Hurricane Wind Retrofit Technical Review

This job aid supplement covers requirements associated with the technical reviews for hurricane wind retrofit projects funded by Hazard Mitigation Assistance. FEMA will also conduct an Environmental Planning and Historic Preservation review of each project. Refer to the Hurricane Wind Retrofit: Information Required for Environmental Review Job Aid.

This Technical Review Supplement provides additional information, examples and potential sources of documentation for items in the job aid to help communities applying for Hazard Mitigation Assistance grants comply with application requirements.

- All Hazard Mitigation Assistance (HMA) applications must comply with the requirements outlined in the HMA Guidance.
- According to the guidance, in addition to a general programmatic review, an EHP review and a technical review will be performed by FEMA for each proposed project.
- The technical review will verify that a project demonstrates feasibility, effectiveness and cost-effectiveness. The document is intended for technical reviews of applications only.
- For assistance completing EHP compliance reviews, see the EHP Supplement Job Aids.

Introduction

The following provides a review of the information that should be provided with the grant application, including recommended documentation and a list of supplemental information, to assist FEMA when conducting technical reviews of the project application. Technical resources are identified throughout this supplement to provide clarifying information on specific project application components. The final section provides a comprehensive list of resources identified throughout this supplement.

It is recommended that the grant applicant consult a professional engineer to assist in preparing the application, as many of the documentation requirements for hurricane wind retrofit applications are technical in nature. An engineer will be required for the initial hurricane retrofit building assessment, design and implementation. For complex hurricane wind retrofit projects, applicants may want to consider Advanced Assistance or a phased project approach (phasing is allowable for Hazard Mitigation Grant Program [HMGP] and Building Resilient Infrastructure Communities [BRIC] projects only). Initial funds can be obtained (Advanced Assistance or Phase 1) to produce a detailed design of the project for further FEMA review and approval (Phase 2 or HMGP Application Development). Refer to HMA Guidance, Part VIII, A.12 and A.13 for additional advanced assistance and phased project requirements and guidance.

The project-specific guidance in this supplement does not provide all the information necessary to apply for funding through an HMA program and must be read in conjunction with all other relevant guidance documents.

Additional Resources

- Hazard Mitigation Assistance Guidance (HMA Guidance)
- Hazard Mitigation Assistance Guidance Addendum
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide
- Hazard Mitigation Assistance Application Development – Hurricane Wind Retrofit Projects
- Sample Engineering Case Study for Wind Shutters

A list of all resources referenced is provided on the last page of the supplement.

Summary of Steps

- ☐ STEP 1: Provide a Scope of Work
- ☐ STEP 2: Provide Structure-Specific Details
- ☐ STEP 3: Provide Available Technical Data
- ☐ STEP 4: Provide a Project Schedule
- ☐ STEP 5: Provide a Project Cost Estimate
- ☐ STEP 6: Provide a Project Site Map
- ☐ STEP 7: Provide Property Location Information
- ☐ STEP 8: Provide Structure Photographs
- ☐ STEP 9: Determine if Project Location is in a Floodplain
- ☐ STEP 10: Identify Design Wind Speed and Risk Category
- ☐ STEP 11: Identify Wind Exposure Category
- ☐ STEP 12: Cost-Effectiveness Analysis
- ☐ STEP 13: Environmental and Historic Preservation Considerations

Important Terms

ASCE/SEI 7-22 (American Society of Civil Engineers/Structural Engineering Institute – Minimum Design Standards and Other Structures, 2022 Edition)**:** This standard is used by engineers and architects to determine design loads for buildings, including seismic loads on buildings.

Basic wind speed: Tree-second gust speed measured at 33 feet (10 meters) above the ground in Exposure C (described in Step 11 of this supplement).

Built-up Roof (BUR): A roof system that is composed of multiple layers of roof felts that are laminated together with bitumen (a type of asphalt) and covered with asphalt, aggregate or an emulsion with a granular surface. In hurricane-prone regions, aggregate is not permitted to be used as the top surface for BUR.

