resistance	16
Tile Slippage Resistance	17
Granule Adhesion	18
Tensile Adhesion	19
Accelerated Weathering	20

2. Referenced Documents

2.1 *ASTM Test Standards*

~~D 570 Water Absorption of Plastics~~

D 1079 Standard Definitions and Terms Relating to Roofing, Waterproofing and Bituminous Materials

~~D 1938 Tear Propagation Resistance of Plastic Film and Thin Sheeting by a Single Tear Method~~

D 4073	Standard Test Method For Tensile Tear Strength of Bituminous Roofing Membranes
D 1970	Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection ~~(Low Temperature Flexibility)~~
D 2523	Testing Load-Strain Properties of Roofing Membranes
D 1623	Standard Test Method For Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
D 5147	Sampling and Testing Modified Bituminous Sheet Materials
E 96	Water Vapor Transmission of Materials
E 380	Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *The Florida Building Code, Building*

3. Terminology & Units

3.1 Definitions - For definitions of terms used in this Protocol, refer to ASTM D 1079; Chapters 2 and 15 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building.* The definitions from the *Florida Building Code, Building* shall take precedence.

3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E 380.

4. Significance and Use

4.1 The test procedures outlined in this Protocol provide a means of determining whether a mechanically attached roofing material, intended for use as an underlayment in a Discontinuous Roof System, for use in the High-Velocity Hurricane Zones, meets the requirements of the *Florida Building Code, Building*.

5. Conditioning

5.1 Specimens shall be selected in accordance with ASTM D5147. Unless otherwise specified, condition test specimens for a minimum of four (4) hours at 73.4 ± 3.6°F and 50 ± 5 % relative humidity prior to testing. Note separate conditioning requirements for ~~cold bend~~ low temperature flexibility testing in Section 11.1.

6. Thickness

6.1 Materials shall be checked at five points across the roll width. Measurements shall be made at two points, each being 6 ± 0.5 inches from each edge, and at three points equally spaced between these two points.

6.2 Compute the average thickness and the standard deviation of the thicknesses, in mils, based on the total number of point measurements from all of the rolls taken.

6.3 Report the individual point measurements, average, and standard deviation in mils.

6.4 Any modified bitumen ~~and~~ or bituminous test specimen which exhibits an average thickness less than sixty (60) mils shall be considered as failing the thickness test. For granular surfaced products, ~~T~~thickness measurements shall be at the selvage edge, not at a granular surface.

6.5 Non-bituminous membranes shall not nave a thickness minimum. Performance shall be based on physical property testing.

7. Dimensional Stability

7.1 Prepare five (5) 2 foot wide x 6 foot long specimens with a 4 inch overlap seam across the center of the 6 foot length. Prepare the specimens: one from each edge of the roll and three from random places in the roll. The length of each specimen should be in the 'machine direction' of the roll.

7.2 The substrate shall be $^{32}/_{16}$ APA span rated plywood sheathing of a $^{15}/_{32}$ in. thickness that has been reinforced on the back side with two angle irons.

7.3 Place the underlayment specimen on the substrate and install a 1$^{1}/_{2}$ in. x 1$^{1}/_{2}$ in. x 2' wood termination batten to one "free" end of the underlayment using three (3) equally spaced #12 wood screws to secure the batten through the underlayment and the sheathing. Mechanically attach the other "free" end of the underlayment using three (3) equally spaced ~~10d~~ roofing nails, located two (2) inches from the "free" end, with one nail at one inch from each edge, penetrating the sheathing a minimum of $^{1}/_{2}$ inch.

7.4 Condition each specimen in an oven or under heat lamps maintained at 180 ± 5°F for a minimum of six (6) hours.

7.5 Report any tears or "tear drop" conditions which arise at fastener penetrations during and/or after conditioning is complete. Report any shrinking or wrinkling which appears to have compromised the lapped area of underlayment.

7.6 Any test specimen which exhibits conditions noted in Section 7.5 of this Protocol shall be considered as failing the dimensional stability test.

7.7 Provide before and after photographs of each specimen in the final test report.

8. Tear Resistance

8.1 This test covers the determination of the tear propagation resistance of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 4073, except as noted below.

8.1.1 The prescribed Test Method shall be run in both the machine and the cross-machine direction of the roll material.

8.1.2 The final test report shall include average tear propagation force values and standard deviations of these value for both the machine and the cross-machine direction of the material.

8.1.3 Any test specimen which exhibits a tear propagation value less than 20 lbf (88.5 N) in either the machine or cross-machine directions shall be considered as failing the tear strength test.

9. Breaking Strength and Elongation

9.1 This test covers the determination of the breaking strength and elongation of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 2523, except as noted below.

9.1.1 Sampling

9.1.1.1 Ten specimens; five in the machine direction and five in the cross-machine direction of the roll, shall be cut to dimensions of 1 in. x 6 in.

9.1.2 Conditioning

9.1.2.1 Heat Aging~~,~~ shall consist of seven (7) days in an air circulating oven at a controlled temperature of 149 ± 5°F.

9.1.2.2 UV Exposure~~,~~ shall consist of 460 hours of continuous ultraviolet light exposure per Section 12.1.2.2.

9.1.3 Procedure

9.1.3.1 Each set of samples, as specified in 9.1.1.1 herein, shall be tested "as received," after heat aging, and after UV exposure, as specified in 9.1.2.1 and 9.1.2.2 herein.

9.1.3.2 Grip separation rate shall be 20 ± 0.2 inches per minute for all tests conducted.

9.1.3.3 Testing shall be performed at 73.4 ± 3.6°F for all tests.

9.1.3.4 Specimens and testing grips shall be conditioned at 73.4 ± 3.6°F 77°F for a minimum of one (1) hour prior to testing~~.~~

9.1.4 Report

9.1.4.1 Report the grip separation rate used.

9.1.4.2 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of "as received," after heat conditioning, and UV exposure as specified in 9.1.2.1 and 9.1.2.2 herein. The~~se~~ ~~grouping~~ test specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits a breaking strength value less than those listed in Table 1 shall be considered as failing the breaking strength test.

TABLE 1 MINIMUM BREAKING STRENGTH VALUES (%)

SPECIMEN	**BREAKING STRENGTH** (Machine Direction or Cross-Machine Direction)
As Received	25 lbf/inch of width (35 N/cm of width)
After Heat Aging	25 lbf/inch of width (35 N/cm of width)
After QUV Exposure	25 lbf/inch of width (35 N/cm of width)

9.1.4.3 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of "as received," after heat conditioning, and after UV exposure. These grouping shall be itemized in subgroups of machine direction and cross-machine direction. Any test specimen which exhibits elongation values less than those listed in Table 2 shall be considered as failing the elongation test.

10. Reserved

11. Low Temperature Flexibility

11.1 This test covers the determination of the low temperature flexibility of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method D 1970 except as noted below. Membranes shall be test at a maximum of 10°F.

11.1.1 Procedure

11.1.1.1 Each set of specimens shall be tested “as received” and after conditioning, as specified in ASTM D 1970.

11.1.2 Report

11.1.2.1 Low temperature flexibility results shall be reported on a pass/fail basis, for all test specimens and shall be itemized in grouping of “as received” and after conditioning. No cracking at -10°F shall be considered as passing the low temperature flexibility test.

TABLE 2 MINIMUM ELONGATION VALUES (%)

SPECIMEN	ORGANIC REINFORCEMENT	FIBERGLASS REINFORCED	POLYESTER OR POLYPROPYLENE REINFORCED	SOLID THERMOPLASTIC ~~SHEATHING~~SHEETS
As Received	6%	3%	25%	225%
After Heat Aging	5%	2.5%	21%	191%
After QUV Exposure	5%	2.5%	21%	191%

12. Ultraviolet Resistance

12.1 This test covers the determination of the ultraviolet resistance performance of materials specified in Section 1.

12.1.1 Sampling - Two 18 in. x ~~18~~ 48 in. specimens are to be cut.

12.1.2 Conditioning

12.1.2.2 Ultraviolet light shall be produced by four ~~300~~ 275 W~~watt~~ UV lamps in an enclosure in accordance with Figure 1. Recommended lamps are: Ultra-Vitalux, ~~300~~ 275 W, 220-230 V, #E27;~~, or~~ O~~o~~s~~h~~ram ~~300~~ 275 W lamps, or; equivalent bulbs providing UV characteristics of 5.0 W/m2/nm irradiance at a wavelength of 315 to 400 nm at one meter.~~.~~

12.1.2.3 Specimens to be exposed for ~~200~~ 460 (± 2) continuous hours ~~(10 hours per day for 20 days)~~.

12.1.2.4 Specimen temperature to be maintained at 135-140°F throughout the~~ UV exposure portion of the ~~test period. ~~Specimens shall be maintained between 70°F +/- 15°F when not exposed to UV during the test period.~~

12.1.3 Report & Conditions of Acceptance

12.1.3.1 Report any visible peeling, chipping, cracking, flaking, pitting or other damage, under 5x magnification, which resulted from the ultraviolet conditioning. Report the type and location of the damage (if any).

12.1.3.2 Report the type of UV lamps used to condition the samples.

12.1.3.3 Any test specimen which exhibits damage as defined in Section 12.1.3.1 of this Protocol shall be considered as failing the ultraviolet resistance test.

13. Accelerated Aging

13.1 This test covers the determination of the accelerated aging performance of materials specified in Section 1 of this protocol.

13.2 ~~Sampling~~ Specimen Preparation - Six (6) 12 in. x 12 in. specimens shall be prepared with three (3) in the machine direction and three (3) in the cross-machine direction of the roll. Specimens shall be marked to indicate machine direction.

13.2.1 Accelerated Aging – The specimens prepared per Section 14.1 are aged by the following cyclic process. Twenty-five cycles cycles are required, with each cycle consisting of the following:

1. Oven dry at 120°F (48.9°C) for three hours with all surfaces exposed.
2. Immerse in water maintained at room temperature for three hours, with all surfaces exposed.
3. Remove from water and blot dry, then air dry for 18 hours at room temperature for eighteen hours with all surfaces exposed.

Samples shall be in the air dry period over weekends and holidays, which shall be confirmed in the test log. The room temperature shall be maintained at 73.4 ± ~~5~~3.6°F (23~~2.8~~ ± 2~~.8~~°C).

13.2.2 Conditions of Acceptance – No visible damage to the specimens, such as chipping, cracking, or delamination.

13.2.3 Breaking strength and elongation tests of aged specimens shall be conducted in accordance with Section 9 of this Protocol, except as noted below.

13.2.3.1 Sampling - After the six (6) 12 in. x 12 in. aged specimens have been examined for visible damage, prepare ten (10) 1 in. x 6 in. specimens from the aged material; five in the machine direction and five in the cross-machine direction of the roll. In addition to these ten aged specimens, prepare ten “as received” specimens of the same dimensions; five in the machine direction and five in the cross-machine direction of the roll.

