CHAPTER 5

Implementing Mitigation Projects

This chapter offers guidance for implementing residential building wind retrofit projects and the factors to consider when implementing them, and also discusses possible funding of resources. Factors to consider for wind retrofit projects include code compliance, local permitting and inspection requirements, and general construction challenges. Addressing hazards other than high-wind events is also discussed.

5.1 Wind Retrofit Programs

Several Federal, State, and nonprofit retrofit programs are currently available to homeowners and local governments. These programs include FEMA's HMA Grant Programs, the IBHS FEH program, Rebuild Northwest Florida, the Residential Construction Mitigation Program (RCMP), SC Safe Home, Mississippi Windstorm Underwriting Association Retrofit Mitigation Program, and the Federal Alliance for Safe Homes (FLASH) Blueprint for Safety Program®. This section briefly describes each of these programs. Appendix D of this Guide includes a list of FEMA's HMA and other funding programs, as well as links to them. However, this Guide does not provide an exhaustive list of all such programs. Additionally, there are other retrofit programs offered through different States, but these are generally disaster specific and have limited operational time frames. Each of the retrofit programs provides guidance on mitigating wind hazards; some of the programs also offer funding assistance.

5.1.1 Federal Emergency Management Agency

FEMA administers several programs that provide grant funding for mitigation projects as described below (see Appendix D for links to FEMA resources). FEMA funds both structural and non-structural retrofits to existing buildings for wind hazard mitigation. Wind mitigation retrofit projects are defined as modifications to the elements of a building to reduce or eliminate the risk of future wind damage and to protect inhabitants. The PDM Program and HMGP are both applicable for wind retrofit projects. These programs comply with local, State, or national building codes, standards, and regulations—such as the IBC, the FBC, and the ASCE and ASTM standards—for structural retrofits.

Pre-Disaster Mitigation Program. FEMA's PDM Program provides nationally competitive grants to States, territories, federally recognized Indian Tribal governments, and local governments for hazard mitigation planning and implementing mitigation projects *before* a disaster event. Funding these plans and projects reduces overall risks to the population and structures, as well as reliance on funding from actual disaster declarations to rebuild after disasters.

Hazard Mitigation Grant Program. FEMA's HMGP provides grants to States, territories, federally recognized Indian Tribal governments, local governments, and private nonprofit organizations to implement long-term hazard mitigation measures *after* a major disaster declaration in a given State. The purpose of HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during recovery from a disaster.

Figure 5-1 shows the process for FEMA grant applications and approvals. It is divided into five stages, starting with mitigation planning and ending with the successful execution of a project. The process requires coordination among FEMA, the State, and the local government. This is represented by the three rings in the figure.

Whether PDM or HMGP funds will be used, the FEMA grants cycle process includes the following five stages.