Hurricane-prone region: Areas vulnerable to hurricanes in the United States and its territories defined as:

- The U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed for Risk Category II buildings is greater than 115 miles per hour (mph) as indicated by ASCE/SEI 7-10
- Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa

Hurricane Retrofit Building Assessment: An inspection, performed by a professional engineer or licensed architect, utilizing the methodology provided in Chapter 3 of FEMA P-804 that is used to determine whether a structure is a good candidate for a wind retrofit and identifies the retrofits to be performed on the structure that will improve its ability to resist the forces associated with a hurricane.

Single-Ply Membrane (SPM): A roof system comprised of a single layer of thermoplastic that is adhered to the roof surface or held down with aggregate ballast. In hurricane-prone regions, aggregate is not permitted to be used as the top surface in a single-ply roofing system.

Wind-borne debris region: Areas within hurricane-prone regions that are located:

- Within 1 mile of the coastal mean high-water line where the basic wind speed is equal to or greater than 130 mph
- In areas where the basic wind speed is equal to or greater than 140 mph wind speed for Risk Category II buildings, as indicated by ASCE/SEI 7

Wind exposure category: A classification or category to address the characteristics of the ground roughness and surface irregularities in the vicinity of a building to be retrofitted. The exposure categories (B, C and D) are based on the natural topography, vegetation and constructed facilities surrounding the project location.

Technical Review Components

To complete a successful project application, a minimum amount of technical information is required for review. The following is a step-by-step approach addressing the major components of a hurricane wind retrofit project. Data collected in these steps will provide reviewers with the necessary information to determine whether a project is feasible and effective.

The data requirements in the following steps should be compiled in an attachment to the project application. If the project impacts multiple structures, this information must be provided for each structure.

STEP 1: Provide a Scope of Work

Description: Provide a project narrative clearly outlining the existing conditions of the structure to be mitigated, including components that are susceptible to damage, a detailed description of the hazard(s) being mitigated, a detailed description of the proposed mitigation action, the project useful life, a description of proposed activities and a clear explanation of how the project will mitigate the identified risk(s). The SOW should include key milestones and coincide with the design information, project schedule and cost estimate. It is important to state in the SOW that the hurricane retrofit package will comply with the guidelines outlined in FEMA P-804. Prior to developing the scoping narrative and application, the hurricane retrofit building assessment, as defined in Chapter 3 of FEMA P-804, should be performed.

References: When preparing a SOW, refer to the following:

- HMA Guidance Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate

- HMA Application Development – Procedures for Developing Scopes of Work for Wind Retrofit Projects
- Sample Engineering Case Study for Wind Shutters
- FEMA P-804, Wind Retrofit Guide for Residential Buildings
- ASCE 7, Minimum Design Loads for Buildings and Other Structures

Approach: Wind retrofit projects for non-residential or multi-family residential buildings must be designed in conformance with the design criteria found in ASCE 7 and the locally enforced building code. Identify the proposed action and level of wind retrofit based on conducting a building assessment outlined in FEMA P-804. An engineer, architect, building official, or contractor may be required to assist in collecting the necessary information for the mitigation project. A common error with wind retrofit project applications is the lack of a comprehensive approach to mitigation. For example, a project may incorporate the use of storm shutters to protect the windows but have a roof system that may still be vulnerable in a high wind event. The SOW should cover any vulnerabilities identified in the building assessment.

The following items are recommended in the scoping narrative:

- Provide a detailed description of the hurricane risk being mitigated, including hurricane damage history in the project area, if available.
- Mitigation project alternatives are required as part of application development. Document at least two alternatives that were considered as part of the planning or design phase. Clearly indicate which alternative is the preferred mitigation alternative and discuss why it is the most practical, effective and environmentally sound alternative. One alternative is often considered the "no-action alternative" and reflects conditions expected to exist if a mitigation project is not completed. This is a key step to verify an efficient EHP review process.
- Describe the existing conditions of the structure(s) to be mitigated and its ability to resist hurricane wind forces. Specific details and documentation to support the narrative are described in **Step 3**.
- Clearly explain the proposed mitigation activity, specifying the deliverables, identifying the tasks required to complete the proposed activity and defining the tasks to be accomplished in clear, concise and meaningful terms.
- All cost elements must match tasks and provide sufficient detail for FEMA to determine whether the application is eligible. The scoping narrative will become part of the conditions of the award.
- Wind retrofit projects for one- and two-family residential buildings must be designed in conformance with the design criteria found in FEMA P-804 and the locally enforced building code. Prior to completing an application for a one- and two-family residential wind retrofit, familiarize yourself with FEMA P-804. Identify the proposed action and level of wind retrofit based on the results of the building assessment outlined in the methodology indicated in Chapter 3 of FEMA P-804. Hurricane wind retrofit projects for one- and two-family residential buildings typically fall into one of three packages: basic, intermediate and advanced mitigation; these are explained in further detail below. An engineer, architect, building official or contractor may be required to assist in collecting the necessary information for the mitigation project. The SOW should cover any vulnerabilities identified in the building assessment.

