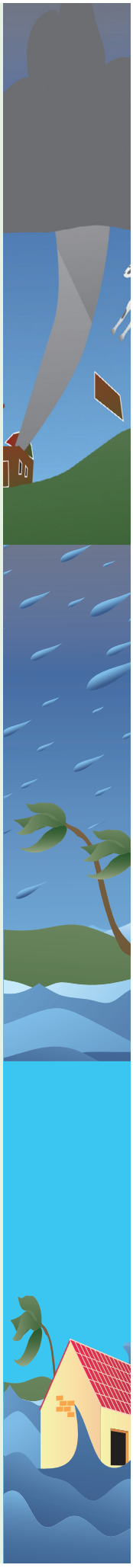
Part 4
Protecting Your Property



Protecting your property and protecting your family go hand in hand. You don't have to be blown away when a natural hazard strikes. It's never too early to prepare and you can take several basic steps right now to protect your family and your home from disaster. By strengthening your house, you can reduce the risk of damage to your home and possibly reduce insurance premiums. Additionally, you may be able to shelter in place during a minor hazard event.

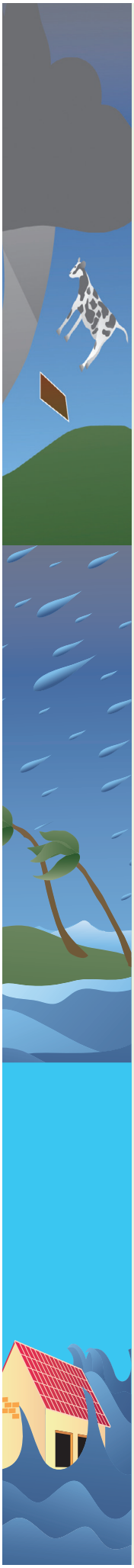
The amount of protection your house can provide from a natural hazard is limited by a number of factors which you should very carefully consider before taking shelter in your home:

1) The Severity of the Hazard Event. Protecting your home against a tropical storm or Category 1 hurricane is much easier than against a major event. For stronger storms, eliminating all damage is difficult, so the main goal is to significantly lessen the amount of damage which could occur. Each and every small improvement you invest in your home can make a difference. The more small improvements you make to your home, the less likely there will be severe damage to in minor events.

2) Your Location. Even though a hurricane may be a Category 1, you could experience much stronger wind. Being on a ridge, for example, amplifies the wind speed. Additionally, if your home is close to the open beach, a large bay, or a large marshland, the force of the wind will be much greater than if the house were surrounded in all directions by buildings, other homes and/or trees.

3) How Your House Was Built. The building codes adopted by many communities require new houses to have hurricane clips that tie the roof to the wall and other connectors that tie the wall to the foundation. This is known as a "continuous load path connection." Because of this requirement, many of the newer homes are generally much stronger than those built before this requirement was in effect.

4) How Your House Is Maintained. Maintenance of your house is important. Painting the exterior every five years protects the wood



and prevents rot, which can weaken the structure. Termites can also weaken a wood-framed house. If the wood in the house is rotten or has severe termite damage, it will be more difficult, or even impossible, to strengthen the home. So, it is important to maintain your house by periodic painting and eliminating termites. Proper maintenance will extend the life of a house in more ways than one.

5) How You Strengthen Your House. Even if your house was not built with hurricane clips, there are many small steps and some major ones that can be taken to retro-fit or address how to strengthen your existing home.

The remainder of Part 4 concentrates on many of the options to consider when strengthening your home, whether you're designing a new home or planning a retro-fit of an existing home, including:

a) Roof-to-wall connections
b) Wall-to-foundation connections
c) Hurricane clips with additional foundation connection
d) Stronger connectors than those required in the current building code
e) Protection for windows, doors and garage doors
f) Improving the connection of the roof-sheathing to roof-framing members (rafters or trusses)
g) Reinforcing gable ends with bracing
h) Reinforcing weak roof framing members and connections of auxiliary structures (porches, carports, storage rooms)
i) Alternate sources of back-up electricity
j) Flood Retro-Fit measures (strengthening existing foundations and piers for flood forces, elevating mechanical equipment, elevating structures

You may be able to perform the work for many of these measures. However, if the work is beyond your capabilities, consider hiring a structural engineer and/or architect to plan the strengthening/retro-fitting program for your home and a licensed contractor to do the installation/construction. Even if you do this work yourself, it is best to contact one or more of these professionals first to obtain guidance and details specific to your house.

The complete topic of retro-fitting existing homes has been tackled by numerous non-profit organizations and governmental agencies and the

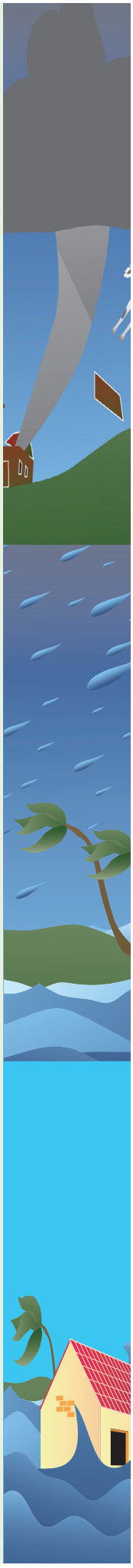
result of their hard work fills many reports and several excellent videos. The following sources can give you more information:

The Institute for Business and Home Safety (IBHS) website has numerous articles, reports and videos which are extremely informative and explain preventative measures which reduces losses from all natural hazards, including hurricanes www.disastersafety.org.[12]

The Mitigation Directorate of FEMA is continuously researching hurricane resistant designs and building methods for the construction of residences and the performance of residences which have been subjected hurricanes. All of the government publications are available for free and most can be downloaded conveniently from the FEMA website: www.FEMA.gov and from links at their Rebuild Smarter and Stronger page: www.fema.gov/rebuild/smart_strong.shtm.[13]

4.1 CREATING THE WIND- AND RAIN-RESISTANT ENVELOPE

During a hurricane, it is very important to protect the envelope of your house from wind and rain. The wind from a hurricane attacks any weaknesses in the roof. Once a weakness is exposed, adjacent areas can be more easily damaged and peeled away. Windows can serve to protect that envelope, unless they shatter, which is almost certain to happen if they are unprotected. Taping your windows will not protect that envelope. A broken window during a hurricane can be devastating in several ways: besides the incoming hurricane-force wind and torrential rain in your living room, there is shattered glass and debris from outside flying in. It can make walking in your own house hazardous. Even more importantly, there is the problem with internal pressurization of your house (see Figure 4-1).



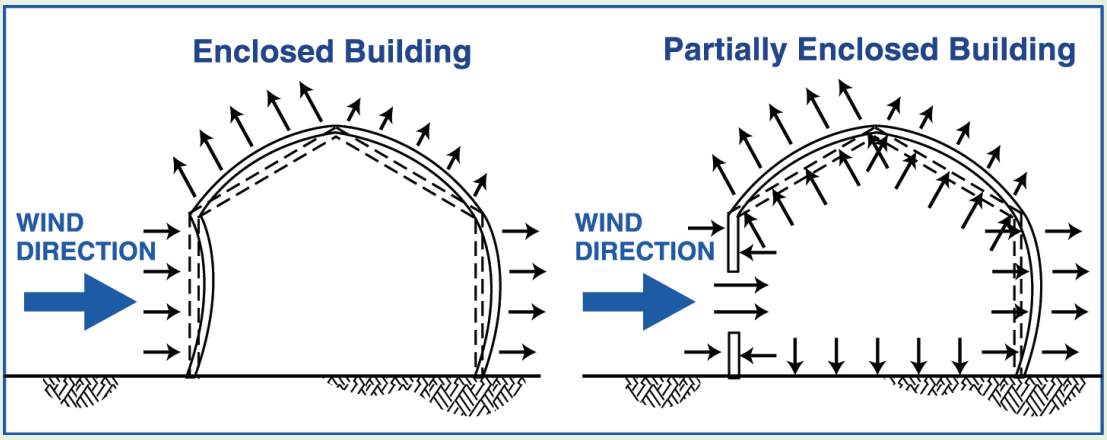


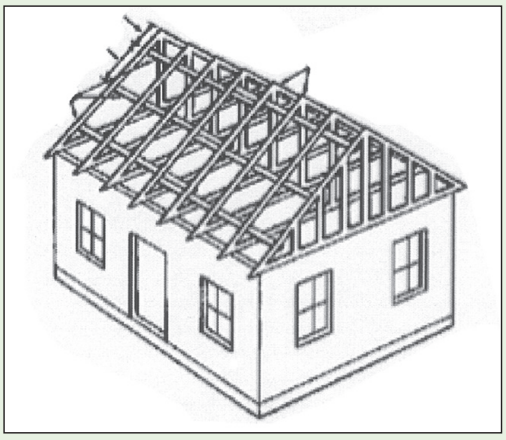
Figure 4-1. The diagram on the left shows a structure with the wind- and rain-resistant envelope intact. Pressure on the walls and roof comes from the outside only. In the diagram on the right, the structure's wind- and rain-resistant envelope has been breached due to a broken window. Now, pressure on the walls and roof comes from the outside and inside. The total amount of pressure on the roof and leeward wall increases significantly and can lead to the roof flying off and complete structural failure. Source: FEMA's Coastal Construction Manual (2000).[14]

Some reports indicate that a door or window breach can potentially double the uplift forces on your roof and can significantly increase the chances that your roof will lift off.[15] This is why FEMA indicated in their assessment report that breach of the building envelope and subsequent internal pressurization led to progressive structural failure for many houses.