13.2.3.2 Conditioning - No further conditioning is to be incurred on the aged specimens.

13.2.3.3 Procedure - Each set of samples, as specified in 13.2.3.1 herein, shall be tested “as received” and after accelerated aging.

13.2.3.4 Report

13.2.3.4.1 Breaking strength shall be reported, in lbf/inch of width, for all test specimens and shall be itemized in grouping of “as received” and after accelerated aging. These ~~grouping~~ specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits a breaking strength less than the value listed in Table 2 shall be considered as failing the accelerated aging test.

13.2.3.4.2 Elongation shall be reported, in (%), for all test specimens and shall be itemized in grouping of ‘as received’ and after accelerated aging. These ~~grouping~~ specimens shall be itemized in subgroups of machine direction and cross-machine direction. Any aged specimen which exhibits an elongation value less than the applicable value listed in Table 2 shall be considered as failing the accelerated aging test.

14. Cyclic Elongation

14.1 This test covers the determination of the cyclic elongation performance of materials specified in Section 1 of this Protocol.

14.1.1 Three specimens are prepared with $^{15}/_{32}$-inch-thick (12.7 mm), 3-inch-by-6-inch (76 mm by 152 mm) APA Rated A-C plywood. Each specimen includes two plywood pieces aligned so that the 6-inch (152 mm) edges are parallel and separated by 1/8 inch (3.2 mm). Once piece of underlayment, 5~~-1/2~~ inches by 5~~-1/2~~ inches, is attached to the plywood pieces across the joint using four (4) ~~10d~~ roofing nails, one at each outside corner of the underlayment. See Figure 2. The specimens are then conditioned at 73 ± 4°F (22.8 ± 2.2°C) for seven days. After conditioning, specimens are placed in a cold box, which is maintained at –20°F (–28.9°C) for ~~48~~ 24 hours ± 1 hour. Specimens are then cycled between a 1/8-inch (3.2 mm) and 1/4-inch (6.4 mm) plywood edge separation for 100 cycles while maintaining the temperature at –20°F (–28.9°C). The rate of movement shall be 1/8 inch (3.2 mm) per hour.

14.1.2 Conditions of Acceptance - Any test specimen which exhibits cracking of material shall be considered as failing the cyclic elongation test.

15. Water Vapor Transmission

15.1 This test covers the determination of the water vapor transmission of materials specified in Section 1 of this Protocol in accordance with ASTM Test Method E 96, Procedure B.

15.2 The water vapor transmission of the membrane shall not be greater than 1.0 g/m2 in 24 hours.

16. Puncture Resistance

16.1 This test covers the determination of the puncture resistance of materials specified in Section 1 of this Protocol as noted below.

16.1.1 Two 12 in. x 25 in. specimens shall be prepared; one ultraviolet light conditioned and one accelerated aging conditioned, as specified in Sections 13 and 14 of this Protocol, respectively.

16.1.2 The puncture point shall be affixed to any shaft and have a right angle triangular pyramid shape that is 1 inch in height with rounded leading edges of 0.062 ± .002 inch radius. The point should be honed to a 0.062 inch radius and the base edges left sharp. The weight of the puncture point and shaft shall be 1.0lb ± 0.1lb.

16.1.2.1 Attach each specimen to a frame consisting of nominal wood members spaced 24 inches on center.

16.1.2.2 The test specimens shall have a maximum sag of 1 inch measured from the top of the framing member.

16.1.2.3 Drop the puncture point from a height of 30 inches above the top of the framing in five different locations.

16.1.3~~2~~ Any test specimen which exhibits any sign of puncture shall be considered as failing the puncture test.

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17. Tile Slippage Resistance

17.1 Prepare three (3) 4 foot ~~wide~~ x 8 foot ~~long~~ test frames using min. 2 inch by 4 inch nominal lumber spaced at 24 inches on center. ~~specimens with a 4 inch overlap seam across the center of the 8 foot length. Prepare the specimens: one from one edge of the roll and one from the center of the roll. The length of each specimen should be in the "machine direction" of the roll.~~

17.2 ~~The substrate shall be~~ Install ~~32/16~~ $^{15}/_{32}$ in. APA 32/16 span rated sheathing on the test frames ~~that has been reinforced on the back side with two angle irons~~.

17.3 Nail the underlayment to the substrate through "tin caps," not less than $1^{5}/_{8}$ in. and not more than 2 in. in diameter and of not less than 32 gage (0.010 in.) sheet metal, using ~~10d~~ roofing nails, in a grid pattern of 12 in. with 6 in. spacing at the lap, penetrating the sheathing a minimum of $^{1}/_{2}$ inch, with a side lap per the manufacturer's installation instructions. The side lap width shall be included in the final test report.

17.4 Condition each test deck in a~~n~~ ~~oven or under heat lamps~~ conditioning cell or room maintained at 165~~-~~± 5°F for a minimum of four (4) hours. Thereafter, the deck shall be cooled for minimum three hours at 75° ± 5°F.

17.5 After conditioning, position one test deck at a slope of 4 in:12 in.; one at 5 in:12 in. and the third at a slope of 6 in:12 in.. A 5 in:12 in. test deck may be omitted if requested by the client.

17.6 Onto each sloped test deck, place one (1) stack of 10 flat concrete tiles and one (1) stack of 10 profiled ~~clay~~ tiles manufactured ~~equipped~~ with "lugs" on the underside of each tile ~~at the center of each underlayment piece, equidistant from the edge and the seam~~, to simulate actual loading conditions. Allow the tile stacks to sit on the underlayment surface for ~~72~~ minimum 36 hours while maintaining a controlled surface temperature of 165° ± 5°F. Temperature to be maintained by a ~~surface mounted~~ thermocouple mounted on the surface of the underlayment.

17.7 Report any of the following: ~~tears, slippage, or "tear drop" condition which arise at fastener penterations during the test. Report any tile sliding which has damaged any portion of the top surface of the underlayment.~~

- Any tile slippage on any portion of the underlayment
- Any tears in the underlayment
- Any tears in the underlayment surfacing
- Any delamination of the underlayment facing from the adhesive layer
- Any "tear drop" conditions at fastener penetrations

17.8 Any test specimen which exhibits conditions noted in Section 17.7 of this Protocol shall be considered as failing the tile slippage resistance test.

17.9 Provide before and after photographs of each specimen in the final test report.

17.10 Alternate ~~slippage resistance testing and~~ stacking configurations shall be permitted to be approved as part of a Product Approval. Details of such stacking configurations shall be included in the final test report.

FOR MINERAL SURFACED ~~ROLL~~ MATERIALS TO BE USED AS A MORTAR OR ADHESIVE SET TILE UNDERLAYMENT

18. Granule Adhesion

18.1 This test covers the determination of granule loss of materials specified in Section 1 of this Protocol, which employ a fine or granular surfacing on one side, in accordance with ASTM Test Method D 5147, except as noted below.

18.1.1 Any test specimen which exhibits an average granule loss greater than 0.75 grams shall be considered as failing the granule adhesion test.

FOR UNDERLAYMENTS TO BE USED WITH ADHESIVE SET TILE SYSTEMS

19. Tensile Adhesion of Tile Adhesives

19.1This test covers the determination of the tensile adhesion bond between a tile adhesive and the underlayment surface.

19.2 This test is required to be performed on all adhesives for which approval is sought.

19.3 Sample Preparation and Testing

19.3.1 Prepare 20 (5 each) specimens for testing at 0 days (control), 14 days, 60 days, and 120 days:

19.3.1.1 Bond a 2 inch wide by 24 inch long piece of underlayment to a 2 inch wide by 24 inch long piece of 23/32" B-C APA rated plywood. Take care that the method of bonding does not interfere with or otherwise alter the surface of the underlayment to which the tile adhesive is to be applied. Prepare (6) underlayment/plywood strips in this fashion.

19.3.1.2 Place 2 prepared specimens with the long edge horizontal in a jig such that there is a max. ¾ inches between specimens and the specimens are braced to prevent expansion. The exposed surface of the specimens should be facing each other.

19.3.1.3 Apply foam adhesive in void between the specimens in the manner specified by the adhesive manufacturer's instructions.

19.3.1.4 Allow the adhesive to cure for min. two hours.

19.3.1.5 Remove the adhered specimens from the jig and trim excess adhesive from all edges.

19.3.1.6 Cut each adhered specimen into 2 inch by 2 inch squares.

19.3.2 Condition the 2 inch by 2 inch specimens as follows:

19.3.2.1 Control specimens shall be conditioned at 77 ± 2.5°F and 50% relative humidity for 4 hours.

19.3.2.2 All remaining specimens shall be conditioned at 180 ± 2°F and 65% relative humidity. Six specimens each shall be conditioned for 14, 60, and 120 days.

19.3.3 Test samples in accordance with ASTM D1623. Testing shall be performed after a stabilization at 77 ± 2.5°F and 50% relative humidity.

19.4 The average tensile adhesion of (5) specimens after 0, 14, 60, and 120 days shall be min. 15 psi. Any set of specimens with an average tensile adhesion below 15 psi will be considered as having failed this test.

20. Accelerated Weathering

20.1 Underlayments for which an outdoor exposure greater than 30 days is desired must comply with the requirements of this section.

20.2 Underlayments shall be exposed to accelerated weathering in accordance with ASTM D4798, Cycle A-1.

20.2.1 Exposure Limitations shall be established per Table 20.1.

20.2.2 At the conclusion of the required accelerated weathering, the weathered underlayment shall be tested per Table 20.2. Any product not achieving the values therein will be considered as having failed the test.