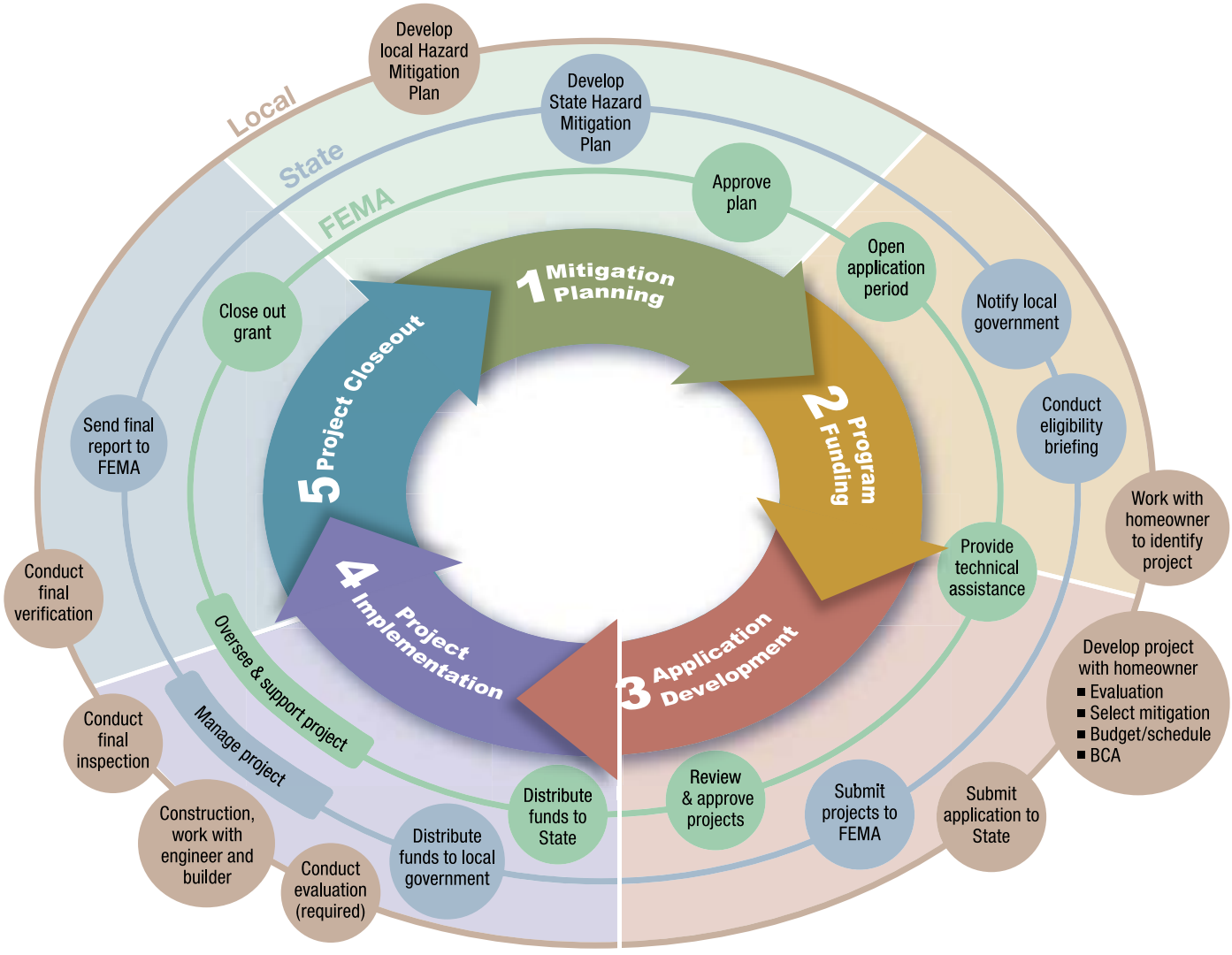

FIGURE 5-1:
HMA grants cycle process showing roles and responsibilities of each stakeholder

Stage 1. Mitigation Planning

A State Multi-Hazard Mitigation Plan is a prerequisite for both HMGP and PDM project grants. The State Multi-Hazard Mitigation Plan lays out the process for identifying the hazard risks of a community and the actions that will help reduce those risks. Wind retrofit projects that are proposed for FEMA funding under these programs must be consistent with the State's mitigation plan. The mitigation planning process requires public participation and identification of measures to reduce risks, and is therefore a good opportunity for homeowners to address concerns about high-wind hazards. More information is available on the FEMA Web site at www.fema.gov/plan/mitplanning.

Stage 2. Program Funding

HMA Programs enable hazard mitigation measures to be implemented before, during, and after disasters. Funding depends on the availability of appropriation funding or is based on disaster recovery expenditures, as well as any directive or restriction made with respect to such funds. HMGP funding depends on Federal assistance provided for disaster recovery following a Presidential disaster declaration in a State, while PDM funding is appropriated annually by Congress on a competitive basis to all States and tribes. Once the application period is open, the State notifies the local governments of the availability of funds and relays information on the application process, project requirements, and eligibility criteria for the local government. Homeowners should work with their local government to express their interest in participating in a wind retrofit project; the local government can then submit a subapplication to the State and request HMA funding.

Stage 3. Application Development

Individuals and businesses are not eligible to apply for HMA funds, so individual homeowners must work with their local government to develop a complete project subapplication on their behalf. Local governments may submit a retrofit project for a single home as an individual subapplication or combine it with other homes as part of an aggregate subapplication. Aggregating benefit and cost values is allowed for multiple structures if they are all vulnerable to damage as a result of similar hazard conditions. Users of this Guide should refer to the latest HMA Unified Guidance at www.FEMA.gov for information on aggregating projects in an application.

Key steps for wind retrofit applications are:

1. Identify the property to be mitigated.
2. Identify key project personnel and roles such as evaluator, inspector, and design professional.
3. Identify the approach that will be used, such as the IBHS FEH program, to establish the target level of risk to which the structure will be mitigated.
4. Have an evaluator or other professional inspect the structure utilizing the approach identified in Stage 3 (if possible; if not done at this stage, it must be done during Stage 4, Project Implementation).
5. Select a Mitigation Package (Basic, Intermediate, Advanced) and its associated retrofit projects based on the evaluation.
6. Develop a project cost estimate and work schedule.

7. Conduct a BCA using the FEMA BCA Tool (refer to Appendix C for additional information); if the benefit-cost ratio (BCR) is 1.0 or more, the project is cost effective. FEMA requires a BCR of 1.0 or greater for funding.

8. Ensure that properties located in designated Special Flood Hazard Areas (SFHAs) will obtain flood insurance and that this condition will be recorded on the property deed.