4.1.1 Keep Your Roof On

Roof Framing/Truss Bracing

It is possible to significantly strengthen your roof by providing lateral and diagonal bracing to the rafter or trusses. This is particularly important for houses with gable-end roofs. This bracing can be done simply with 2-inch by 4-inch boards (2 x 4's) purchased at a local hardware store. Figures 4-2 and 4-4 are from the FEMA brochure "Against the Wind" (FEMA 247) which



In Figure 4-2, the trusses are built with a peak at the ridge line of the house. The trusses at the end of the house form an A-shaped pattern known as a gable end. During a hurricane, the gable end is subject to great forces from the wind and is likely to tip over, collapsing the other trusses in a domino fashion. Source: FEMA's "Against the Wind" brochure 247.

can be downloaded from FEMA's website www.FEMA.gov.

For lateral bracing, 2 x 4's are attached to the trusses that run the length of the roof. The 2 x 4's overlap over two trusses. Braces should be 18 inches from the ridge, in the center and at the base, about 8 feet to 10 feet. apart. You or a professional can do this work.

Figure 4-3. In this application of lateral bracing, the 2 x 4's are 18 inches from the ridge and connect to horizontal members that attach the opposing trusses. Not all roofs will have the horizontal members. The 2 x 4's are connected with two #14 3-inch screws (A) and overlap over two trusses (A and B). The end is connected to the gable end with an angle or L bracket (C).

Another important type of bracing for your gable end involves making diagonal braces (Figure 4-4). Diagonal braces provide additional support against collapse of the gable end.

Hip-style roofs do not need as much bracing, as they are aerodynamically superior and they have the bracing built into the design of the structure. While gable end roofs have a flat end that is A-shaped, hip-style roofs have all four sides of the roof sloping towards the center of the roof.

An additional source of information regarding roof bracing can be found at the IBHS web site www.disastersafety.org.[16] There is a video on their site, called "Gable End Retrofit" which explains many of the details for reinforcing your roof and gives several construction tips.

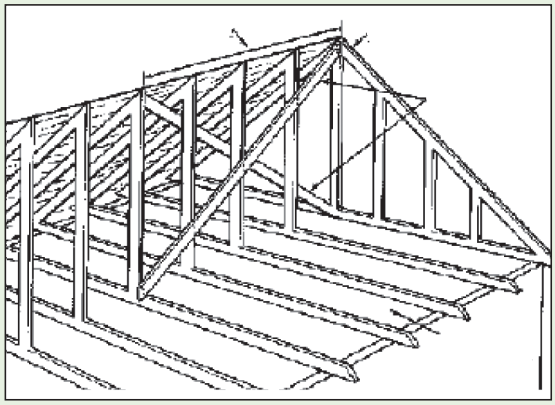
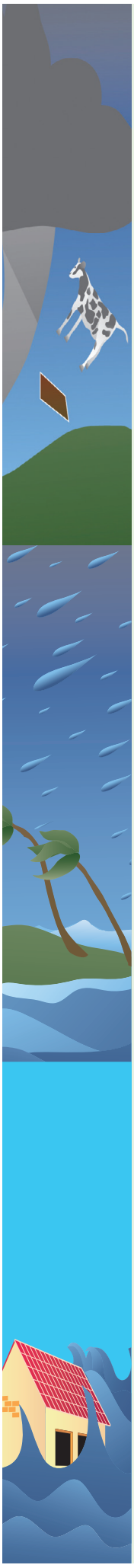


Figure 4-4. Diagonal braces form an X pattern from the top center of the gable end to the bottom center of the fourth truss and from the bottom center of the gable end to the top center of the fourth truss. The same screws as for lateral bracing are used. Source: FEMA's "Against the Wind" brochure 247.



Contiuous Load Path Connections

The continuous load path connection is analogous to a chain: both are only as strong as their weakest link. Historically, the weakest link has often been the roof-to-wall connection. Thus, the hurricane clip was created. The concept of continuous load path connection is illustrated in Figure 4-5. This

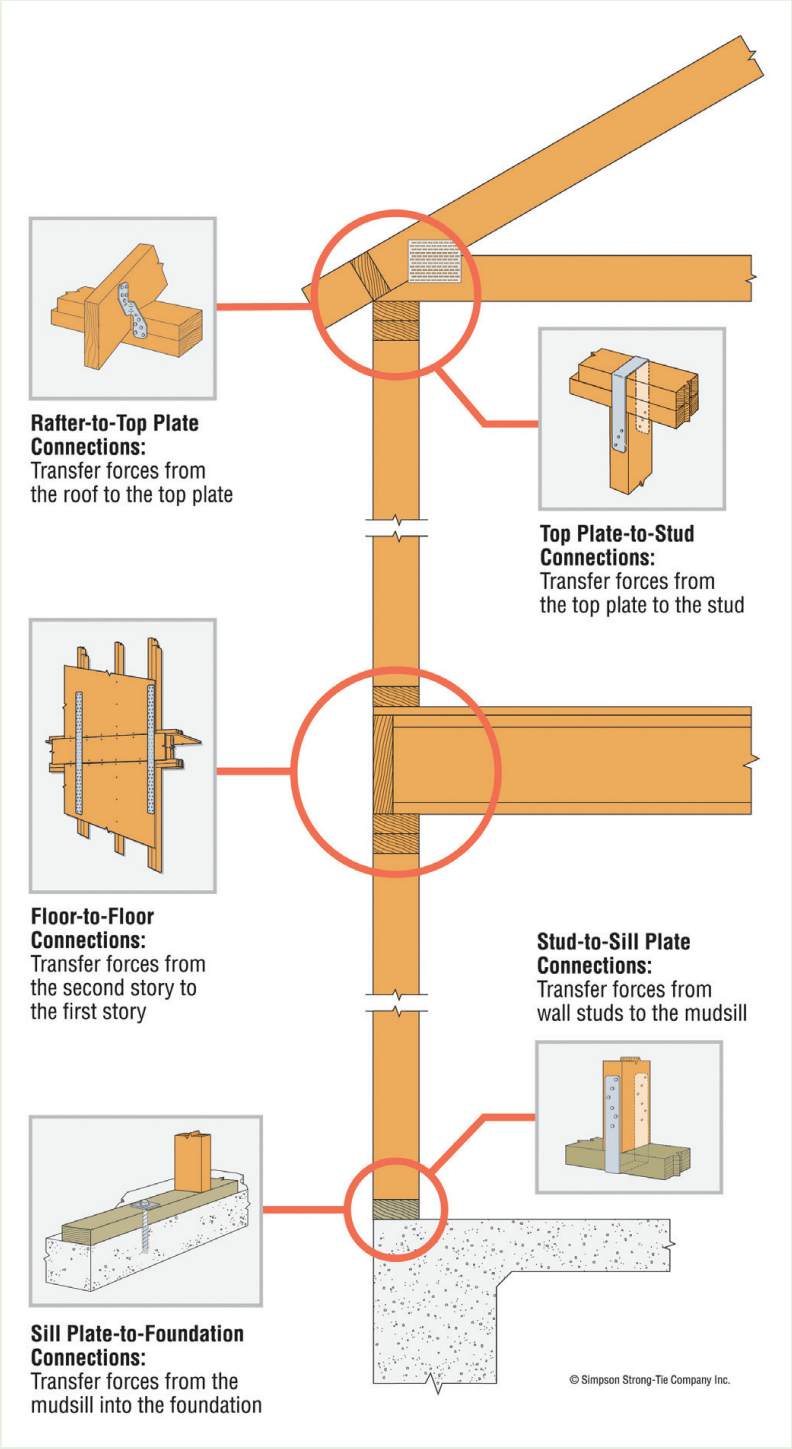


Figure 4-5: Continuous load path connection ties: (i) the roof to wall typically with hurricane clips (A) and plate ties (B); (ii) the wall of a higher story to the wall of a lower story with straps (C); and (iii) the wall to the foundation with plate ties (D and anchors (E). For a single story house, the connections at (C) are not needed. These connections are in all new houses (Table 4-1). Older homes usually will not have these features. In many cases, retrofit can easily be done for certain portions. Source: Simpson Strong-Tie

connection ties your roof to your house's foundation and helps to keep the roof from blowing off during a hurricane.

Naturally, all houses have some connection from the roof to the foundation, otherwise they would fall apart. However, in response to recent hurricane damage much stronger connections are now required in the form of straps, anchors and hurricane clips to protect against hurricane winds, as depicted in Figure 4-6.