20.3 Report the results of testing per Table 20.2 and the duration of Accelerated Weathering exposure.

TABLE 20.1

Days of Allowable Outdoor Exposure	Accelerated Weathering Duration (Hours)
45	250
60	333
90	500
120	666
150	833
180	1,000

TABLE 20.2

Property Tested	Section Number	Minimum Requirement (MD & CD)			
Breaking Strength	10	25 lbf/in			
Elongation	10	Organic Reinforcement	Fiberglass Reinforcement	Polyester or Polypropylene Reinforced	Solid Thermoplastic Sheeting
		6%	3%	25%	225%
Low Temperature Flexibilty	12	No Cracking			

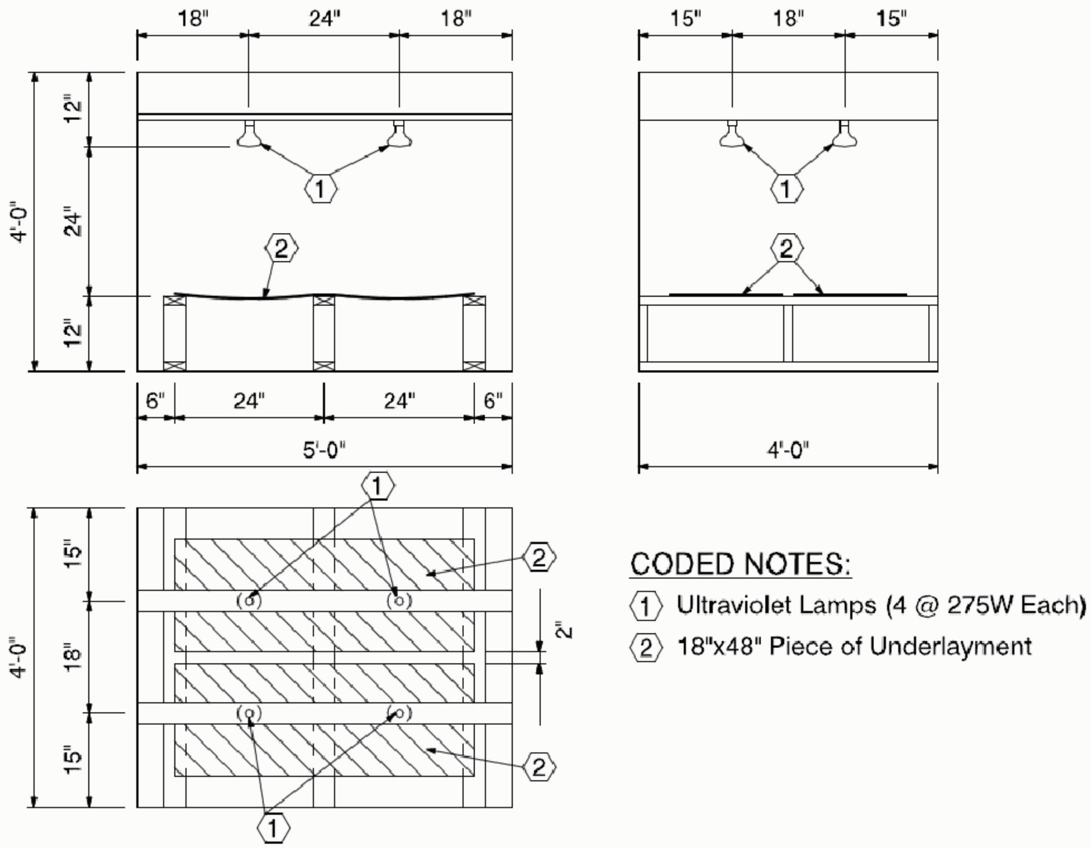

FIGURE 1

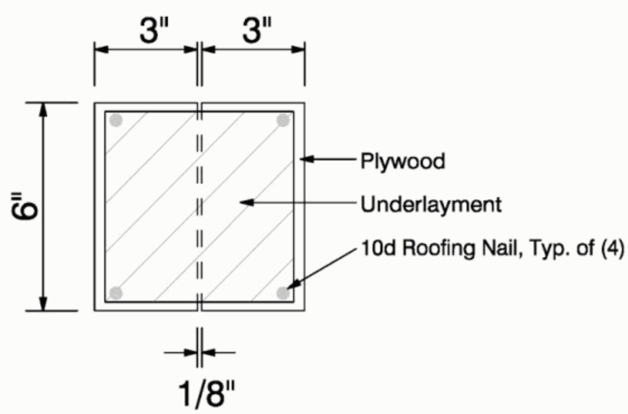

FIGURE 2

R7184

Date Submitted	11/5/2018	**Section**	8	**Proponent**	Michael Goolsby
Chapter	TAS 105	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Establish consistency with ASCE 7-16.

Rationale

Revisions necessary to reflect consistency with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, merely reflects revisions necessary to reflect ASCE 7-16 terminology.

Impact to building and property owners relative to cost of compliance with code

None, merely reflects revisions necessary to reflect ASCE 7-16 terminology.

Impact to industry relative to the cost of compliance with code

None, merely reflects revisions necessary to reflect ASCE 7-16 terminology.

Impact to small business relative to the cost of compliance with code

None, merely reflects revisions necessary to reflect ASCE 7-16 terminology.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Yes, by identifying elevated pressure zones.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Yes, by identifying elevated pressure zones.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the effectiveness of the code.

TESTING APPLICATION STANDARD (TAS) No. 105-~~11~~20
TEST PROCEDURE FOR FIELD WITHDRAWAL RESISTANCE TESTING

8. Test Procedure for Anchor or Base Sheet, Insulation, and Membrane Attachment testing

8.1 On roof decks of 100 squares or less, ten (10) withdrawal resistance tests shall be conducted, not less than three (3) of which shall be in Zone 2 ~~the perimeter areas (2)~~, three (3) in Zone 3 ~~corner areas (3)~~, the remainders in Zone 1' and Zone 1 ~~the field areas (1)~~ as defined in ASCE7.

8.6 Stair towers, mechanical penthouses and mechanical rooms shall have a minimum of four (4) withdrawal resistance tests, two of which shall be taken ~~at perimeter areas~~ in Zones 2 & 3, as defined in ASCE 7.

10.1.10 Field fastener withdrawal testing shall be performed in the preceding three (3) months, unless otherwise authorized by the *building official.*

TESTING APPLICATION STANDARD (TAS) 105-~~98~~20
APPENDIX A
FIELD WITHDRAWAL RESISTANCE TEST RESULTS REPORT

FIELD WITHDRAWAL RESISTANCE TEST RECORDING SHEET

See Section 8 to determine number of tests (If drill bit is high tolerance, include range in 1/1000" tolerances)

SAMPLE NO.	PLAN IDENTIFIER	INITIAL FAILURE LOAD (lbf)	Zone 1', Zone 1, Zone 2 or Zone 3 (Circle one) FIELD PERIMETER OR CORNER AREA (circle one)			
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3

			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3
			Z-1'~~F~~	Z-1~~P~~	~~C~~ Z-2	Z-3

R8284

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 107	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

TESTING APPLICATION STANDARD (TAS) No. 107-~~95~~20

TEST PROCEDURE FOR WIND RESISTANCE TESTING OF NON-RIGID, DISCONTINUOUS ROOF SYSTEM ASSEMBLIES (Modified from ASTM D3161)

1. Scope

1.1 This test method covers the determination of the resistance to wind blow-up ~~or blow-off~~ of asphalt shingles, metal shingles or other non-rigid, discontinuous Roof System Assemblies when installed in compliance with the manufacturer's current, published installation instructions.

2. Referenced Documents

2.1 ASTM Standards

D3161 Standard Test Method for Wind Resistance of Asphalt Shingles

E380 Excerpts from the Standard Practice for Use of the International System of Units (SI) (the Modernized Metric System)

2.2 *The Florida Building Code, Building*.

3. Terminology & Units

3.1 Definitions- For definitions of terms used in this specification, refer to ASTM D3161; and/or Chapters 2 and 15 (High-Velocity Hurricane Zones) of the *Florida Building Code, Building*. Definitions from the *Florida Building Code, Building* shall take precedence.

3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Types of Roof System Assemblies

4.1 Asphalt shingles are of two types:

4.1.1 *Type I* - Shingles with a factory-applied adhesive (self-sealing shingles).

4.1.2 *Type II* - Shingles of the lock-type, with mechanically interlocking tabs or ears.

4.2 Metal shingles or other non-rigid, discontinuous Roof System Assemblies shall be tested under this Protocol at the direction of the Authority Having Jurisdiction.

5. Significance and Use

5.1 Asphalt shingles, metal shingles or other non-rigid, discontinuous Roof System Assemblies that have demonstrated wind resistance by this test have also performed well in use. Local wind conditions may differ from the test conditions both in intensity and duration, and should be taken into consideration. This method is suitable for use in specifications and regulatory statutes. This method, assisted by experience and engineering judgment, will also prove useful for development work.

6. Test Limitations and Precautions

6.1 This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7. Apparatus

7.1 Test Machine

7.1.1 The "test machine" shall be capable of delivering a horizontal stream of air through a rectangular opening, 36 in. (914 mm) wide and 12 in. (305 mm) high, at a velocity of 110 mph (177 km/h) ± 5% as measured at the orifice.

7.1.2 The "test machine" shall be equipped with an adjustable stand on which a test panel is placed. The stand shall be adjustable to setting the test panel at any desired slope, at any horizontal distance from the lower edge of the duct opening, and at various angles incident to the wind direction.

7.2 Clock

7.3 Mechanical Circulation Conditioning Cell or Room

7.3.1 A mechanical circulation conditioning cell or room with a forced air circulation shall be utilized for self-sealing shingle conditioning. The cell or room shall be capable of receiving a minimum 50 in. (1.27 m) wide by 66 in. (1.68 m) long test panel at a slope of 2 in:12 in. and of maintaining a uniform temperature of 135 to 140°F (57 to 60°C).

8. Test Specimen

8.1 Deck

8.1.1 The wood test deck shall consist of APA 32/16 span rated sheathing of $^{15}/_{32}$ in. thickness and not less than 50 in. by 66 in. (1.27 m by 1.68 m) in dimension. The wood test deck shall be of such rigidity that it will not twist or distort with normal handling, or vibrate from the wind velocity during the test.

8.2 Underlayment

8.2.1 Underlayment shall be either two layers of *approved* ~~15 lb~~ ASTM D226, Type I or one layer of *approved* ASTM D226, Type II asphalt saturated felt underlayment mechanically attached to the wood test deck, with 12 ga. roofing nails and 1 5/8 in. tin caps, in a 12 in. grid patter staggered in two rows in the field and 6 in. o.c. attachment at any laps.

8.3 Self-Sealing Asphalt Shingles

8.3.1 Apply self-sealing asphalt shingles with multiple tabs to duplicate test decks, parallel to the short dimension of the test deck, in compliance with the manufacturer's instructions. Apply products with single tabs to duplicate test decks, parallel to the short dimension of the test deck, in such a manner that there is at least one full shingle in each course.

8.3.2 Secure the exposed portion of any partial product tab or shingle with face nailing or stapling such that the partial product tabs or partial shingles will remain in place for the entire duration of the test.

8.3.~~2~~3 Asphalt shingles shall be attached using 12 ga. roofing nails, properly positioned in compliance with the manufacturer's instructions, to fasten each shingle. No cement, other than the factory-applied adhesive, shall be used to fasten down the tabs. Do not apply pressure to the shingle tabs either during or after application.

8.4 Lock-Type Asphalt Shingles

8.4.1 Apply lock-type asphalt shingles to not less than four test decks, parallel to the short dimension of the panel, in compliance with the manufacturer's instructions. Se- cure the shingles at the outer edge of the test panel by exposed nailing to simulate anchoring at the rake edges of a roof deck.