SFHA

The SFHA is the area covered by the floodwaters of the 100-year flood. NFIP's floodplain management regulations must be enforced in the SFHA.

The local government submits the subapplication to the State. The State then selects projects based on its priorities and submits applications to FEMA for review. FEMA reviews the projects for eligibility, completeness, engineering feasibility, cost-effectiveness, cost reasonableness, and environmental and historic preservation documentation. The review process also confirms that all hazard mitigation activities adhere to all relevant statutes, regulations, and program requirements including other applicable Federal, State, Indian Tribal, and local laws, implementing regulations, and executive orders, which are detailed in the HMA Unified Guidance. Once FEMA approves and awards the project, the grant funds are distributed by the State to the local governments, who will distribute it to individuals, as appropriate. No construction activities should begin until after the money has been awarded because HMA funding is not available for activities initiated or completed prior to award or final approval.

Stage 4. Project Implementation

Once the State has awarded the funds to the local government, the next stage in the process is project implementation. HMA projects have to be completed within a specific amount of time called a period of performance, which is usually not more than 36 months. The homeowner or local government should secure the professional services of a contractor (and engineer for non-prescriptive solutions) at this stage to develop a detailed construction plan. If the scope of work or cost estimate changes as a result, consult the HMA Unified Guidance for direction on how to revise the scope of work prior to construction.

During the period of performance, the local government must maintain a record of work and expenditures for the quarterly reports that the State submits to FEMA. To ensure that mitigation retrofits are being implemented in a manner that will effectively reduce the home's risk to wind-related damage as approved, inspections should be conducted during the project. For example, if a wind retrofit project involves replacing the roof covering, the selection and spacing of fasteners should be verified by an evaluator before the underlayment and new roof covering are installed. Conducting inspections while the project is underway can ensure that any improperly installed components can be corrected before additional work is implemented, which can help reduce or eliminate unanticipated construction costs. The basic steps for implementing an HMA mitigation wind retrofit project are:

1. Evaluate the building to identify the viable Mitigation Package(s) and associated hazard mitigation projects (unless already completed during Stage 3, Application Development).

2. Select viable Mitigation Package(s) and eligible hazard mitigation projects (unless already completed during Stage 3, Application Development).

3. Secure professional services to complete the approved project.

4. Complete installation of the approved hazard mitigation.
5. Inspect the completed hazard mitigation elements and verify other program requirements.

Stage 5. Project Closeout

Once the wind retrofit project has been completed, a professional should conduct a final verification to ensure that the project was implemented as intended. This will allow project closeout documentation and confirm that the building provides the desired level of protection. In addition, the State or the FEMA Region will verify that the work was completed in accordance with the approved scope of work and closeout procedures. If the house is located in an SFHA, the local government must provide documentation of flood insurance for the structure and a copy of the recorded deed amendment. The HMA Unified Guidance should be referenced to ensure all closeout requirements are addressed.

Eligible and Ineligible Costs

Allowable mitigation costs for FEMA wind retrofit projects are for project components, such as design and building costs, directly related to and necessary for providing increased hazard protection from wind and wind-driven rain intrusion during a high-wind event . FEMA will only compensate costs that are consistent with the Basic, Intermediate, and Advanced Mitigation Packages described in this Guide. Eligible costs consistent with these Mitigation Packages include key personnel (such as the evaluator, inspector, and design professional); structure evaluation and inspection; planning and design activities; site preparation, building materials, and construction; structural systems capable of resisting design wind loads (including roof decking and roof support structures); soffits, vents, and turbines; protective envelope components such as walls, ceiling/roof systems, and doors; and other retrofit hardening activities that meet the criteria in this Guide. Performance-related improvements may also be eligible costs under FEMA's grant programs.

FEMA wind retrofit projects are not intended to result in activities such as structure elevation or mitigation reconstruction. The structure evaluation process, as discussed in Chapter 3 and Appendix B, should identify existing conditions that must be addressed for the proposed Mitigation Packages to be effective. The structure evaluation may identify alternate or additional hazard mitigation measures that should be completed, such as a wind retrofit in combination with a structure elevation. In these cases, the local government developing the HMA project subapplication should modify the scope of work to accurately reflect all eligible hazard mitigation activities being requested.

Ineligible costs include, but are not limited to, project activities and components not consistent with the Basic, Intermediate, or Advanced Mitigation Packages described in this Guide, uncertified construction products, costs related to functionality or outfitting such as furniture, interior or exterior decorative elements and fixtures, floor treatments, electrical and plumbing utilities, and other finishing materials that do not enhance the structural performance of the home. In addition, costs associated with the repair of gross negligence by a homeowner, previous homeowner, or bank are ineligible. This includes, but is not limited to, negligence, lack of maintenance and subsequent damage, termite infestation, and damage where there was a lack of termite inspections and termites were a known hazard.

