

# **APPENDIX P: Home Hardening Matters**

# HOME HARDENING MATTERS

**Special Report on Efficacy of Hurricane Wind Mitigation  
Measures Against EF3 Tornadoes  
Escambia County, Florida • February 2016**

PREPARED BY



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## About REBUILD Northwest Florida, Inc.

REBUILD Northwest Florida, Inc. is a not-for-profit, §501(c)(3) organization that began as a grassroots effort by a core group of individuals in response to Hurricane Ivan, which struck Pensacola, Florida, on September 16, 2004. Early on, our goal was to assist homeowners in the Pensacola MSA, which encompasses Escambia and Santa Rosa counties in Florida, with recovery initiatives. Over the next few years, REBUILD repaired in excess of 2,000 need-based homes in the two-county area, with an average cost of approximately \$14,000 to \$15,000 per home.

We had done much to help rebuild our communities, but questions remained: “Will we have to do this again after the next hurricane? Is there not a better way?”

We began working with dedicated senior-level leadership in FEMA Region IV and the Florida Division of Emergency Management (FDEM) to develop an approach for mitigating individual private homes against windstorm damage. Subsequently, REBUILD applied for, and was awarded, a number of HMGP grants pursuant to Section 404 of the Stafford Act.

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REBUILD hardened its first home in 2008, and continued to refine our various scope of work and administrative procedures. It should be noted that REBUILD’s initiative predated all subsequently developed, relevant FEMA guidance (e.g., P-804 and P-55) and subsequently announced, authoritative, private sector programs (e.g., IBHS’s “Fortified for Existing Homes”). The REBUILD model that was then evolving benefited in significant part because it relied heavily upon the Florida statewide building code, one of the nation’s most advanced windstorm-worthy building codes; the Florida Building Commission, which manages a reasonably sophisticated product approval system, and solid construction and installation processes; and the State-monitored building permitting and inspections procedures within Florida’s system of local governments.

The REBUILD program revolves around hardening the entire envelop of the home to certain defined windstorm standards, utilizing a variety of listed potential improvement techniques, all pursuant to a home-by-home, individualized scope of work prescribed by REBUILD’s Florida licensed structural engineer. As of March 2016, REBUILD had completed hardening approximately 12,500 homes in the Pensacola MSA — an average of 31+ homes hardened per week. REBUILD’s average cost of hardening a home is approximately \$9,200 each (100%), with HMGP typically providing 75% of the funding and homeowners providing the 25% match. (REBUILD has utilized other sources of State funding, when available, to supplement HMGP and homeowner funding.)