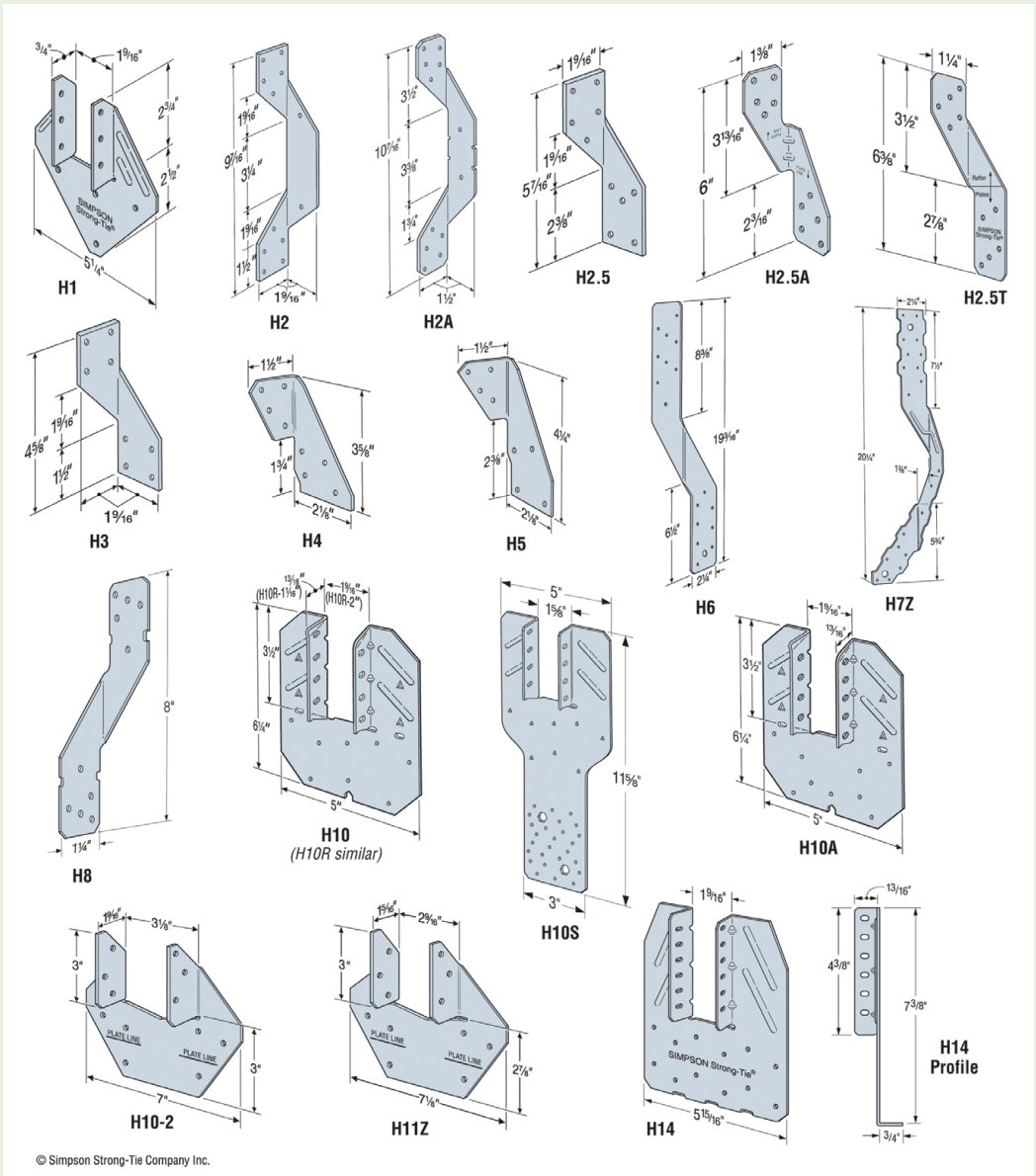
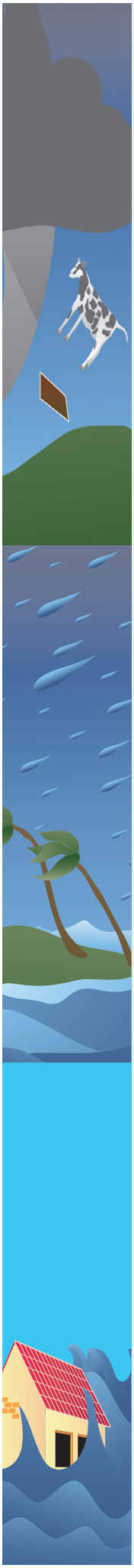


Figure 4-6. There are many different types of hurricane clips. Your licensed architect, structural engineer, or contractor can tell you what is suitable for your house and for the amount of protection you want. Source: Simpson Strong-Tie.



For many homeowners, even minor damage of 15 percent or less can be an extreme hardship. After Hurricane Iniki in Hawaii in 1992, FEMA conducted an assessment of building performance and determined the following:

> "Incomplete design and construction for load transfer and improper connections, especially between roof and walls, were found to be the most important factors causing structural failure of buildings due to uplift wind forces."[17]

Recently built houses are required to have a complete load path connection. For older houses, it is possible to retrofit to add components of the connection (see Figures 4-5 and 4-6). Each house is different but, in general, it will be easier and less expensive to put in hurricane clips than to do the foundation connection. Check with a licensed structural engineer or architect to determine what is feasible for your house.

It is preferable to do both the roof-to-wall connection and the wall-to-foundation connection. However, if the wall-to-foundation connection is too difficult or expensive because of the way your house was built, installing only the roof-to-wall connection is better than doing nothing. Remember, the weakest link for many homes is the roof-to-wall connection and thus the hurricane clip will make that weakest link significantly stronger.

Figure 4-7. This is the popular H2.5 hurricane clip installed during new construction of houses. Five nails are hammered into the lower beam (or top plate) and five more need to be used for the roof (truss-rafter) connection. A hurricane clip is required for each truss-rafter. Upon completion of this structure, the hurricane clip will be hidden from view. This particular clip costs 30 cents. For less than a dollar in material cost, stronger ones can be installed for both new and retrofit applications.

Synthetic Roof Underlayment

Until the twenty-first century, most residential sloped roofs received a layer of asphalt-saturated felt building paper underneath the roofing material.

Mimicking the attributes of housewraps, synthetic roof underlayments (Figure 4-5) are now available to serve the same function as a secondary weather barrier with better resistance to tearing, moisture and ultraviolet rays than traditional roofing felt.

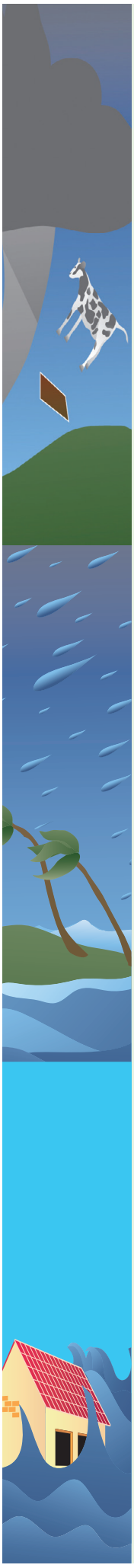
Figure 4-8. Synthetic underlayments are typically made from polypropylene, polyester or fiberglass fabric which weighs less than felt building paper, can be manufactured with anti-slip surfaces and can withstand exposure to the elements for six months. Source: Carlisle Residential

Recent natural disasters and subsequent rebuilding efforts highlighted the versatility of synthetics as roof underlayment by providing a real-life test environment. After several hurricanes ravaged southern coastal areas of the United States, many people were forced out of their damaged homes. At the same time, large numbers of homes required quick roof repair and "drying in" to minimize further damage due to water intrusion. With limited resources, contractors triaged homes, repairing the critical components and installing synthetic underlayments as temporary roofing. The underlayments performed better than FEMA's blue tarps and did not require removal and discard when the new shingles were installed.[18]

4.1.2 Keep Water Out

Flood Prevention

Protecting your property from flooding can involve a variety of actions, from inspecting and maintaining the building to installing protective devices. Most of these actions, especially those that affect the structure of your building or their utility systems, should be carried out by qualified maintenance staff or professional contractors licensed to work in your state, county, or city. The most important information to know about your home when considering flood prevention techniques is the base flood elevation (BFE) shown on the Flood Insurance Rate Map (FIRM) for your community.