5.1.2 State Programs

Some States also offer funding for a wind retrofit project or, in some cases, insurance credits. Some examples of State programs and organizations that educate homeowners, fund wind retrofit projects, and reduce insurance premiums for residential buildings are described below.

Rebuild Northwest Florida

Rebuild Northwest Florida is a public/private partnership that coordinates need-based recovery initiatives for citizens impacted by Hurricane Ivan in Santa Rosa and Escambia Counties, Florida. Current Rebuild Northwest Florida clients may qualify for residential wind retrofit funding through a partnership with the Florida Hurricane Relief Fund. The program is designed to help citizens fortify their living structures against future storm damage by funding items such as hurricane ties, straps, and shutters.

FLORIDA WINDSTORM INSURANCE SAVINGS CALCULATOR

The Florida Division of Emergency Management has an online insurance savings calculator. It allows homeowners and builders to estimate wind insurance savings that Florida insurance companies make available for new construction and retrofits, such as those outlined in the Florida retrofit programs and this Guide.

The calculator is available at floridadisaster.org/mitdb.

Residential Construction Mitigation Program (Florida)

The RCMP receives $7 million annually from the Florida Hurricane Catastrophe Trust Fund for the Mobile Home Tie-Down Program, hurricane research conducted by Florida International University, and to improve the wind resistance of residences through loans, subsidies, grants, and cooperative programs with local and Federal governments. The RCMP complies with the mitigation requirements outlined in their Hurricane Retrofit Guide (Florida Division of Emergency Management, 2007), a prescriptive guide to help homeowners decide how to protect their homes against the winds and rains of hurricanes. The guide includes ideas for homeowners on protecting their homes from wind hazards as well as technical help for people familiar with construction or in the construction business.

South Carolina Comprehensive Hurricane Damage Mitigation Program (SC Safe Home)

The South Carolina Department of Insurance established the SC Safe Home Grant Program in 2007 to provide grants to individual homeowners for retrofitting primary single-family residences. The program is based on the principle that retrofitted homes are less vulnerable to hurricane damage, resulting in fewer and lower insurance claims. This program requires a home inspection by a certified wind inspector prior to applying for a grant. The program awards up to $5,000 in matching funds for eligible retrofits, including roof covering , roof attachments , opening protection, and load path strengthening. Manufactured homes are eligible to receive funds for tie-downs only.

Mississippi Windstorm Underwriting Association Retrofit Mitigation Program

This program gives homeowners up to 30 percent in credit on their wind insurance premiums for retrofitting their homes to help protect the structure from loss due to windstorms. Insurance credit can be obtained when homeowners implement one of four groupings of wind retrofit projects. Each retrofit item in a particular grouping must be completed to receive credit for that group.

5.1.3 Federal Alliance for Safe Homes Program

The FLASH Program's mission is to provide residential builders and citizens with accurate, current, and reliable information about how to make homes more disaster resistant. The FLASH

program uses the *Blueprint for Safety: Contractor's Field Manual* (FLASH, 2010) guidance to implement residential wind retrofit improvements. The *Blueprint for Safety Field Manual* supports FLASH's mission to build, remodel, or restore homes using disaster-resistant techniques, technologies, and products specifically for wind hazards.

5.1.4 FORTIFIED *for Existing Homes*™ Program

The FEH program was developed by the IBHS. The FEH program was developed in conjunction with this Guide, and as a result, the framework for these two programs is similar. Both guides were developed based on FEMA's MAT observations and guidance documents, as well as modern engineering codes and standards. While the FEH program does not provide grants for projects, IBHS has developed the program in coordination with many prominent insurance companies. In doing so, homeowners who participate in the FEH program may be eligible for reductions in their home insurance premiums.

Similar to this Guide, the FEH program involves an accredited FEH evaluator evaluating the home in its existing condition. The evaluator assesses the home and provides a report to the homeowner of the current condition of the home and retrofit options. The FEH program outlines three levels of increasing protection to retrofit a home to: Bronze, Silver, and Gold. More information on the FEH program can be found in Appendix A.

5.2 Factors to Consider When Implementing Wind Retrofit Projects

Retrofitting existing buildings can be a complicated process. Building configurations, material types, construction methods, and local code and ordinances can all differ widely. This section discusses these issues so that the homeowner, local government, evaluator, contractor, and design professional can consider how such concepts may apply to their project and what potential issues may need to be addressed over the course of the project. Code compliance, local permitting and inspection requirements, and general construction hazards are also addressed in this section.