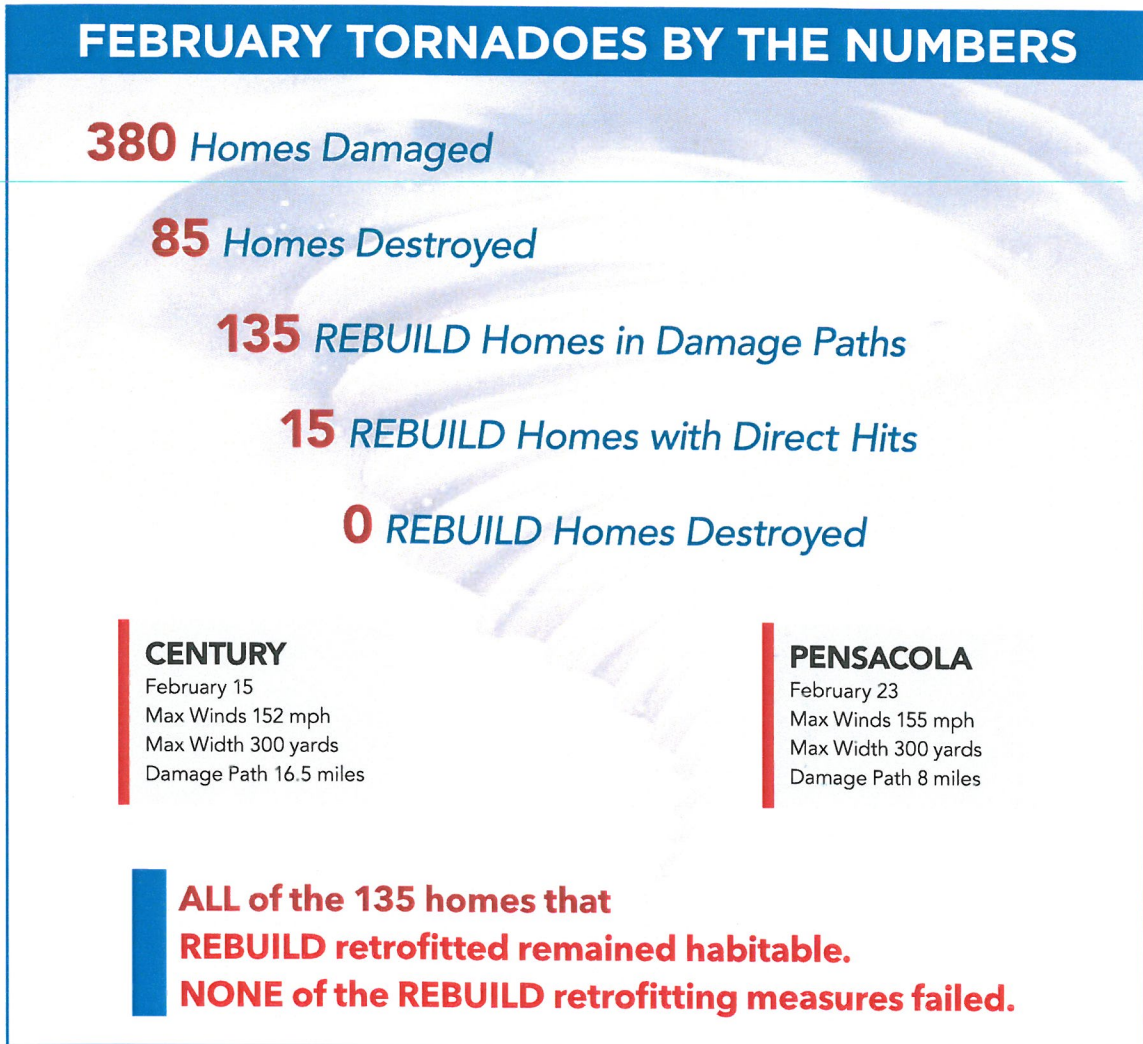
The Pensacola MSA has been very fortunate and not experienced any significant windstorm events since Hurricane Dennis in 2005. While the REBUILD model is based upon up-to-date building science and implemented pursuant to the Florida Building Code, the Pensacola MSA had not had a windstorm event from which to evaluate—on the ground, after the fact—the effectiveness of the REBUILD home hardening program. However, that changed on February 15, 2016, when an EF3 tornado touched down in Century (a city in north Escambia County along the Florida-Alabama State line), and on February 23, 2016, when another EF3 tornado passed through Ferry Pass (an area at the northeasterly boundary of the Pensacola city limits).

The report that follows is the result of an inspection conducted by REBUILD of homes within the damage path of both tornadoes that compares “REBUILD homes” (i.e., homes that were hardened by REBUILD) and “non-REBUILD homes” (i.e., homes that were not hardened by REBUILD).

## Report Summary

Escambia County had enjoyed 46 years without an EF3 tornado. In February 2016, we were hit with two in two weeks. Both were extremely powerful, packing winds that approached those of a Category 5 hurricane (156+ mph).

