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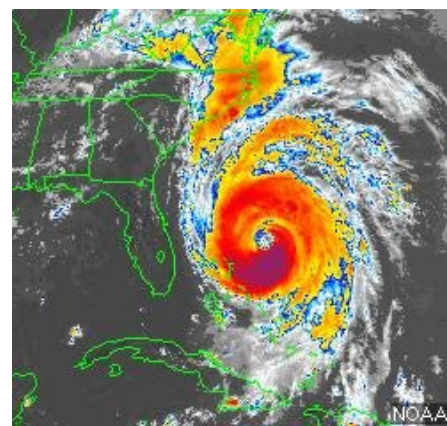
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Understanding the Risks

Hurricanes are well known for causing damage to homes and property, for destroying family keepsakes, and for disrupting family life. But, as this website explains, you can take action to protect your home. First, though, it helps to learn a little more about the nature of hurricanes. These large, usually slow moving storms bring high winds and wind driven rain that can impact your home from a wide range of directions if the eye of the storm passes nearby. As a result, the wind affects different homes in profoundly different ways, depending on their design, location, and neighboring structures. In addition, hurricanes can cause storm surge that affects coastal properties and rain induced inland flooding.

The Power of the Wind: Among other things, the wind can knock out or burst open windows and doors, rip off roof sheathing (decking) and destroy gable end walls. Over-hanging eaves and gable end rakes, extended awnings, open porches, and other features that tend to trap air beneath them are particularly susceptible to being damaged or torn off the building during a hurricane. Wind-borne debris from neighboring buildings, including shingles and tiles, can break windows and damage roof coverings and walls. With or without the help of wind blown objects, the wind can push in a garage door,



Hurricane Hugo, 1989

(click image for larger version)



Hurricane Katrina, 2005

(click image for larger version)



window, or door on the windward side of the house and move inside, increasing uplift forces on the roof (in some cases doubling them). In fact, these powerful forces can literally lift the roof right off of the house. When wind forces break open part of your home, wind and water enter your home and damage to the interior escalates dramatically. Because older less wind resistant homes tended to break open regularly in high winds, a lot of the focus over the past couple of decades has been on strengthening the structure and load resisting connections in homes.

Homes Damaged by Hurricane Andrew in 1992

(click image for larger version)

Pervasive Water: At nearly the same level of importance as direct wind damage is the issue of **water intrusion**. Direct wind damage to the structural elements of homes built to high wind standards has been reduced; however it has become clear that just improving the structural integrity of your home is not enough. Wind driven water intrusion can cause catastrophic damage to the walls, ceilings and interiors of homes that leads to major disruption of households. Furthermore, water



Drywall damaged by water intrusion

(click image for larger version)

intrusion can be of particular importance to you as a homeowner because some insurance policies do not cover water intrusion unless it originates from damage to the roof, walls, windows or doors of your home. When wind speeds get above 60 mph, rain water is driven against the exterior of your house with great force. Whenever water builds up on the exterior wall surface and there is lower pressure on the inside of your house, the water can penetrate in large quantities (quarts and gallons) through cracks, holes and gaps in the siding and around windows and doors. When this happens for hours at a time and usually there is no electricity available to dry out homes using air conditioning or dehumidifiers, the resulting damage and mold can be as devastating as wind damage. Water intrusion has recently become recognized as the major issue it really is. While going through this website take note of the water intrusion issues as much as you do the direct wind load related issues.

Protecting your Home: The most important precaution you can take to reduce damage to your home and property is to protect the areas where wind can enter. According to research into hurricane induced damage, it's important to strengthen the exterior of your house so wind forces and debris impacts do not create large openings and so that wind driven rain does not cause water intrusion. You can do this by protecting and reinforcing these six critical areas:

- Roof
- Windows
- Doors
- Garage doors
- Soffits and attic vents

- Gable ends

A great time to start securing - or retrofitting - your house is **now!** Don't wait until a hurricane is threatening before you take action. By taking actions sooner than later you can get things taken care of in a less stressed environment and complete them in a better way than when you are being threatened by an impending hurricane. Combining retrofitting with other maintenance work , home improvement projects or building an addition can reduce the costs of the retrofits. In many cases, your local building code will require that your work conform to certain requirements. And, although you may not need to comply with current code requirements on the rest of your house, this may be a good opportunity to strengthen critical parts or connections. Remember: building codes reflect the lessons we have learned from past catastrophes and represent **minimum** levels of protection required for all new construction. Contact a design professional (architect or professional engineer) or your local building code official to find out what the requirements are for your home improvement projects.