8.5 Metal Shingles or Other

8.5.1 Apply metal shingles or other non-rigid, discontinuous components to duplicate test decks, parallel to the short dimension of the test deck, in compliance with the manufacturer's instructions.

8.6 Control the temperature at 80 ± 15°F (27 ± 8°C) and maintain the slope of the panel at 2 in:12 in. (17% slope) during shingle application.

9. Conditioning

9.1 Maintain the test specimens at a slope of 2 in:12 in. and at a temperature of 80 ± 15°F (27 + 8°C) until the commencement of heat conditioning.

9.2 Place the test specimens in the conditioning cell or room at a slope of 2 in:12 in. and maintain at a temperature of 135 to 140°F (57 to 60°C) for a continuous 16 hour period.

9.3 After completion of the conditioning period, allow the test specimens to come to room temperature [80 ± 15°F (27 ±8°C)] while at a slope of 2 in:12 in

9.4 Exercise care to avoid pressure on shingle tabs by any twisting or distortion of the test specimens during handling.

10. Procedure

10.1 Location of the Test Panel

10.1.1 Install the test specimen on the test carriage and adjust it in relation to the duct such that the exposed edge of the target course is on the same level as the lower edge of the duct orifice at a horizontal distance of 7 in. ± $^{1}/_{16}$ in. (178 ± 1 mm). The target course shall be the third course up from the bot- tom of the test specimen. The test incline shall be 2:12 in. for self-sealing shingles, and at the lowest incline recommended by the manufacturer for lock-type asphalt and metal shingles and other non-rigid, discontinuoussystems.

10.1.2 Since the design of lock-type shingle may make it difficult to determine the most critical angle of wind direction, conduct the test at a minimum of three different angles: 1) head-on; 2) with the bottom of the target course parallel to and 7 in. (178 mm) away from the machine orifice; and, 3) with the test specimen rotated 30 and 60 degrees from the head-on position, with the bottom corner of the third-course tab nearest to the duct being 7 in. (178 mm) away from and in the same horizontal plane as the bottom of the machine orifice. Test another panel at the position judged to be most critical on the basis of the first three tests.

10.2 Performing the Test

10.2.1 Maintain the ambient temperature at 75 ± 5°F (24 + 3°C) during the wind tests.

10.2.2 As soon as the test specimen is set in position, start the fan, adjust to produce a velocity of 110 mph (177 km/hr) ± 5% at the orifice, and maintain continuously for 2 hours, or until such lesser time as a failure occurs.

10.2.3 ~~During the test, an observer shall note any lifting of shingle tabs or non-rigid components and shall record any damage to a full shingle or non-rigid component or the disengaging of a locking ear or tab, or a shingle tab, including any failure of adhesive. The time at which any of these "failures" occurs should be noted.~~

Any steep slope roofing product assembly that fails to restrain full product tabs shall be considered as having failed this test.

10.2.4 If failure occurs during the test as defined in Section 10.2.3, stop the air flow and record the exposure time. ~~The end point for failure shall be taken as the time at which the sealing feature fails to restrain one or more full shingles or full shingle tabs, or a locking ear or tab of a lock shingle tears loose or disengages from its locking position or a non-rigid component is damaged so as to affect the performance of the system. In addition, no free portion of a shingle or non-rigid component shall lift so as to stand upright or bend back on itself during the test.~~

11. Certification

11.1 A test report will be provided to the Authority Having Jurisdiction confirming successful compliance with the test provisions of this Protocol. Completion of this test Protocol is one in a series of Testing Application Standards required by the Florida Building Code, Building for Product Approval of non-rigid, discontinuous Roof System Assemblies.

R7299

Date Submitted	11/16/2018	**Section**	1	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	No	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Specifies Testing Labs must verify manufacturing location of tested products.

Rationale

Clarifies requirement for Test Labs to verify manufacturing location of samples submitted for testing.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Traceability of approved components for the purpose of insuring product approved components perform as tested and certified.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes any obstacles to quality assurance of product approval components.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

applies equally to all products seeking approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying requirement to document product traceability.

TAS 110 Section 1

Add Section 1.2

1.2 Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

R7300

Date Submitted	11/16/2018	**Section**	4	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Modifies Table 4 in Section 4 to include updated requirement for TPO membranes.

Rationale

Updates requirement for TPO membranes to coincide with current requirements with other certification bodies.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 4

Modify Table 4

PRODUCT STANDARD	TEST
Membrane Products	
Polyvinyl Chloride Sheet Roofing - PVC (Spec.)	D4434
Vulcanized Rubber Sheet Roofing - EPDM (Spec.)	D4637
Poly-isobutylene Sheet Roofing - PIB (Spec.)	D5019
Polyethylene Chlorinated Polyethylene Sheet Roofing - CMS (Spec.)	D5019
Hypalon Sheet Roofing	D5019
Unreinforced Thermoplastic Olefin Elastomer Sheet Roofing - TPO	TAS 131
Keytone Ethylene Ester Sheet Roofing - KEE (Spec.)	D6754
Thermoplastic Olefin Elastomer Sheet Roofing – TPO (Internally Reinforced only)	
Standard Specification	D6878
Static Puncture Resistance Report Results Only	D5602
Dynamic Puncture Resistance Report Results Only	D5635
Breaking Strength (after accelerated weathering) Report Results Only	D751
Elongation at Reinforcement Break (after accelerated weathering) Report Results Only	D751
All Single-Ply Membranes	TAS 117(B)
Other Components	
Sealants	TAS 132
Insulation	See Section 7 of this Protocol
Fasteners, Stress Plates, etc.	See Section 12 of this Protocol

R7301

Date Submitted 11/16/2018
Chapter TAS 110
Section 8
Affects HVHZ Yes
Proponent Jorge Acebo
Attachments No
TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Modifies Table 8 in Section 8 to include requirements for Gypsum and Cementitious insulation boards and Lightweight Insulating Concrete.

Rationale

Updates requirement for Gypsum and Cementitious insulation boards and Lightweight Insulating Concrete to coincide with current requirements with other certification bodies.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 8

Modify Table 8

Physical Property	Test Standard	Requirement
Expanded Polystyrene (EPS)		
Standard Specification	C578	Minimum Type IX
Flame Spread	E84	max. < 75
Extruded Polystyrene (XPS)		
Standard Specification	C578	Minimum Type IV
Flame Spread	E84	max. < 75
Fiberglass/Mineral Wool Fiber		
Standard Specification	C726	Type I or Type II
Wood Fiberboard		
Standard Specification	C208	Grade 1 or 2
Compressive Strength	C165	nominal 30 psi
Perlite		
Standard Specification	C728	Type I or Type II
Compressive Strength	C165 Procedure "A"	min. 35 psi
Water Vapor Permeability	C355	max. 25 perm-inch
Dimensional Stability	D2126	max. 2%
Flame Spread	E84	max. < 75
Polyisocyanurate		
Standard Specification	C1289	
Density	D1622	nominal 2 pcf
Compressive Strength	D1621	min. 18 psi
Water Absorption	C209	max. 1.0%
Water Vapor Permeance	E96	max. 1.0 perm
Dimensional		

Stability (7 Days)	D2116	max. 2%
Flame Spread	E84	max. < 75
Spread of Flame (with Roof Cover)	E108	min. Class 'B'
Gypsum		
Standard Specification	C1177	Type X
Cementitious		
Standard Specification	C1325	Type A or Type B
Lightweight Insulating Concrete		
Standard Specification	C869	Cellular
Standard Specification	C332	Aggregate

R7303

Date Submitted	11/16/2018	**Section**	9	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modifies Table 9 footnote in Section 9 to exclude requirements for TAS 103 and TAS 104 membranes which are being modified to include the additional testing specified in the footnote.

Rationale

Excludes requirement for TAS 103 and TAS 104 membranes to perform the additional testing requirements listed within the footnote because the requirement is being included into TAS 103 and TAS 104 protocols.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 9

Modify Table 9 footnote only

TABLE 9

Product	Test	Test Standard
Fiber Cement Roof Assembly	Wind Driven Rain Resistance	TAS 100
Fiber Cement Roofing Products	Physical Properties	TAS 135
Mechanical Attached Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Mechanically Attached, Clipped Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Fiber Cement Panel Roof Assemblies	Uplift Pressure Resistance	E 330 (See TAS 135 for details)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A-1); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may beomitted.

R7304

Date Submitted	11/16/2018	**Section**	10	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments No **Alternate Language** No

Related Modifications

Summary of Modification

Modifies Table 10 footnote in Section 10 to exclude requirements for TAS 103 and TAS 104 membranes which are being modified to include the additional testing specified in the footnote.

Rationale

Excludes requirement for TAS 103 and TAS 104 membranes to perform the additional testing requirements listed within the footnote because the requirement is being included into TAS 103 and TAS 104 protocols.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 10

Modify Table 10 footnote only

TABLE 10

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Non-Rigid, Discontinuous Roof Assembly	Wind Resistance	TAS 107
Non-Rigid, Discontinuous Roof Assembly	Fire Resistance min . Class 'B'	E 108 min. Class 'B'
Granule Surfaced, Glass Felt Asphalt Shingles	Physical Properties	D3462
Granule Surfaced, Class 'A' Asphalt Shingles Fiberglass Reinforced	Physical Properties	D3018 TAS 135
Composite Shingles Fiber Cement Shingles	Physical Properties	TAS 135
Metal Shingles	Salt Spray and Accelerated Weathering	B117 and G23
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc	Corrosion Resistance	Appendix E of TAS 114

AllUnderlayments (with the exception of TAS 103 or TAS 104 underlayments) withexposurelimitationinexcessof30daysmust submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlinedinASTMD5147~~for1000hours(cycleA-1);pass/failestablished by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may beomitted.

R7305

Date Submitted	11/16/2018	**Section**	11	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modifies Table 11(A) and 11(B) footnote 3 in Section 11 to exclude requirements for TAS 103 and TAS 104 membranes which are being modified to include the additional testing specified in the footnote.

