

RICOWI, Inc.

Roofing Industry Committee on Weather Issues, Inc.

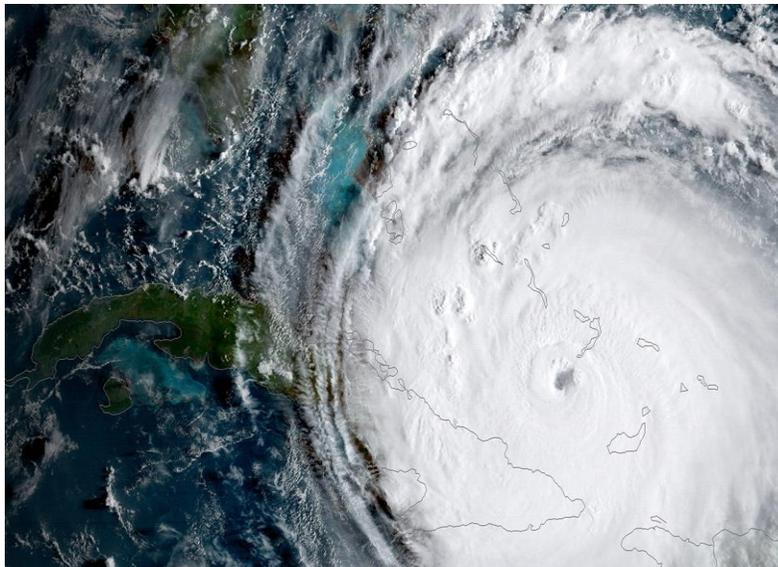


October 30-31, 2017
Key West and Naples, FL

www.ricowi.com

Hurricane Irma

Hurricane Irma Photo compliments of NOAA Satellite Imagery



RICOWI Wind Investigation Hurricane Irma, Florida

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**RICOWI Wind Investigation
Hurricane Irma, Florida**

PREFACE

This document was prepared and published by the Roofing Industry Committee on Weather Issues, Inc. (RICOWI). The following organizations are Sponsor Members of RICOWI:



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RICOWI Wind Investigation Hurricane Irma, Florida

ABSTRACT

The Roofing Industry Committee on Weather Issues, Inc. (RICOWI, Inc.) investigates and reports the field performance on low slope and steep slope roofing systems after major hurricanes (that have sustained winds of 95 mph or greater) make landfall in a populated area of the continental United States.

RICOWI, Inc. deployed teams to investigate conditions of roofs in the areas impacted by Hurricane Irma in the Gulf Coast landfall regions of Florida and surrounding areas. This report covers investigations conducted between October 31, 2017 and November 1, 2017.

Information on the damage encountered, including photos and specific information is included in this unbiased report.

INTRODUCTION

INVESTIGATION PROTOCOL

RICOWI, Inc. sent teams to investigate the condition of roofs in the areas impacted by Hurricanes Charley, Ivan, Katrina and Ike. Reports on these extreme weather events have been published and are available at www.ricowi.com. The valuable experience gained from prior investigations was applied to the investigation of roof condition damage from Hurricane Irma.

RICOWI deploys to hurricane damaged areas if they meet the following criteria: To investigate and report the field performance of low slope and steep slope roofing systems after major hurricanes i.e., those with sustained wind speeds of 95 mph or greater at landfall in the continental United States.

Generally, team members are wind engineers, roofing material specialists, insurance analysts, structural engineers, and/or roofing consultants. Some teams included roofing contractors or other interest parties who aided in arranging inspections or in providing access and equipment.

A refresher wind investigation training workshop was held on October 30, 2017. Investigators were provided information on damage modes, gathering and recording information, and safety training. Members were assigned to the teams based on their expertise.

Each team had four positions: (1) report writer, (2) photographer, (3) data recorder, and (4) sample collector. In some instances positions were combined. All team members acted as observers, combining their expertise and observations to maximize the data obtained. In addition to manufacturing members, each team was balanced by including members of the insurance industry, consulting firms, or other non-manufacturer associations.

Clearance letters were requested from the investigation site cities. Local law enforcement officials were also notified.

Briefings were held each day, with collected information reviewed each evening

RICOWI Wind Investigation Hurricane Irma, Florida

EXECUTIVE SUMMARY

Hurricane IRMA traveled over the Caribbean as a Category 5 Storm (Sustained winds greater than 155 mph) and continued at that level until it hit Cuba, where it weakened to a Category 3 Storm (Winds 111-130 mph) it regained strength to a Category 4 Storm (Winds 131 to 155 mph), and then weakened again to a Category 3 Storm when it arrived at the Florida Keys. It made landfall near Marco Island as a Category 2 Storm (Sustained winds 96-110 mph).

As the wind speeds in IRMA did not meet the RICOWI Deployment Criteria, it was the decision of the Wind Investigation Steering Group not to deploy. Many on the ground in Naples and Key West Florida stated there was limited roof damage. This reinforced the decision not to deploy.

There was however much scattered damage and significant misinformation about the wind speeds and the damage caused. There was a report of 142 mph winds near Naples. This is likely, as with all land falling hurricanes there are wind streaks and imbedded tornados as discussed below.

Because there were many damaged roofs in Florida and significant misinformation, RICOWI decided that a limited review of the storm damage was appropriate. Three volunteer teams of 4 professionals each conducted the investigations. Areas were selected for investigation based on reports from local professionals, NOAA flight overview photos, and team drone observations.

The teams spent a day in the Naples area and a day in the Florida Keys. The teams inspected 33 roofs and observed by street survey or drone overflight, an additional 50 roofs that fit the general pattern of the inspected roofs. While it was observed that there were typical damage patterns for many types of roofs, there was not enough data to make statistical conclusions. The information gathered will be helpful to determine the weakest link in the systems observed.

Wind streaks or small tornados can cause significant damage in local areas, but the data from inspections of damage from localized winds have limited value. Because the lack of verified wind speeds means lack of verified uplift forces that caused the damage. For example the uplift force on a roof in a wind streak of 140 mph is about double the uplift force on the same roof at a wind of 100 mph. As a result, when inspecting roofs in an area damaged by a wind streak, a conclusion is often drawn that the damage is due to problems with product, workmanship or design, whereas the roofs were actually damaged by the unusually high winds of the streak or tornado.

There were wind streaks that were well defined in the Naples area, and the information that the teams gathered from this pointed to the vulnerable issues on the roof or weakest links in the system. The data should not be used to give any relative classification of systems.

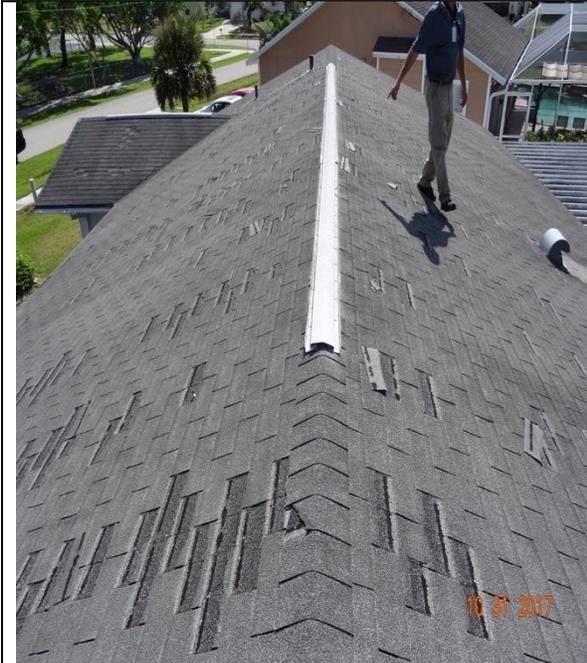
ASPHALT SHINGLE INVESTIGATION SITES

**RICOWI Wind Investigation
Hurricane Irma, Florida**

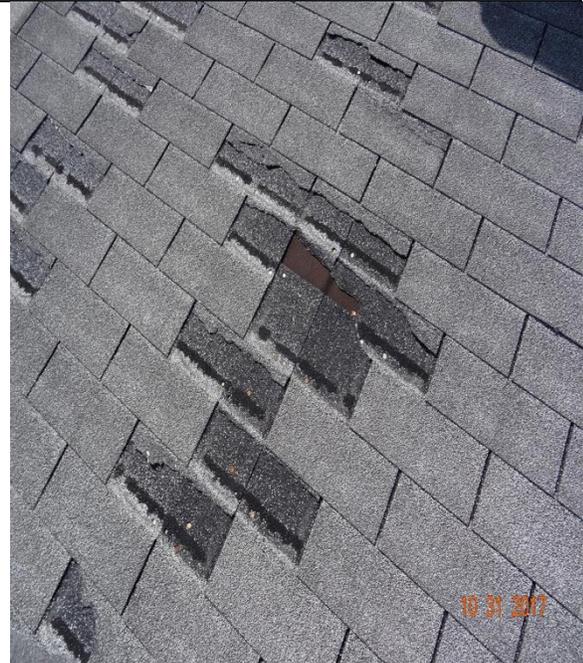
Team 1 Asphalt Shingle Investigation Site	
Inspection Number	1.1.4
Zip	34145
Building Type	Home
Building Latitude	25° 54'57" N
Building Longitude	81 42'45"W
Altitude at Ground	6
Front of the Building	East
Exposure Category	B
Primary Upwind Terrain	Trees
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long
Building Age	27
Building Code	
Roof Age	8-12
Roof Age Source	Best Guess
Slope	Low Slope > 3 1/2 to 5/12
Shingle Type	Standard 3 tab.
Peak Height	18
Fasteners	Nails
Fasteners Per Shingle	6
Nailing Pattern	Racked
Valleys	Closed Cut (lapped}
Underlayment Exposed After Storm	Yes
Underlayment Type	#30 Felt
Deck	Other
Ventilation	Soffits, Ridge
Hip/Ridge Shingles	Standard
Solar Equipment on the Roof	No
Damage Assessment	2
Location of Roof Damage	Entire Roof
Type of Damage	Racked shingles with tabs lost at end joints, light weight shingles. Fiberglass 3-1. Failure in adhesive only. Cemented in at eaves. Plastic gutters remain attached.
Damage Initiation	
Describe Damage	Racked shingles with tabs lost at end joints, light weight shingles. Fiberglass 3-1. Failure in adhesive only. Cemented in at eaves. Plastic gutters remain attached
Roof Length	
Roof Area	

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Inspection 1.1.4 Team 1 Asphalt Shingle Investigation Site



Asphalt Shingle Rack Installation



Partially missing shingles



Rack Installation



Shingles Showing Nailing

**RICOWI Wind Investigation
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Team 1 Asphalt Shingle Investigation Site	
inspection Number	1.2.3
Zip	33050
Building Type	Residence
Building Latitude	24°43'59"N
Building Longitude	81°1' 23"W
Altitude at Ground	15
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	
Wind Speed ARA	120
Wind Primarily Hit Building On:	Corner
Building Age	
Building Code	
Roof Age	4-7
Roof Age Source	Best Guess
Slope	Low Slope > 3 1/2 to 5/12
Shingle Type	2 ply laminated
Peak Height	40
Fasteners	Nails
Fasteners Per Shingle	6
Nailing Pattern	Staggered
Valleys	
Underlayment Exposed After Storm	Yes
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	Soffit
Hip/Ridge Shingles	Standard
Solar Equipment on the Roof	No
Damage Assessment	1
Location of Roof Damage	Eave, Field, Soffit vent, One entire soffit detached
Type of Damage	Shingles Dislodged
Damage Initiation	N/A
Describe Damage	Shingles failed at nailing line. Nails stayed in place. Underlayment stayed in place.
Damaged Area	
Roof Length	
Roof Area	