Roof damage is by far the greatest risk that your home faces when a hurricane strikes. Well over 90 percent of the homes that are damaged in a hurricane suffer damage to the roof and particularly to the roof covering. The second greatest risk is that wind and water will enter your home through damaged or leaky doors and windows. This includes entry doors, sliding glass doors, garage doors and all types of windows. The highest priority should be placed on reinforcing, protecting or replacing double-wide (two car) garage doors (probably the largest and one of the most vulnerable openings), double entry doors such as French doors, and large windows. Failure of the larger units can allow pressures that would have built up on the doors or windows to enter the house and dramatically increase the loading on the roof structure, interior walls and other exterior walls. Consequently, it is generally recommended that you start with protecting the largest doors and windows first and then work your way down to the smaller units.

Leaks: Cracks around windows and doors are areas where large amounts of water can enter your home; even without structural failures. Additional potential leak areas are: gable end attic vents, roof vents and soffit vents, along with even small holes or cracks around dryer, kitchen and bathroom vents or places where pipes and cables stick through the walls. Many homeowners do not know that winds and rain outside the center of the storm can still be strong enough to create a lot of damage to ageing or poorly installed roof coverings and can produce enough water intrusion to create substantial damage and disruption of households.

The issues discussed in the preceding paragraphs are usually the ones that make the greatest difference to the most people's houses. This is because more people experience high winds and wind driven rain from the edges of the storm than the number who experience the most intense winds near the center of the storm. However, if your goal is to give your home the best chance of surviving the heart of an intense hurricane, then you need to concentrate a good part of your efforts on retrofits that ensure that the parts of the house are well connected together. Generally, homes built

under high wind standards developed in the mid 1990's are much better connected than those built in the 1970's and 1980's. If your home is built in an area where these newer standards have not been adopted or it was built before the new standards were adopted, then it is more likely you'll have roof sheathing lifted off and further suffer catastrophic damage that could endanger anyone inside and dramatically slow your recovery after the storm.

Assessing the Risks

An important part of assessing the hurricane risks you face is to find out the **design wind speed** for the area **where your house is located**. Two different scales have been used over the years to define design wind speeds. The latest codes all use gust wind speeds and all wind speeds referred to on this website are gust speeds with an assumed averaging time of 3-seconds. Building codes used in Florida before 2001 used something called a fastest-mile wind speed that has an averaging time of between about 45 and 20 seconds, depending on the wind speed. You can check with your building department to determine what design wind speed was being used when your home was built. If it is a fastest mile speed, add 20 to get close to the wind speeds used in this guide.



These design wind speeds are determined based on balancing the risk of high winds in every area of the state. In general terms, the design wind speed for a given location is the wind speed that has approximately a 1% chance of being met or exceeded in any given year. Keep in mind that this does not mean that your home will not experience wind speeds greater than the design speed published in the code, it merely has less of a chance than areas with higher design wind speeds. The following map shows the design wind speeds currently published in the Florida Building Code.

(click image for larger version)

If the design wind speed in your area is:

120 mph or higher	then you have a high risk for hurricane wind damage and water intrusion
Between 100 and 120 mph	then you have a moderate risk for hurricane wind damage and high risk for water intrusion
Between 90 and 100 mph	then you have a low risk for hurricane wind damage, but moderate risk for water intrusion (high risk of water intrusion in slow moving hurricane)

In addition to risk based on design wind speed, recent research conducted for the Florida Department of Community Affairs has demonstrated that terrain conditions in inland locations can have a dramatic effect on the risk of hurricane damage. If you live in an area with few trees and large open spaces, your home is at a much greater risk of wind borne debris impact than homes built in areas with trees. However, if you live in an area with even light to moderate tree coverage, which reduces your risk of wind borne debris impact, you have increased risk associated with trees potentially falling and damaging your home.

A careful review of the damage that has happened over the years in numerous hurricanes reveals patterns that can be used to help set priorities.

1. **Roof Coverings:** Roof covering damage is observed in 95+ percent of all homes that suffer significant damage and loss.



(click image for larger version)

2. **Roof Sheathing:** Wind can pull sheathing off roofs when the sheathing is not nailed to high wind standards.



(click image for larger version)

3. **Broken Glass:** When gust wind speeds climb above 120 mph, about one third of homes without window protection suffer broken glass to at least one window.



(click image for larger version)

4. **Double Entry Doors:** When gust wind speeds climb above 120 mph, older (not current code approved) double entry doors may burst open, allowing wind and water to enter the home.



(click image for larger version)

5. **Garage Doors:** Two car garage doors that have not been braced or are not high wind rated, frequently fail as gust wind speeds climb above 120 mph.