The best way to protect a structure and its contents from flood damage is to seal the building so that flood waters cannot enter. This method, referred to as "dry floodproofing," encompasses a variety of measures:[19]

- Applying a waterproof coating or membrane to the exterior walls of the building
- Installing watertight shields over doors, windows and other openings
- Anchoring the building as necessary so that it can resist floatation
- Installing backflow valves in sanitary and storm sewer lines

Figure 4-9. FIRM map in Harrison County indicating open coast BFE. Source: FEMA

- Raising HVAC and electrical system components above the flood level
- Anchoring fuel tanks and other storage tanks to prevent flotation
- Installing a sump pump and foundation drain system
- Strengthening walls so that they can withstand the pressures of flood waters and the impacts of floodborne debris
- Building with materials that can withstand flood waters for at least 72 hours (examples: concrete, ceramic tile, pressure-treated lumber, steel, metal, brick, epoxy paint, foam and closed cell insulation)
- Ensuring wells are properly constructed to avoid contamination from flood waters

Keep these points in mind when you dry floodproof:

Dry floodproofing is appropriate primarily for slab-on-grade buildings with concrete or solid masonry walls. Concrete and masonry are easier to seal, more resistant to flood damage and stronger than other conventional construction materials.[19]

If you dry floodproof a "substantially damaged" or "substantially improved" building (as defined by the National Flood Insurance Program [NFIP] regulations) or a newly constructed building and if the building's lowest floor (including any basement) is below the BFE shown on the FIRM map for your community, your dry floodproofing must be certified as providing protection from the BFE. To obtain this certification, you must floodproof your building to a height at least 1 foot above the BFE. Check with your local floodplain manager or building official for more information.[19]

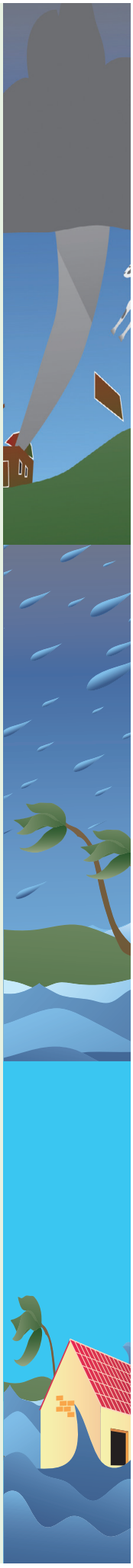
The height of your dry floodproofing should not exceed 3 feet. The pressures exerted by deeper water can cause walls to buckle or collapse. Before you use dry floodproofing to protect against greater flood depths, have a structural engineer evaluate the strength of your walls.[19]

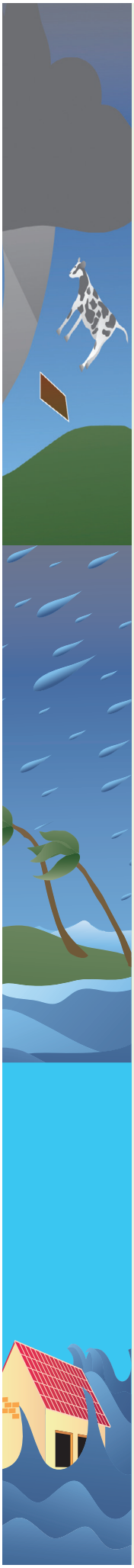
If your dry floodproofing measures require human intervention before flood waters arrive, such as placing shields over doors and windows, you should have an operations and maintenance plan that describes all the actions that must be taken and lists the persons who are responsible. It must also include a schedule of periodic maintenance that states how often the dry floodproofing measures will be inspected and who will perform the inspections.[19]

The cost of individual dry floodproofing measures will vary with the size, condition and use of your building; the dry floodproofing height; and the extent to which you use contractors and engineers.[19]

In many cases flooding on a property can be caused by poor drainage. If this is the case, it may be of great benefit to address the drainage issue with the professional advice of a licensed civil engineer.[19]

An excellent source of information for protecting your property from flooding is found in the FEMA's Coastal Construction Manual available by search on FEMA's website: www.fema.gov/ or refer to the "Protecting Your Property from Flooding," found at: www.fema.gov/plan/prevent/howto/index.shtm#4.[20]





Window Coverings

Protection of your home's envelope from breaches during a windstorm is critically important, particularly its vulnerable windows and doors.

If your home is located in a windborne debris zone (any location where the basic wind speed for code purposes is 120 mph or greater), it is important that window coverings not only withstand hurricane force winds, but also withstand impacts. The usual standard for impact resistance is known as the "Large Missile Impact Test" as defined by several similar norms. Essentially, these tests determine whether a given shutter can withstand the impact of a nine-pound 2 x 4 fired at the shutter at 30+ mph, followed by cyclic wind load testing.

Coverings that are installed should be tested and approved to meet industry standards for hurricane impact. Check with the manufacturer. Always use only licensed contractors and reputable dealers.

The International Hurricane Protection Association (a trade association group comprising manufacturers, contractors and other industry professionals) has several tips regarding selection of products, selection of installing contractors and other useful information on its website: www.inthpa.com.[21]

Below, several types of opening protection systems are generically described. Within each category, numerous reputable manufacturers provide different products, each with individual features, benefits and cost. The prices shown are estimates for installed costs and represent local and nationwide averages as of May 2010. Pricing will vary between providers and will change over time. We encourage you to consult with a competent contractor specializing in supplying and installing these systems.

Roll-down Shutters

Roll-down shutters represent the window covering type that is easiest to deploy and offers the best overall protection features (Figures 4-10 and 4-11). These are permanently attached to the building. The shutter consists of a movable "curtain" of slats that is held in place by vertical tracks. When not deployed, the shutter stores in a hood that is housed above the window or

Figure 4-10. Coastal home protected with roll-down shutters on all windows and doors. The shutter is held in place by vertical guide tracks and can be deployed manually or with integrated electric motor.
Source: Roll-a-way/QMI

Figure 4-11. Interior of home with deployed roll-down shutters. Roll-down shutters can be used not only for storm protection, but also for security, privacy, light, heat and noise control.
Source: Roll-a-way/QMI

door being protected. Most of the components of roll-down shutters are made from extruded aluminum.

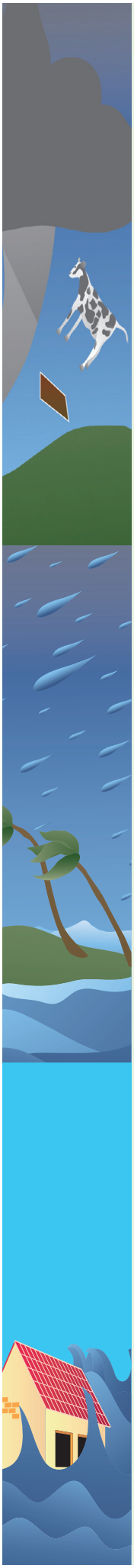
Because the roll-down shutter makes solid contact with the window sill, patio deck or other structure at the bottom, this shutter type demonstrates the highest level of protection against wind-driven rain in addition to wind and debris. Roll-down shutters can be deployed using a variety of operators – both manual and electric motor types. These can be installed directly over windows and doors, or in some cases, at balcony's edge to form an enclosure.

Since roll-down shutters are easily deployed, these often are used on a regular (non-storm) basis for light control, insulation against heat and noise, or for privacy and security.

The variety of features and methods of operation leads to a wide range of costs for this shutter type.

Accordion Shutters

One of the most commonly used shutter types in hurricane-prone regions is the accordion shutter (Figure 4-12). This is a permanently installed system with interconnected "blades" that operate between horizontal tracks. When not in use, the blades fold and are stored on either side of the door



or window being protected. Accordion shutters are manually deployed and can be deployed from the inside of the home, if the opening is a single- or double-hung window or an in-swinging window or door. Installed prices range from approximately $16 to $30 per square foot.

Figure 4-12. Accordion shutter (shown in the open position) installed over a large window of a coastal home. Shutter has been installed to allow deployment from inside the home. Source: Roll-a-way/QMI

Decorative / Protective Shutters

For homeowners who wish to add a decorative flair to the home's exterior while protecting windows against storm forces, Bahama (or Bermuda) and colonial-type shutters are available for window protection (Figures 4-13 and 4-14). These are most commonly made using extruded aluminum frames and louvers, although some composite materials have also found application in these types of shutters. Typically, these are finished using a durable exterior grade powder coating, or automotive-grade polyurethane paint system.

Figure 4-13. Bahama shutters made from durable extruded aluminum components add "Islands" flair to a home and provide effective opening protection. Source: Roll-a-way/QMI

Figure 4-14. Colonial shutters made from durable extruded aluminum components add a traditional look to the home and provide effective opening protection. Source: Roll-a-way/QMI

While these shutter types imitate the design of traditional wood shutters, it should be noted that no wood shutter of either type has been tested and approved as opening protection.

Storm Panels

Removable storm panel systems (Figure 4-15) are one of the most widely used and cost effective systems available for opening protection. These consist of a series of panels, made from steel, aluminum or impact-resistant polycarbonate.

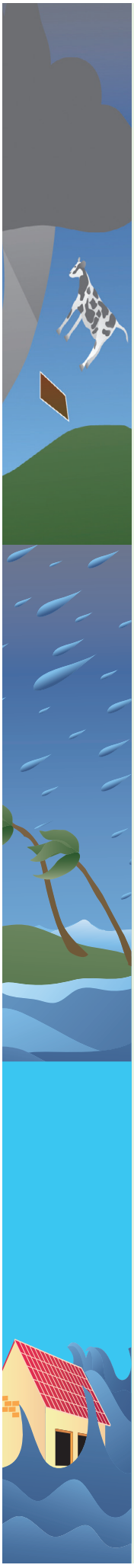
Figures 4-15. These 0.050 gauge aluminum storm panels offer cost effective storm protection. In this example, panels slip into a track above the window and secure onto a bottom track using wingnuts. Source: Roll-a-way/QMI

When not in use, panels are stackable for convenient storage. A wide variety of track options are possible. While these systems are relatively inexpensive (approximately $7 to $15 per square foot, depending on panel type and track options), they require much more effort for the homeowner to deploy than the other types mentioned above.

In-Place Systems

Requiring no advance deployment, impact-resistant systems that are permanently installed on a structure can

Figure 4-16. In-place stainless steel impact screen protects several windows of a coastal residence. This system requires no deployment and provides shade. Source: Roll-a-way/QMI



be an attractive option for opening protection. Two types currently on the market are: 1) impact-resistant stainless steel screen units and 2) installed flat impact polycarbonate. Both of these have little, if any, negative aesthetic impact on the home.