RICOWI Wind Investigation Hurricane Irma, Florida

Inspection 1.2.3 Team 1 Asphalt Shingle Investigation Site



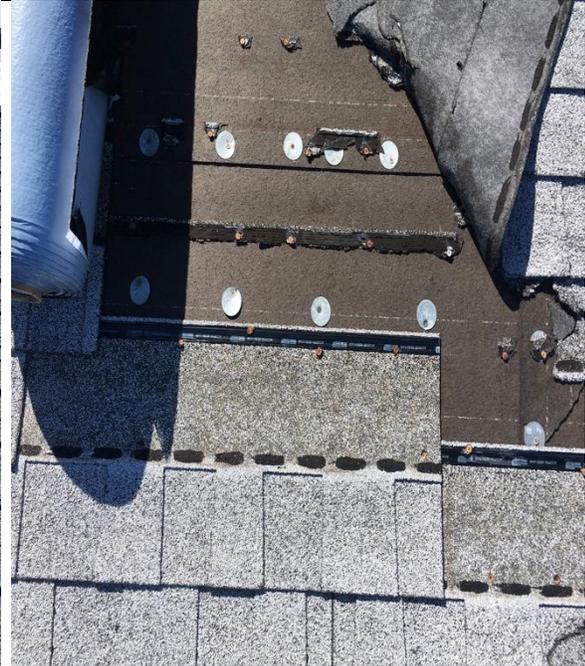
Entire Water Side Soffit Missing



Soffit Missing



Shingles Missing



Shingle Detail

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Asphalt Shingle Investigation Site	
Inspection Number	2.2.2
Zip	33001
Building Type	Residence
Building Latitude	24°49'31"N
Building Longitude	80°48'56"W
Altitude at Ground	3
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Buildings, Similar
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	120
Wind Speed ARA	120
Wind Primarily Hit Building On:	Long Side
Building Age	
Building Code	
Roof Age	
Roof Age Source	
Slope	Moderate .5/12 to 9/12
Shingle Type	2 ply laminated
Peak Height	35
Fasteners	Nails
Fasteners Per Shingle	6
Nailing Pattern	Staggered
Valleys	
Underlayment Exposed After Storm	Yes
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	Soffits, Gable ends
Hip/Ridge Shingles	Standard
Solar Equipment on the Roof	No
Damage Assessment	3
Location of Roof Damage	Corner, Eave, Rake Edge, Field, Soffit vent, Ridge
Type of Damage	Shingles Dislodged
Damage Initiation	Eave and ridge shingles were first to be dislodged
Describe Damage	Soffits were blown out. There was no mastic at eave and ridge shingles. Appears some eave shingles were reversed.
Damaged Area	More than 50%

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Inspection 2.2.2 Team 2 Asphalt Shingle Investigation Site



Asphalt Shingle Roof



Damage undetermined

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Team 3 Asphalt Shingle Investigation Site	
Inspection Number	3.1.5
Zip	34104
Building Type	Residential Apartment
Building Latitude	26°8'22N
Building Longitude	81°44'22"W
Altitude at Ground	14
Front of the Building	South
Exposure Category	B
Primary Upwind Terrain	Similar Buildings
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	Unknown
Building Age	22
Building Code	
Roof Age	4-7 years
Roof Age Source	Best Guess
Slope	Moderate .5/12 to 9/12
Shingle Type	Standard 3 Tab
Peak Height	30'
Fasteners	Nails
Fasteners Per Shingle	4
Nailing Pattern	Racked
Valleys	Closed Cut (Lapped)
Underlayment Exposed After Storm	No
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	Soffits, Ridge
Hip/Ridge Shingles	Standard
Solar Equipment on the Roof	No
Damage Assessment	2
Location of Roof Damage	Corner, Field Ridge
Type of Damage	Shingles Dislodged
Damage Initiation	Sealant strip appears to have come loose, some progressive damage from racking
Describe Damage	Damage in the field of the roofs was spotty with individual shingles dislodged and in some cases racking installation progressed up the slope. Several roofs were tarped at the ridge. We were not permitted to do an extensive evaluation.

RICOWI Wind Investigation Hurricane Irma, Florida

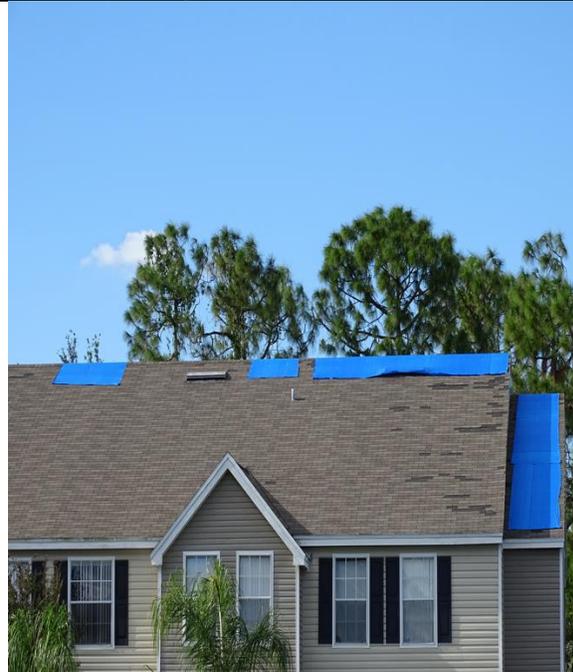
3.1.5 Team 3 Asphalt Shingle Investigation Site



Overview of Apartments



Missing Shingles



Typical South East Facing Roof



Missing siding and a few shingles

**BUILT UP ROOF MODIFIED
BITUMEN INVESTIGATION SITES**

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 1 Built Up Roof Mod Bit Site	
Inspection Number	1.1.6
Zip	
Building Type	Municipal Services
Building Latitude	25°56'16"N
Building Longitude	81°42'55"W
Altitude at Ground	4
Front of the Building	North
Exposure Category	B
Primary Upwind Terrain	Buildings Similar Height
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	110
Wind Speed ARA	110
Wind Primarily Hit Building On:	Short Side
Building Age	36
Building Code	
Roof Age	12-16
Roof Age Source	Best Guess
System	BUR
Surface	Pea Gravel Surfaced
Number of Plies	N/A
Membrane Attached	N/A
Membrane Attached To	N/A
Insulation Type	N/A
Insulation Thickness	
Insulation Attachment	Not Determined
Deck Type	Concrete
Metal Edge Thickness	
Type of Metal Edge	Aluminum
Metal Edge Fasteners distance between centers (typical)	
Solar Equipment on the Roof	None
Damage Assessment	3
Location of Roof Damage	Around Penetrations 4' or larger
Type of Damage	Corner or edge peel, Metal edge, Fastener Pull out, Aggregate Scour
Extent of Damage Detail Rating	5
Damage Initiation	At edge, nailer and fasteners corroded.
Describe Damage	Elevator roof cover blown off. Failed wood nailer. Main roof-no damage. Base sheet fasteners corroded through. 1982 constructed
Damaged Area	
Roof Height	26'
Roof Width	

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Inspection 1.1.6 Team 1 Built Up Roof/Modified Bitumen Investigation Site



Overview



Aggregate in Corner



Cover of Raised Crib



Note Uneven and Rusted Fasteners

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Team 2 Built Up/Mod Bit	
Inspection Number	2.1.2
Zip	34103
Building Type	Commercial Bank
Building Latitude	26°12',07" N
Building Longitude	81°48;36"W
Altitude at Ground	12
Front of the Building	East
Exposure Category	B
Primary Upwind Terrain	Smooth (Parking Lot, etc.) Buildings similar
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	90
Wind Speed ARA	100
Wind Primarily Hit Building On:	Corner
Building Age	
Building Code	
Roof Age	4-7
Roof Age Source	Best Guess
System	Modified Bitumen
Surface	Reflective Coated
Number of Plies	2
Membrane Attached	Nailed
Membrane Attached To	Wood Deck
Insulation Type	Polyisocyanurate
Insulation Thickness	Tapered ISO and perlite
Insulation Attachment	Screws and Plates
Deck Type	Wood
Metal Edge Thickness	Not Determined
Type of Metal Edge	Aluminum
Metal Edge Fasteners distance between centers (typical)	12"
Solar Equipment on the Roof	None
Damage Assessment	4
Location of Roof Damage	Entire Roof, Corner
Type of Damage	Corner or edge peel, Fastener Pull out
Extent of Damage Detail Rating	4
Damage Initiation	Scuppers allowed air infiltration
Describe Damage	Apparently the entire roof ballooned and pulled fasteners over
Roof Height	12'

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2.1.2 Continued

Roof Width	62'
Roof Length	76'
Area Damaged	More than 50%
Parapet Height	12"
Roof Area	

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2.1.2 Team 2 Built Up Mod Bit



Subject property.



Scupper pulled loose.



The Southeast corner.



Overview.

**RICOWI Wind Investigation
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Team 2 Built Up/Mod Bit	
Inspection Number	2.1.5
Zip	34108
Building Type	Residential
Building Latitude	26°12'54"
Building Longitude	81°48'41"
Altitude at Ground	16
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Buildings
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	100
Wind Speed ARA	100
Wind Primarily Hit Building On:	Long Side
Building Age	26
Building Code	
Roof Age	
Roof Age Source	
System	Modified Bitumen
Surface	Reflective Coated
Number of Plies	2
Membrane Attached	Nailed
Membrane Attached To	Lightweight Insulating Concrete
Insulation Type	Lightweight Concrete
Insulation Thickness	Unknown
Insulation Attachment	Not Determined
Deck Type	Concrete
Metal Edge Thickness	No Metal Edge
Type of Metal Edge	
Metal Edge Fasteners distance between centers (typical)	
Solar Equipment on the Roof	None
Damage Assessment	4
Location of Roof Damage	Corner
Type of Damage	Corner or Edge Peel
Damage Initiation	Corner, may be at vent.
Extent of Damage Detail Ranking	5
Describe Damage	Membrane lifted and pulled fasteners from lightweight concrete. Membrane missing from stairwell roofs
Damaged Area	Less than 10%
Roof Height	200'