  - **Basic mitigation package:** The basic mitigation package focuses on securing the roof system and improving the water intrusion resistance of an existing home. The basic mitigation package can be performed with or without replacing the roof covering (e.g., shingles, tiles, metal panels) and requires strengthening of vents and soffits (areas under the eaves) and roof overhangs (where the roof overhangs the gables and walls). If the residential building is in a wind-borne debris region, the openings are to be protected in accordance with the specifications of the intermediate package. It is recommended that the roof cover be replaced in the basic mitigation package because it allows for easier installation of a secondary water barrier (underlayment below the roof covering) to prevent water intrusion. Replacing the roof covering also allows the roof deck (wood sheathing) to be repaired, if required, and verify that the deck is properly fastened and corrected, if required.
  - **Intermediate mitigation package:** The intermediate mitigation package includes the components of the basic mitigation package and additionally includes protecting windows and doors from wind-borne debris, protecting garage doors from wind pressure and wind-borne debris, bracing gable end walls that are over 4 feet tall and strengthening the connections of attached structures (carports, awnings, porches). As with the basic mitigation package, the intermediate mitigation package can be performed with or without replacing the roof cover system. It is recommended that the roof cover be replaced in the intermediate mitigation package.
  - **Advanced mitigation package:** The advanced mitigation package requires that a continuous load path (designed connections) from the roof to the foundation be provided and that openings are protected from wind-borne debris and wind pressure. Additionally, the components of the basic and intermediate mitigation packages are to be included in the advanced mitigation package.
- Verify that the project will be constructed to the latest edition of codes and standards by including the following:
  - A statement that the proposed project will be designed and constructed in accordance with the requirements of FEMA P-804 and ASCE 7
  - A description of any additional building code or standards that will be followed

STEP 2: Provide Structure-Specific Details

Description: Provide the following information about the structure(s) to be mitigated; if there are multiple structures, this information must be provided and documented for each.

- Date structure was built
- Building type (e.g., one-story, two-story, or split level residential; apartment building; water treatment plant; municipal office building; police station; hospital)
- Structure information, including the square footage, number of stories, if a garage is present and description of outbuildings, if present
- Construction type (e.g., wood-framed, masonry/brick, concrete, or steel)

- Additional details related to the existing condition of the structure such as condition of the existing building envelope
- Provide a description of the foundation. See **Figure 1** for examples of foundation types.