Figure 4-17. Flat impact polycarbonate panels are installed directly over windows of a coastal home. This window covering provides excellent storm protection with minimal aesthetic impact. Source: Roll-a-way/QMI

Impact-resistant stainless steel screen systems (Figure 4-16) consist of a heavy-gauge stainless steel screen mesh that is secured in an extruded aluminum frame. This unit is installed over the window to be protected. These are available as operable units, which facilitates cleaning and emergency egress. Screen units also provide excellent solar shading characteristics. These systems cost approximately $25 to 50 per square foot.

Flat impact polycarbonate units (Figure 4-17) are available to protect most single and double window sizes and types found in residential homes. These are made from UV-stable optical quality grades of polycarbonate and provide excellent protection against all storm forces. Because these systems are not operable from the inside of the home, emergency egress from the home must be considered before installing this system. Typical systems cost approximately $25 to 35 per square foot.

Fabric Windscreen

Impact-resistant fabric panels (Figure 4-18) made from high-tensile strength geosynthetic fibers such as polyethylene, or from reinforced PVC have become

Figure 4-18. Polyethylene basketweave fabric windscreen deploys directly over ground floor windows of coastal home. Source: Roll-a-way/QMI

Figure 4-19. Polyethylene basketweave fabric windscreen is deployed at edge of patio, enclosing the entire area. Source: Roll-a-way/QMI

increasingly popular for use as window and door protection. These systems are attached on two opposite sides of the window or door, usually to permanently installed panel mates or tracks with mounting studs. The panels include integrated grommets, which facilitate the deployment of the windscreens. These systems are also relatively inexpensive, costing approximately $7 to 12 per square foot.

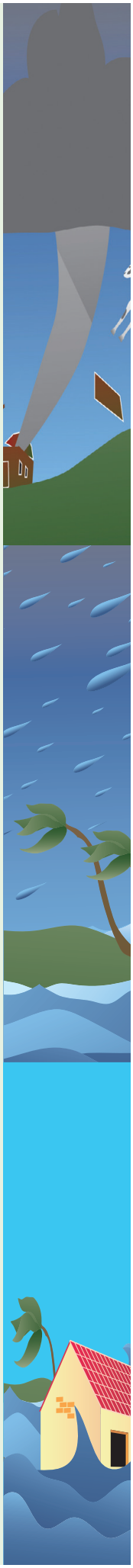
The polyethylene fabric types, which are basketweave systems, allow some light and visibility through the deployed screens. Some models incorporate emergency egress zippers. The PVC types are somewhat translucent, allowing light in the dwelling, but do not allow visibility through the screen.

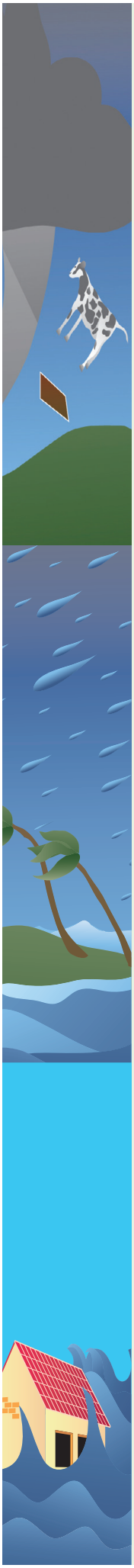
The geosynthetic screens have also been extensively employed to enclose large, even irregularly shaped openings (Figure 4-19). Such systems range in price from $20 to 40 per square foot. Because of the installation requirements of such systems, site-specific engineering is often required. Consultation with a contractor is recommended.

Impact-resistant Windows and Glazed Doors

In order to withstand both wind forces and impact from windborne debris, window and door manufacturers have developed products (Figure 4-20) with both sturdier frames and laminated

Figure 4-20. This attractive window can be fitted with energy-efficient glass, impact-resistant glass, or both. The impact resistant glass consists of a laminate or film sandwiched between two glass panes. The frames are reinforced and the hinges have extra fasteners to withstand high wind events. During a wind event, debris may crack the glass, but the laminate will hold the window pane together in the frame and prevent breaching of the wind- and rain-resistant envelope. After the storm, the glass will need to be replaced.



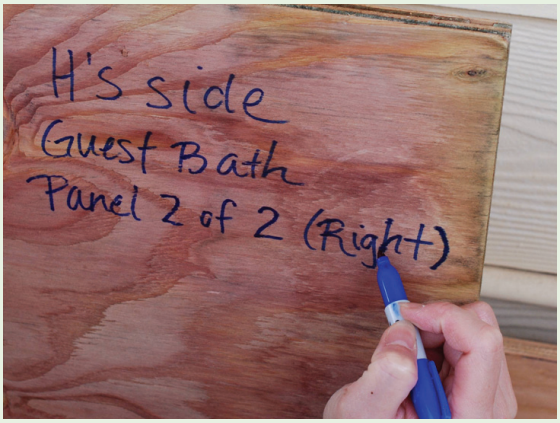


(impact resistant) glazing. Such systems are available in a variety of styles, options and costs.

While impact-resistant openings offer deployment-free protection, the glass can still be broken (but remains in the frame). Also, while these products are often available to the consumer through home improvement stores, professional installation is highly recommended in order to insure that proper attachment of the windows to the structure is achieved.

Plywood

Historically, plywood has been the most commonly used option for protection of window openings. This is undoubtedly due to its relatively low cost and ready availability. However, plywood covers only offer a limited amount of protection in moderate level storms and only if it is properly installed (Figures 4-21 and 4-22).



Figures 4-21 and 4-22. Not only is it necessary to install plywood opening covers correctly, it is also important to correctly label them and store them away from heat and humidity.

The disadvantages of plywood are that it can rot or warp if stored in a wet or warm area. Also, plywood shutters are relatively heavy. You will need two people to help with the preparation and deployment of these shutters. Because of their weight, it would be difficult, or even dangerous, to install plywood shutters if a ladder is needed.

Most significantly, however, plywood is increasingly viewed by both code and insurance entities as an inadequate means of protecting openings. While the International Residential Code (and other similar codes) allow some use of plywood under very specific conditions, these are restricted to areas where

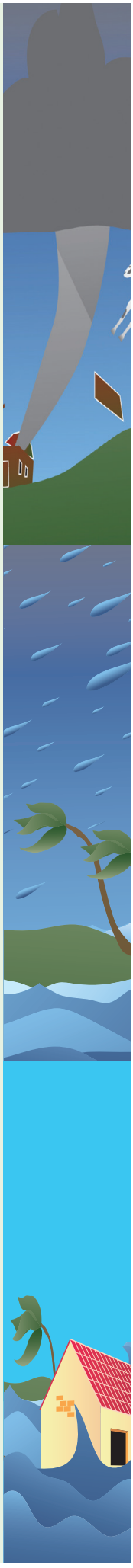
the design wind speed is 130 mph or less. Simply put, plywood does not demonstrate the levels of performance achieved by the engineered shutter types listed above.

Window Film

An after-market product used to enhance glass breakage characteristics is commonly known as security window film. Such products are often touted as "hurricane film" or similar – claims that cannot be substantiated by testing. Application of any of these window films to existing windows does NOT constitute adequate opening protection and should not be considered for use as opening protection. For more information, visit the website of the International Window Film Association (IWFA): www.iwfa.com.[22]

For further information regarding opening protection, visit the IBHS website, www.ibhs.org, in particular the Fortified for Existing Homes Program.

Table 4-1 lists the advantages and limitations of each type of window covering discussed above. For most homes, a combination of different covering types is employed, based on the needs and budget of the homeowner. Also, an estimate of the installed cost for each type is given, assuming that the system will protect a 3-foot x5-foot (3'x5') window.



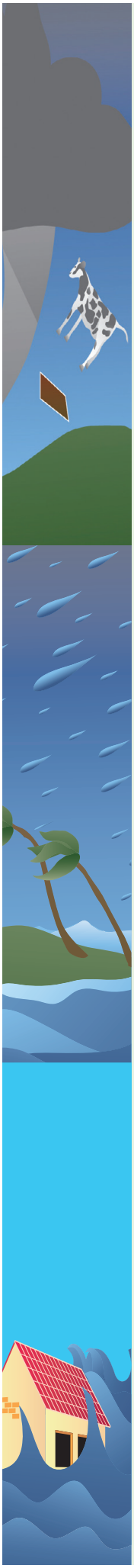


Table 4-1: Pros and Cons of Various Types of Window Protection

Type of Protection	Pros	Cons	Approx. Cost for 3'x5' Window Protection
Roll-down Shutters	Easiest to deploy Best overall protection, especially wind-driven rain	Expensive	$450 (manual) - $900 (electric motor)
Accordion Shutters	Easily deployed, Simple manual operation, Good overall protection, Modest cost	Possible aesthetic issues	$300 - $450
Bahama Shutters	Easily deployed, "Islands" decorative flair, Provides shade	Blocks some light and view	$450 - $675
Colonial Shutters	Easily deployed, "Traditional" decorative flair,	Cost, Requires adequate room for "swing" of shutters	$675 - $900
Storm Panels	Removable, Inexpensive	Manual deployment required, Must be stored when not in use	$105 - $225
Stainless Steel Impact Screens	Always in place, Provides shade	Some aesthetic impact, Egress issues must be considered, Less effective for wind-driven rain	$375 - $750
Flat Impact Polycarbonate Units	Always in place, Minimal aesthetic impact	Egress issues must be considered, Care must be taken in cleaning	$375 - $525
Fabric Windscreen (Direct Mount)	Inexpensive, Easy to handle and store	Manual deployment required, Greater shutter deflection than metal systems	$105 - $180
Impact Resistant Windows and Doors	Always in place, Many styles and options	Costs vary widely and can be high, Glass can still break, requiring expensive replacement	$450 - $900 and higher
Plywood	Inexpensive, Available	Manual deployment is difficult, Must be properly stored, Doesn't provide impact-resistance for winds > 130 mph	$120 +

Note: Window protection options were provided by Roll-a-way. Pricing is current as of May 2010.