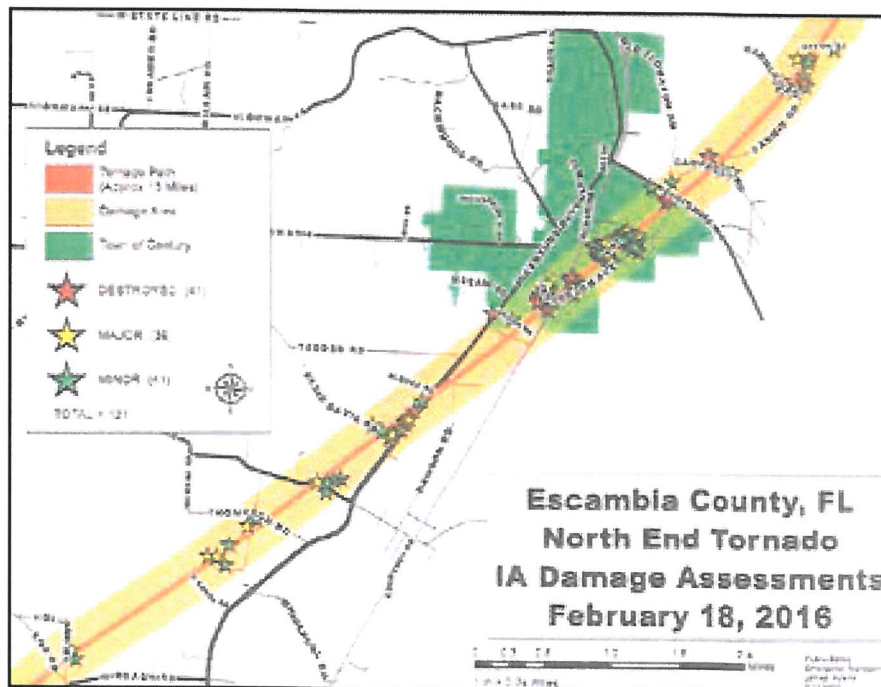
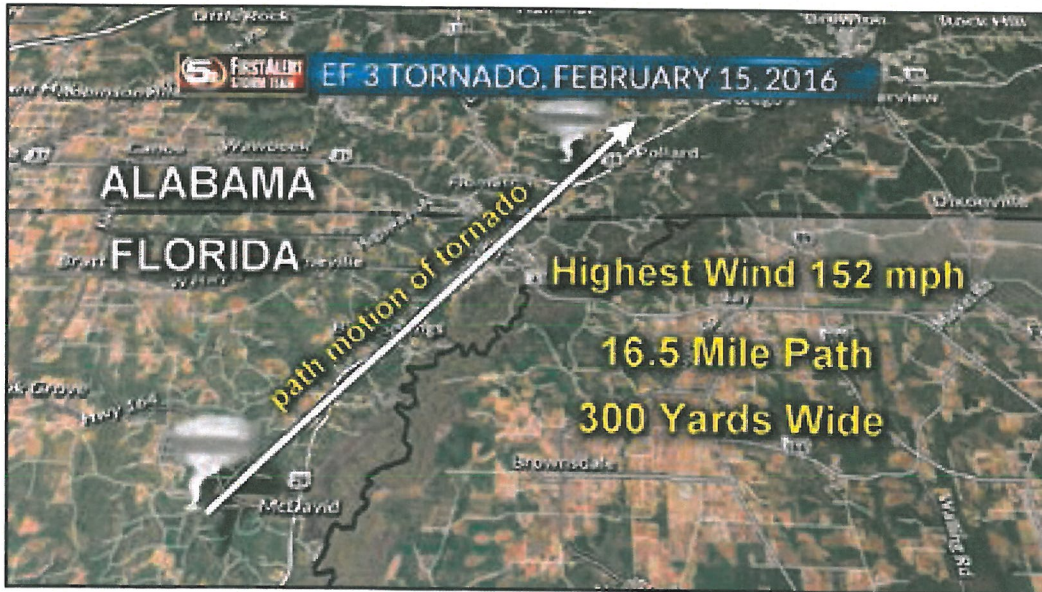
What we learned in the aftermath is that wind mitigation is not just for hurricanes. The home hardening measures done by REBUILD, while not designed for tornadoes, were extremely effective in minimizing damage to homes.



