

# Rebuilding and Repairing Your Home After a Tornado



FEMA

## TORNADO RECOVERY ADVISORY

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### Purpose and Intended Audience

The purpose of this advisory is to identify which standard of construction should be used when repairing houses damaged in high-wind events (see Figure 1). The intended audience for this Tornado Recovery Advisory is homeowners or home builders. The advisory explains how to determine which building code is appropriate, describes how to incorporate best practices into construction, and lists resources for installing residential safe rooms. Homeowners and renters should also refer to Tornado Recovery Advisory No. 3, *Residential Sheltering: In-Residence and Stand-Alone Shelters* (updated in 2011).

### This Recovery Advisory Addresses:

- Determining the Appropriate Building Code
- Incorporating Best Practices
- Protecting Building Occupants by Installing Residential Safe Rooms

### Determining the Appropriate Building Code

Building codes are used in many jurisdictions as a minimum standard of construction practice to provide occupants with an improved level of safety from natural hazards, fire, and poor air quality. Building codes are instituted when either the State or a local jurisdiction adopts them. Most building codes are based on one of the current prevailing model building codes published by the International Code Council (ICC).

Houses constructed in hurricane-prone regions may be constructed to the ICC 600, *Standard for Residential Construction in High-Wind Regions*, in addition to the International Residential Code. ICC 600 provides a prescriptive approach for building and repairing houses in regions where the design wind speed is above 90 mph (3-second gust) and, for some construction methods, up to 150 mph. Even if the design wind speed for your location is 90 mph or less, designing to the ICC 600 standard may improve the performance of your house in a high-wind event such as a weak tornado. Although constructing to a higher standard may not eliminate all damage to the building, it may reduce damage from high-wind storm events.

While building codes can be adopted at the State, county, or local jurisdiction (city) level, in some areas of the United States, no building codes are adopted or enforced. Where building codes are not adopted and enforced, residential construction quality may not be ensured by plan reviewers or a building inspector. In these areas, the building owner should hire a qualified professional to conduct inspections and verify that the work is being done properly.



**Figure 1: A house that lost large sections of the roof and the garage due to internal pressurization.**



## Incorporating Best Practices

Best practices are design or construction practices that go beyond the minimum code requirements of the latest model codes to improve building performance. An example of a best practice is adding metal connectors to a structure to improve the transfer of loads through the house from the roof system to the foundation. Construction details and material selection can result in a house with improved resistance to wind pressures and wind-borne debris. Resources for best practices include the ICC 600 standard and FEMA P-499, *Home Builder's Guide to Coastal Construction* (FEMA 2010), which is a technical fact sheet series for improving house performance in high-wind regions. The FEMA P-499 fact sheets are appropriate for use throughout the country, and they provide best practice recommendations for a variety of building systems.


Best practices can be incorporated not only into new construction, but also into existing homes. Houses can be retrofitted either as part of the repair process, such as when replacing the roof covering, or as part of an independent retrofit project. FEMA P-804, *Wind Retrofit Guide for Residential Buildings* (FEMA 2010), describes how to improve a house's performance during high-wind events. The guide outlines three levels of building performance and describes groups of retrofits that can reduce damage to a house. In addition, proper application of the retrofit packages described in FEMA P-804 may result in insurance premium rate reductions in certain areas of the country.

When constructing a new home or repairing a damaged house, certain practices should be considered. Table 1 lists building components that are commonly observed to fail during high-wind events and provides recommended practices to avoid these failures. The failure of these components often results in damage from wind-blown rain and, in some cases, pressurization of the house, which may lead to the loss of walls or the entire structure. While this list is not all-inclusive, it addresses some of the most common and inexpensive preventive measures.

**Table 1. Upgrades to Prevent Common Building Component Failures**

Building Component	Typical Failure	Recommended Practice
Asphalt Shingles	<p>Shingles blown off in high-wind events, exposing the roof to wind-blown rain</p> 	<p>Use shingles rated for 90+ mph wind and use a minimum of four nails per shingle; preferred use is six nails per shingle (Source: FEMA P-499, Fact Sheet 7.3)</p>
Windows and Doors	<p>Windows and doors can be dislodged from the walls</p> 	<p>Make sure windows and doors are properly shimmed and nailed into the framed opening using nails of sufficient length to tie the window and door frames into the adjacent studs (Source: FEMA P-499, Fact Sheet 6.1)</p>