Impact-resistant Garage and Entry Doors

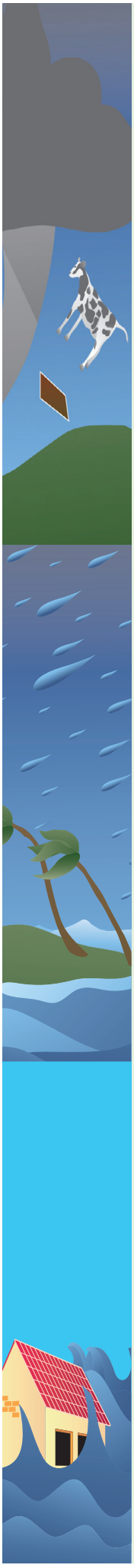
One of the most important, yet overlooked openings in a home that requires protection are its doors – both the garage door and entry doors. Most major suppliers of both types of doors offer products (with or without glazing options) that meet both wind and impact resistance requirements. Often, replacement of a non-rated door with one of these newer types is cost-effective, when compared to the cost of providing a covering for the door.

As with impact-resistant glazed windows and doors, any replacement of a door with an impact-resistant garage or entry door should be done by a qualified professional installer.

The garage door is a significant weakness during a hurricane due to its large area and the stress it is subject to (Figure 4-23). Garage door options include: (i) replacement with a stronger door, (ii) horizontal bracing, (iii) vertical bracing, or (iv) other types of a bracing kit. For many garage doors the vertical bracing is a popular and reasonably priced option.

Figure 4-23. Because of their width, double-wide garage doors are more susceptible to wind damage than single doors. The wind can force it out of the roller track, especially if the track is light weight or some of the anchor bolts are not in place. This occurs because the door deflects too much under excessive wind pressure and fails. You should reinforce your garage door by installing horizontal and/or vertical bracing onto each panel, using wood or light gauge metal girds bolted to the door mullions. You may also need heavier hinges and stronger end and vertical supports for your door.[23] Source: Florida Hurricane Depot

Double entry doors should have slide bolts at the top header and bottom threshold of the inactive door, a deadbolt with at least 1-inch throw length between each door and three hinges for each door. This requirement is similar to other guidelines for single entry doors, which call for at least three hinges and a bolt long enough that goes into the 2x4 framing of the door. Whenever entry doors are fortified, at least two of them must be operable for access and exiting at any time.



4.1.3 Trees

Cutting or trimming trees that overhang your house are additional measures that you can take to protect your property during a hurricane. However, even though trees provide a buffer to the full strength of the wind, there is a serious danger if there are large trees or limbs that are close enough to fall on the house. Few roofs are strong enough to withstand a falling 20-inch diameter, 40-foot tall pine tree.

Tree limbs or branches falling onto or impacting your house will cause considerable damage. Figure 4-24 illustrates the distance from the tree to the house to ensure that falling limbs do not affect the roof.

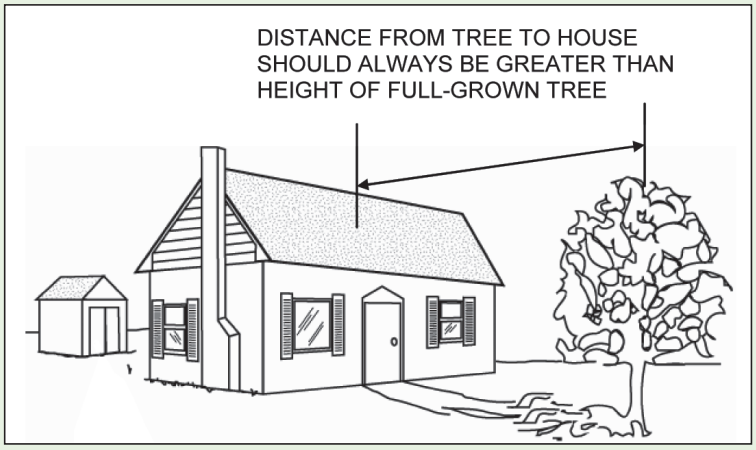


Figure 4-24. FEMA recommends that the distance between a tree and your house should always be greater than the height of the full-grown tree. This is to prevent trees from falling on the roof, either currently or in the future. Source: FEMA

If it is not possible to remove a tree, you can at least cut off all branches which hang over the roof of the house. Generally, you should hire a licensed tree trimmer to perform this work. More information regarding how and what to trim can be found at the Mississippi Forestry Commission's website: www.mfc.ms.gov/.[24]

4.1.4 Safe Rooms

A safe room is a room designed to withstand winds from the strongest hurricanes (Categories 3–5) and strong tornados. This option should only be considered if the house is outside of all known flood and storm surge zones and is strengthened to the highest level. Safe rooms should not be built in a flood zone, where there is threat of moving water. During a hurricane or other high flood event, even these areas need to be evacuated no matter how fortified the room is against the wind.

It is much less expensive to build a safe room during original construction of the house. FEMA notes that while construction costs vary nationwide, the cost to build a safe room inside a new house (which can also double as a master closet, bathroom, or utility room) ranges from $2,500 to $6,000.

The additional cost can be wrapped into the original home mortgage. This is a good investment that yields a sizable return in that it that adds value to your house as well as protection and peace of mind for your family.

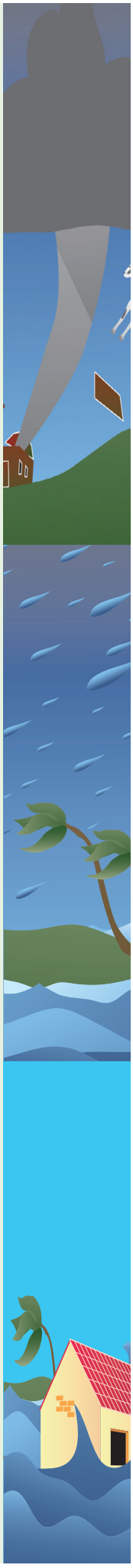
For more information regarding the design and construction of Safe Rooms see FEMA Publication 361, "Design and Construction Guidance for Community Safe Rooms" and FEMA Publication 320, "Taking Shelter From the Storm" available from www.FEMA.gov.

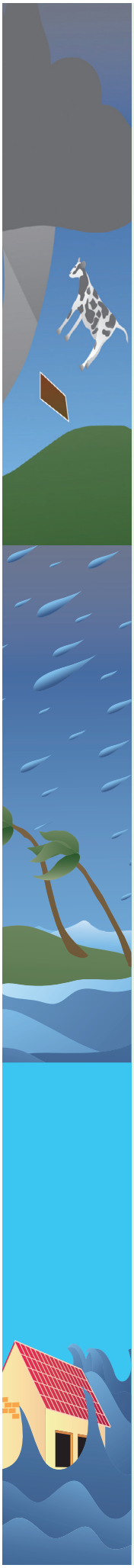
4.2 ELECTRICAL AND POWER ISSUES

In case of an emergency, the power to your house should be turned off through the main breaker switch, circuit breaker panel, or fuse box. In addition, all homes should be equipped with ground fault circuit interrupters (GFCIs). GFCIs are inexpensive electrical devices that, if installed in household branch circuits, are designed to protect people from severe or fatal electric shocks. GFCIs could prevent over two-thirds of the electrocutions.[25] Because a GFCI detects ground faults, it can also prevent some electrical fires and reduce the severity of others by interrupting the flow of electric current. GCFI's are commonly found in kitchens, bathrooms, laundry rooms, or other places where water and electricity are close together. If you don't have them, consider having them installed by a licensed electrician.[25]

By following key safety precautions when dealing with electricity during and after storms and other disasters, you can help prevent death, injuries and property damage. Take care when stepping into a flooded area and be aware that submerged outlets or electrical cords may energize the water, posing a potential lethal trap.[25]

Flooded Areas: Do not use electrical appliances that have been wet. Water can damage the motors in electrical appliances such as furnaces, freezers, refrigerators, washing machines, and dryers.[26]