Rationale

Excludes requirement for TAS 103 and TAS 104 membranes to perform the additional testing requirements listed within the footnote because the requirement is being included into TAS 103 and TAS 104 protocols.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 11

Modify Table 11(A) and 11(B) footnote 3 only

TABLE 11(A)

Product	Test	Test Standard
Mechanically Attached Rigid, Discontinuous Roof Assembly	Wind Driven Resistance	TAS 100
Mechanically Attached Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102
Mechanically Attached Clipped, Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102(A)
Mortar or Adhesive Set Tile Roof Assembly	Static Uplift Resistance	TAS 101
Rigid, Discontinuous Roof Assembly	Wind Tunnel Performance	TAS 108
Rigid, Discontinuous Roof Assembly	Air Permeability	TAS 116
Concrete Roof Tile	Physical Properties	TAS 112
Clay Roof Tile	Physical Properties	C 1167
Fiberglass Reinforced Composite Tile	Physical Properties	TAS 135
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114
Mortar (for use in mortar set tile Roof System Assemblies)	Physical Properties	TAS 123
Adhesive (for use as a repair or supplemental attachment component)	Physical Properties	TAS 123(A)

TABLE 11(B)

Product	Test	Test Standard
Slate	Physical Properties	C406
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol

Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

Notes:

1. Wind tunnel testing of rigid, discontinuous roof assemblies is op- tional and is only applicable to systems having rigid components which meet the size constraints set forth in TAS108.
2. Air permeability testing of rigid, discontinuous roof assemblies is onlyapplicabletothosesystemswhicharetobetestedincompliance withTAS108andisnotrequiredforthosesystemsgenerallyconsid- ered to be air permeable. This is a test to confirm the roofassembly would apply to wind tunneltesting.
3. All Underlayments <u>(with the exception of TAS 103 or TAS 104 underlayments)</u> with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 as outlined in ASTM D5147 for 1000 hours (cycle A-<u>1</u>); pass /fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

R7306

Date Submitted	11/16/2018	**Section**	17	**Proponent**	Jorge Acebo
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modifies Table 17 footnote in Section 17 to exclude requirements for TAS 103 and TAS 104 membranes which are being modified to include the additional testing specified in the footnote.

Rationale

Excludes requirement for TAS 103 and TAS 104 membranes to perform the additional testing requirements listed within the footnote because the requirement is being included into TAS 103 and TAS 104 protocols.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 110 Section 17

Modify Table 17 and footnote

TABLE 17

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Plastic Tile/Shake/Slate Systems	Uplift Performance	TAS 125
Plastic Tile/Shake/Slate	Outdoor Exposure Xenon Arc	G26 (6500 watts) Test Method 1 or G155 (4500 hours)
	Tensile Test	D638 (+/- 10% allowable difference between exposed and non-exposed samples)
	Flexural Test	C158 (+/- 10% allowable difference between exposed and non-exposed samples)
Plastic Tile/Shake/Slate	Self Ignition	D1929 (greater than 650$_o$F)
Plastic Tile/Shake/Slate	Smoke Density Rating	E84 (rating less than 450) or D2843 (rating less than 75)
Plastic Tile/Shake/Slate	Rate of Burning	D635 (Class ~~C1~~ CC-1 or ~~C2~~ CC-2)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycleA-1); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may beomitted.

R7439

Date Submitted	11/26/2018	**Section**	15	**Proponent**	Gaspar Rodriguez
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

7437; 7438; 7439. These three mods need to be considered concurrently.

Summary of Modification

Will allow for standing seam metal roof systems to be install to a minimum 1:12 slope.

Rationale

Many property owners have requested metal panel roof on low-slope roofs. This modification will allow the option for the property owner to install metal roof panels to a minimum 1:12 slope roofs.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

None, it will require the same amount of enforcement.

Impact to building and property owners relative to cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to industry relative to the cost of compliance with code

This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Impact to small business relative to the cost of compliance with code

Many small business will perform the required testing to expand their product line.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

The general public is asking for this option. This modification is an option (not a requirement) that many property owners have requested in the HVHZ.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Allows for greater options for low slope roofing, while maintaining product standards.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not discriminate.

Does not degrade the effectiveness of the code

Does not degrade the code, allows optional systems for certain low slope roofs.

Table 15

Product	Test	Test Standard
Structural, Nonstructural Metal Panels and Metal Shingle Roof Assemblies	Uplift Resistance	TAS 125
Structural, Nonstructural Metal Panels and Metal Shingle Roof Assemblies	Wind and Wind Driven Rain Resistance	TAS 100
Structural, Nonstructural Metal Panels and Metal Shingle Roof Assemblies	Fire Resistance	E108 (min. Class "B")
Structural, Nonstructural Metal Panels and Metal Shingle Roof Assemblies	Accelerated Weathering	G152 or G155 (2000 hours)
Structural, Nonstructural Metal Panels and Metal Shingle Roof Assemblies	Salt Spray	B117 (1000 hours)
Insulated Metal Panels	Thermal Value	C518 (report)
Nonstructural Standing Seam Metal Panels	Static Water Leakage Test [1]	FM 4471 Appendix G or ASTM E2140-01[2]

1 Optional test to allow minimum slope of 1:12.

2 Standing seam metal roof panel systems that pass the requirements of FM 4471 Appendix G or ASTM E2140-01, shall be permitted to be installed to a minimum slope of 1:12

R8299

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates roofing requirements and removes outdated references.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific product

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards

See attached file.

TAS 110 Section 1

Add Section 1.2

Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

TAS 110 Section 4

Modify Table 4

PRODUCT	TEST STANDARD
Membrane Products	
Polyvinyl Chloride Sheet Roofing - PVC (Spec.)	D4434
Vulcanized Rubber Sheet Roofing - EPDM (Spec.)	D4637
Poly-isobutylene Sheet Roofing - PIB (Spec.)	D5019
Polyethylene Chlorinated Polyethylene Sheet Roofing - CMS (Spec.)	D5019
Hypalon Sheet Roofing	D5019
Unreinforced Thermoplastic Olefin Elastomer Sheet Roofing - TPO	TAS 131
Keytone Ethylene Ester Sheet Roofing - KEE (Spec.)	D6754
Thermoplastic Olefin Elastomer Sheet Roofing – TPO (Internally Reinforced only)	
Standard Specification	D6878
Static Puncture Resistance Report Results Only	D5602
Dynamic Puncture Resistance Report Results Only	D5635
Breaking Strength (after accelerated weathering) Report Results Only	D751
Elongation at Reinforcement Break (after accelerated weathering) Report Results Only	D751
All Single-Ply Membranes	TAS 117(B)
Other Components	
Sealants	TAS 132
Insulation	See Section 7 of this Protocol
Fasteners, Stress Plates, etc.	See Section 12 of this Protocol

TAS 110 Section 8

Modify Table 8

Physical Property	Test Standard	Requirement
Expanded Polystyrene (EPS)		
Standard Specification	C578	Minimum Type IX

Flame Spread	E84	max. < 75
Extruded Polystyrene (XPS)		
Standard Specification	C578	Minimum Type IV
Flame Spread	E84	max. < 75
Fiberglass/Mineral Wool Fiber		
Standard Specification	C726	Type I or Type II
Wood Fiberboard		
Standard Specification	C208	Grade 1 or 2
Compressive Strength	C165	nominal 30 psi
Perlite		
Standard Specification	C728	Type I or Type II
Compressive Strength	C165 Procedure "A"	min. 35 psi
Water Vapor Permeability	C355	max. 25 perm-inch
Dimensional Stability	D2126	max. 2%
Flame Spread	E84	max. < 75
Polyisocyanurate		
Standard Specification	C1289	
Density	D1622	nominal 2 pcf
Compressive Strength	D1621	min. 18 psi
Water Absorption	C209	max. 1.0%
Water Vapor Permeance	E96	max. 1.0 perm
Dimensional Stability (7 Days)	D2116	max. 2%
Flame Spread	E84	max. < 75
Spread of Flame (with Roof Cover)	E108	min. Class 'B'
Gypsum		
Standard Specification	C1177	Type X
Cementitious		
Standard Specification	C1325	Type A or Type B
Lightweight Insulating Concrete		
Standard Specification	C869	Cellular
Standard Specification	C332	Aggregate

TAS 110 Section 9

Modify Table 9 footnote only

TABLE 9

Product	Test	Test Standard
Fiber Cement Roof Assembly	Wind Driven Rain Resistance	TAS 100

Fiber Cement Roofing Products	Physical Properties	TAS 135
Mechanical Attached Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Mechanically Attached, Clipped Fiber Cement Tile or Shake Roof Assemblies (Uplift Based System)	Static Uplift Resistance	TAS 102(A) (See TAS 135 for details)
Fiber Cement Panel Roof Assemblies	Uplift Pressure Resistance	E 330 (See TAS 135 for details)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments <u>(with the exception of TAS 103 or TAS 104 underlayments)</u> with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A<u>-1</u>); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 10

Modify Table 10 footnote only

TABLE 10

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Non-Rigid, Discontinuous Roof Assembly	Wind Resistance	TAS 107
Non-Rigid, Discontinuous Roof Assembly	Fire Resistance min. Class 'B'	E 108 min. Class 'B'
Granule Surfaced, Glass Felt Asphalt Shingles	Physical Properties	D3462
Granule Surfaced, Class 'A' Asphalt Shingles Fiberglass Reinforced	Physical Properties	D3018 TAS 135
Composite Shingles Fiber Cement Shingles	Physical Properties	TAS 135
Metal Shingles	Salt Spray and Accelerated Weathering	B117 and G23
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc	Corrosion Resistance	Appendix E of TAS 114

All Underlayments <u>(with the exception of TAS 103 or TAS 104 underlayments)</u> with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A<u>-1</u>); pass/fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 11

Modify Table 11(A) and 11(B) footnote 3 only

TABLE 11(A)

Product	Test	Test Standard
Mechanically Attached Rigid, Discontinuous Roof Assembly	Wind Driven Resistance	TAS 100
Mechanically Attached Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102
Mechanically Attached Clipped, Rigid, Discontinuous Roof Assembly	Static Uplift Resistance	TAS 102(A)
Mortar or Adhesive Set Tile Roof Assembly	Static Uplift Resistance	TAS 101
Rigid, Discontinuous Roof Assembly	Wind Tunnel Performance	TAS 108
Rigid, Discontinuous Roof Assembly	Air Permeability	TAS 116
Concrete Roof Tile	Physical Properties	TAS 112
Clay Roof Tile	Physical Properties	C 1167
Fiberglass Reinforced Composite Tile	Physical Properties	TAS 135
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114
Mortar (for use in mortar set tile Roof System Assemblies)	Physical Properties	TAS 123
Adhesive (for use as a repair or supplemental attachment component)	Physical Properties	TAS 123(A)

TABLE 11(B)

Product	Test	Test Standard
Slate	Physical Properties	C406
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

Notes:

1. Wind tunnel testing of rigid, discontinuous roof assemblies is op- tional and is only applicable to systems having rigid components which meet the size constraints set forth in TAS 108.
2. Air permeability testing of rigid, discontinuous roof assemblies is only applicable to those systems which are to be tested in compliance with TAS 108 and is not required for those systems generally consid- ered to be air permeable. This is a test to confirm the roof assembly would apply to wind tunnel testing.
3. All Underlayments <u>(with the exception of TAS 103 or TAS 104 underlayments)</u> with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 as outlined in ASTM D5147 for 1000 hours (cycle A-1); pass /fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 17