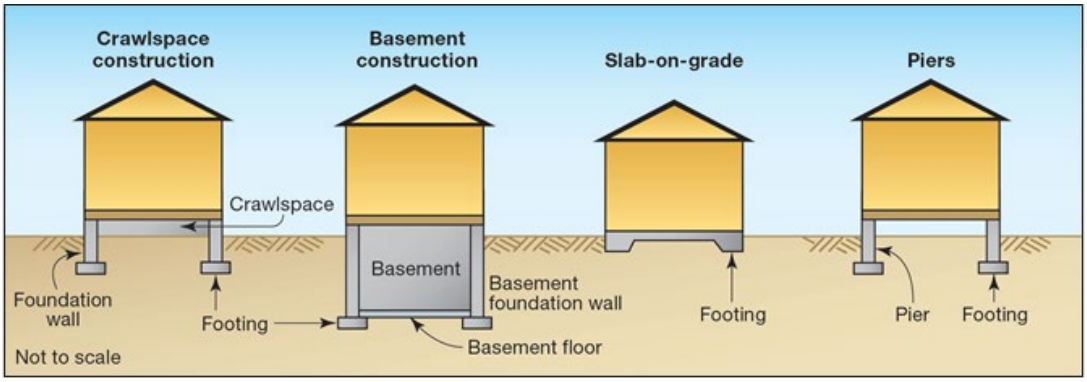
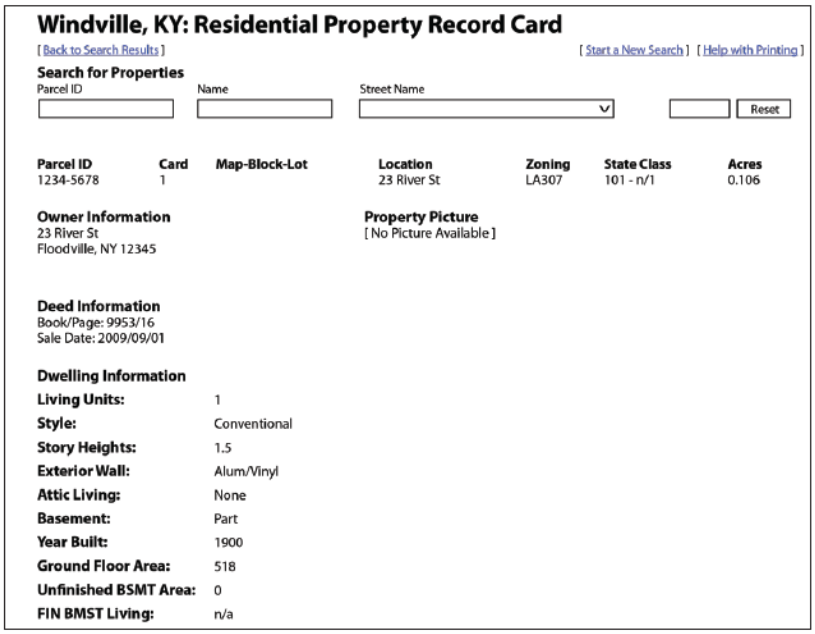


Figure 1. The four foundation types represented in this figure are crawlspace construction, basement construction, slab-on-grade, and piers.

Potential sources: The age of a structure may be verified through city or county property records or from building permit information. This information can often be found from publicly available websites such as the tax assessor website. Some cities and counties have parcel databases with this information. Alternatively, online mapping programs with measuring features and high-quality aerial photographs may be used to estimate the size of the building. Building information can also be provided by the licensed engineer, architect or building inspector who performed the hurricane retrofit building assessment as outlined in Chapter 3 of FEMA P-804.

Example: One-story, wood-framed residential building, gable roof, concrete slab-on-grade, without a basement, no garage, built in 1900. See **Figure 2** Residential Property Record Card for documentation.



Windville, KY: Residential Property Record Card

[Back to Search Results] [Start a New Search] [Help with Printing]

Search for Properties

Parcel ID | Name | Street Name | Reset

Parcel ID	Card	Map-Block-Lot	Location	Zoning	State Class	Acres
1234-5678	1		23 River St	LA307	101 - n/1	0.106

Owner Information
23 River St
Floodville, NY 12345

Property Picture
[No Picture Available]

Deed Information
Book/Page: 9953/16
Sale Date: 2009/09/01

Dwelling Information

Living Units:	1
Style:	Conventional
Story Heights:	1.5
Exterior Wall:	Alum/Vinyl
Attic Living:	None
Basement:	Part
Year Built:	1900
Ground Floor Area:	518
Unfinished BSMT Area:	0
FIN BMST Living:	n/a

Figure 2. An example of a Residential Property Record Card that can be used for documentation of the structure's details.

STEP 3: Provide Technical Data to Support the Scope of Work

Description: It is necessary to demonstrate that a project is feasible and effective at reducing risk. Provide engineering or design plans of the proposed hurricane wind retrofit mitigation; these may be conceptual (e.g., sketches or schematics) with the project application. This information can be further developed following the grant award and should be accounted for in the scoping narrative, schedule and cost estimate, if not available during application development.

It must be shown that a proposed structural retrofit project will meet the requirements of the most current, enforced version of the International Existing Building Code (IEBC), International Building Code (IBC), International Residential Code (IRC) and ASCE 7. Additionally, it must be demonstrated that the proposed retrofits will improve the structure to the desired performance level, as described in **Step 1**. For multiple buildings, the information must be provided and documented for each.