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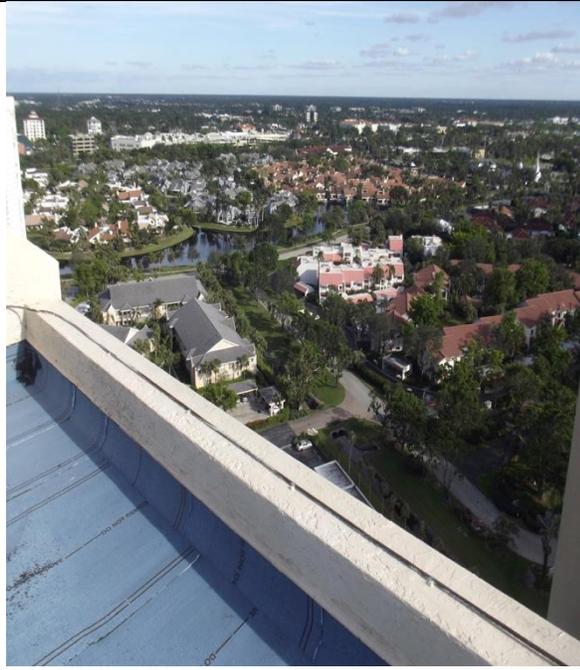
2.1.5 Continued	
Roof Height	200'
Roof Width	60'
Roof Length	215'
Roof Area	
Parapet Height	3'

RICOWI Wind Investigation Hurricane Irma, Florida

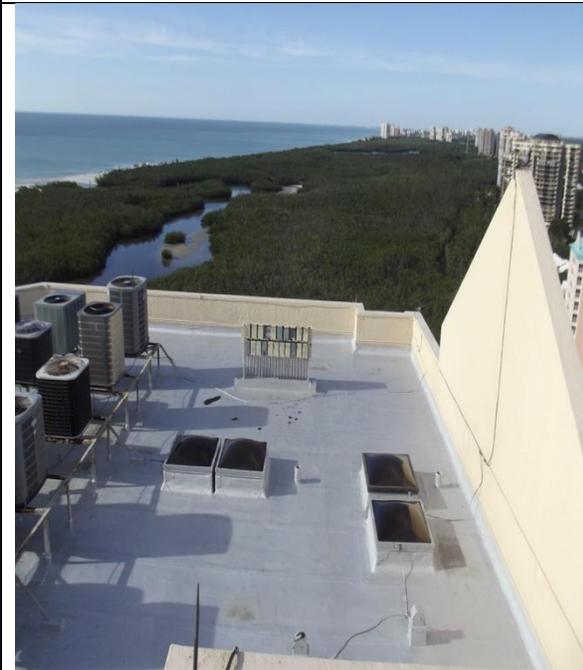
Inspection 2.1.5



Roof Overview



Replaced Section of Mod Bit



Punctures Repaired



Punctures and Clutter

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Built Up/Mod Bit	
Inspection Number	2.2.1
Zip	33036
Building Type	Church
Building Latitude	24°55'59"N
Building Longitude	80°37'06"
Altitude at Ground	6
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Trees
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	110
Wind Speed ARA	120
Wind Primarily Hit Building On:	Long Side
Building Age	42
Building Code	
Roof Age	
Roof Age Source	
System	Modified Bitumen
Surface	Reflective Coated
Number of Plies	
Membrane Attached	Fully Adhered Using Asphalt
Membrane Attached To	Wood Fiber
Insulation Type	Not Determined
Insulation Thickness	
Insulation Attachment	Not Determined
Deck Type	Concrete
Metal Edge Thickness	No Metal Edge
Type of Metal Edge	No Metal Edge
Metal Edge Fasteners distance between centers (typical)	
Solar Equipment on the Roof	None
Damage Assessment	3
Location of Roof Damage	Corner, Field
Type of Damage	Corner or edge peel, Punctures
Extent of Damage Detail Rating	5
Damage Initiation	Corner Peel Corners of membrane peeled and mechanical units punctured membrane
Describe Damage	Corners of membrane peeled and mechanical units punctured membrane.

**RICOWI Wind Investigation
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2.2.1 continued	
Damaged Area	More than 10% but less than 25
Roof Height	12'
Roof Width	60'
Roof Length	110'
Roof Area	

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Inspection 2.2.1



Overview



Overview



Membrane Deterioration in Ponding Area



Membrane Deterioration, No Wind Damage

**RICOWI Wind Investigation
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Team 3 Built Up/Mod Bit	
Inspection Number	3.1.1b
Zip	34103
Building Type	Condominium
Building Latitude	26.12.44
Building Longitude	81.48.37
Altitude at Ground	10
Front of the Building	South
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	Corner
Building Age	30
Building Code	1980
Roof Age	16
Roof Age Source	Data from Source
System	BUR
Surface	Pea Gravel surfaced
Number of Plies	3
Membrane Attachment	Nailed
Membrane Attached to:	Lightweight Insulating Concrete
Insulation Type	Not Determined
Insulation Thickness	
Insulation Attachment	Not Determined
Deck Type	Metal
Metal Edge Thickness	
Type of Metal Edge	Steel
Metal Edge Fasteners distance between centers (typical)	Not Determined
Solar Equipment on the Roof	No
Damage Assessment State Rank	5
Location of Roof Damage	Corner, Field
Type of Damage	Corner or edge peel, Aggregate Scour
Damage Initiation	Upwind Corner, severe scour and membrane missing
Extent of Damage Detail Ranking	5

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3.1.1b continued

Describe Damage	Gravel was scoured and membrane was blown off in upwind corner. Gravel and chunks of membrane and insulation were blown into adjacent impact resistant glass doors that were cracked. There was no parapet, and the wind was likely to have been formed into a vortex due to a low wall on one side and the 20 story building on the other. The adjacent metal roof lost several panels.
Damaged Area	
Roof Length	
Roof Area	

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3.1.1b Team 3 Built Up/Mod Bitumen	
 <p style="text-align: right; color: orange;">10/31/2017</p>	 <p style="text-align: right; color: orange;">10/31/2017</p>
<p>Pea Gravel Surfaced BUR, Note gravel scour from all corners. Large section of metal roof blown off.</p>	<p>Major scour in middle of roof, gravel is not imbedded in asphalt.</p>
 <p style="text-align: right; color: orange;">10/31/2017</p>	 <p style="text-align: right; color: orange;">10/31/2017</p>
<p>Edge metal is also missing on upwind side. No parapet.</p>	<p>Damage to impact resistant windows from pea gravel and debris.</p>

**RICOWI Wind Investigation
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Team 3 Built Up/Mod Bit	
Inspection Number	3.1.1c
Zip	34103
Building Type	Retail Strip Mall
Building Latitude	26,12,8
Building Longitude	81,48,12
Altitude at Ground	10
Front of the Building	North
Exposure Category	B
Primary Upwind Terrain	Buildings –Similar
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	
Building Age	40
Building Code	1970
Roof Age	16+
Roof Age Source	Best Guess
System	BUR
Surface	Granular Surfaced
Number of Plies	3
Membrane Attached	Nailed
Membrane Attached To	Lightweight Insulating Concrete
Insulation Type	Not Determined
Insulation Thickness	
Insulation Attachment	Not Determined
Deck Type	Metal
Metal Edge Thickness	Not Determined
Type of Metal Edge	Steel
Metal Edge Fasteners distance between centers (typical)	Not Determined
Solar Equipment on the Roof	None
Damage Assessment	0
Location of Roof Damage	No Damage
Type of Damage	
Extent of Damage Detail	No Damage

**RICOWI Wind Investigation
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3.1.1c continued	
Extent of Damage Detail Rating	No Damage
Damage Initiation	No Damage
Extent of Damage Detail Ranking	No Damage
Describe Damage	Minor Scour
Damaged Area	
Roof Height	45
Roof Width	80
Roof Length	180
Roof Area	14400

RICOWI Wind Investigation Hurricane Irma, Florida

3.1.1.1c Team 3 Built Up/Mod Bit



**METAL PANELS
INVESTIGATION SITES**

**RICOWI Wind Investigation
Hurricane Irma, Florida**

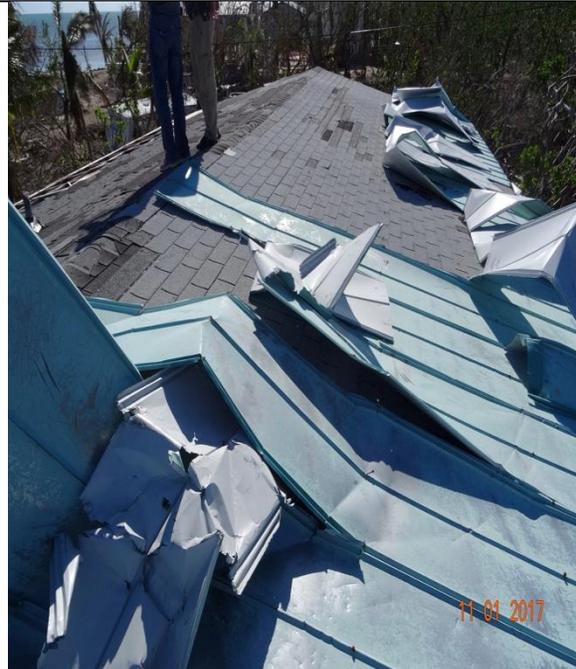
Team 1 Metal	
Inspection Number	1.2.4
Zip	33050
Building Type	Residential
Building Latitude	24°45' 51"N
Building Longitude	80°56'48"
Altitude at Ground	1
Front of the Building Faces	South
Exposure Category	D
Primary Upwind Terrain	Open Water, Trees
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	120
Wind Primarily Hit Building On:	Short Side
Building Age	29
Building Code	
Roof Age	8-12
Roof Age Source	Best Guess
Slope	Low Slope >31/2 to 5/12
System Type	Architectural – Through-Fastened
Unfinished Metal	
Painted	Galvanized
Installation	Through Fastened
Fastener Spacing	4 inch centers on ribs
Corner of Perimeter Enhancement	None
Valleys	
Underlayment Exposed	No
Underlayment Type	Other
Deck	Plywood
Ventilation	None
Damage Assessment	5.50% to 100% of panels missing
Location of Roof Damage	Entire Roof
Type of Damage	Sheets Dislodged, Metal Edge, Fastener Pull out, Structural Deck Failure
Damage Initiation	South eave facing water
Describe Damage	Metal panel and shingle loss and south edge deck loss. Metal panels installed over two layers of asphalt shingles.

RICOWI Wind Investigation Hurricane Irma, Florida

1.2.4 Through - Fastened Metal



Total Roof Damaged



Overview From top



Metal Blown Back



System installed with Roofing Nails that only Penetrated Into the Recovered Asphalt Shingle Roof

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Metal	
Inspection Number	2.1.6
Zip	34102
Building Type	Retail
Building Latitude	26°08'28"N
Building Longitude	81°47'22"W
Altitude at Ground	13
Front of the Building Faces	East
Exposure Category	C
Primary Upwind Terrain	Open
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	100
Wind Speed ARA	100
Wind Primarily Hit Building On:	Long Side
Building Age	41
Building Code	
Roof Age	
Roof Age Source	
Slope	Moderate >5 1/2 to 9/12
System Type	Architectural – Standing Seam
Unfinished Metal	Galvanized
Painted	
Installation	Clips
Fastener Spacing	6 inch center on ribs
Corner of Perimeter Enhancement	None
Valleys	None
Underlayment Exposed	Yes
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	None
Damage Assessment	5.50% to 100% of panels missing
Location of Roof Damage	Corner, Eave, Rake Edge, Field
Type of Damage	Sheets Dislodged
Damage Initiation	Not Known
Describe Damage	Metal panels, fascia, hip ridge missing on south side. Damage at corner, eave field ridge and hip.