Modify Table 17 and footnote

TABLE 17

Product	Test	Test Standard
Non-Rigid, Discontinuous Roof Assembly	Wind Driven Rain Resistance	TAS 100
Plastic Tile/Shake/Slate Systems	Uplift Performance	TAS 125
Plastic Tile/Shake/Slate	Outdoor Exposure Xenon Arc	G26 (6500 watts) Test Method 1 or G155 (4500 hours)
	Tensile Test	D638 (+/- 10% allowable difference between exposed and non-exposed samples)
	Flexural Test	C158 (+/- 10% allowable difference between exposed and non-exposed samples)
Plastic Tile/Shake/Slate	Self Ignition	D1929 (greater than 650ºF)
Plastic Tile/Shake/Slate	Smoke Density Rating	E84 (rating less than 450) or D2843 (rating less than 75)
Plastic Tile/Shake/Slate	Rate of Burning	D635 (Class ~~C1~~ CC-1 or ~~C2~~ CC-2)
Underlayment		
Self-Adhered Underlayments	Physical Properties	TAS 103 or ASTM D1970
Nail-On Underlayments	Physical Properties	TAS 104
Asphalt Based Underlayments	Physical Properties	See Section 2 of this Protocol
Attachment Components		
Nails, Screws, Clips, etc.	Corrosion Resistance	Appendix E of TAS 114

All Underlayments (with the exception of TAS 103 or TAS 104 underlayments) with exposure limitation in excess of 30 days must submit enhanced Accelerated Weathering testing in conjunction with applicable Physical Properties testing. Exposure limitations up to a maximum of 180 days will be established through ASTM D4798 ~~as outlined in ASTM D5147~~ for 1000 hours (cycle A-1); pass /fail established by physical properties testing of the weathered samples. Physical property testing where specimen size will not fit into the accelerated weathering device may be omitted.

TAS 110 Section 18

ADD ALL ASTMs Specified in TAS 110

R7308

Date Submitted 11/16/2018
Chapter TAS 110
Section 1
Affects HVHZ Yes
Proponent Jorge Acebo
Attachments No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No**

Alternate Language **No**

Related Modifications

Summary of Modification

Modifies TAS 114 Appendix D uplift test over steel substrates.

Rationale

Modifies TAS 114 Appendix D uplift test because the testing is for fully adhered roof systems. The size of the 2' x 2' specimens over steel substrates does not allow for deck attachment or deflection considerations of the substrate which leads to higher uplift results which are not applicable in real life conditions.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Allows improvement of building performance expectations based on properly tested and evaluated roof system requirements.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Adds clarification language that eliminates testing that achieves results not consistent with real jobsite expectations.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Applies to all Roof system assembly testing over steel substrates.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TAS 114 Appendix D Section 1

Add Section 1.2

1.2 This procedure is not applicable to roofing assemblies applied onto a steel deck substrate.

R8300

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 110	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates roofing requirements for HVHZ use

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code through clarification of the roofing systems this procedure is intended for use.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require the use of any specific product

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research.

See attached file

TAS 114 Appendix D Section 1

Add

Section 1.2

This procedure is not applicable to roofing assemblies applied onto a steel deck substrate

R7183

Date Submitted	11/5/2018	**Section**	1	**Proponent**	Michael Goolsby
Chapter	TAS 124	**Affects HVHZ**	Yes	**Attachments**	No
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Clarification of uplift testing requirements and reporting.

Rationale

The purpose of this modification is to eliminate confusion and additional cost of testing by clarifying and bringing into alignment requirements contained in the base code with TAS 124. The modification also brings consistency with the industry standard regarding testing for mechanically fastened roof systems. Additionally, the report has been modified to be consistent with ASCE 7-16.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

Clarifies necessary path to compliance.

Impact to building and property owners relative to cost of compliance with code

Will economize costs by eliminating confusion related to field test compliance.

Impact to industry relative to the cost of compliance with code

No additional cost associated with this modification.

Impact to small business relative to the cost of compliance with code

Will economize costs by eliminating confusion related to field test compliance.

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Improves the effectiveness of the code by providing a less confusing path to compliance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Strengthens the code by providing a less confusing path to compliance.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

The change does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities.

Does not degrade the effectiveness of the code

Does not degrade the code, instead the modification increases the effectiveness of the code and the protection of the public by eliminating confusion regarding compliance.

TESTING APPLICATION STANDARD (TAS) 124-~~11~~20

TEST PROCEDURE FOR FIELD UPLIFT RESISTANCE OF EXISTING MEMBRANE ROOF SYSTEMS AND IN SITU TESTING FOR REROOF ANDNEW CONSTRUCTIONAPPLICATIONS

1.1 This protocol covers the determination of the resistance to uplift pressure of newly installed, adhered, single-ply, built-up, bituminous roofing systems over mechanically attached or adhered rigid board insulation over various deck types.

1.2 The test procedures outlined herein are intended as quality control to ~~determine~~ confirm the performance of a new roof system assembly or when determining the wind resistance of ~~installed over~~ an existing roof system assembly where a bonded recover roof system is to be installed ~~or directly over a roofing substrate~~.

4.1 The field test procedures specified herein provide a means for determining the uplift resistance of a new, adhered, single-ply, built-up, bituminous roof systems ~~assembly~~, ~~as stated in applicable specification bid documents,~~ installed on a building within the high-velocity hurricane zone. The test procedures are intended to confirm and supplement the uplift resistance performance of roofing systems as determined under laboratory conditions and confirm that a given installation meets the design pressure requirements under ASCE 7, as required in the Florida Building Code, Building.

6.2.4 Testing under this protocol shall be conducted on mechanicallyattached roof systemassemblies, with fastener spacing of no more than two (2) feet in any direction or may be conducted on fully adhered system assemblies. When testing mechanically attached roof system assemblies, deflection measurement shall not be required.

7.1 The total number of tests to be conducted when testing over an existing roof assembly is listed in Table 1, on the following page. Of these tests, half shall be conducted at selected locations within the Zone 2 and Zone 3 ~~perimeter~~ areas of the roof and half shall be conducted at selected locations within the Zone 1 ~~field~~ area of the roof.

~~7.2 Three test samples are required for all assemblies tested on any size roof deck when the test assembly is applied directly to the substrate for confirmation of design pressure performance. (See Section 4.1.1.)~~

9. Procedure:
9.1 Bell chamber tests over an existing roof system assembly:

9.1.1 The test area's membrane surface shall be clean, smooth and dry to provide a continuous contact surface for the edges of the pressure chamber. For roof surfaces which contain surfacing such as gravel, slag or granules, the test areas shall be prepared as follows:

- Remove the loose gravel surfacing; sweeping a 12 inch (300 mm) wide square in which the chamber perimeter will be placed.
- Apply a heavy pouring of hot asphalt over the swept area and allow to completely cool. The use of other approved compatible sealants or adhesives shall not be prohibited.
- This test area preparation is intended to provide a continuous, smooth surface to which the edges of the test chamber make contact such that accurate pressure measurements are taken.
- Deflection measurement shall not be required when testing mechanically attached roof system assemblies.

9.1.8 At the end of the first one minute interval, increase the pressure within the chamber in increments of 15 + 0.5 lbf/ft2 (720 + 20 Pa), holding each pressure level for a period of one minute, until:

- the roof system assembly fails, as noted in Section 10.1; or,
- the pressure within the chamber is held at the design pressure for the particular roof area (i.e., Zone 1, Zone 2 or Zone 3 ~~field, perimeter or corner~~ areas) for a period of one minute. These design pressures are determined in compliance with ASCE 7, as specified in the *Florida Building Code, Building* and are listed on Section II of the Uniform Building Permit.

9.3.4 Apply a flood coat of hot steep asphaltcoal tar pitch over the marked test area at an application rate of 4 lb/ft2 and float the test panel into place. Allow a curing time of 24 hours for hot asphalt and 48 hours for coal tar pitch applications. Curing time may vary due to atmospheric conditions. The use of other approved compatible sealants shall not be prohibited.

11.2.8 Field uplift resistance testing shall be performed in the preceding three (3) months, unless otherwise authorized by the *building official.*

TESTING APPLICATION STANDARD (TAS) 124-~~11~~20
BELL CHAMBER TEST RESULTS

Design Pressures: **Level #1:**

~~Field Area~~ Zone 1: P_{f1} =___________ psf

~~Perimeter Area~~ Zone 2: P_{p1} =___________ psf

~~Corner Areas~~ Zone 3: P_{c1} =___________ psf

~~Extended Corner:~~ ~~P_{ec1} =___________ psf~~

Design Pressures: **Level #2:**

~~Field Area~~ Zone 1: P_{f2}=__________ psf

~~Perimeter Area~~ Zone 2: P_{p2}=____________ psf

~~Corner Areas~~ Zone 3: P_{c12} =____________ psf

~~Extended Corner: P_{ec2} =____________ psf~~

Design Pressures: **Level #3:**

~~Field Area~~ Zone 1: P_{ff3}=____________ psf

~~Perimeter Area~~ Zone 2: P_{p3} =____________ psf

~~Corner Areas~~ Zone 3: P_{c3} =____________ psf

~~Extended Corner: P_{ec2} =____________ psf~~

TESTING APPLICATION STANDARD (TAS) 124-~~11~~20
BONDED PULL TEST REPORT

Design Pressures: **Level #1:**

~~Field Area~~ Zone 1: P_{f1} =____________ psf

~~Perimeter Area~~ Zone 2: P_{p1} =____________ psf

~~Corner Areas~~ Zone 3: P_{c1} =____________ psf

~~Extended Corner: P_{ec1} =____________ psf~~

Design Pressures: **Level #2:**

~~Field Area~~ Zone 1: P_{f2}=____________ psf

~~Perimeter Area~~ Zone 2: P_{p2}=____________ psf

~~Corner Areas~~ Zone 3: P_{c12} =____________ psf

~~Extended Corner:~~ ~~P_{ec2} =____________ psf~~

Design Pressures: **Level #3:**

~~Field Area~~ Zone 1: P_{ff3}=____________ psf

~~Perimeter Area~~ Zone 2: P_{p3} =____________ psf

~~Corner Areas~~ Zone 3: P_{c3} =____________ psf

~~Extended Corner:~~ ~~P_{ec2} =____________ psf~~

R7307

Date Submitted	11/16/2018	**Section**	1	**Proponent**	Jorge Acebo
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	No

TAC Recommendation Pending Review
Commission Action Pending Review

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

Summary of Modification

Modifies the standard because the TPO TAS 131 testing requirements are being incorporated into TAS 110 as a submitted code mod.

Rationale

Modifies the existing testing protocol to be for unreinforced TPO membranes only. The Reinforced TPO membrane requirements are included in a proposed code mod for TAS 110 Section 4.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

$0

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Correlates updates for HVHZ requirements to improve building performance.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated requirements.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Incorporates latest versions of referenced standards and removes obstacles to product approval.