(click image for larger version)

- Anchorage of Roof Structure:** Homes that lose the entire roof frequently don't have hurricane straps holding down the roof structure and almost always have a window or a door that is broken open on the windward side of the home which has allowed wind pressures to increase significantly inside the house.



(click image for larger version)

- Soffits:** Vinyl and aluminum soffits are frequently installed so poorly that they are not able to resist positive and negative (suction) pressures created when gust wind speeds exceed about 100 mph. Soffit damage can also occur in thunderstorms, especially to upper soffits on a two story house. When soffit panels become dislodged, strong winds can cause rain to blow up into the attic where damaging amounts of water can enter the house.



(click image for larger version)

8. **Attic Ventilation:** Ridge vents, off ridge vents and gable end vents can let a lot of water into the attic which can lead to the collapse of ceilings in homes that otherwise look fine from the outside.



(click image for larger version)

9. **Gable Ends:** Gable end walls over about 5-feet tall at the peak are a frequent area where damage is concentrated. The roof sheathing may be lifted off at the gable end, opening up the attic to wind and rain. The bottom of the gable wall may break loose from the wall below. The members used to support the gable end wall exterior finish and/or their connections may fail. Typically, houses built in areas where the high wind building code provisions developed in the early 1990's have not been adopted and followed, have gable end walls that are not properly anchored to the top of the wall below and the wall has not been properly braced. If this wall and/or gable end is pulled away from the house by the wind, it will open up the entire end of your house.



(click image for larger version)

- Porch Roofs:** Most porches and overhangs are poorly anchored and can get torn off the house, causing damage that extends well into the house. In many cases this will result in catastrophic damage to the house. The uplift forces on these wing-like roofs can be tremendous compared to the ability of their supporting posts, and especially the connections to the posts, to hold them down. Don't be deceived by seeing straps or other connectors. They are frequently undersized and should be checked for adequacy.



(click image for larger version)

- Aluminum Structures:** Aluminum structures such as carports and pool enclosures are often inadequately anchored, braced and connected. They are often the first structures to be blown down and then blow into your house and possibly your neighbor's.



(click image for larger version)

- 12. Surroundings:** While nearby buildings may help break up the wind by acting as shields, they can also channel the wind so that it becomes more intense in some areas. Furthermore, other buildings can be a source of debris that is picked up by the wind and hurled at your windows and doors. As long as trees are still standing, they can have an overall calming effect by slowing down the wind near the ground. However, they can also be a source of trouble by shedding branches which become wind-borne debris and if they are too close they can fall on your house. Tall pine trees are one of the most dangerous sources of tree damage as they have often sliced through roofs and walls. However, the fact that an oak tree has survived for a century or more is no guarantee that it won't fall on your house. It has been seen many, many times.



(click image for larger version)

Roofs: Tile roofs generally perform better than pre FBC/IRC (Florida Building Code/International Residential Code) shingle roofs of the same age until gust wind speeds exceed about 120 mph. At that point, experience with existing roofs indicates that they both start blowing off. If the shingle roof is covered with one of the newer high wind rated products, and it was installed properly there is a reasonably good chance that it will survive (at present, the newer high wind rated roofs have only been available for a few years so it is not possible to know how well they will hold up in the long run). Also, if the tile roof is well attached with mechanical fasteners (screws or nails), the ridge and edge tiles are mechanically fastened to a support structure such as a ridge board, and the tiles are not hit by flying debris, there is a reasonable chance that it will survive. It will take a professional roofer to determine how adequately the tiles are attached.

While replacing a tile roof can cost two to four times as much as replacing a shingle roof, the typical underlayment for a tile roof is much more apt to stay on the roof and is more resistant to water penetration after the roof covering is damaged than that applied under a shingle roof. Consequently, houses with damaged tile roofs are less likely to suffer damage to the interior from water entering from the top surface of the roof than houses with damaged shingle roofs. The difference in

performance is because roof tiles are usually just a covering that has been placed over a weatherproof roof membrane whereas shingles are the weatherproof roof. When shingles are lost, the weatherproofing is lost. The exception is that when tile are over a ridge that has vents cut into the roof that serve as a way of venting (cooling) the attic. Losing those tiles can leave a hole for rain to enter the house.

Metal roof coverings are gaining a reputation as being resistant to high winds. However, the performance depends on how the metal is connected to the structure. The metal edges and ridge covers are somewhat more vulnerable than the rest of the metal roof. The underlayment is typically the same used under shingles, so it can easily be damaged if exposed by loss of the metal roof covering.

If you have an older shingle roof, one of your top priorities should be taking steps to reduce the risks that it will be damaged in a hurricane. Loss of shingles could lead to water flooding into the house from above, resulting in collapsed ceilings, water soaked walls and everything inside the house. If not dried out right a way mold is likely to develop and require gutting of the house to remove the remaining drywall on the ceilings and walls. This damage is of nightmare proportions.