# Century Tornado Overview

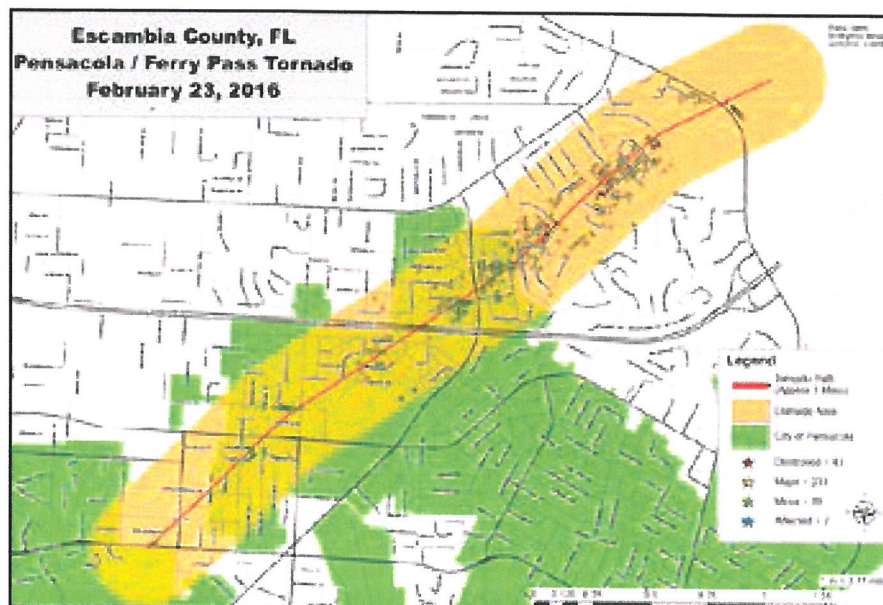
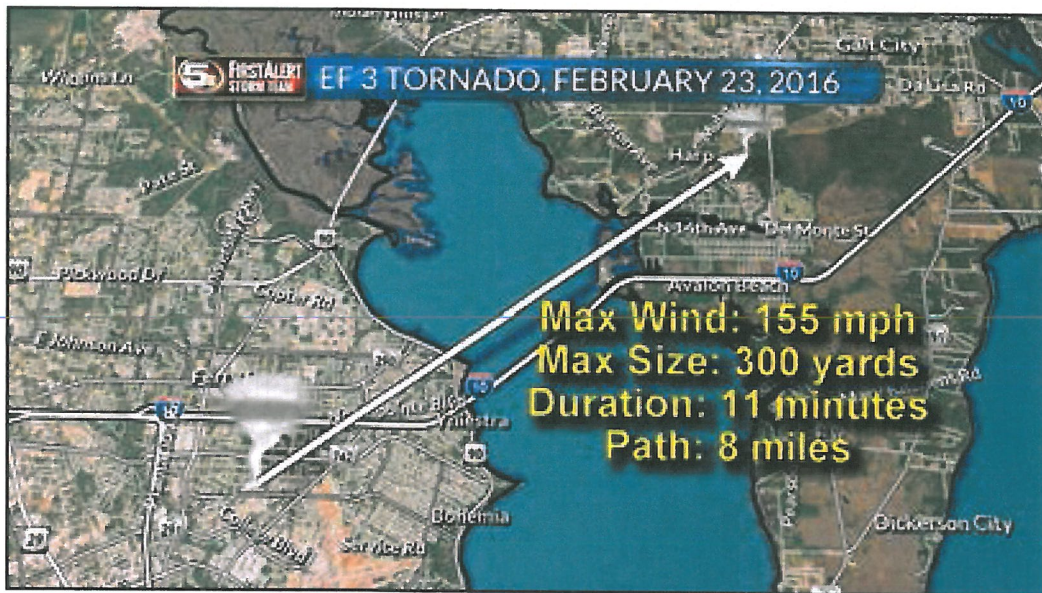
On February 15, 2016, an EF3 tornado passed through the northeastern section of Escambia County, primarily affecting the town of Century, Florida.

Escambia County performed damage assessment and found 121 homes with reportable damage. REBUILD had retrofitted 19 homes within the damage path (150 yards either side of the centerline). Escambia County's list of damaged homes did not include any of the 19 homes that REBUILD had retrofitted.



# Pensacola Tornado Overview

On February 23, 2016, an EF3 tornado passed through the Ferry Pass community of northeast Pensacola. The impacted area was primarily residential neighborhoods, but also included commercial and industrial areas.



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In the days immediately following the tornado, the Florida Department of Emergency Management's State Emergency Response Team (SERT) conducted damage assessments, finding:

- 259 total homes with storm damage
- 152 were single-family homes
- 107 were multi-family dwellings

The assessment categorized the damaged structures into one of four categories:

- Affected
- Minor Damage
- Major Damage
- Destroyed

Of the 152 single-family homes, SERT reported:

- 42 Affected
- 59 Minor Damage
- 35 Major Damage
- 16 Destroyed

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Of the 107 multi-family homes, SERT reported:

- 14 Affected
- 55 Minor Damage
- 10 Major Damage
- 28 Destroyed

REBUILD compared the homes it had retrofitted in the damaged area with the SERT assessment. Although Escambia County's path map (page 6) shows damage extending out approximately 0.25 miles from the tornado's centerline, REBUILD compared homes it retrofitted within 150 yards of either side of the centerline. REBUILD chose 150 yards since the overwhelming majority of damage was within that distance of the path. REBUILD had retrofitted 116 homes within 150 yards of either side of the tornado's centerline. The tornado's path crossed 14 homes (direct hits) that REBUILD had retrofitted, none of which were rendered uninhabitable.