**RICOWI Wind Investigation
Hurricane Irma, Florida**

2.1.6 Standing Seam Metal



Standing Seam Metal Dislodged



Damage to Ridge Cap



Clip Damage



Damage to Adjacent Though Fastened Metal Roof.

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Metal	
Inspection Number	2.2.3
Zip	33050
Building Type	Boat Storage
Building Latitude	24°46'29"N
Building Longitude	80°54'58"W
Altitude at Ground	10
Front of the Building Faces	East
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	
Estimated Gust Wind Speed	120
Wind Speed ARA	120
Wind Primarily Hit Building On:	Short Side
Building Age	Unknown
Building Code	
Roof Age	
Roof Age Source	
Slope	3/12
System Type	Structural – Through- Fasteners
Unfinished Metal	Galvanized
Painted	Galvanized
Installation	Through Fasteners
Fastener Spacing	4
Corner of Perimeter Enhancement	None
Valleys	None
Underlayment Exposed	No
Underlayment Type	
Deck	None
Ventilation	Off Ridge
Damage Assessment	3.10% to 25% of panels missing
Location of Roof Damage	Corner, Eave, Rake Edge, Field
Type of Damage	Sheets Dislodged, Metal Edge
Damage Initiation	Unknown
Describe Damage	Both wall and roof panels were dislodged. Some fastener corrosion was noted. It is likely that a door was damaged and the building pressurized.

RICOWI Wind Investigation Hurricane Irma, Florida

2.2.3 Through-Fastened Metal



Overview



Coated Fasteners



Small SPF Roofs with Missing Aggregate



Graveled BUR, with Some Aggregate Scour

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Metal	
Inspection Number	3.1.1a
Zip	34103
Building Type	Condominiums
Building Latitude	26.12.44
Building Longitude	81.48.37
Altitude at Ground	10
Front of the Building Faces	South
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	Corner
Building Age	30
Building Code	1980
Roof Age	16+
Roof Age Source	Data from Source
Slope	Steep >9/12
System Type	Structural – Standing Seam
Unfinished Metal	
Painted	Untreated Steel
Installation	Clips
Fastener Spacing	10
Corner of Perimeter Enhancement	None
Valleys	None
Underlayment Exposed	No
Underlayment Type	
Deck	None
Ventilation	Open
Damage Assessment	
Location of Roof Damage	
Type of Damage	Sheets Dislodged, Fastener Pull out
Damage Initiation	Fastener failure at bottom of panels. Highly corroded metal. Peel of panels was up from that point and still some attachment at the uppermost edge.
Describe Damage	There was corrosion at the bottom of panels that in some cases had previously been "repaired" with an overlay and a coating. The entire roof section had this same corrosion at almost all points. Fasteners were mostly attached to very corroded metal. Clips were corroded and widely spaced.

RICOWI Wind Investigation Hurricane Irma, Florida

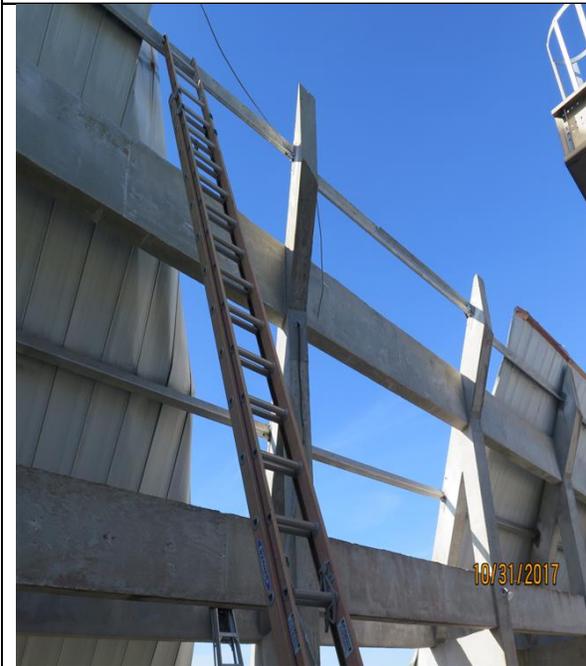
3.1.1a Standing Seam Metal



Tower Building with missing panels on decorative mansard



Metal as damaged



View from under mansard



Totally deteriorated metal

RICOWI Wind Investigation Hurricane Irma, Florida

3.1.1a Standing Seam Metal continued



Clips spaced about 6 ft. on center



Typical Clip damage



Fastener deterioration



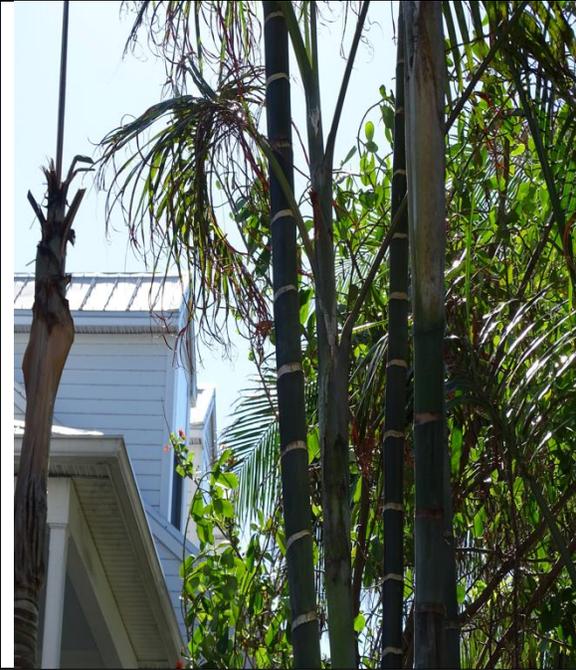
Localized very high wind

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Metal	
Inspection Number	3.2.1
Zip	33040
Building Type	Apartments
Building Latitude	24°33'58" N
Building Longitude	81°46'24" W
Altitude at Ground	10
Front of the Building Faces	South
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	100
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long Side
Building Age	10
Building Code	
Roof Age	8-12
Roof Age Source	Data from Source
Slope	Moderate >51/2 to 9/12
System Type	Architectural – Through-Fastened
Unfinished Metal	Galvanized
Painted	
Installation	Through Fastened
Fastener Spacing	2
Corner of Perimeter Enhancement	None
Valleys	Closed
Underlayment Exposed	No
Underlayment Type	Synthetic
Deck	OSB
Ventilation	Soffits, Ridge
Damage Assessment	0
Location of Roof Damage	None
Type of Damage	None
Damage Initiation	None
Describe Damage	None

RICOWI Wind Investigation Hurricane Irma, Florida

3.2.1 Parrot Key Resort Through-Fastened Metal



Overview-Ocean directly behind building



Typical Roof Profile



Excellent Workmanship and design



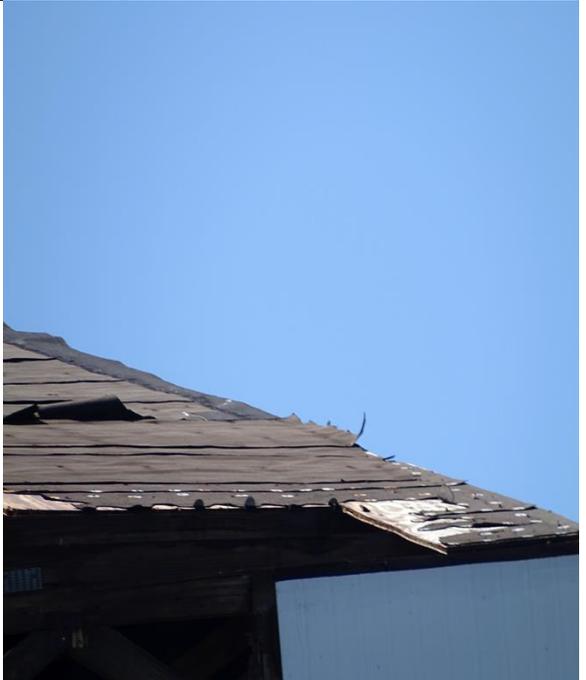
No damage to roof

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Metal	
Inspection Number	3.2.2
Zip	33040
Building Type	Residence
Building Latitude	24,33'31" N
Building Longitude	81°47'17"W
Altitude at Ground	5
Front of the Building Faces	North
Exposure Category	D
Primary Upwind Terrain	Buildings – Smaller
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	Corner
Building Age	34
Building Code	
Roof Age	16+
Roof Age Source	Best Guess
Slope	5/12 to 9/12
System Type	Architectural – Through-Fastened
Unfinished Metal	Galvanized
Painted	
Installation	Through Fastened
Fastener Spacing	4 inch center on ribs
Corner of Perimeter Enhancement	None
Valleys	None
Underlayment Exposed	Yes
Underlayment Type	#15 Felt
Deck	Plywood
Ventilation	Soffits, Ridge
Damage Assessment	(5) 50% - 100%
Location of Roof Damage	Corner, Ridge
Type of Damage	Sheets Dislodged, Fastener Pull out
Damage Initiation	Eave / Corner
Describe Damage	5V crimp metal totally removed from upwind corner, fascia dislodged, underlayment missing, some plywood missing, some fasteners were rusting. Likely 26 gauge steel metal. Roof was installed over an old shingled roof.

**RICOWI Wind Investigation
Hurricane Irma, Florida**

3.2.2 Pelican Key Resort Through Fastened Metal

	
Overview facing NE directly off the water	Fastener pattern
	
Missing Fascia	Stripped to the deck

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Metal	
Inspection Number	3.2.3
Zip	33040
Building Type	Hotel
Building Latitude	24°34'18"N
Building Longitude	81°45'35"W
Altitude at Ground	5
Front of the Building Faces	North
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	110
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long Side
Building Age	31
Building Code	
Roof Age	3
Roof Age Source	County Records
Slope	Moderate >5/12 to 9/12
System Type	Architectural – Through-Fastened
Unfinished Metal	Galvalume
Painted	Galvalume
Installation	Through Fastened
Fastener Spacing	Unknown
Corner of Perimeter Enhancement	Unknown
Valleys	
Underlayment Exposed	Yes
Underlayment Type	#15 Felt
Deck	Plywood
Ventilation	Unknown
Damage Assessment	6. Panels missing and structural damage
Location of Roof Damage	Entire Roof, Corner, Eave, Rake Edge, Field
Type of Damage	Sheets Dislodged, Fastener Pull out, Structural Deck Failure
Damage Initiation	Unknown
Describe Damage	Entire roof dislodged, including deck and supporting structure.