Building Component	Typical Failure	Recommended Practice
Baseplate or Sillplates	<p>Uplift of the wall systems and shear failures</p> 	<p>Make sure there are anchor bolt connections between the plate and the foundation at least every 4 feet (Source: FEMA P-499, Fact Sheet 4.3)</p>
Roof-to-Wall Connections	<p>Uplift of the roof systems and either significant damage or loss of the entire roof</p> 	<p>Ensure there is a continuous load path from the roof to the foundation using metal connectors that are approved for use with the applicable basic wind speed (Source: FEMA P-499, Fact Sheets 4.1, 4.2, and 4.3)</p>
Sheathing	<p>Penetration of fiberboard sheathing and rigid insulation board by wind-borne debris in even weak tornadoes</p> 	<p>Use oriented-strand board (OSB) or plywood to prevent penetration from wind-borne debris and racking (Source: FEMA 342, Chapter 8)</p>
Garage Doors	<p>Buckling of doors either outward or inward</p> 	<p>Select doors designed for higher wind speeds (Source: FEMA P-804, Chapter 4)</p>

Building Component	Typical Failure	Recommended Practice
Brick Veneer	<p>Brick veneers pull away from the wall systems</p> 	<p>Attach veneers with brick ties to the wall framing at adequate spacing as shown in FEMA P-499 (Source: FEMA P-499, Fact Sheet 5.4)</p>
Vinyl Siding	<p>Vinyl siding pulls off wall sheathing</p> 	<p>Use vinyl siding rated for high wind applications and attach it to the wall framing as noted in FEMA P-499 (Source: FEMA P-499, Fact Sheet 5.3)</p>
Gable End Walls	<p>Gable end walls collapse or rotate, causing loss of the roof system, causing failure of hinges and possibly large sections of the building, and causing walls to buckle</p> 	<p>Improve the gable end wall bracing details with additional connections and by improving the load path with additional framing and metal connectors (Source: FEMA P-804, Chapter 4)</p>

## Protecting Building Occupants by Installing Residential Safe Rooms

When reconstructing after a tornado event, homeowners may want to consider installing a residential safe room to protect building occupants in the event of a future tornado. A safe room can be an interior room, a space within a building, or an entirely separate building designed and constructed to protect its occupants from tornadoes and hurricanes. Safe rooms are intended to provide protection against both wind forces and the impact of wind-borne debris.

Additional information on safe rooms can be found in Recovery Advisory No. 3, *Residential Safe Rooms: In-Residence and Stand-Alone Safe Rooms* (updated in 2011).

## Useful Links and Resources

**2011 Tornado Recovery Advisories.** FEMA. 2011. <http://www.fema.gov/library/viewRecord.do?id=4723>

**Recovery Advisory No. 3, Residential Safe Rooms: In-Residence and Stand-Alone Safe Rooms.** FEMA. 2011. <http://www.fema.gov/library/viewRecord.do?id=4723>

**Recovery Advisory No. 5, Critical Facilities Located in Tornado-Prone Regions: Recommendations for Facility Owners.** FEMA. 2011. <http://www.fema.gov/library/viewRecord.do?id=4723>

**Taking Shelter from the Storm: Building a Safe Room for Your Home or Small Business** (FEMA 320). August 2008, Third Edition. <http://www.fema.gov/library/viewRecord.do?id=1536>

**Midwest Tornadoes of May 3, 1999: Observations, Recommendations, and Technical Guidance** (FEMA 342). October 1999. <http://www.fema.gov/library/viewRecord.do?id=1423>

**Home Builder's Guide for Coastal Construction** (FEMA P-499). December 2010, Second Edition. [http://www.fema.gov/rebuild/mat/mat\\_fema499.shtm](http://www.fema.gov/rebuild/mat/mat_fema499.shtm)

**Wind Retrofit Guide for Residential Buildings** (FEMA P-804). December 2010. <http://www.fema.gov/library/viewRecord.do?id=4569>

**Standard for Residential Construction in High-Wind Regions.** ICC 600, International Code Council (ICC). 2008. Country Club Hills, IL.

**International Residential Code for One- and Two-Family Residences** (IRC) ICC. 2009. Country Club Hills, IL.

**ICC/NSSA Standard for the Design and Construction of Storm Shelters** (ICC-500), June 2008. [http://www.iccsafe.org/Store/Pages/Product.aspx?id=8850P08\\_PD-X-SS-P-2008-000001](http://www.iccsafe.org/Store/Pages/Product.aspx?id=8850P08_PD-X-SS-P-2008-000001)