References: When preparing technical data, refer to the following resources, as appropriate:

- ASCE 7-16 (or most recent version) – Minimum Design Loads for Buildings and Other Structures
- FEMA P-804 – Wind Retrofit Guide for Residential Buildings
- FEMA P-424 – Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds
- FEMA P-543 – Design Guide for Improving Critical Facility Safety from Flooding and High Winds
- FEMA P-577 – Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds

Approach: Project plans should comply with the latest edition of codes, standards and minimum construction requirements. Clearly document how the scope solves a problem independently or is a **functional portion of a solution** where there is verification that the overall project is being completed. The assistance of a licensed engineer, architect or contractor may be required to help obtain the necessary information about mitigation materials. For mitigation projects where the load path for the one- or two-family residential house is not being modified, a signed and sealed statement from a professional engineer or licensed architect, indicating the existing structure can resist the currently enforced design level wind speeds and corresponding loads, is required to demonstrate technical feasibility of the mitigation project. Prior to beginning construction, for non-residential and multi-family structures, documentation should indicate that the final design drawings and specifications will be signed and sealed by an engineer licensed in the state where the project is located.

A project represents a **functional portion of a solution** if it produces quantifiable benefits shown through an approved BCA methodology.

The following is a list of common items that are addressed in hurricane wind mitigation projects and details on what is typically provided to support their mitigation effectiveness.

- **Roof coverings, underlayments and secondary water barriers:** Proposed changes to the roof covering and underlayment or inclusion of secondary water barriers should be documented using product specifications that will state the design wind speed for the covering and include any installation guidelines by the manufacturer to meet the warranty requirements. The design wind speed for the product should exceed the minimum design wind speed for the project. The design wind speed for projects must conform to ASCE 7 wind speeds, and the applicant should verify with the manufacturer's representative that the product wind speeds

use the same approach. If a different wind speed guideline is used by the product manufacturer, it is important to provide documentation of compliance by working with the manufacturer.

- **Roof decking:** Proposed changes to the roof decking should utilize a nailing pattern that will meet or exceed the wind speed requirements. For one- and two-family structures, if design plans are not available, the applicant can provide a statement assuring that nailing patterns will meet or exceed the locally enforced building code requirements or the IEBC, IBC or IRC (most recent edition), whichever is more restrictive. For multi-family and non-residential structures, the proposed changes will need to meet or exceed the locally enforced building code requirements or IEBC, IBC or IRC (most recent edition), whichever is more restrictive. The design professional responsible for the project will need to provide preliminary designs or documentation to indicate the mitigation measure is feasible. Any new or replaced equipment should include any relevant product specifications so it can be verified that the design wind loads will be met.
- **Soffits, vents, overhangs and gable end walls (one- and two-family residential structures):** Recommended construction details are provided for soffits, vents, overhangs and gable end walls in FEMA P-804. Any proposed mitigation project prepared to address these areas should reference compliance with FEMA P-804 unless the design professional overseeing the mitigation project elects to use a more robust design, which should be detailed and provided in the application.
- **Soffits, vents, overhangs, louvers and rooftop-mounted equipment (multi-family and non-residential structures):** The retrofitting of soffits, vents, overhangs, louvers and rooftop-mounted equipment should be documented by the evaluating engineer. Mitigation measures may include replacement or retrofitting of these items to improve connections and anchorage. Any proposed mitigation project prepared to address these areas should reference compliance with wind loading requirements of the locally enforced building code or the IEBC, IBC or IRC (most recent edition), whichever is more restrictive. The design professional responsible for the project will need to provide preliminary designs or documentation to indicate the mitigation measure is feasible. Any new or replaced equipment should include any relevant product specifications so it can be verified that the design wind loads will be met.
- **Connections to attachments and load path improvements:** Proposed improvements to the connections from the structure to attached structures, such as canopies and carports, and to load path connections within the structure will need to be defined by the design professional reviewing the structure, accompanied by documentation and statements indicating they will meet or exceed the design wind speed requirements for the mitigation project. Example photos showing the existing condition and any product sheets showing the proposed connector should be included in the application.
- **Wind-borne debris protection:** Protection from wind-borne debris can be achieved either through impact-resistant glazing (glass openings) or shutter systems for windows and doors. All openings into the building should be protected, including windows, sliding glass doors, skylights, entry doors and any other glass on the exterior of the house. Product specifications and installation instructions should be submitted with the application. A statement from an engineer should be provided indicating that any areas not addressed by the retrofit will be able to resist the currently enforced design level wind speeds and corresponding loads. This is critical for mitigation projects where impact-resistant windows are installed. If the structure is not able to transfer the forces the windows are capable of resisting, the structure can become overstressed, resulting in failure, and the benefit of the mitigation is lost.