5.2.1 Code Compliance Check

Modern building codes contain provisions for existing buildings to ensure that renovations, alterations, repairs, and relocations of space are completed in a manner that does not compromise the structural integrity of the building. While a wind retrofit project should improve the structural integrity of a home rather than reduce it, every wind retrofit project should still undergo a code compliance check to verify that the project does not trigger provisions for existing buildings. These types of provisions for existing buildings can potentially disrupt a wind retrofit project by creating additional work to implement the selected Mitigation Package. Additional information on these provisions, and the type of work they apply to, can be found in FEMA 499 Technical Fact Sheet No. 9.2 (see Figure 5-2).

As with new construction, individual retrofit measures and the measures that are part of the Mitigation Packages should comply with the ICC model building codes (or the effective building code adopted by the community, if it is more restrictive). This Guide does not intend for any retrofit measures to be performed that would result in a conflict with the building code as it applies to the hardening of residential buildings.

FIGURE 5-2:
FEMA 499 Technical Fact Sheet No. 9.2, *Repairs, Remodeling, Additions, and Retrofitting—Wind*

SUBSTANTIAL IMPROVEMENT/ SUBSTANTIAL DAMAGE (SI/SD)

Section R112.2.1 of the IRC defines SI as "any repair, reconstruction, rehabilitation, *addition* or improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the building or structure before the improvement or repair is started. If the building or structure has sustained substantial damage, all repairs are considered substantial improvement." (IRC, 2009)

Section 1612.2 of the IBC defines SD as "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damage condition would equal or exceed 50 percent of the market value of the structure before the damage occurred." (IBC, 2009)

One type of provision that is prevalent in existing building codes is for homes undergoing extensive repairs or improvements. Homes that experience severe damage from a storm may require repairs that would have to comply with substantial damage code triggers in the building code or the local flood ordinance. The resulting code compliance checks are generally triggered when work is considered to be a result of substantial improvement/substantial damage (SI/SD) of the home. The SI or SD provisions are not likely to be triggered unless other work is being done at the same time as the retrofit measures. More information on SI/SD can be found in FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference* (FEMA, 2010b).

A summary of code compliance checks for the 2009 IEBC; 2009 IRC; and 2007 FBC: Existing Building (ICC, 2008b) is provided in Table 5-1. Table 5-1 also includes a brief commentary on how the provision may apply to a wind retrofit project. Note that there may be additional provisions not included in Table 5-1; this should be verified before implementing a wind retrofit project.

5.2.2 Permitting and Inspections

Homeowners should ensure that their retrofit projects are properly permitted through their local building department and that inspections required by the local building department are carried out. Permitting and inspection procedures in coastal areas are usually more involved than those in inland areas, and, if unanticipated, can complicate a wind retrofit project. For instance, in addition to meeting all of the Federal, State, and local requirements, the design plans and specifications may need to be sealed by a design professional. Building permit submittals must often include detailed drawings and information for all elements of the wind-resisting load path, including sheathing material, sheathing nailing, strap and tie-down descriptions, bolted connections, and pile description and placement. Local building department requirements vary with each community and should be considered as early as possible in the process of developing a wind retrofit project.

This Guide provides only an overview of the permitting and inspection process. Homeowners should be aware that most of the retrofit projects described in Chapter 4 of this Guide would be considered *repairs, alterations,* or *additions*. These terms have specific meanings with regard to building codes, and may trigger a special permitting process, depending on local code provisions as described above.

TABLE 5-1: Code Compliance Checks

Flood Hazard Areas	**303.2:** Any alteration that constitutes SI/SD shall comply with flood damage requirements for new construction.	**AJ102.5:** Any alteration that constitutes SI shall comply with the flood damage requirements of new construction.		**All Packages:** Applicable if done simultaneously with SI/SD and located in a flood hazard area.
Existing Structural Elements Carrying Gravity Load	**303.3:** Any existing gravity load-carrying structural element for which an alteration causes an increase in design load of more than 5% shall be strengthened, supplemented, replaced or otherwise altered to carry the increased load.		**606.2.1:** Addition or replacement of roofing or equipment resulting in additional dead load greater than 5% or a second layer of roof covering weighing more than 3 psf over an existing, single layer roof covering results in the need for reroofing and equipment to comply with the vertical load requirements of the FBC.	**Basic Package:** New roof covering may weigh more than the previous roof covering (or greater than 5% of the previous in the case of the FBC). **IEBC:** Existing load-carrying structural elements should not require strengthening to carry increased gravity loads from retrofits. **FBC:** It is recommended that a roof covering product less than 5% heavier than the existing roof covering be selected.
Wall Anchors for Concrete and Masonry Buildings	**606.2.1:** Re-roofing more than 25% of roof area if concrete and masonry building is in seismic design category D, E, or F, work shall include installation of wall anchors to resist IBC seismic forces.			**Basic Package:** Applicable if re-roofing in an area that is both hurricane- and earthquake-prone (e.g., Charleston, SC) with concrete and masonry construction.
Voluntary Lateral-Force-Resisting System Alterations	**707.6:** Alterations of existing and new structural elements intended to increase the lateral force-resisting strength need not be designed for the IBC forces if an engineering analysis is submitted to show: lateral loading is not increased beyond 10%; new elements are detailed and connected according to IBC; and a dangerous condition does not result.			**All Packages:** Applicable if wind retrofit project qualifies as a Level 2 alteration;[2] an engineer may be needed to conduct an analysis. Wind retrofit projects should not qualify as a Level 2 alteration unless additional work is being done to the home.