RICOWI Wind Investigation Hurricane Irma, Florida

3.2.3 Bayside Inn Through-Fastened Metal

	
<p>Overview, Structural Damage</p>	<p>5V crimp totally blown off, fasteners pulled from deck, Structural damage</p>
	
<p>More Structural damage</p>	<p>Building faces open water</p>

**SINGLE PLY ADHERED
INVESTIGATION SITES**

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Adhered Single Ply	
Inspection Number	2.1.1
Zip	34102
Primary Building	Hotel
Building Latitude	29°08'29"N
Building Longitude	81°47'17"W
Altitude at Ground	15
Front of the Building	West
Exposure	C
Primary Upwind Terrain	Open Water, Trees
Highest Wind Direction in the Storm	North East
Estimated Gust	90
Wind Speed ARA e	90
Wind Primarily Hit	Corner
Building Age	1
Building Code	1-3
Roof Age	1
Surface	White
Membrane Type	TPO
Membrane Adhered To	Cover Board
Insulation Type	Polystyrene Foam
Insulation Thickness	4.5
Insulation Attachment	Low Rise Foam
Deck Type	Concrete
Metal Edge	No
Metal Edge Thickness	No
Metal Edge Metal	No
Fastener Spacing	
Damage Assessment State Rank	4
Location of Roof Damage	Corner, Field
Type of Damage	
Extent of Damage	4
Damage Initiation	Air Infiltration
Describe Damage	There was air infiltration around the perimeter that pressurized the systems and the membrane peeled the facer off the insulation. It proceeded to the parapet wall and bent back the termination metal that was on the top of the wall. There was no termination bar at the angle change from the field of the roof to the wall.
Roof Height	30 feet

RICOWI Wind Investigation Hurricane Irma, Florida

Inspection 2.1.1 Adhered Single Ply



1. Subject property.



2. The Southwest corner whereas the insulation has stacked.



3. Overview facing West.



4. Facing East



5. Access doors were bent and open after the storm.



6. Surface mount counter flashings and coping at standing seam eyebrows.

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Adhered Single Ply	
Inspection Number	2.1.3
Zip	34108
Primary Building	Retail
Building Latitude	26°15'09"N
Building Longitude	81°47'51"N
Altitude at Ground	18
Front of the Building	East
Exposure	Northeast
Primary Upwind Terrain	Buildings – Smaller
Highest Wind Direction in the Storm	Northeast
Estimated Gust	100
Wind Speed ARA	100
Wind Primarily Hit	Long Side
Building Age	
Building Code	
Roof Age	
Roof Age Source	
Surface	White
Membrane Type	TPO
Membrane Adhered To	Polyisocyanurate Foam
Insulation Type	Polyisocyanurate Foam
Insulation Thickness	2.5” tapered
Insulation Attachment	Low Rise Foam
Deck Type	Concrete
Metal Edge	No
Metal Edge Thickness	No
Metal Edge Metal	No
Fastener Spacing	
Damage Assessment State Rank	4
Location of Roof Damage	Corner, Field
Type of Damage	
Extent of Damage	4
Damage Initiation	Wind Entering
Describe Damage	The roof became pressurized through soffits and mansards. The membrane lifted and insulation was moved and stacked. Apparently no leaks.
Roof Height	50’
Parapet Height	5’
Roof Width	125’
Roof Length	245’
Roof Area	

RICOWI Wind Investigation Hurricane Irma, Florida

2.1.3 Adhered Single Ply



Overview, Adhered Single Ply

Disbonded Single Ply



Loose Membrane

Unusual Vent Cover

**SINGLE PLY MECHANICALLY ATTACHED
INVESTIGATION SITE**

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 1 Mechanically Attached Single Ply	
Inspection Number	1.2.2
Zip	33050
Building Type	Retail
Building Latitude	24°43'50"N
Building Longitude	81°1'54"N
Altitude at Ground	7
Front of the Building	North
Exposure	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	
Estimated Gust	
Wind Speed ARA	120
Wind Primarily Hit	Short Side
Building Age	33
Building Code	
Roof Age	8-12
Roof Age Source	Best Guess
Surface	White
Membrane Type	TPO over pre engineered metal building
# of Perimeter Membrane Attachment rows	1
Perimeter Row Spacing ft	5
Perimeter Fasteners on Centers Spacing (inches)	.05
Field Row Spacing Ft.	10
Field fasteners on Centers Spacing (inches)	6
Fastener Type	N/A
Plate Diameter	2"
Fastener Spacing	
Directly Below Membrane	Foam Insulation
Insulation Type	Polystyrene Foam Board
Insulation Thickness	2.25"
Insulation Attachment	Screws & Plates
Deck Type	Metal
Metal Edge	No Metal Edge
Metal Edge metal thickness (inches or gauge)	N/A
Metal Edge Metal Type	N/A

RICOWI Wind Investigation Hurricane Irma, Florida

Inspection 1.2.2 Mechanically Attached Single Ply



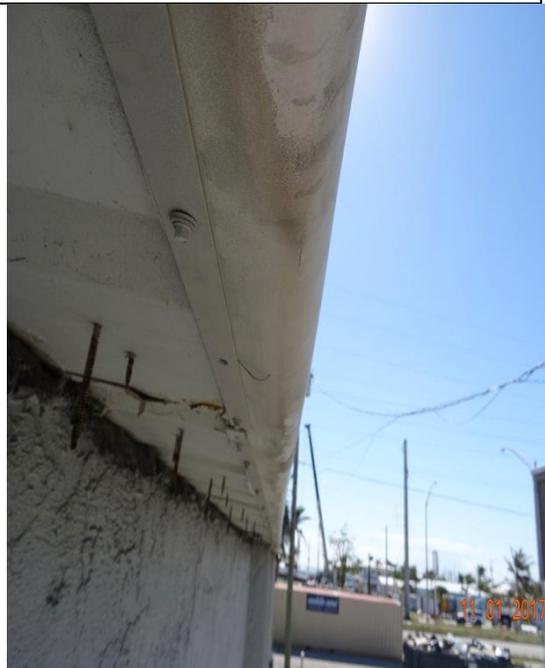
Overview



Insulation Detail, Recover Over Metal



Edge Detail



Underside Edge

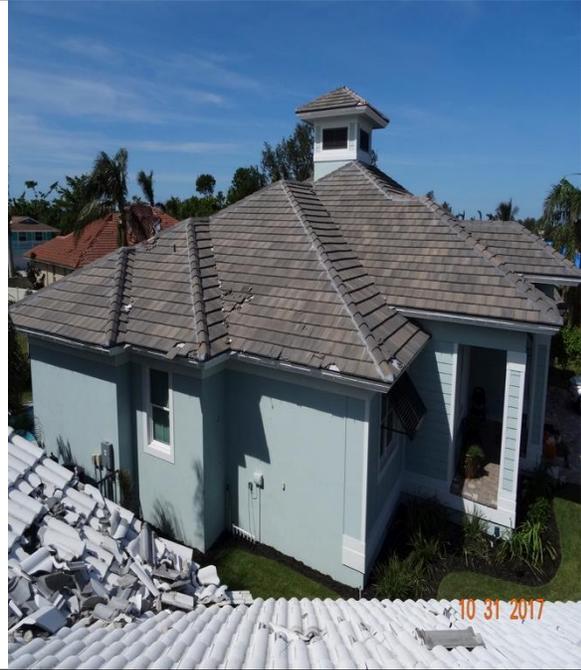
TILE ROOF INVESTIGATION SITES

**RICOWI Wind Investigation
Hurricane Irma, Florida**

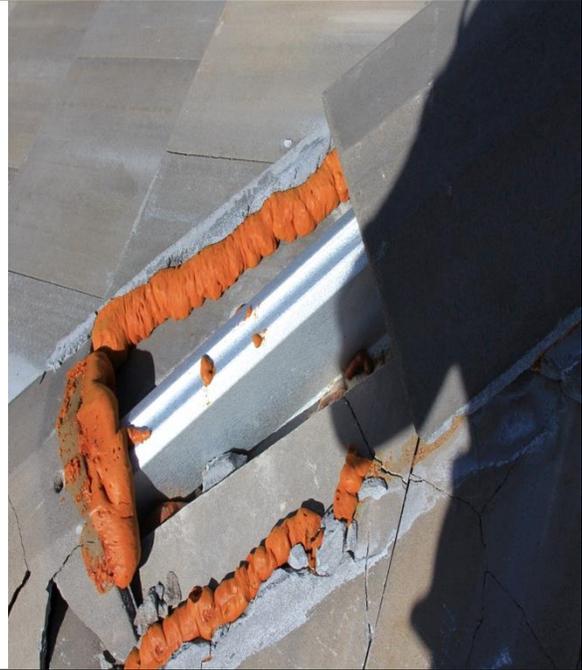
Team 1 Tile	
Inspection Number	1.1.1
Zip	34145
Building Type	Residence
Building Latitude	25 54' 19"N
Building Longitude	81 42'45"W
Altitude at Ground	6
Front of the Building	North
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long Side
Building Age	1
Building Code	
Roof Age	1
Roof Age Source	Best Guess
Eave Height (Feet)	10
Ridge Height	24
Slope	Moderate 5/12 to 9/12
Tile Type	Flat and Interlocking
Tile Material	Concrete
Attachment	Foam
Underlayment Type	Self Adhered
Deck	
Ventilation	Soffits and Cupola
Solar Equipment on the Roof	No
Damage Assessment	3 More than 25 percent tiles damaged
Location of Roof Damage	Eave, Field, Valley
What Failed First	
Describe Damage	Impact damage from tile Blown off higher roof areas and wind driven debris Insufficient foam volume No mechanical fasteners Tile rise from foam lift

RICOWI Wind Investigation Hurricane Irma, Florida

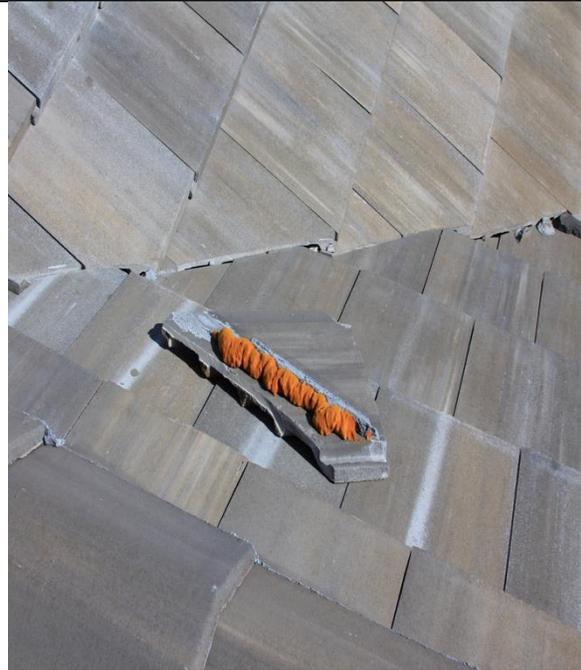
1.1.1 Tile



Cement Tile Roof



Ridge Tile Missing



Foam Adhesive on Tile



Underlayment

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 1 Tile	
Inspection Number	1.1.2
Zip	34145
Building Type	Residence
Building Latitude	25°56'18"
Building Longitude	81°42'45"
Altitude at Ground	6
Front of the Building	North
Exposure Category	B
Primary Upwind Terrain	Buildings Similar Height
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	North East
Building Age	15
Building Code	
Roof Age	15
Roof Age Source	County Records
Eave Height (Feet)	12
Ridge Height	24
Slope	Moderate 5/12 to 9/12
Tile Type	Barrel and Interlocking
Tile Material	Concrete
Attachment	Foam
Underlayment Type	
Deck	
Ventilation	Soffits and power ventilating
Solar Equipment on the Roof	No
Damage Assessment	Less than 25% of tiles damaged
Location of Roof Damage	Eave, Field, Ridge
What Failed First	Ridges
Describe Damage	Foam insufficient, no nailers, over exposed tile. 2003 construction.