Wet Electrical Equipment: A qualified service repair dealer should recondition electrical equipment that has been wet. For more information, the National Electrical Manufacturers Association (NEMA) has produced a brochure, *Guidelines for Handling Water Damaged Electrical Equipment*, for use by suppliers, installers, inspectors and users of electrical products to provide advice on the safe handling of electrical equipment that has been exposed to water. It outlines which items will require complete replacement or can be reconditioned by a trained professional. Equipment covered includes electrical distribution equipment, motor circuits, power equipment, transformers, wire, cable and flexible cords, wiring devices, GFCIs and surge protectors, lighting fixtures and ballasts, motors, electronic products including signaling, protection, communication systems, industrial controls and cable trays.[25] The NEMA brochure can be downloaded free of charge at www.nema.org/.[26]

Downed Power Lines: These can carry an electric current strong enough to cause serious injury or possibly death. The following tips can keep you safe around downed lines:[26]

- If you see a downed power line, move away from the line and anything touching it. The human body is a ready conductor of electricity.
- The proper way to move away from the line is to shuffle away with small steps, keeping your feet together and on the ground at all times. This will minimize the potential for a strong electric shock. Electricity wants to move from a high voltage zone to a low voltage zone—and it could do that through your body.
- If you see someone who is in direct or indirect contact with the downed line, do not touch the person. You could become the next victim. Call 911 instead.
- Do not attempt to use another object such as a broom or stick to move a

Figure 4-25. Downed or damaged power lines in a residential area can pose a serious danger to public safety. Source: U.S. EPA

downed power line or anything in contact with the line. Even non-conductive materials like wood or cloth, if slightly wet, can conduct electricity and then electrocute you.

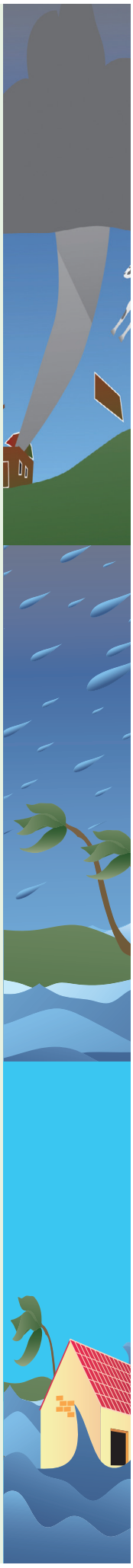
- Be careful not to put your feet near water where a downed power line is located.
- If you are in your car and it is in contact with the downed line, stay in your car. Tell others to stay away from your vehicle.
- If you must leave your car because it's on fire, jump out of the vehicle with both feet together and avoid contact with the live car and the ground at the same time. This way you avoid being the path of electricity from the car to the earth. Shuffle away from the car.
- Do not drive over downed lines.

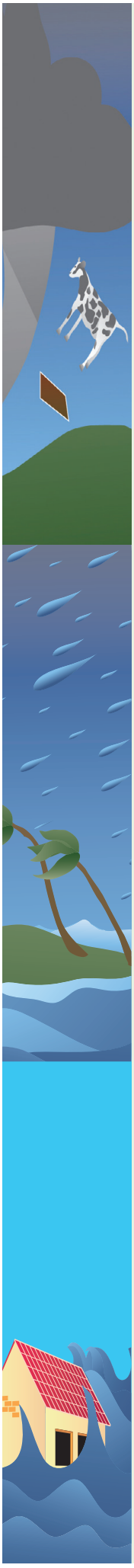
4.2.1 Alternate Power Sources

Before discussing alternate power sources during an emergency, one general suggestion is to make your house as energy efficient as possible as you replace equipment and appliances in your house after they have outlived their normal life. For example, if the lights, a television, or refrigerator need replacing, consider products with the EPA's Energy Star label (Figure 4-26). These products may cost slightly more, but over their lifetime, the energy savings will far outweigh the small initial cost increase.

Figures 4-26. Items with the Environmental Protection Agency's Energy Star Label use much less energy than standard models. Items include washing machines, dishwashers, refrigerators, freezers, air conditioning units, and light bulbs.

Energy efficient equipment will be especially useful during an emergency, when you may be on alternative forms of power with limited supply. For example, a regular 100-watt lamp running off an emergency power station (essentially built around a car battery) may run for two hours. That same emergency station can run a fuel efficient 23-watt compact fluorescent





light almost 8–9 hours with the same light output. As another example, a refrigerator with the EPA's Energy Star label can run on a fuel-efficient generator for 16 hours on one gallon of gas. Since most refrigerators do not need to run continuously, it may be possible to run the efficient refrigerator on one gallon of gas for one or two days.

4.2.2 Generators

Some households may require uninterrupted power because of the critical needs of some family members. For example, the elderly, disabled, or sick may require a respirator, dialysis machine, or other medical equipment. Some medicine such as insulin, which is stored over a month, may need to be refrigerated. For many families, the most important major power requirement is to run a refrigerator or freezer. If your family cannot get by without the refrigerator, or there are other critical power needs for medical or other purposes, then you may want to consider a portable generator.

Take special care with portable electric generators, which can provide a good source of power, but if improperly installed or operated, can become deadly.[25] Do not connect generators directly to household wiring. Power from generators can backfeed along power lines and electrocute anyone coming in contact with them, including line workers making repairs. A qualified, licensed electrician should install your generator to ensure that it meets local electrical codes.[26]

Other generator-related tips include:

- Make sure your generator is properly grounded.
- Keep the generator dry.
- Plug appliances directly into the generator.
- Make sure extension cords used with generators are rated for the load, and are free of cuts, worn insulation and have three-pronged plugs.

- Do not overload the generator.
- Use a ground fault circuit interrupter (GFCI) to help prevent electrocutions and electrical shock injuries. Portable GFCIs require no tools to install and are available at prices ranging from $12 to $30.

Most importantly, never run a generator indoors or in your garage because of the possibility of carbon monoxide gas accumulation, which cannot be detected by smell. Good ventilation is required. Operate your generator outside and away from open windows. Do not hook up a generator to your house power supply without a licensed electrician.[26]

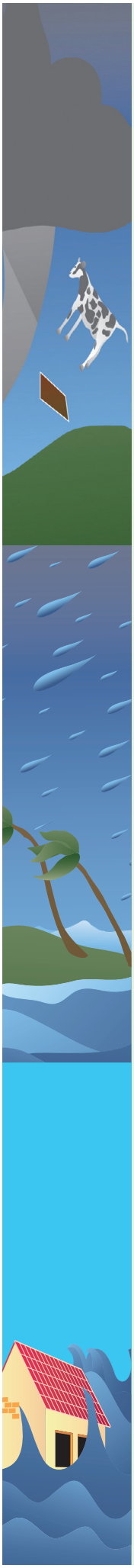
In general, when running your refrigerator with a generator, keep the refrigerator and freezer at the coldest setting. Refrigerators may only need to run a few hours a day to preserve food. Using a refrigerator thermometer, you should aim to maintain 40 degrees in the refrigerator compartment and 0 degrees in the freezer. Open the refrigerator door as little as possible.

4.2.3 Power Stations

Power stations are found in many hardware stores and may have a radio, flash light, air compressor, battery jump starter, AC outlet, or DC outlet built around a modified car battery. These units can come in handy during a power outage, since they can form part of your stock of emergency supplies and also provide limited emergency power. If your cordless phone does not work because the base of the unit has no power, a power station could supply electricity so that calls could be made. (An alternative is to use a corded phone.) It should be noted that after an emergency, there may be many reasons the phone does not work that are beyond your control, such as heavy traffic or loss of function with the phone system.

4.2.4 Inverters

Inverters take the 12-volt DC power from your car battery and convert it to 115-volt AC power that can run household appliances. This can be very important if you need to run power tools in an emergency and the power is



out. The inverter will drain your car battery, but look for inverters that have a low battery shutdown feature to prevent total battery drain. You should not run an inverter with the car running unless the manufacturer provides specific instructions with safety guidelines. In addition, the car should not be run in a garage, but rather in a well-ventilated area if the manufacturer approves of such procedures.

4.2.5 Battery Chargers

Your car battery can be an important source of DC and AC power with an inverter. To keep the car battery charged, you should consider a battery charger as part of your emergency supplies. The charger only works when there is household power, or backup power through a generator, but it can recharge your car battery if it is needed. New units are small and portable and provide a quick charge to a dead battery in only a few minutes and a total charge in a few hours.

4.3 HAZARD MITIGATION ASSISTANCE PROGRAM

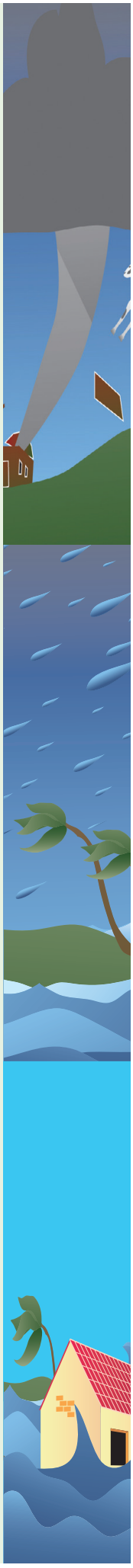
FEMA's Hazard Mitigation Assistance (HMA) program is intended to encourage investment in long-term mitigation measures to reduce vulnerability to natural hazards. The Mississippi Emergency Management Agency administers the HMA program to reduce the risk to individuals and property from natural hazards while simultaneously reducing reliance on federal disaster funds. As such, MEMA encourages state, local, tribal governments, and communities to take advantage of funding provided by HMA programs in both the pre- and post-disaster timeframes.