TABLE 5-1: Code Compliance Checks (continued)

Code Check	IEBC[1]	IRC	FBC[3]	Comments
Structural Alterations	**807.4:** If a Level 3 alteration results, all structural elements of the lateral force-resisting system in buildings shall comply with 807.4.2 below.			**All Packages:** Applicable if the wind retrofit project results in a Level 3 alteration. Wind retrofit projects should not qualify as a Level 3 alteration unless additional work is being done to the home.
Substantial Structural Alterations	**807.4.2:** Where more than 30% of the total floor and roof areas of the building have been proposed to be involved in a structural alteration in a 1-year period, an analysis must show the altered building complies with the IBC for wind loading and reduced seismic forces.			**All Packages:** Applicable if the wind retrofit project results in Level 3 alterations. Wind retrofit projects should not qualify as a Level 3 alteration unless additional work is being done to the home. *NOTE: 30% of the total floor and roof area includes tributary areas to vertical load-carrying components.*
Roof Diaphragm	**606.3.2:** Where roofing materials are removed from more than 50% of the roof diaphragm or if the building is located where the basic wind speed is greater than 90 mph or in a special wind region, the integrity of the roof diaphragm shall be evaluated and connections need be provided or replaced to meet IBC requirements.		**606.3:** Where roofing materials are removed from more than 50% of the roof diaphragm, the integrity of the roof diaphragm shall be evaluated and connections need be provided or replaced to address deficiencies.	**Basic Package:** Applicable only if home has "defective" roof sheathing, and such a home would not generally be considered a good candidate for a retrofit project. **IEBC:** Provision applies only if roof structure and not roof covering is at least 50% replaced. This condition should not occur for eligible candidates.
Roof Covering			**611.1.1:** Not more than 25% of the total roof area or roof section shall be repaired, replaced or recovered in any 1-year period unless the entire roofing system or section conforms to the FBC: Existing Building.	**Basic Package:** Applicable when reroofing. *NOTE: The entire roof system and section must conform to the FBC, but the roof diaphragm does not have to meet the requirements for new buildings.*

TABLE 5-1: Code Compliance Checks (continued)

Code Check	IEBC[1]	IRC	FBC[3]	Comments
Roof-to-Wall Connections			**611.8 and 611.8.1:** When the roof covering is removed and replaced in a windborne debris region and the home has an insured value of $300,000 or more, if the building is uninsured, has a just valuation for the structure for the purposes of ad valorem taxation of $300,000 or more, roof to wall connections shall be improved to meet the uplift loads specified in the FBC: Existing Building.	**Basic Package:** Applicable when reroofing a home that triggers this provision, unless the gable-end work costs more than 15% of the roof covering work. If provision is triggered, some roof-to-wall connections may have to be installed, even for the Basic Package.

1) The IBC states that there is an alternative compliance with the IEBC in place of the IBC for existing structures (any retrofit projects would fall into this category). It should be noted that most of the provisions of the IBC are similar to the IEBC, but the IBC is not as stringent in its requirements.

2) Levels of alteration correspond to the three levels defined in the IEBC, IRC, IBC, and FBC: Existing Building.

3) 2007 FBC including the 2009 supplement.

Homeowners or their contractors will need: (1) construction documents consisting of plans and a bill of materials; and (2) descriptions of the proposed project, including a scope of the work that complies with the requirements of any funding source that may be sought (refer to Section 5.1) and the local building code.

Homeowners should be aware that retrofit actions may trigger the requirement for code verification; additionally, those elements of the home affected by the retrofit may be required to be brought up to the current building code as discussed in Section 5.2.1. These elements may include the structural, electrical, mechanical, or plumbing systems, or the method by which the structure provides fire protection. If there is a local building department, inspections may be required throughout the process in addition to a final inspection.