**RICOWI Wind Investigation
Hurricane Irma, Florida**

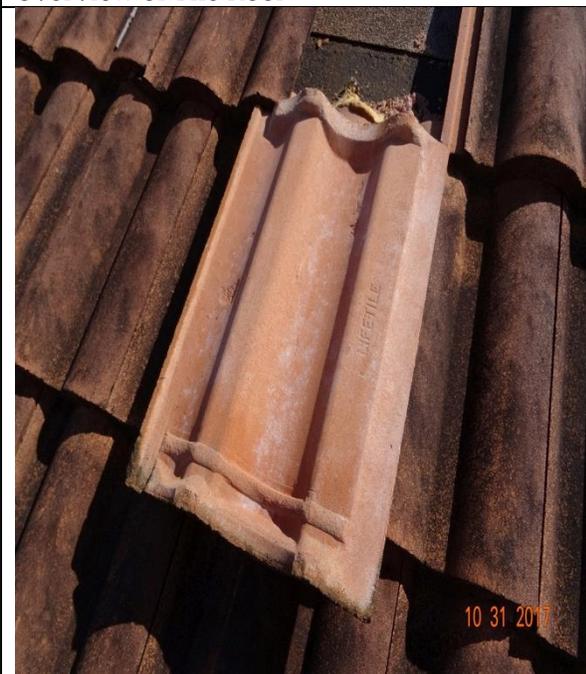
1.1.2 Team 1 Tile



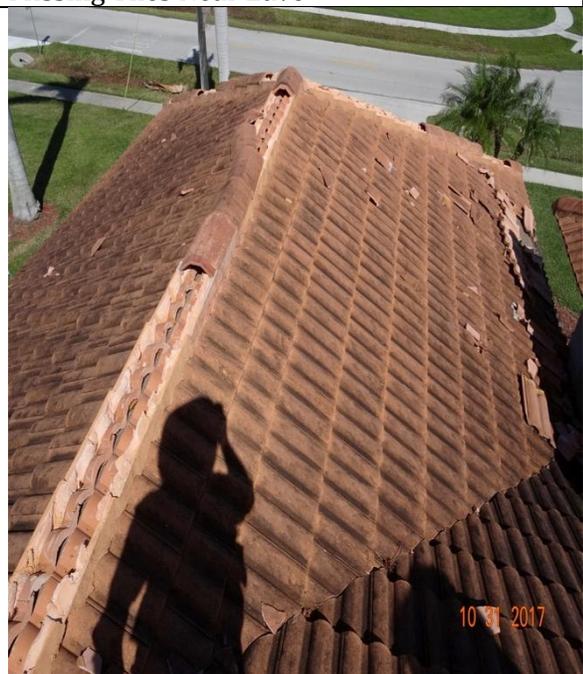
Overview of Tile Roof



Missing Tiles Near Eave



No Foam Adhesive contact



Lack of Foam Contact on Ridge

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 1 Tile	
Inspection Number	1.1.3
Zip	34145
Building Type	Residence
Building Latitude	25°56'18"
Building Longitude	81°42'47"
Altitude at Ground	2
Front of the Building	South
Exposure Category	
Primary Upwind Terrain	Buildings – Similar Height
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long Side
Building Age	29
Building Code	
Roof Age	8-12
Roof Age Source	Best Guess
Eave Height (Feet)	12
Ridge Height	24
Slope	Moderate 5/12 to 9/12
Tile Type	Barrel
Tile Material	Concrete
Attachment	Cement
Underlayment Type	Self Adhered
Deck	Wood
Ventilation	Soffits, Ridge
Solar Equipment on the Roof	No
Damage Assessment	Less than 25% of tiles damaged
Location of Roof Damage	Corner, Eave, Field, Valley
What Failed First	NA
Describe Damage	Missing, broken tiles, 1983 Construction

RICOWI Wind Investigation Hurricane Irma, Florida

1.1.3 Tile



Overview



Garage Roof



Cemented Tiles



No Adhesion of Cement to Tile

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 1 Tile	
Inspection Number	1.1.5
Zip	34145
Building Type	Residence
Building Latitude	25°56'16"N
Building Longitude	81°42'55"W
Altitude at Ground	4
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Open Water
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	
Wind Speed ARA	110
Wind Primarily Hit Building On:	Long Side
Building Age	14
Building Code	
Roof Age	14
Roof Age Source	County Records
Eave Height (Feet)	15
Ridge Height	30
Slope	Moderate 5/12 to 9/12
Tile Type	Roman
Tile Material	Clay
Attachment	Foam
Underlayment Type	Self Adhered
Deck	Wood
Ventilation	None
Solar Equipment on the Roof	No
Damage Assessment	3 More than 25 percent tiles damaged
Location of Roof Damage	All areas primarily rear slopes.
What Failed First	Eaves
Describe Damage	Broken, missing, lifted tiles. 2003 construction

RICOWI Wind Investigation Hurricane Irma, Florida

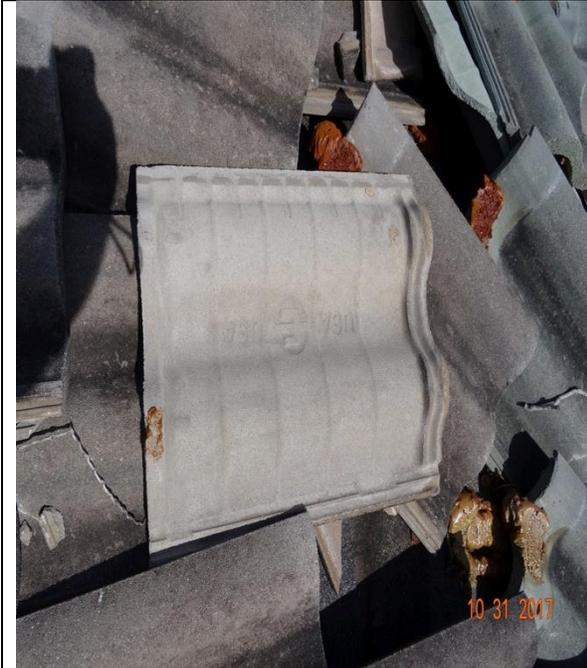
1.1.5 Tile



Overview Directly Exposed to Water



Ridge Tile Missing



Lack of Foam Adhesion



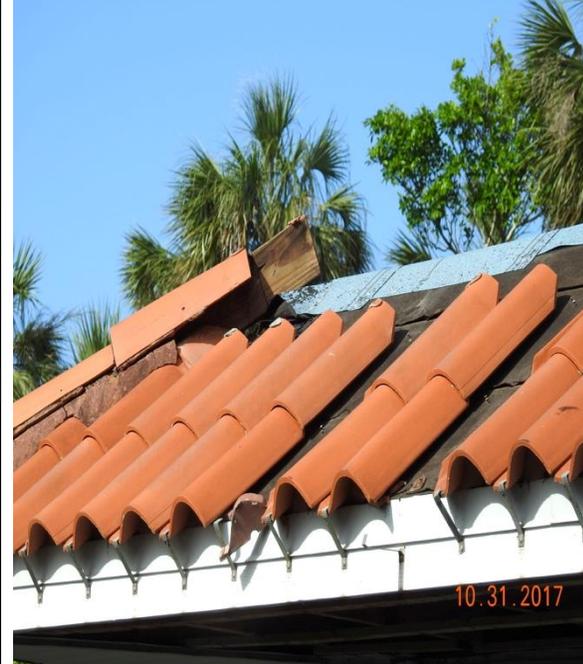
Debris

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Tile	
Inspection Number	2.1.4
Zip	34108
Building Type	Residence
Building Latitude	26°13'33"N
Building Longitude	81°48'39"W
Altitude at Ground	14
Front of the Building	East
Exposure Category	D
Primary Upwind Terrain	Buildings – Smaller, Similar
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	100
Wind Speed ARA	100
Wind Primarily Hit Building On:	Long Side
Building Age	25
Building Code	
Roof Age	25
Roof Age Source	Best Guess
Eave Height (Feet)	9
Ridge Height	14
Slope	Moderate 5/12 to 9/12
Tile Type	Barrel
Tile Material	Clay
Attachment	Nails
Underlayment Type	#30 felt
Deck	Plywood
Ventilation	None
Solar Equipment on the Roof	No
Damage Assessment	5 Tiles missing from all of at least one slope
Location of Roof Damage	Corner, Eave, Ridge Vents
What Failed First	Ridge tiles may have been dislodged due to membrane displacement
Describe Damage	Random eave hip and field tile missing on all slopes

RICOWI Wind Investigation Hurricane Irma, Florida

2.1.4 Tile

 <p>10.31.2017</p>	 <p>10.31.2017</p>
<p>Overview</p>	<p>Tile Attached with Clips</p>
 <p>10.31.2017</p>	 <p>10.31.2017</p>
<p>Clips</p>	<p>Ridge Tiles were Cemented, Field Tiles Clipped</p>

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 2 Tile	
Inspection Number	2.2.4
Zip	33050
Building Type	Residence
Building Latitude	24°48'12"N
Building Longitude	80°55'28" W
Altitude at Ground	10
Front of the Building	South
Exposure Category	D
Primary Upwind Terrain	Buildings Similar Heights
Highest Wind Direction in Storm	North East
Estimated Gust Wind Speed	110 - 120
Wind Speed ARA	120
Wind Primarily Hit Building On:	Short Side
Building Age	47
Building Code	
Roof Age	25+
Roof Age Source	Best Guess
Eave Height (Feet)	20
Ridge Height	45
Slope	Steep >9/12
Tile Type	Barrel
Tile Material	Concrete
Attachment	Nails
Underlayment Type	#30 Felt
Deck	
Ventilation	None
Solar Equipment on the Roof	No
Damage Assessment	6 Structural damage to building
Location of Roof Damage	Entire Roof, Corner, Eave, Rake Edge, Field, Ridge
What Failed First	Ridge overhang lifted and precipitated damage. There may also have been pressurization from failed doors and shutters
Describe Damage	The approximately 7 ft. cantilevered roof structure was lifted and broke structural support members. Dislodged wood plank decking and tile roofing. The front door was racked. Shutters were off their tracks. The building sustained significant structural damage.