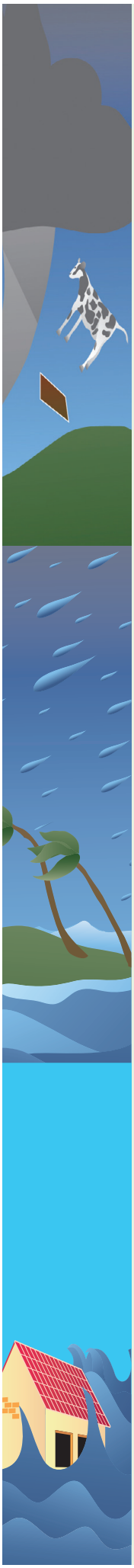
Among other things, the program can provide funds to states to assist homeowners in implementing mitigation measures to existing structures. Some of the project types that have been approved by FEMA for use to assist homeowners are:

- **Property Acquisition and Structure Demolition -** the acquisition of an existing at-risk structure and, typically, the underlying land, and conversion of the land to open space through the demolition of the structure. The property must be deed-restricted in perpetuity to open space uses to restore and/or conserve the natural floodplain functions.

- **Property Acquisition and Structure Relocation - t**he physical relocation of an existing structure to an area outside of a hazard-prone area, or a regulatory erosion zone and, typically, the acquisition of the underlying land. Relocation must conform to all applicable state and local regulations. The property must be deed-restricted in perpetuity to open space uses to restore and/or conserve the natural floodplain functions.
- **Structure Elevation - p**hysically raising an existing structure to an elevation at or above the Base Flood Elevation or higher if required by FEMA or local ordinance. Structure elevation may be achieved through a variety of methods, including elevation on continuous foundation walls; elevating on open foundations, such as piles, piers, posts, or columns; and elevating on fill. Foundations must be designed to properly address all loads, be appropriately connected to the floor structure above and utilities must be properly elevated as well. FEMA encourages applicants and sub-applicants to design all structure elevation projects in accordance with the American Society of Civil Engineers 24-05 *Flood Resistant Design and Construction*.
- **Structural Retrofitting of Existing Buildings -** modifications to the structural elements of a building to reduce or eliminate the risk of future damage and to protect inhabitants. The structural elements of a building that are essential to protect in order to prevent damage include foundations, load-bearing walls, beams, columns, structural floors and roofs and the connections between these elements.

Funding under HMA programs is subject to the availability of appropriations and, for Hazard Mitigation Grant Program funds, to the amount of FEMA disaster recovery assistance under the Presidential major disaster declaration. To assist in establishing funding priorities, local and state mitigation plans are utilized to identify the highest risks.





4.4 RETRO-FITTING AN EXISTING HOME

When retro-fitting an existing home, you should consult with a licensed structural engineer or architect. The structural engineer can go over the cost and benefits of installing the following common retro-fit options:

1) Roof-to-wall and wall-to-foundation connections;
2) Hurricane clips only without additional foundation connection; or
3) Stronger connectors than those required in the current building code.

4.4.1 Roof-to-Wall Connection

Concepts regarding the roof-to-wall connection were covered in Part 4.1. A properly selected hurricane clip is required for each rafter. In addition, the rafters at gable end eaves should be strapped down. Exterior beams supported by corner columns also require strap down. For houses with post and beam roof construction, fasteners should be for roof rafter to roof beams, top of post to horizontal ridge beam and post to beam connections located at the exterior wall (see Figures 4-27, 4-28 and 4-29).

Figure 4-27. This is an example of retrofitting an existing house, originally built without hurricane clips. The popular H3 clip is used here; four nails attach the clip to the roof (truss-rafter) and four more nails attach to the wall or top plate below. For a retrofit, the clips are exposed on the outside of the house; therefore, both the clip and fasteners should be corrosion resistant and painted to blend with the exterior of the house. With the correct clip and nails you could perform the work or, if you prefer, hire a licensed contractor.

Figure 4-28. In this retrofit example, a hurricane clip attaches the roof structure to a horizontal ridge beam, which is in turn attached to the vertical post with a metal strap. This is an attempt to tie the load from the roof to the foundation, or create the complete load path connection. Note that these clips and straps are in the process of being painted. Source: Hurricane Protection Services.

Figure 4-29. In some retrofit examples, it is possible to tie a portion of the house to the foundation. Here, a metal strap connects the vertical post to the foundation, which finishes the continuous load path connection from roof to the foundation. Source: Hurricane Protection Services.

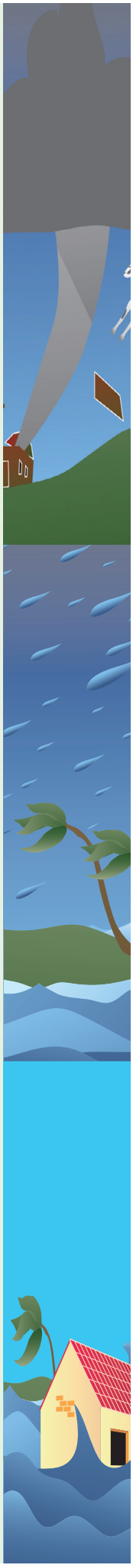
You should seek a licensed structural engineer or architect to select the proper connectors and nails for your house. You can then do either all or part of this work yourself, or hire a licensed contractor.

4.4.2 Roofing

The wind from a hurricane attacks any weaknesses in the roof. Once a weakness is exposed, adjacent areas can be more easily damaged and peeled away. Thus, strengthening the roof is important and it should be considered for new construction and when a roof is replaced after its expected life.

The roofing option involves installing a continuous structural sheathing (for example, plywood where it is missing or damaged). Additional fasteners and a secondary waterproof membrane are required. You should seek a licensed roofing contractor to do this work.

As a side note, there are small things you can do to strengthen the roof even if is relatively new. For example, if you climb in your attic and see nails that are supposed to attach the plywood sheathing to the truss have missed the truss, then you have found what could be a structural weakness. The joint can be strengthened with a wood epoxy or the application of closed cell foam insulation.



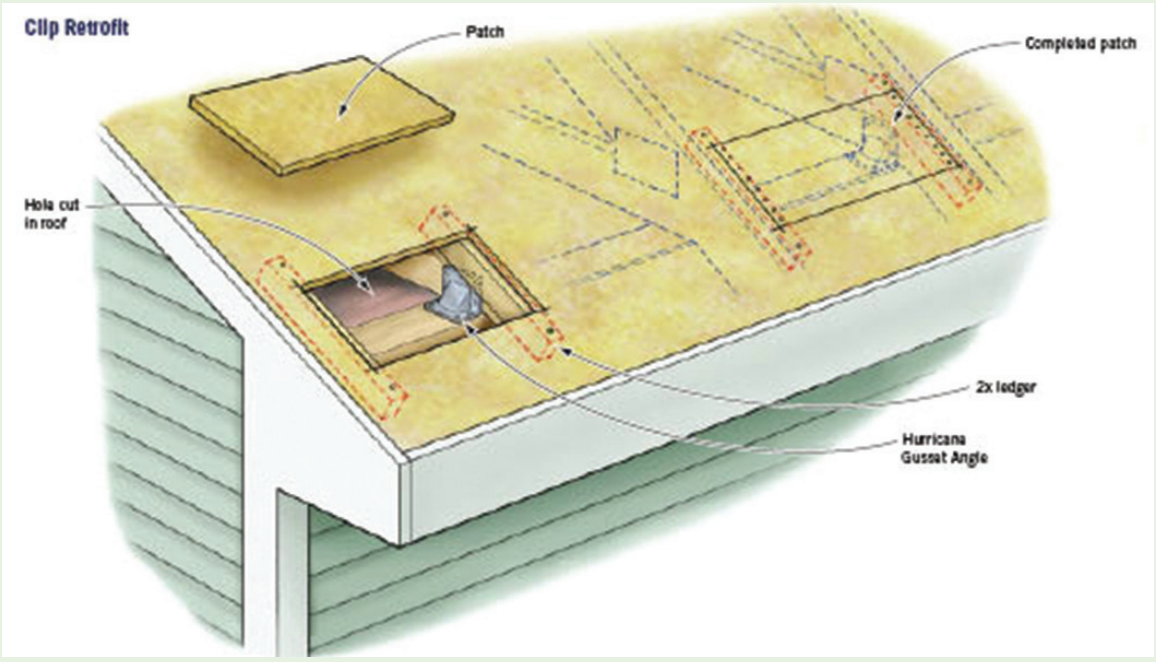


Figure 4-30. To install connectors with minimal demolition, cut rectangular holes between pairs of trusses. A connector can be attached to a truss on each side of the hole, allowing four trusses to be attached with just two holes. Holes are patched by resting the patch on scabs nailed to the sides of the trusses. Source: Coastal Contractors Online.

4.4.3 Foundation Uplift Strengthening Restraint

Strengthening the foundation to resist uplift will generally require the removal of interior finishes. The installation of uplift connections should be planned by a licensed structural engineer and only after they have inspected the home to understand materials and methods used to construct the home and have calculated the uplift requirements.