If there is no building department or building codes are not being enforced, it is important that the evaluator who performed the home evaluation (or the designer involved in the project, if applicable) inspect the construction of the retrofit to ensure that the work was performed as outlined in the Mitigation Package. Multiple evaluations during the course of the project (as well as once the project has been completed) should be performed to verify that the work is completed in a manner consistent with the plans (see Chapter 3). At the conclusion of the retrofit, it is important that the homeowner obtain written documentation from the individual performing the final inspection to verify that the retrofit was properly installed and that the materials used were consistent with the requirements of the construction plans. If the homeowner is anticipating an insurance premium adjustment, a

ADDITIONAL INFORMATION ON PERMITTING AND INSPECTIONS:

Chapter 4 of FEMA P-762, *Local Officials Guide for Coastal Construction,* presents important regulatory facts, management tools, detailed information for conducting effective and efficient building permit application reviews, sample organizational structures, and a permit-processing flowchart.

passing "notice of the final inspection" from the building department or written documentation from a design professional will need to be submitted.

It is important to verify that the retrofit project, or projects being done simultaneously with the retrofit project, do not constitute a substantial improvement if the building is located in the SFHA (refer to Section 5.2.1 for additional discussion). In the event that the project meets the substantial improvement designation, per the building code or local ordinances, additional work may be required. Whether the work will meet the substantial improvement designation should be verified prior to submitting the permit application or, if there is no permitting process, before beginning the work.

It is also important to make sure that the retrofits performed comply not only with the codes, but with local ordinances. Historic structures may need to comply with additional standards to maintain the designation as a historic structure. Noncompliance can lead to fines, work stoppage, and possibly legal issues. While variances are granted by local building departments for certain projects and are considered part of the construction process, the issuance of a variance is rare and should not be considered an alternative to compliance with codes and ordinances.

VARIANCE

A variance is a process that allows a building to be constructed in a manner that is usually prohibited by either the building code or local ordinances. The criteria for this are usually very specific, and typically the requirement is that it will be granted only if there is a unique characteristic to the land or historically significant structures.

5.2.3 Construction Challenges

The process for implementing a retrofit project should be carefully planned before removing the first piece of siding or pulling off the first shingle. Homeowners should consider a variety of factors, including how the exterior of their home will look after the retrofit is completed, how to optimize labor versus material costs for the retrofit project, selection and proper use of connectors, availability of materials, and home maintenance.

Ideally, the resulting retrofitted house will have an exterior that looks similar to the house before the retrofit. Exterior building materials should be carefully removed if they are to be replaced.

Access to the soffit or rafter system may be another instance where careful planning will pay off for the homeowner. One method of retrofitting may cost more in materials but require less labor to install, or may require fewer repairs to the house in order to install them. For example, the homeowner may wonder whether it is more cost effective to retrofit a gable end wall with lumber and fewer connectors. Although this may be a cost-effective solution, if the attic access is very small, a retrofit using more metal connectors may be a more practical solution. The work (and associated cost of labor) required to implement a retrofit should be discussed among the homeowner, evaluator, contractor, and design professional (if applicable) in detail and considered in the homeowner's decision process.

The selection of the proper fasteners and connectors is critical to the success of a retrofit. Connectors are designed to use specific fasteners and used in specific situations. Manufacturers provide information on how the connectors should be used, how many fasteners are required, and what size fasteners are required. They

ADDITIONAL CONSIDERATIONS

Additional information on issues to consider before starting a retrofit can be found in FEMA 499 Technical Fact Sheet No. 9.2, *Repairs, Remodeling, Additions, and Retrofitting—Wind* (see Figure 5-2).

should never be bent or forced into a location; this compromises the strength of the connector and can result in an ineffective retrofit. In some situations, longer fasteners may be required. For example, if uplift connectors are being attached between the rafter and the wall top plate, a longer fastener may be needed if exterior sheathing is covering the top plate. The connectors are designed to be used with fasteners that have a minimum embedment into the top plate, so the fastener would need to be longer to account for the thickness of the exterior sheathing. The construction techniques used to build the house and the accessibility of the work space may dictate the selection of the connectors and fasteners.

Another consideration is the availability of materials. Consider that although a nominal 2x2 may be the minimum required size, a nominal 2x4 may be a cheaper alternative. An experienced contractor can assist homeowners with this type of decision before beginning the retrofit project. Terms such as "minimum" used in retrofitting guides (e.g., those described in Section 5.1) may be clues that other design solutions exist and, if the work space permits, that a more cost-effective solution may be available that provides the same or better level of protection. Retrofit guides may list numerous fastener options. Some construction materials may respond better to certain types of fasteners, or some fasteners may be easier to use in specific locations.

Remember that the effectiveness of a retrofit rests on the ability of the materials to maintain their strength through time. Maintenance of the home is critical to maintaining the level of protection desired; this is especially true in corrosive environments common to coastal areas, where wood should be regularly inspected for decay, and metal connectors and fasteners should be inspected for corrosion. Replacement of these materials may be required periodically to maintain the strength of the system. When determining which Mitigation Package to implement, it is important to evaluate the ease with which materials can be maintained or replaced as needed. The level of effort required for maintenance is generally proportionate to the accessibility of the retrofit. More information on the selection of construction materials can be found in FEMA 499 Technical Fact Sheet No. 1.7, *Coastal Building Materials*.