Of the 116 REBUILD homes within the 300-yard path of the tornado, 97 did not have enough visible impact to be assessed by SERT officials for damage, and none were uninhabitable after the tornado.

Of the 19 REBUILD homes that SERT assessed for damage, they found:

- 6 Affected
- 10 Minor Damage
- 3 Major Damage\*
- 0 Destroyed

**\*All three of the REBUILD homes that SERT lists as having "Major Damage" were among those what sustained direct hits (in the tornado's path). All remained habitable after the storm, and all are repairable. None of REBUILD's retrofit measures failed.**





STATE OF FLORIDA  
**DIVISION OF EMERGENCY MANAGEMENT**

**RICK SCOTT**  
Governor

**BRYAN W. KOON**  
Director

March 8, 2016

To whom it may concern:

On February 23, 2016 multiple neighborhoods in the Pensacola, Florida, area experienced an EF3 tornado causing significant damage to residential structures among other impacts. On March 2, 2016, two technical staff (David Ugrekhelidze and James Price) from the Florida Division of Emergency Management's Bureau of Mitigation Technical Unit and myself toured areas damaged by the storm.

Prior to this event, my staff and I have conducted various site visits related to REBUILD Northwest Florida (RNWF), a subgrantee under the Hazard Mitigation Grant Program and are familiar with the program, its implementation, and approved scope of work. While in the field we met with William Merrill, P.E. of RNWF to assess structures that participated in RNWF's wind mitigation program and inspect the performance of these structures following the impact of the high velocity wind event. Many structures in the impact swath of the storm were severely damaged or totally destroyed however, structures that participated in the RNWF program were intact and habitable with damage that appeared to require relatively minimal repair. Observed damages on RNWF participating homes included shingle loss, vinyl siding/soffit damage, and damage resulting from fallen trees.

Conversely, and in some cases directly adjacent to RNWF participating structures, non-retrofitted homes exhibited significant damage, total destruction, or otherwise appeared to uninhabitable. In one instance, structures on each side of a RNWF participating structure were destroyed while the RNWF structure remained intact although required repairs. Uplift force from wind loads appeared to be the cause of much of the significant damage or total loss, primarily due to garage door failures and roof-to-wall connections.

Although RNWF's wind mitigation program is designed for hurricane wind loads, it was clear during this tour of tornado damage that properly implemented wind mitigation measures resulted in a significant reduction in damage from high velocity winds generated by the tornado.

Should you have any questions, please contact me, at (407)856-5010 or by email at [Luz.Bossanyi@em.myflorida.com](mailto:Luz.Bossanyi@em.myflorida.com).

Sincerely,

A handwritten signature in blue ink that reads "Luz Bossanyi".

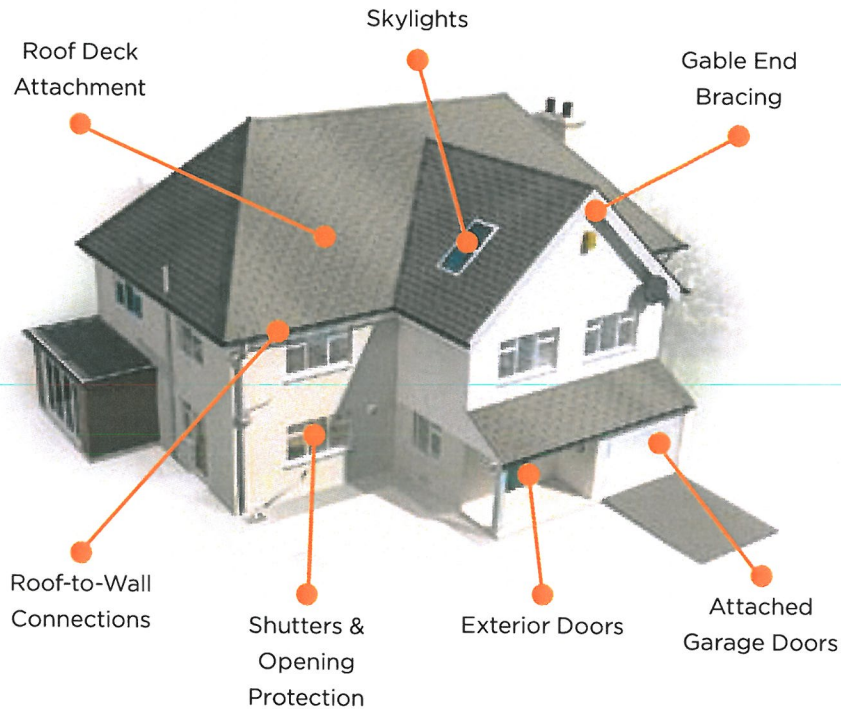
Luz Bossanyi  
Planning Manager, Technical Unit  
Bureau of Mitigation

Cc: Miles Anderson, State Hazard Mitigation Officer

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# REBUILD Home Hardening Measures Overview

Home hardening or wind mitigation involves several measures taken to strengthen a home and make it better able to withstand windstorms.