While the roof covering is the first line of defense against the storm, the switch from wood planks to structural wood panels (plywood and Oriented Strand Board - OSB) in the 1970's was done without adequate requirements for anchoring the panels to the trusses and rafters. In addition, a large number of homes were built in the 1980's and 1990's where the sheathing was stapled to the trusses and rafters instead of using nails. The use of staples has been shown to be one of the poorest connections for roof sheathing. Unfortunately, it is still being used in some hurricane prone regions, although it is now prohibited from use in new construction and remodeling of roofs in Florida. Loss of even one piece of roof sheathing can result in internal damage to your home and contents that is nearly ten times the cost of the damage to the exterior of your home. Consequently, one of the items in the checklist is to try and determine what kind, size and spacing of fasteners (nails or staples) is used to attach the roof deck to the trusses or rafters. The roof deck attachment should always be brought up to the latest code requirements for your area or by simply re-nailing the deck with ring-shank nails as described in this guide. The greatest risk of losing roof sheathing is on houses with gable ends where the sheathing has been attached with staples and is compounded by inadequately anchored overhangs. Click on [What To Do When Re-Roofing](#) to learn how to improve your roof sheathing performance when re-roofing your home. If it will be some years before you re-roof and you have these features, the website does give some suggestions for stop-gap measures in [Enhancing Roof Sheathing Attachment Strength](#).

Windows and Doors: Protecting windows and doors (including sliding glass doors and garage doors) is an important part of protecting your home, your belongings, and your roof in a hurricane. Your home is particularly vulnerable to windows being broken by windborne debris if your design wind speed is 120 mph or greater, you live in a neighborhood without dense tree cover, and you have neighbors with tile, gravel or older shingles

on their roofs. Also, if your home is an older home or was built in an area where they have not been following a modern high-wind building code, you may not have hurricane clips or straps holding your roof structure to your walls. If that is the case, window and door protection may make the critical difference between losing your roof and keeping it on. Installing shutters over windows and doors can protect them from the impacts of windborne debris but may not keep the doors and windows from bursting open from wind pressure if they are weak or poorly anchored to the walls of the house.

Keeping Water Out: A high quality wind resistant roof covering attached to a well anchored roof deck and protection of windows and doors are the most critical elements in reducing your chances of having extensive water damage. However, even if these are in place, other sources of water leaks can combine to overwhelm the ability of your wall system to resist prolonged exposure to wind driven rain from a slow moving hurricane. A tremendous amount of water can be forced through cracks and holes in your wall and around windows, doors, vent holes and places where cables or pipes pierce your exterior wall. The remedies that include caulking and sealing are not very difficult to do and can be accomplished pretty quickly. Consequently, these actions should be given a reasonably high priority as you head into hurricane season. Caulking and sealing is a good practice, even if you have storm panels in place, because wind driven rain can get behind most if not all types of panels.

Structural Retrofits: Except for improving the anchoring of porch roofs and overhangs, or bracing gable ends, carrying out structural retrofits that will provide a meaningful upgrade in the strength of your home are usually very expensive and difficult to accomplish. To be effective, they normally require opening up the exterior or interior wall surfaces although some can be done by opening up the soffit area. Usually, structural retrofits that involve improving the anchorage of the roof structure to the walls, strengthening the connections between walls at the corners of your house, upgrading the wall strength and resistance to flying debris, and improving the anchorage of the walls to the foundations are best accomplished at relatively small additional cost when you remodel, re-side your home, or when you are rebuilding after your home has been damaged.

Food for Thought

This website contains suggestions for a number of home improvement projects. If you do them correctly, you can greatly reduce the extent of hurricane damage. However, nothing can guarantee total protection. Please follow the instructions of your local authorities if told to evacuate, even if you have completed these projects. More people die from storm surge and flooding in hurricanes than die from wind induced damage. There is a wise old saying, "run from the water and hide from the wind" that is still appropriate today. We have talked with homeowners who bought some of the latest impact resistant products and then proceeded to watch the storm through the protected openings; they watched their neighbors swing set pull out of the ground and fly towards their house. This is not a good example of hiding from the wind - you want to put as many solid walls as possible between you and the exterior wall facing into the

wind during the hurricane.

Also, remember that this website provides general recommendations that may need to be modified or refined depending on the construction details for your house. You or a building contractor may be able perform many of the retrofits outlined in this guide. However, if your house is complex or unusual, or if you are uncertain about how the ideas presented here apply to your house, you should consult with your building department or a registered design professional to determine what may be appropriate for your particular situation.

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