5.3 Addressing Other Hazards

The retrofits described in this Guide are intended to be implemented in hurricane-prone regions, but may be applied elsewhere. The most significant natural hazards that affect the coastlines of the United States and its territories can be divided into tornadoes, coastal flooding, erosion, earthquakes, and other hazards. Additionally, homeowners should be aware that residual risk to their home always exists, even when properly implemented hazard resistance projects are undertaken. When applying for a FEMA grant, residual risk must be identified.

Tornadoes: Although a tornado is a high-wind hazard, it is not specifically addressed in this Guide. Tornadoes require special consideration for mitigation. PDM and HMGP funds may be used for the construction of a tornado or combined hurricane/tornado safe room that provides near-absolute protection if constructed according to guidelines of FEMA 320 and FEMA 361. For more information on the FEMA safe room program, see Chapter 2 of this Guide. PDM and HMGP funds are not available for construction of general population shelters, including evacuation or recovery shelters intended to provide longer-term services and housing. For more information, refer to the HMA Unified Guidance.

Flooding: Coastal flooding often results in significant damage to homes in coastal areas. Hurricanes, tropical cyclones, other coastal storms, and tsunamis generate the most significant coastal flood hazards. Their floodwaters can create hydrostatic and hydrodynamic forces, wave effects, and floodborne debris effects that can significantly affect the performance of residential buildings. In addition, there is the risk of riverine flooding for buildings farther from the coast. For guidance on retrofitting homes for flood hazards, see FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Structures* (FEMA, 2001). If retrofitting is considered a substantial improvement (see text box in Section 5.2.1) and the home is in an SFHA, the construction must comply with local or NFIP floodplain regulations. To determine if a home is in an SFHA, visit the FEMA Map Service Center (msc.fema.gov) or check with your local floodplain management official.

Storm Surge: Storm surge is distinct from the coastal flooding that defines the SFHA. Storm surge is the water that is pushed toward the shore by the high winds associated with tropical storms and hurricanes. This increases the mean water level and can cause severe flooding that reaches farther inland, beyond the SFHA. Storm surge is particularly high when combined with the normal high tide. The Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model maps five categories of storm surge. SLOSH models and storm surge maps are available from State emergency management departments. For examples of coastal storm surge maps, see MEMA's Web page on hurricanes (www.msema.org/preparation/hurricanes.html).

Erosion: Erosion is the wearing or washing away of land and is one of the most complex hazards to understand and predict at a given site. Typically, erosion refers to the horizontal recession of a shoreline. Erosion is capable of threatening coastal buildings by destroying dunes or other natural protective features, destroying erosion control devices, lowering ground elevations, undermining shallow foundations, reducing depths of deep foundations such as piles, supplying overwash sediments that can bury structures farther landward, breaching low-lying

coastal barrier islands, and sometimes exposing structures on the mainland to increased flood and wave effects.

Earthquakes: Earthquakes can affect coastal areas through ground shaking, liquefaction, surface fault ruptures, other ground failures, and the generation of tsunamis. Therefore, coastal construction in seismic hazard areas must take earthquake hazards into account. Proper design in seismic hazard areas employs techniques to stabilize or brace the building against violent accelerations and shaking due to earthquakes. For guidance on seismic retrofits of existing homes, see FEMA 232, *Homebuilders' Guide to Earthquake Resistant Design and Construction* (FEMA, 2006b).

Other Hazards: Other hazards that coastal construction may be exposed to include a wide variety of hazards whose incidence and severity may be highly variable and localized. Examples include subsidence and uplift, landslides and ground failures, salt spray and moisture, rain, hail, wood decay and termites, wildfires, floating ice, snow, and atmospheric ice. These hazards do not always come to mind when coastal hazards are mentioned, but should be considered in design and construction decisions.

Residual Risk: While homeowners may retrofit their houses to mitigate wind hazards, residual risk will remain. No wind retrofit project completely protects a home against wind damage; furthermore, the risk from hazards described above will remain unless specifically addressed. The failure to properly identify and design to mitigate other hazards in coastal areas and hurricane-prone regions can lead to severe consequences, such as building damage or even destruction. When following the guidance presented in this Guide, homeowners should understand the elements of risk that remain in their homes. Publications such as FEMA 55, *Coastal Construction Manual,* FEMA P-762, *Local Officials Guide for Coastal Construction,* and FEMA 499, *Home Builder's Guide to Coastal Construction* can help homeowners further understand the residual risks from wind retrofit projects and to successfully account for and mitigate other relevant coastal hazards. Appendix D of this Guide includes a list of links to FEMA and other building science publications that should be considered when planning a wind retrofit project.