## Opening Protection

Wind-borne debris can breach a home's opening and cause catastrophic damage and even collapse. Windows can be protected with shutters. Exterior doors and garage doors can be replaced, strengthened or shuttered.

## Roof-to-Wall Connections

Reinforcing the structural connections between the roof and walls of a home is one of the most important measures REBUILD takes to help harden a home.

## Roof Deck Attachment

If the roof deck is not properly attached to the structure of a house, a tornado or hurricane can rip off more than shingles.

## Gable-End Bracing

The gable-end walls of a home receive the full force of a windstorm. If the framing is not braced to resist high winds, the entire roof could collapse, resulting in catastrophic damage.

# REBUILD Homes: Direct Hit Damage Report

## CENTURY TORNADO BY THE NUMBERS

**121** Homes Damaged  
**41** Minor Damage  
**39** Major Damage  
**41** Homes Destroyed



**19** REBUILD Homes in Damage Paths  
**1** REBUILD Home with a Direct Hit  
**0** REBUILD Homes on List of Damaged Homes

One REBUILD home took a direct hit by the tornado as confirmed by the published path, debris trail and the homeowners, who were home during the storm.

### 111 Upton Road, Century

On February 18, 2016, REBUILD employees William Merrill, P.E. and Zac Gilmore inspected 111 Upton Road. The home was intact, habitable, and the homeowners have continued to live in the house since the storm.

#### Home Information

- Constructed 1973
- Single-family residential
- 1 story
- 2,148 sq. ft.

#### REBUILD Information

REBUILD Project No. 22069  
Retrofitted May, 2012

#### Retrofit Scope

- Added 2 hurricane clips
- Added shutters
- Replaced an entry door with an impact-rated entry door
- Added gable-end bracing

#### Damage Observed

- Loss of some shingles
- Siding damage
- Fence damage
- Slight water damage from water coming through roof deck after shingles removed
- Destroyed 11 trees in their yard
- Screen porch damage



*Front and side views of 111 Upton Road after the tornado.*



## NEARBY DAMAGE

*The tornado destroyed a mobile home across the street and damaged structures on either side of the home at 111 Upton.*



## PENSACOLA TORNADO BY THE NUMBERS

<b>259</b> Homes Damaged		<b>116</b> REBUILD Homes in Damage Paths
<b>56</b> Homes Affected		<b>14</b> REBUILD Homes with Direct Hits
<b>114</b> Minor Damage		<b>6</b> REBUILD Homes Affected
<b>45</b> Major Damage		<b>10</b> REBUILD Homes with Minor Damage
<b>44</b> Homes Destroyed		<b>3</b> REBUILD Homes with Major Damage*
		<b>0</b> REBUILD Homes Destroyed

On February 26, February 27, March 2, and March 8, 2016, REBUILD employees William Merrill, P.E. and Zac Gilmore inspected the two neighborhoods north of I-10 that were hardest hit. On homes that REBUILD had retrofitted, we observed relatively minor and repairable damage. The most typical damage was loss of some shingles, garage door impacts (dented but intact) and minor gutter damage.

**On street after street, we saw REBUILD homes standing intact and habitable next to non-REBUILD homes that had experienced significant damage or total destruction.**

\*All three of the REBUILD homes that SERT lists as having "Major Damage" sustained direct hits, and all remained habitable. None of REBUILD's retrofit measures failed.

## 4660 Tradewinds Drive, Pensacola

This home received a direct hit, but remained intact and habitable. The homeowner was cleaning up his yard when we inspected. The tornado destroyed homes on both sides of this residence. Power to the home was restored on or about February 27, and the homeowner has continued to occupy the home.

### Home Information

- Constructed 1985
- Single-family detached
- 2 stories
- 2,336 sq. ft.