- For proposed impact-resistant glazing, it is important to work with a manufacturer's representative who will be able to verify the window will meet the requirements. Product specifications should indicate the design wind pressure, the missile level requirements and wind zone information based on the location of the house and the wind speed requirements. It is important that the application state that the installation will follow the manufacturer or designed anchorage requirements for the window.
- Shutters are similarly rated with respect to missile level ratings. The missile level ratings refer to the resistance of the shutter or window to damage from flying objects as part of the testing procedure. Like the windows, it is important that the application states that the installation will follow the manufacturer or designed anchorage requirements for the shutters.

  While shutter systems protect the glass from being broken by wind-borne debris, not all shutter systems address the design wind pressure with respect to the glass. If the shutter system does not protect against the expected wind pressure, the glass protected by shutters should be rated for the expected wind pressure associated with the design wind speed.

- **Garage or roll-up doors:** Owing to the size of garage or roll-up doors and the potential for them to fail during a high wind event, these items should be evaluated as part of the hurricane wind retrofit building assessment. If the garage or roll-up door must be replaced, the product specifications should be included with the application. This may include anchorage requirements since a common failure point for garage doors is the failure of the tracks that allow the door to roll up and down. A garage or roll-up door manufacturer should be able to provide product specifications and installation procedures for a system that meets the wind speed requirements associated with the mitigation project.

STEP 4: Provide a Project Schedule

Description: Include a detailed project schedule for all tasks identified in the project cost estimate and SOW. The schedule identifies major milestones with start and end dates for each activity. Project schedules must show completion of all activities (including construction period) within the period of performance (POP) allowed by the relevant HMA program. Sufficient details must be provided so FEMA can determine whether the proposed activities can be accomplished within the POP.

References: HMA Guidance Part VI, Section D.4: Program Period of Performance and Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate

Approach: Verify that the information in the schedule supports the SOW and aligns with the project cost estimate.

STEP 5: Provide a Project Cost Estimate

Description: Include a detailed line-item cost estimate for all tasks identified in the project schedule and SOW. All costs included in the application should be reviewed to verify they are necessary, reasonable and allocable consistent with the provisions of 2 Code of Federal Regulations Part 200. Include sufficient detail so that FEMA can determine whether costs are reasonable based on proposed activities and level of effort. Costs incurred prior to award may be considered pre-award costs and may be eligible for reimbursement. Eligibility may depend on the date they occurred and the grant program. Refer to HMA Guidance and the Notice of Funding Opportunity for specifics.

References: HMA Guidance Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate

Approach: Applications must include detailed, line-item costs in the project cost estimates for each mitigation item provided in the SOW. Well-documented project cost estimates contain quantities, unit costs and a source for each unit cost. Lump sum cost estimates are not acceptable. The assistance of a licensed engineer, architect or contractor may be required to help develop the project cost. Provide line-item costs using the recommended line items below, where applicable. Allowable costs are costs that are necessary and reasonable for the proper and efficient performance and administration of the federal award. They may include but are not limited to:

- Roof covering replacement (cost/square foot)
- Secondary water barrier installation (cost/square foot)
- Structural strengthening of vents (each)
- Structural strengthening of soffits (linear foot)
- Structural strengthening of gable end walls (each)
- Structural bracing for the lateral load resisting system (each location)
- Structural strengthening of connections (each)
- Impact-resistant replacement windows or shutters (cost/window or shutter)
- Shutters for entry doors (cost/door)
- Protection/replacement of the garage or roll-up door (cost/door)
- Strengthening of roof connectors (each)
- Anchorage of roof-top equipment (each)
- Installation or replacement of load path connectors (each)
- Project management costs
- Construction management costs

It is important to verify that an annual maintenance cost has been determined using appropriate methods. The annual maintenance cost is necessary to address those costs associated with maintaining the effectiveness of the mitigation measures. Although the costs will not be funded by FEMA, they are required to be included in the BCA.