Does not degrade the effectiveness of the code

Improves code effectiveness by specifying testing requirement specified and used by other certification bodies.

TESTING APPLICATION STANDARD (TAS)131-95
STANDARD REQUIREMENTS FOR UNREINFORCED THERMOPLASTIC OLEFIN
ELASTOMER BASED SHEET USED IN SINGLE-PLY ROOF ~~MEMBRANE~~SYSTEMS

1. Scope:

1.1 This Protocol covers unreinforced ~~and reinforced~~ thermoplastic olefin elastomer sheet made from blends of polypropylene and ethylene-propylene rubber (TPO), intended for use as a roof membrane exposed to the weather.

1.2 The test and property limits are used to characterize the membrane and are minimum values. In-place roof system design criteria, such as fire resistance, field seaming strength, material compatibility, and up-lift resistance, in situ shrinkage, among others, are factors which must be considered but are beyond the scope of this specification.

1.3 The following precautionary caveat pertains to the test methods portion only, Section 8, of this specification: This Standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

1.4 All testing shall be conducted by an approved testing agency, and all test reports shall be signed by an authorized signer of the testing/listing agency. Manufacturing location of tested products shall be verified by the testing laboratory and be included in the report.

2. Referenced Documents:

2.1 ASTM Standards

D412 Test Method for Rubber Properties in Tension

D471 Test Method for Rubber Property - Effect of Liquids

D573 Test method for Rubber-Deterioration in an Air Oven

D624 Test Method for Rubber Property - Tear Resistance

D751 Method of Testing Coated Fabrics

D816 Methods of Testing Rubber Cements

D1149 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

D1204 Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature

~~D1822 Tensile Impact Testing~~

D2137 Test Method for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics

E 96 Water Vapor Permeability, Method BW

E380 Excerpts from Use of the International System of Units (SI) (The Modernized Metric System)

~~G 154 Standard Practice for Operating Fluorescent Light Apparatus for UV-Condensation (QUV) Exposure of Nonmetallic Material~~

G 155 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

2.2 The Florida Building Code, Building
2.3 Application Standards
TAS 114 Test Procedures for Roof System Assemblies in the High Velocity Hurricane Zone Jurisdiction

3. Terminology & Units:
3.1 Definitions - For definitions of terms used in this Protocol, refer to Chapter 2 and Section 1513 of the Florida Building Code, Building and/or the RCI Glossary of Terms. Definitions from the Florida Building Code, Building shall take precedence.
3.2 Units - For conversion of U.S. customary units to SI units, refer to ASTM E380.

4. Limitations and Precautions:
4.1 This Protocol may involve hazardous materials, operations and equipment. This Protocol does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

5. Classification:
5.1 Types are used to identify the principal polymer component of the sheet.
5.1.1 Ethylene-Propylene based elastomer (TPO)
~~5.2 Grades indicate the mass percentage of the polymer (TPO) in relation to the total sheet:~~
~~5.2.1 Grade 1 - Greater than 95%.~~
~~5.2.2 Grade 2 - 50 to 95%.~~
~~5.3 Class describes sheet construction.~~
~~5.3.1 Class U - Unreinforced.~~
~~5.3.2 Class SR - Reinforced, internally or externally.~~

6. Materials and Manufacture:
6.1 The sheet shall be formulated from the appropriate polymers and other compounding ingredients. The principal polymer used in the sheet shall be one of those listed in Section 5.1.1 ~~in accordance with the percentages listed in Sections 5.2.1 and 5.2.2.~~
6.2 The sheet shall be capable of being bonded to itself for making watertight field splices and repairs, and the supplier or fabricator shall recommend suitable bonding methods and materials.

7. Physical Properties:
7.1 The test shall conform to the physical requirements prescribed in Table 1 of this Protocol.

8. Dimensions and Permissible Variations:
8.1 The width and length of the sheet shall be as published and tested for physical property values. The sheet width shall be as tested for system performance in compliance with TAS 114.
8.1.1 The width and length tolerance shall be + 3%, - 0%.
8.2 The published sheet thickness tolerance shall be +15%, -10% of the specified thickness, but in no case shall the thickness be less than the minimum listed Table 1 of this Protocol.

Remove this table and footnotes

~~TABLE 1~~

~~PHYSICAL REQUIREMENTS FOR TPO ELASTOMER SHEETS~~

~~Physical Property~~	~~Grade 1 or 2 Class SR~~	~~Grade 1 or 2 Class U Unreinforced~~
~~Thickness (over scrim) in. (mm)~~	~~min. 0.015 (0.385)~~	~~NA~~
~~Thickness (overall) in. (mm)~~	~~min. 0.039 (1.0)~~	~~min. 0.039 (1.0)~~
~~Tensile Strength psi (MPa)~~	~~NA~~	~~min. 1740 (12.0)~~
~~Breaking Strength lbf (kN)~~	~~min. 225 (1.0)~~	~~NA~~
~~Elongation (ultimate) %~~	~~NA~~	~~min. 500~~
~~Elongation (at break) %~~	~~min. 151~~	~~NA~~
~~Tensile set %~~	~~NA~~	~~max. 10~~
~~Tear Resistance lbf/in (kN/m)~~		~~min. 340 (60)~~
~~Tearing Strength lbf (N)~~	~~min. 55 (245)~~	~~NA~~
~~Brittleness Point °F(°C)~~	~~max. -49 (-45)~~	~~max. -30 (-34)~~
~~Ozone Resistance no cracks~~	~~pass~~	~~pass~~
	~~After Heat Aging (A.H.A.)~~	
~~Tensile Strength-A.H.A. psi (MPa)~~	~~NA~~	~~min. 1740 (120)~~
~~Breaking Strength-A.H.A. lbf (kN)~~	~~min. 225 (1.0)~~	~~NA~~
~~Elongation (ultimate)-A.H.A. %~~	~~NA~~	~~min. 500~~
~~Elongation (at break)-A.H.A. %~~	~~min. 151~~	~~NA~~
~~Tear Resistance -A.H.A. lbf/in. (kN/m)~~	~~NA~~	~~min. 340 (60)~~
~~Linear Dimensional Change -A.H.A %~~ ~~Weight Change -A.H.A %~~	~~max. ± 2~~	~~max. ± 2~~ ~~max. ± 2~~
~~Water Absorption mass %~~	~~max. ± 42~~	~~max. ± 2~~
~~Factory Seam Strength lbf/in. (kN/m)~~	~~min. 51 (9) or Sheet Failure~~	~~min. 51 (9) or Sheet Failure~~
~~Weather Resistance no cracks or crazing~~	~~pass~~	~~pass~~
	~~After Accelerated Weathering A.A.W.~~	
~~Tensile Strength-A.A.W. psi~~	~~report~~	~~min. 1450 (10.0)~~

~~(MPa)~~		
~~Elongation (ultimate) A.A.W. %~~	~~report~~	~~min. 200 %~~
~~PRFSE A.A.W. %~~	~~report~~	~~30.00~~
~~Static Puncture Resistance~~	~~report~~	~~report~~
~~Dynamic Puncture Resistance~~	~~report~~	~~report~~
~~Tensile Impact ft•lb/in2 (kJ/m2)~~	-	~~min. 21 (44)~~

~~1 For reinforcing fabric only.~~
~~2 Test performed on coating elastomer only.~~

Add this table

TABLE 1

PHYSICAL REQUIREMENTS FOR UNREINFORCED TPO ELASTOMER SHEETS

Physical Property	Requirement
Thickness (overall) in. (mm)	min. 0.039 (1.0)
Tensile Strength psi (MPa)	min. 1740 (12.0)
Elongation (ultimate) %	min. 500
Tear Resistance lbf/in (kN/m)	min. 340 (60)
Brittleness Point °F(°C)	max. -30 (-34)
Ozone Resistance no cracks	pass
After Heat Aging-(A.H.A.)	
Tensile Strength-A.H.A. psi (MPa)	min. 1740 (120)
Elongation (ultimate)-A.H.A. %	min. 500
Tear Resistance -A.H.A. lbf/in. (kN/m)	min. 340 (60)
Linear Dimensional Change - A.H.A %	max. ± 2
Weight Change -A.H.A %	max. ± 2
Water Absorption mass %	max. ± 2
Factory Seam Strength lbf/in. (kN/m)	min. 51 (9) or Sheet Failure
Weather Resistance no cracks or crazing	pass
After Accelerated Weathering-A.A.W.	
Tensile Strength-A.A.W. psi (MPa)	min. 1450 (10.0)
Elongation (ultimate)-A.A.W. %	min. 200 %
PRFSE-A.A.W. %	30.00
Static Puncture Resistance	report
Dynamic Puncture Resistance	report

9. Workmanship, Finish, and Appearance:

9.1 The sheet, including factory seams, if present, shall be water tight and free of pinholes, particles of foreign matter, undisbursed raw material, or other manufacturing defects that might affect serviceability. Excessive irregularities on the sheet surface shall not be acceptable (or portion thereof), then its rejection should be negotiated between supplier and buyer.

9.2 Edges of the sheets shall be straight and flat so that they may be seamed to one another without fishmouthing.

10. Test Methods: **(Needs to be Re-numbered)**

~~10.1 Thickness (over scrim) - Appendix A of this Protocol.~~

~~10.2 Dimensions - Test Method D 751~~

~~10.2.1 Testing shall be conducted after permitting the sheet to relax at 73°F (23°C) for 1 hour.~~

10.~~3~~1 Thickness (overall) - Test Methods D 412 for Class U Sheet and D 751 for Class SR Sheet.

10.~~4~~2 Tensile Strength - Test Method D 412, Die C for Class U Sheet.

~~10.5 Breaking Strength - Test Method D 751, Grab Method for Class SR Sheet.~~

10.~~6~~3 Elongation (ultimate) - Test Method D 412, Die C for Class U Sheet.

~~10.7 Elongation (at break) - Test Method D 751, Grab method for Class SR Sheet.~~

~~10.8 Tensile Set - Test Method D 412, Method A, Die C, 50% elongation for Class U Sheet.~~

10.~~9~~4 Tear Resistance - Test Method D 624, Die C for Class U Sheet.

~~10.10 Tearing Strength - Test Method D 751, Procedure B for Class SR Sheet.~~

10.~~11~~5 Brittleness Point - Test Method D 746 or D 2137.

10.~~12~~6 Ozone Resistance - Test Method D 1149.

10.~~12~~6.1 Inspect at 7x magnification on specimens exposed to 1 x 10-5 psi (100 MPa) ozone in air at 100°F (38°C). For Class U Sheet, wrap around 3" (76.2 mm) mandrel for 166 hour exposure. For Class SR Sheets, use Procedure B.

10.~~13~~7 Heat Aging - Test Method D 573.