### REBUILD Information

REBUILD Project No. 12075  
Retrofitted October, 2008

### Retrofit Scope

- Added 2 hurricane clips
- Added shutters
- Added gable-end bracing
- Replaced an existing entry door with an impact-rated entry door
- Replaced an existing garage door with an impact-rated garage door

### Damage Observed

- Loss of some shingles and water damage through the roof
- Window damage (there was not time for shutters to be deployed)
- Tree and fence damage



*Views of 4660 Tradewinds Drive after the tornado*



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## NEARBY DAMAGE

Homes on either side of 4660 Tradewinds Drive and other nearby homes were destroyed.



*Destroyed home to the left of 4660 Tradewinds Drive (non-REBUILD home)*



*Destroyed home to the right of 4660 Tradewinds Drive (non-REBUILD home). The garage door's failure likely led to rapid pressurization of the home. We will discuss these and other failures in subsequent sections.*



*Drone view of 4660 Tradewinds Drive and surrounding non-REBUILD homes*

## 4700 Anchor Lane, Pensacola

This home received a direct hit and remained intact and habitable. There was no indication of structural damage. Homeowners remained in the home, and the power was on when we inspected.

### Home Information

- Constructed 1974
- Single-family detached
- 2 stories
- 2,408 sq. ft.

### REBUILD Information

REBUILD Project No. 13127  
Retrofitted December, 2008

### Retrofit Scope

- Added 1 hurricane clip
- Added shutters
- Added gable-end bracing
- Replaced an existing entry door with an impact-rated entry door

### Damage Observed

- Loss of shingles
- Loss of vinyl siding
- Loss of vinyl soffits and gutters
- Back porch damaged
- Fences destroyed



*Front and back views of 4700 Anchor Lane after the tornado*





## 7800 Le Jeune Drive, Pensacola

This home received a direct hit and remained intact and habitable. We spoke with the homeowner, who said that she was very thankful for all REBUILD had done and cited the many homes in her neighborhood that been destroyed or badly damaged.

### Home Information

- Constructed 1974
- Single-family detached
- 1 story
- 2,408 sq. ft.

### REBUILD Information

REBUILD Project No. 22104  
Retrofitted August, 2012

### Retrofit Scope

- Added 1 hurricane clip
- Added shutters
- Added gable-end bracing
- Replaced an existing entry door with an impact-rated entry door
- Added impact-rated garage door

### Damage Observed

- Loss of some shingles and roof decking damage, primarily above the garage
- Broken front window (there was not time for shutters to be deployed)
- Tree and fence damage



*Front view of 7800 Le Jeune Drive. This home had been repaired and was being re-roofed at the time of our inspection. Note that the gable-end-bracing REBUILD had installed on the garage gable held, preventing the gable truss from failing and causing more extensive damage.*

## NEARBY DAMAGE

Both homes across the street from 7800 Le Jeune Drive and others close by were badly damaged or destroyed.



*Heavily damaged/possibly destroyed homes across the street from 7800 Le Jeune Drive (non-REBUILD homes)*



*Drone view of 7800 Le Jeune Drive and surrounding non-REBUILD homes*

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## 4720 Tradewinds Drive, Pensacola

This REBUILD home received a direct hit but suffered only minor damage. The homeowners sheltered in place during the storm and have continued to live in the home. They said the noise was incredible and that their front door and garage “took a pounding,” but held. They told us that after Hurricane Ivan in 2004, they also lost shingles, and had \$40,000 of water damage. Despite similarly losing shingles in this tornado, they had no water damage due to the adhesive spray (applied for roof deck attachment) acting as a secondary water barrier. Power was restored on February 27 when Gulf Power repaired the overhead line along their street.

### Home Information

- Constructed 1975
- Single-family detached
- 1 story
- 2,304 sq. ft.

### REBUILD Information

REBUILD Project No. 21533  
Retrofitted June, 2012

### Retrofit Scope

- Added sheathing to truss adhesive
- Added gable-end-bracing
- Added 2 hurricane clips
- Added shutters
- Replaced an existing entry door with an impact-rated entry door
- Retrofitted and strengthened existing garage door

### Damage Observed

- Loss of shingles and ridge vent
- Fences destroyed
- Garage door dings



*View of 4720 Tradewinds Drive after the tornado*

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## NEARBY DAMAGE

Approximately 20 feet away, the home next to 4720 Tradewinds Drive was destroyed. Garage door failure likely led to rapid pressurization of this non-REBUILD home.