RICOWI Wind Investigation Hurricane Irma, Florida

2.2.4 Tile



Tile Roof With Large Overhang

Plank Deck and Missing Tile



Deck and Underlayment with Screw

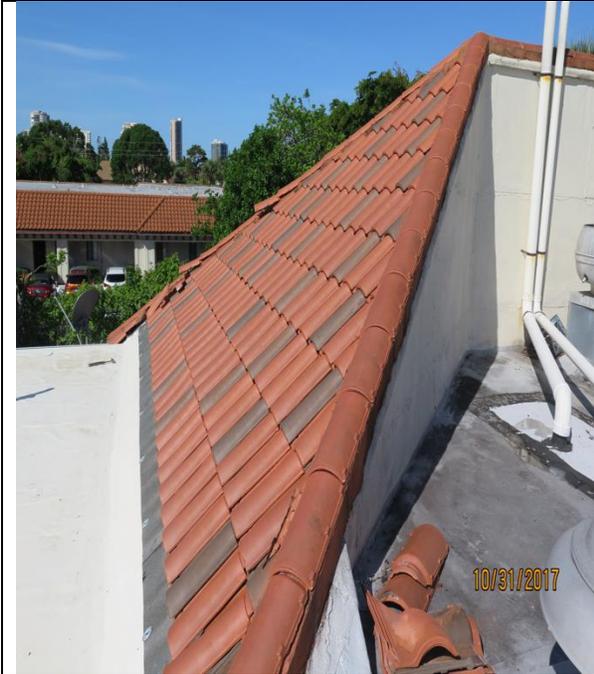
Tile Installed Using Screws

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Tile	
Inspection Number	3.1.2
Zip	34109
Building Type	Retail Strip Mall
Building Latitude	26,12,8
Building Longitude	81,48,12
Altitude at Ground	10
Front of the Building	North
Exposure Category	B
Primary Upwind Terrain	Buildings - Similar Height
Highest Wind Direction in the Storm	Northeast
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	
Building Age	40
Building Code	1970
Roof Age	16+
Roof Age Source	Best Guess
Eave Height (Feet)	12
Ridge Height	19
Slope	Steep >9/12
Tile Type	Barrel
Tile Material	Clay
Attachment	Nails
Underlayment Type	Self Adhered
Deck	Plywood
Ventilation	None
Solar Equipment on the Roof	No
Damage Assessment	Less than 25% of tiles damaged
Location of Roof Damage	Corner, Eave, Ridge
What Failed First	Ridge & valley tiles dislodged.
Describe Damage	Tiles that failed had only one nail and then these tiles hit other tiles creating damage.

RICOWI Wind Investigation Hurricane Irma, Florida

3.1.2 Tile



Ridge Tile Missing



Ridge Tile from Mansard Missing



Ridge Tile Missing



Typical One Nail per Tile

**RICOWI Wind Investigation
Hurricane Irma, Florida**

Team 3 Tile	
Inspection Number	3.1.3
Zip	34105
Building Type	Multi Family
Building Latitude	26°10'17" N
Building Longitude	81°45'7" W
Altitude at Ground	16
Front of the Building	North
Exposure Category	B
Primary Upwind Terrain	Open grassland, Buildings - Similar Height
Highest Wind Direction in the Storm	North East
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	Corner
Building Age	1
Building Code	
Roof Age	1
Roof Age Source	County Records
Eave Height (Feet)	12
Ridge Height	16
Slope	Low Slope 3/12 to 5/12
Tile Type	Barrel
Tile Material	Clay
Attachment	Foam
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	Soffit
Solar Equipment on the Roof	No
Damage Assessment	Less than 25% of tiles damaged
Location of Roof Damage	Eave, Ridge
What Failed First	Ridge tiles displaced
Describe Damage	A few ridge tiles were displaced

**RICOWI Wind Investigation
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3.1.3 Tile



Building Overview



Ridge Tile Missing as Foam did not expand to underside of tile.



Ridge Tile Not Attached



Soffit Damaged

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Team 3 Tile	
Inspection Number	3.1.4
Zip	34109
Building Type	Hotel
Building Latitude	26°14'53" N
Building Longitude	81°46'1" W
Altitude at Ground	20
Front of the Building	West
Exposure Category	B
Primary Upwind Terrain	Open grassland, Buildings -Smaller
Highest Wind Direction in the Storm	East
Estimated Gust Wind Speed	90
Wind Speed ARA	90
Wind Primarily Hit Building On:	Corner
Building Age	16
Building Code	25
Roof Age	16
Roof Age Source	County Records
Eave Height (Feet)	90
Ridge Height	110
Slope	Moderate 5/12 to 9/12
Tile Type	Barrel
Tile Material	Clay
Attachment	Nails
Underlayment Type	#30 Felt
Deck	Plywood
Ventilation	None
Solar Equipment on the Roof	None
Damage Assessment	3 More than 25 percent tiles damaged
Location of Roof Damage	Field, Ridge
What Failed First	Ridge tiles failed in some places. tiles were less than standard thickness
Describe Damage	Random tiles broken on several slopes of the roof. Some ridge tiles missing and may have caused impact damage.

RICOWI Wind Investigation Hurricane Irma, Florida

3.1.4 Tile



Overview of Ritz Carlton Golf Resort



Some ridge tiles missing creating downslope damage



Missing Ridge tiles and downslope damage.



Venezuelan clay tiles were thinner than typical and were nailed through a granular surfaced asphaltic material.

RICOWI Wind Investigation Hurricane Irma, Florida

Acknowledgements

RICOWI wishes to thank the following organizations, corporations, and individuals for supporting this research investigation program through their generous contribution of time, knowledge and funding to this fifth hurricane investigation.

We gratefully acknowledge the following supporters:

- Asphalt Roofing Manufacturers Association
- Cedar Shake and Shingle Bureau
- Insurance Institute for Business and Home Safety
- Metal Building Manufacturers Association
- Metal Construction Association
- RCI, Inc.
- Spray Polyurethane Foam Alliance
- Single Play Roofing Industry
- Tile Roofing Institute

Thank you to the Wind Investigation Program (WIP) Committee Members, and especially the Wind Investigation Team (Appendix C) for this event. Many of the team members gave up their vacation days, and all funded their travel and expenses. Thank you to WIP Committee Chair John Kouba, Vice Chair Phil Mayfield, Program Coordinator David Roodvoets, and Executive Director Joan Cook for your strong leadership and dedication to this program.

Special thanks to Lois Riesebieter for her excellent work providing the name badges to the team.

We also thank Wade Sticht and Jaime Gold for their hard work in providing independent data information for the report.

RICOWI appreciates the State of Florida and the communities that welcomed the researchers and assisted with directions and suggestions.

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Appendices

**RICOWI Wind Investigation
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Appendix A

RICOWI WIND INVESTIGATION TEAM

HURRICANE IRMA



(Left to right, front row)

Jim Bush, Ron Kough, Joel May, and Phil Mayfield

(Left to right, back row)

Allan Kidd, David Roodvoets, David Balistreri, Christopher Lussier, Mark Kubena, Tom Kelly, and Eric Velliquette

Not pictured:

Partheiv Dangadora, Ken Kelly and **Terrill Brake**

**RICOWI Wind Investigation
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Appendix B

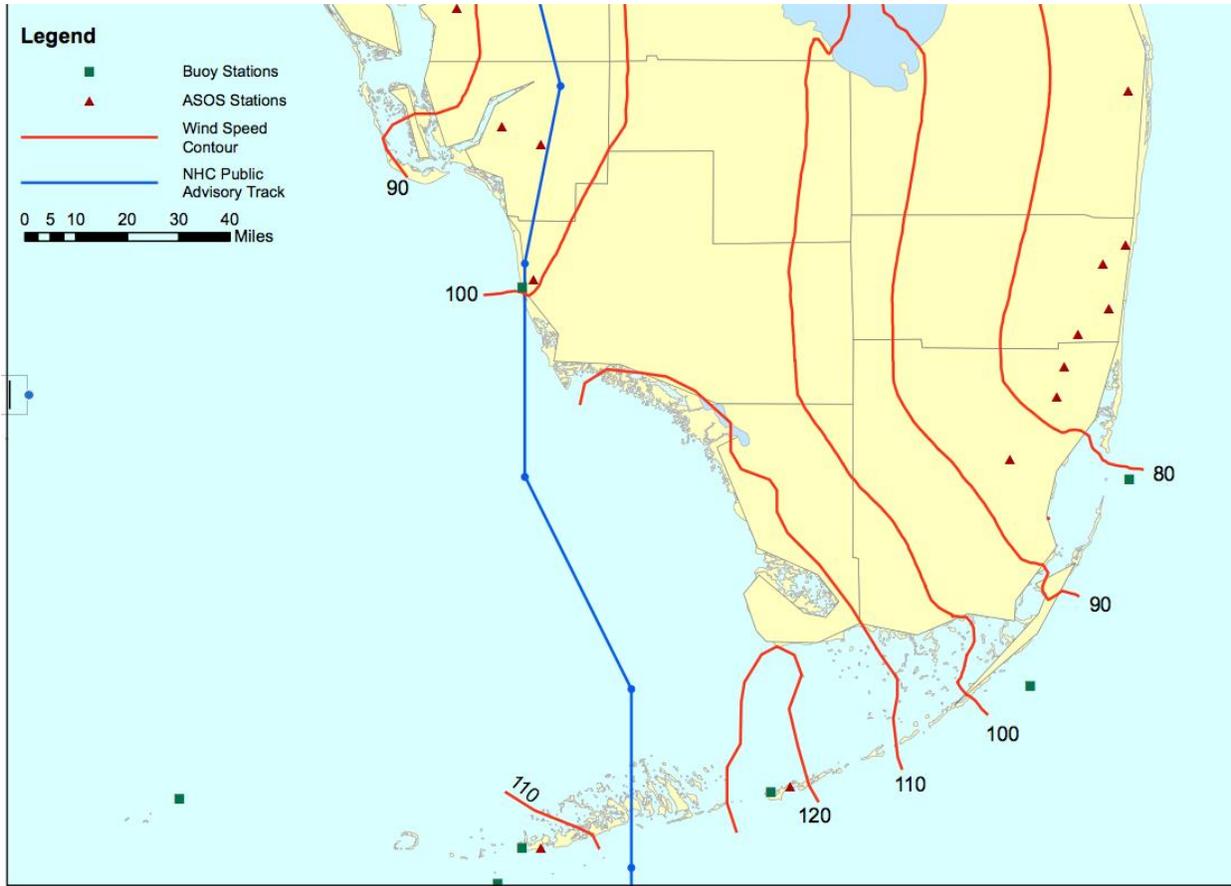
Inspections by Team

Inspection #	Data Set	Leaking
1.1.1	Tile	No
1.1.2	Tile	No
1.1.3	Tile	No
1.1.4	Asphalt	Yes
1.1.5	Tile	No
1.1.6	BUR	Yes
1.2.1	Mod Bit	Yes
1.2.2	MA Single Ply	Yes
1.2.3	Asphalt	No
1.2.4	Metal	Yes
1.2.5	Metal	Yes
Team 2		
2.1.1	Mod bit	Yes
2.1.2	Mod Bit	Yes
2.1.3	Ad Single Ply	No
2.1.4	Tile	Yes
2.1.5	Mod Bit	
2.1.6	Metal	Yes
2.2.1	Mod Bit	Yes
2.2.2	Asphalt	Yes
2.2.3	Metal	Yes
2.2.4	Tile	No
2.2.5	Tile	Yes
Team 3		
3.1.1	Metal	No
3.1.1b	BUR	Yes
3.1.1c	BUR	Yes
3.1.2	Tile	No
3.1.3	Tile	No
3.1.4	Tile	No
3.1.5	Asphalt	Yes
3.2.1	Metal	No
3.2.2	Metal	Yes
3.2.3	Metal	Yes