10.~~13~~7.1 Age sheet specimens at 240°F (115°C) for 670 hours.

10.~~14~~8 Linear Dimensional Change - Test Method D 471.

10.~~14~~8.1 Conduct test at 158°F (70°C) for 166 hours.

10.~~15~~9 Water Absorption - Test Method D 471.

10.~~15~~9.1 Conduct test at 158°F (70°C) for 166 hours.

10.1~~6~~0 Factory Seam Strength - Test Method D 816, Method B.

10.1~~6~~0.1 Modify procedure by cutting a 1 in. (25.4 mm) wide by 12 in. (304.8 mm) long sample across the lap seam. Place in jaws approximately 2 in. (50.8 mm) from edges of the overlap area and test at 2 in. per minute (50.8 mm/min.) claim for rehearing.

10.1~~7~~1 Weather Resistance - Practice G 155

10.1~~7~~1.1 Xenon-Arc shall be operated to the following conditions:

Filter Type: borosilicate inner and outer
Exposure: 0.35 W/m2 at 340 nm
Cycle: 690 min light, 30 min. light and water spray Black Panel
Temperature: 80 ± 3°C
Relative Humidity: 50 ± 5%
Spray Water: deionized
Specimen Rotation: every 250 hours
Exposure Time: 4000 hours

10.1~~7~~1.2 Specimens for exposure shall be mounted under no strain. The recommended specimen size is 2.75 in. x 8.0 in. (70 mm x 203 mm). After exposure, remove the specimens and inspect immediately. Strain Class U specimens 10% and visually inspect for cracks and crazing under 7x magnification.

~~10.18 Weather Resistance - Practice G 154~~

~~10.18.1 Operate to the following conditions:~~

~~Lamp Type: Fluorescent UVB - 313 (UVB-B)~~

~~Test Cycle: 20 hours UV @ 80°C 4 hours condensate @50°C~~

~~Exposure: 2000 hours~~

~~10.19 Tensile Impact - ASTM D1822 for Class U Sheet.~~

11. Inspection and Special Testing:

11.1 The manufacturer shall inspect and test his production to assure compliance of the product with this Protocol.

11.2 If the results of any tests do not conform to the requirements of this specification, retesting to determine conformity shall be performed as required by the Authority Having Jurisdiction.

12. Rejection and Resubmittal:

12.1 Failure to conform to any one of the requirements prescribed in this specification shall constitute grounds for suspension of a current Product Approval.

13. Product Marking:

13.1 The sheet shall be identified on the labeling in compliance with Section 1517 of the Florida Building Code, Building.

14. Certification:

14.1 Upon request of the Authority Having Jurisdiction, a manufacturer may be required to certify that the material was manufactured and tested in accordance with this Protocol. Additional testing for confirmation may be required by an approved testing agency.

15. Packaging and Package Marking:

15.1 The material shall be rolled on a substantial core and packaged in a standard commercial manner.

15.2 Shipping containers shall be marked with the name of the material, the stock and lot number.

~~TESTING APPLICATION STANDARD (TAS) 131-95~~

~~Appendix A~~

~~TEST PROCEDURE FOR THICKNESS MEASUREMENT OF~~

~~COATING OVER CLASS SR OLEFIN ELASTOMER BASED SHEET ROOFING~~

~~1. Scope:~~

~~1.1 The procedure outlined in this Protocol Appendix provides a method for measuring the thickness of the coating over fiber backing or reinforcing fabric.~~

~~2. Measurement Method:~~

~~2.1 Principal~~

~~2.1.1 The thickness of coating material over fiber, fabric, or scrim can be observed with a standard microscope. Measurement is made with a calibrated eyepiece.~~

~~2.2 Apparatus~~

~~2.2.1 Microscope, 60x with reticule.~~

~~2.2.2 Light Source - If light source on the microscope is not adequate, a small high-intensity lamp may also be used.~~

~~2.2.3 Stage Micrometer, 0.001 in. (0.0254 mm) divisions.~~

~~2.3 Calibration Procedure~~

~~2.3.1 Place a standard reflectance stage micrometer in place of the specimen.~~

~~2.3.2 Position the reticle eyepiece and the micrometer such that the scales are superimposed. Focus the reticle by turning the eyepiece. Focus the specimen and reticle by turning the vertical adjustment knob.~~

~~2.3.3 Locate a point at which both scales line up. Count the number of micrometer divisions away. Measure to the nearest 0.0005 in. or 0.5 mil (0.0125 mm). The calibration may be optimized by increasing the number of divisions measured.~~

~~2.3.4 Repeat the calibration three times and average the results. A calibration example is given below.~~

~~2.3.5 Calibration Example~~

~~2.3.5.1 If four reticle divisions (RD) are found equal to 4.5 micrometer divisions (MD), then 1 RD = 0.001125 in. or 1.125 mils (28.6 mm) or the calibration factor.~~

~~2.4 Specimen Analysis:~~

~~2.4.1 Carefully center a sharp single edge razor or equivalent over the fiber intersections along the x-x axis.~~

~~2.4.2 Make a clean bias cut completely through the sheet.~~

~~2.4.3 Remove the razor-cut section and mount in common putty with the cut surface facing upward.~~

~~2.4.4 Observe the cut surface with the eyepiece reticle. Measure the thickness of the coating on either side of the thread intersection by counting the number of reticle divisions (to the nearest one-half division).~~

~~2.4.5 Sample three areas of the coatings and average the results.~~

~~3. Calculation and Report:~~

~~3.1 Multiply the number or reticle divisions representing the thickness of the coating by calibration factor. Report the average results from the areas of the coating to the nearest 0.005” or 0.5 mils (12.7 mm).~~

~~4. Precision:~~

~~4.1 Precision - Measurements are accurate to ± -0.005 in. or 5.0 mils (12.7 mm) when the thickness is about 0.020 in. or 20 mils (0.5 mm).~~

R8286

Date Submitted	12/15/2018	**Section**	1	**Proponent**	Chadwick Collins
Chapter	TAS 131	**Affects HVHZ**	Yes	**Attachments**	Yes
TAC Recommendation	Pending Review				
Commission Action	Pending Review				

Comments

General Comments **No** **Alternate Language** **No**

Related Modifications

RAS TAS

Summary of Modification

HVHZ roofing updates

Rationale

The Asphalt Roofing Manufacturers Association staff and volunteers and the Miami-Dade roofing product staff team worked together over the past year to perform a thorough review of the HVHZ requirements for asphalt roofing, and underlayment materials, as well as related RAS and TAS protocols. Many of these requirements have not been updated in decades; this review is an attempt to correlate the FBC with other changes that have occurred within the FBC, at ASCE, and with other standards developers including ASTM International. ARMA has submitted a series of code modifications that reflect that effort.

These proposed modifications include:

- Removal of references to withdrawn standards.
- Removal of references to legacy documents, including ICBO acceptance criteria.
- Updates to referenced standards, including name changes.
- Updates to performance criteria to reflect changes in referenced standards.
- Modifications to certain initial and aged performance values for test requirements to more accurately reflect the intent of the code.
- Removal of redundant or unnecessary requirements.
- Editorial changes and grammatical corrections.

ARMA would like to thank the staff at Miami-Dade for their efforts in working through this very tedious process.

Fiscal Impact Statement

Impact to local entity relative to enforcement of code

$0

Impact to building and property owners relative to cost of compliance with code

$0

Impact to industry relative to the cost of compliance with code

Reduced product approval expense.

Impact to small business relative to the cost of compliance with code

$0

Requirements

Has a reasonable and substantial connection with the health, safety, and welfare of the general public

Updates important roofing requirements for HVHZ use.

Strengthens or improves the code, and provides equivalent or better products, methods, or systems of construction

Removes outdated references.

Does not discriminate against materials, products, methods, or systems of construction of demonstrated capabilities

Does not require use of any specific type of product.

Does not degrade the effectiveness of the code

Ensures that the code is up to date with available research and referenced standards.

See attached file.

~~TESTING APPLICATION STANDARD (TAS) 131-95~~

~~Appendix A~~

~~TEST PROCEDURE FOR THICKNESS MEASUREMENT OF~~

~~COATING OVER CLASS SR OLEFIN ELASTOMER BASED SHEET ROOFING~~

~~1. Scope:~~

~~1.1 The procedure outlined in this Protocol Appendix provides a method for measuring the thickness of the coating over fiber backing or reinforcing fabric.~~

~~2. Measurement Method:~~

~~2.1 Principal~~

~~2.1.1 The thickness of coating material over fiber, fabric, or scrim can be observed with a standard microscope. Measurement is made with a calibrated eyepiece.~~

~~2.2 Apparatus~~

~~2.2.1 Microscope, 60x with reticule.~~

~~2.2.2 Light Source - If light source on the microscope is not adequate, a small high-intensity lamp may also be used.~~

~~2.2.3 Stage Micrometer, 0.001 in. (0.0254 mm) divisions.~~

~~2.3 Calibration Procedure~~

~~2.3.1 Place a standard reflectance stage micrometer in place of the specimen.~~

~~2.3.2 Position the reticle eyepiece and the micrometer such that the scales are superimposed. Focus the reticle by turning the eyepiece. Focus the specimen and reticle by turning the vertical adjustment knob.~~

~~2.3.3 Locate a point at which both scales line up. Count the number of micrometer divisions away. Measure to the nearest 0.0005 in. or 0.5 mil (0.0125 mm). The calibration may be optimized by increasing the number of divisions measured.~~

~~2.3.4 Repeat the calibration three times and average the results. A calibration example is given below.~~

~~2.3.5 Calibration Example~~

~~2.3.5.1 If four reticle divisions (RD) are found equal to 4.5 micrometer divisions (MD), then 1 RD = 0.001125 in. or 1.125 mils (28.6 mm) or the calibration factor.~~

~~2.4 Specimen Analysis:~~

~~2.4.1 Carefully center a sharp single edge razor or equivalent over the fiber intersections along the x-x axis.~~

~~2.4.2 Make a clean bias cut completely through the sheet.~~

~~2.4.3 Remove the razor-cut section and mount in common putty with the cut surface facing upward.~~

~~2.4.4 Observe the cut surface with the eyepiece reticle. Measure the thickness of the coating on either side of the thread intersection by counting the number of reticle divisions (to the nearest one-half division).~~

~~2.4.5 Sample three areas of the coatings and average the results.~~

~~3. Calculation and Report:~~

~~3.1 Multiply the number or reticle divisions representing the thickness of the coating by calibration factor. Report the average results from the areas of the coating to the nearest 0.005" or 0.5 mils (12.7 mm).~~

~~4. Precision:~~

~~4.1 Precision - Measurements are accurate to ± 0.005 in. or 5.0 mils (12.7 mm) when the thickness is about 0.020 in. or 20 mils (0.5 mm).~~