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## Non-REBUILD Homes: Damage Report

### Roof-To-Wall Failures

REBUILD installs hurricane clips to homes it retrofits. Lack of hurricane clips appears to be a contributing factor to damage to multiple homes.



*No clips on any of the trusses from the debris pile of this home (non-REBUILD home).*



*No clips on any of the trusses on this non-REBUILD home*



*Roof-to-wall failure of an out-building (not hardened by REBUILD) on the property of 111 Upton in Century*

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### Roof Deck Attachment Failures

Roof deck failure was common on these and other non-REBUILD homes located in the damage path.



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## Gable-End Failures

We were thankful to see no gable-end failures that led to other major damage; however, we did find several gable-ends that the storm had damaged.





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## Garage Door Failures

We noticed many garage doors that had failed during the storm. These two photos show the same non-REBUILD home before and after the tornado.

As on many homes we saw, the failure of this home's garage door likely led to rapid pressurization of the home, which in turn caused the roof to collapse and the home to be destroyed.



*Non-REBUILD home prior to the storm*



*Same home after the storm*



*Garage door failure likely led to rapid pressurization of the garage on this non-REBUILD home.*

*On this non-REBUILD home, the garage door appears to have held enough to prevent rapid pressurization.*



*Garage door failure likely led to rapid pressurization of home (non-REBUILD home).*

*Garage door failure likely led to rapid pressurization of home (non-REBUILD home).*



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### Garage Doors on REBUILD Homes

A large majority of homes that go through REBUILD’s program receive new impact rated garage doors. We saw multiple REBUILD homes with garage doors that took impacts, but did not fail. We did not find a REBUILD home with a new impact-rated garage door that failed.



*REBUILD home with a new garage door impacted by a tree.*



*REBUILD home with a new garage door impacted by windborne debris from the destroyed home across the street.*

## Conclusion

Since 2008, REBUILD Northwest Florida has hardened more than 12,500 homes in Escambia and Santa Rosa counties. Because we consistently used the most advanced, yet cost effective, building science available and one of the nation's most stringent building codes, we were confident that the home hardening measures we had taken on behalf of homeowners who participated in our program were sound and would provide increased protection against windstorm damage.

In February 2016, Escambia County, Florida was hit with two EF3 tornadoes—both with maximum wind speeds approaching those of a Category 5 hurricane (156+ mph). After inspecting homes within the damage paths of both tornadoes, we can now be certain that REBUILD's home hardening program is extremely effective and could be expanded beyond hurricane mitigation to cover all windstorm damage.

Of the 135 REBUILD homes located within the damage paths, 15 took direct hits, but none were destroyed. In fact, all of the REBUILD homes remained habitable.

### FEBRUARY TORNADOES BY THE NUMBERS

**380** Homes Damaged

**85** Homes Destroyed

**135** REBUILD Homes in Damage Paths

**15** REBUILD Homes with Direct Hits

**0** REBUILD Homes Destroyed

At this point, we must ask ourselves, how many homes destroyed by the tornadoes could have been saved had they been hardened by REBUILD? How many millions of dollars in damages could have been avoided?

### HOME HARDENING BY THE NUMBERS

Estimated REBUILD Costs	Per Home	85 Homes Destroyed
Government (75%)	\$6,900	\$586,500
Homeowners (25%)	\$2,300	\$195,500
Total Average (100%)	\$9,200	\$782,000

It will be quite some time before we know the full cost of the damage done by the tornadoes, but we know it will far exceed the estimated figures above. What we can be absolutely certain about is that REBUILD's home hardening measures are extremely effective, from both a cost and a loss avoidance standpoint. The State of Florida Division of Emergency Management completed an independent inspection and came to the same conclusion.

More hurricanes and tornadoes are coming. REBUILD's Wind Mitigation Program has the potential to save thousands of homes, billions of dollars, and even lives.

**“The house next door, the roof came off. They tell me it probably won't even be rebuilt. The same amount of wind came through here, and this house is intact. If we hadn't had REBUILD Northwest Florida, I might not even be here.”**

— Survivor of the Pensacola tornado whose REBUILD-retrofitted home took a direct hit

See Tornado Damage Testimonial Video: [rebuildnwf.org](http://rebuildnwf.org) home page  
Drone footage of damage site: [Vimeo.com/156957028](https://www.vimeo.com/156957028) Credit: John Oldshue, Southeastern Sky.com



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