**RICOWI Wind Investigation
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Appendix C

Hurricane Irma Preliminary Peak Wind Gust Map



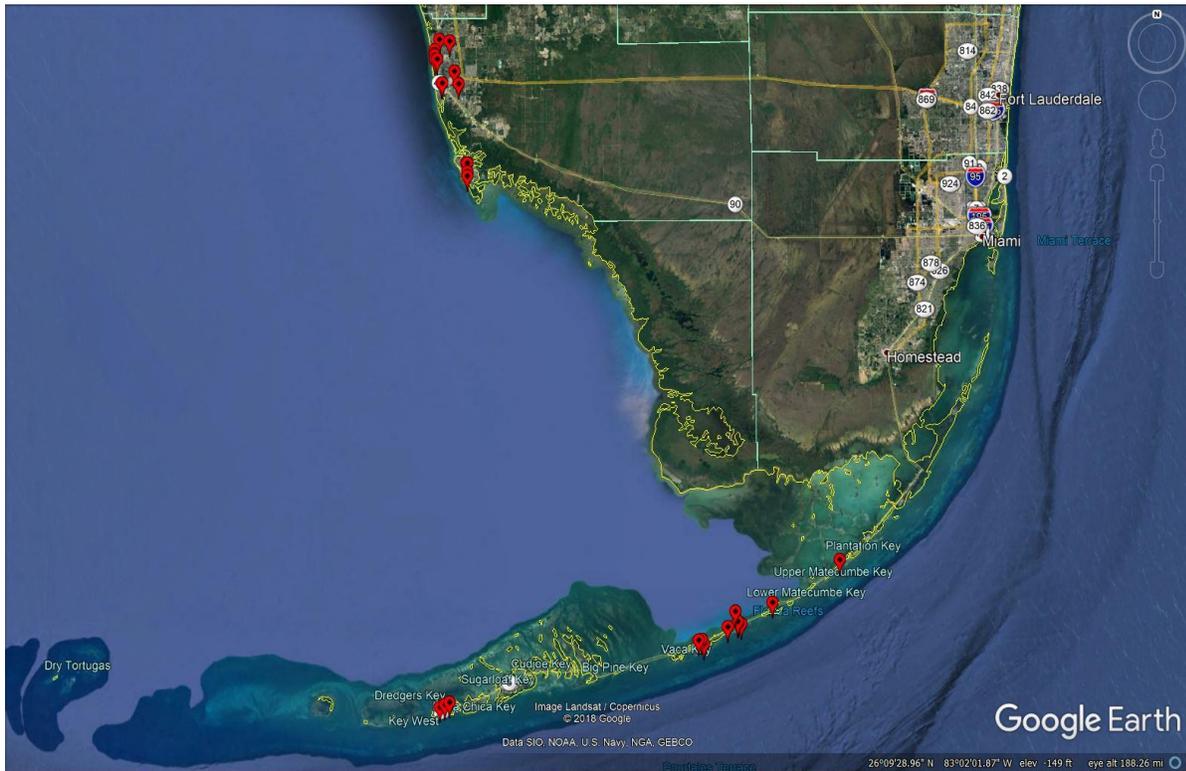
Hurricane Irma (2017): Preliminary Peak Wind Gust(mph)
Estimated 3-second gust wind speeds (mph) at 10 m above ground over open terrain from ARA model fit to surface level observations using NHC storm track and central pressure data through Forecast/Advisory 52 at 0300UTC on 9/12/2017.
Map is subject to change. Created on: 9/18/2017.

Map from Florida ARA

RICOWI Wind Investigation Hurricane Irma, Florida

Appendix D

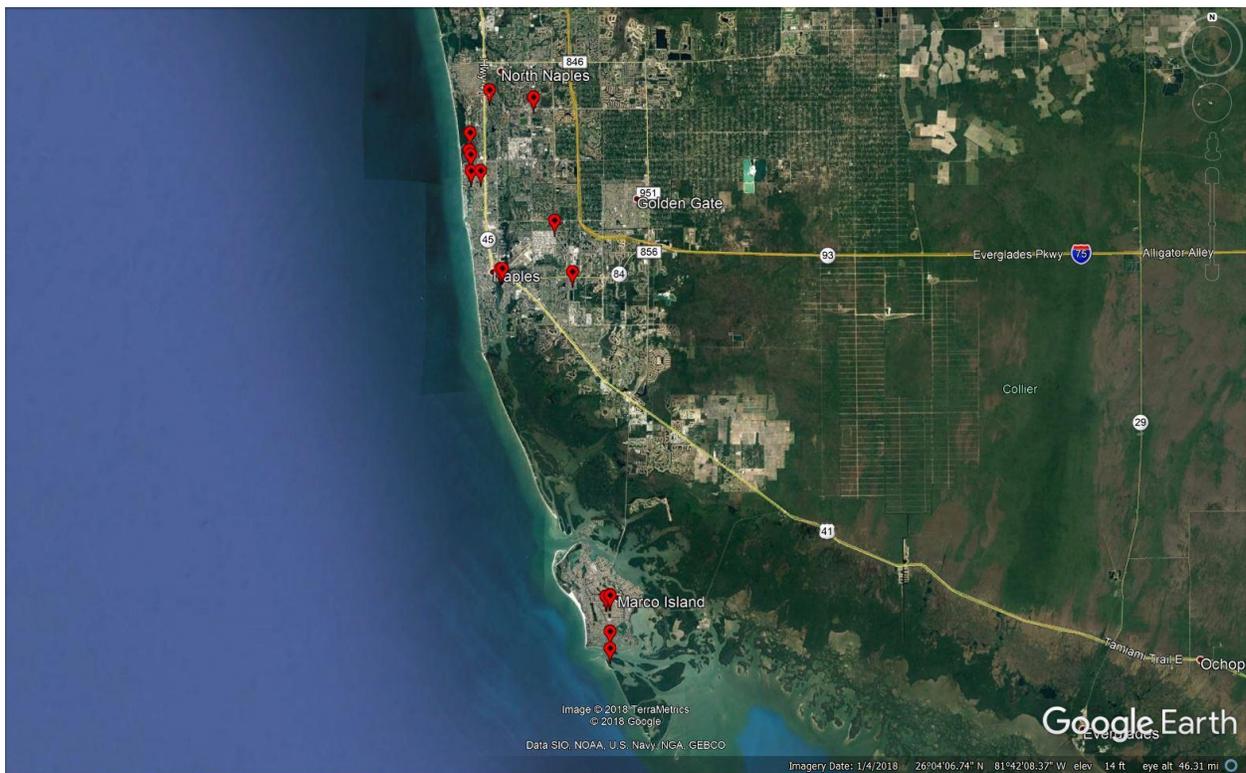
Florida Map of Investigations



**RICOWI Wind Investigation
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Appendix F

Naples Investigation Sites Map



RICOWI Wind Investigation Hurricane Irma, Florida

RICOWI Wind Investigation Program



In 1989, Oak Ridge National Laboratory held two workshops devoted to identifying and discussing roof wind uplift issues and alternatives. Discussions of important technical issues included causes of roof wind damage, dynamic testing of roof systems, the importance of sample size for tests, the role of wind tunnels, air retarders, and the need for acceptable procedures for ballasted systems. There was also concern for the general lack of communication within the roofing industry as to what the problems are, what is being done to alleviate them, and how effectively technology transfer is accomplished within the roofing industry and the building community. At the conclusion of the workshops, a consensus recommendation was to form a committee to address these matters. The Roofing Industry Committee on Wind Issues (RICOWI) was established and the Charter approved October 11, 1990.

Subsequent to RICOWI's formation, other concerns were raised. The insurance industry conveyed their concern regarding excessive property loss from windstorms. They estimated that from 1984 to 2003 hurricanes and high winds have accounted for nearly 64% of catastrophic losses. Insured losses from hurricanes reach billions of dollars each year. In August 1992, Hurricane Andrew caused \$16 billion in insured losses. A one-month period of hurricanes in 2004 resulted in more than \$20 billion in insured losses. Of the top ten most costly catastrophes to ever hit the United States, 8 are hurricanes or a tropical storm. Hurricane Katrina has now set new loss records.



There is an essential link between product research, performance and the model building codes. The model code groups are moving more toward "objective based codes" versus "prescriptive codes." Performance requirements are generally perceived to be requirements stated in a way that allows flexibility in the choice of solutions to satisfy the requirements and are based upon explicitly stated objectives. Code changes are being adopted by the model code groups without adequate industry input. In addition, there is a general feeling that the right type of data, following an event, has not been gathered. There is no question that all roofing products and systems of all roofing manufacturers are going to have to meet more rigorous specifications and will be subject to tougher scrutiny of building departments such as we have seen in Dade and Broward counties (FL). Industry involvement in follow-up of wind events is imperative.

RICOWI and the Department of Energy / Oak Ridge National Laboratory responded to industry involvement by entering into a Cooperative Research Development Agreement (CRADA) to facilitate the Wind Investigation Program (WIP). The Program includes all of the major roofing trade associations in North America. In 1996, a pool of eighty investigators were trained in wind issues by the country's leading scientists and others qualified in examining wind damage to roofing systems.



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The Program identifies an event as A major hurricane making landfall in a heavily populated area in Florida, or in an area previously investigated by RICOWI, with wind speeds at or above ASCE 7-2005 design levels based on early projections by NOAA/NHC and/or other credible sources. Alternatively, a hurricane similarly projected by NOAA/NHC to include one-minute sustained wind speeds equal or greater than 95 mph (Category II) making landfall along the northeast corridor.

The WIP mission is to investigate the field performance of roof assemblies after major wind storm events, factually describe roof assembly performance and modes of damage, and formally report results of investigations and damage modes for substantiated wind speeds.

This Program will put credible people in the field that have the required product knowledge and program training to ensure that sound, scientific and unbiased reporting occurs. Buildings will be safer, property losses will be reduced and industry will meet the challenge with clear insight as to needed direction. The reports generated by our investigation teams and findings will be utilized to help educate, improve products, installation techniques, safety and reduce overall roofing and insurance costs for the industry. The results will also provide a valuable resource to FEMA and state emergency management agencies.



RICOWI has now conducted four of the most comprehensive roofing investigations of hurricane stricken areas immediately following Hurricanes Charley (Aug. 13/04), Ivan (Sept. 16/04), Katrina (Aug. 29/05) and Ike (Sept. 13/08). The reports can be downloaded from our website (www.ricowi.com) and are also available on CD. A smaller investigation was conducted for the Hurricane Irma (Oct. 2017). The research will be available online.

Based on the success of the past investigations, RICOWI's Board of Directors approved a hurricane investigation for 2018. When an event occurs, up to eight four-members teams will be assembled, along with several observers. A logistics team will be deployed immediately following the storm to target damaged areas, select specific buildings and make the preliminary contacts.

Interested members are encouraged to volunteer by signing up as a Team Member online at www.ricowi.com

RICOWI has a similar program for hail investigations. Check the website (www.ricowi.com) for more detail. For additional information, contact RICOWI's Executive Director, Joan T. Cook at the Ohio office: 330-671-4569 or email jcook@ricowi.com.