STEP 6: Provide a Project Site Map

Description: Provide a map showing the project location. If the project includes multiple structures, show the project boundaries, including staging area. **Figure 3** provides an example of a project site map.

Reference: Supplement to the Benefit-Cost Analysis Reference Guide, Section 5: Available Technology Aids

Approach: Provide a map showing the project location, including structures, flooding source, map scale and location information. For any maps provided, verify that a scale bar is shown, and the map is clearly labeled to identify the project boundaries.

Potential Sources: Official site survey, assessor maps, topographic maps obtained from the project engineer or planner and maps created using a web-based service such as Google Maps

Figure 3. Example of a project site map. Map clearly shows the parcel with the structure to be retrofit, the project area, the staging area and a scale.

STEP 7: Provide Property Location Information: Address and Latitude and Longitude

Description: Provide both the physical address(es) and the latitude and longitude of each structure being protected in the project application. For projects with multiple properties, tables containing all relevant information by property can be helpful.

PROPERTY ADDRESS

Approach: Provide property address(es) of each structure involved in the mitigation project. This includes street name and number; city, county or parish; state; and zip code. A post office box number is not an acceptable address. If the address provided does not clearly match up with the structure(s) to be acquired, provide photos or a site map with the structure(s) footprint(s) clearly identified.

Potential Sources: Property owner, local building inspector, tax assessor records, deed to the property, engineering plans

Example: 4100 George J Bean Parkway, Tampa, FL 33607

LATITUDE AND LONGITUDE

Approach: Provide the latitude and longitude for each structure involved in the mitigation. The latitude and longitude should be taken at the center of each property. The latitude and longitude can be provided in either decimal degree (e.g., 27.9807, -82.5340) or degrees, minutes and seconds (27° 58’ 50.5’’ N, 82° 32’ 2.4’’ W).

If your global positioning system (GPS) or mapping application provides degrees, minutes and seconds, you will need to convert this into decimal degrees to enter it into FEMA Grant Outcomes (GO) (BRIC applications only). Several free

tools are available on the internet for this conversion. Enter "coordinate converter" into a search engine to find one of these tools.

Potential Sources:

- GPS device
- Free online map tools or search engines (that generate latitude and longitude when an address is supplied)

Example: 27.9807, -82.5340 or 27° 58' 50.5'' N, 82° 32' 2.4'' W

STEP 8: Provide Structure Photographs

Description: Provide photographs of the property, or properties, and structure(s) that are proposed to be retrofitted.

Approach: Provide photographs of all sides of the structure looking outward from each side of the structure as shown in the example in **Figure 4**.

- Photographs should show the foundation, wall, entrances and roof.
- For each photograph, provide a descriptive caption explaining what the photo shows, the direction it was taken (e.g., "looking east" or "east side of building, looking west"), side of the structure shown (e.g., front, back) and other relevant details.
- Photographs taken that are looking outward from each side of the building will be used to determine the wind exposure category in **Step 11**.
- When a structure has multiple levels, it is important to provide photographs that include different views of the structure.
- Any photographs taken during the hurricane retrofit building assessment should contain similar descriptive captions and be included in the application.

Potential Sources: Use a cell phone, tablet, or camera to take clear, good quality photos for inclusion in the application.

Example:

Figure 4. Photos showing the structure to be mitigated. Photos include all sides of the building from different cardinal directions.

STEP 9: Determine if the Project Location is in a Floodplain

Description: Provide a Flood Insurance Rate Map (FIRM) showing the project location. Include a description of the flood zone in which the existing structure is located and whether the site is in a regulatory floodway. An example is provided in **Figure 5**.

References: To identify flood risk, refer to FEMA's Flood Map Service Center and FEMA's How to Find Your FIRM and Make a FIRMette.

Approach: If a FIRM is available for the project area, provide a copy of the map with the project location(s) and structure(s) footprint clearly outlined on the map. Include a description of the flood zone in which the existing structure is located and whether the site is in a regulatory floodway.

Example:

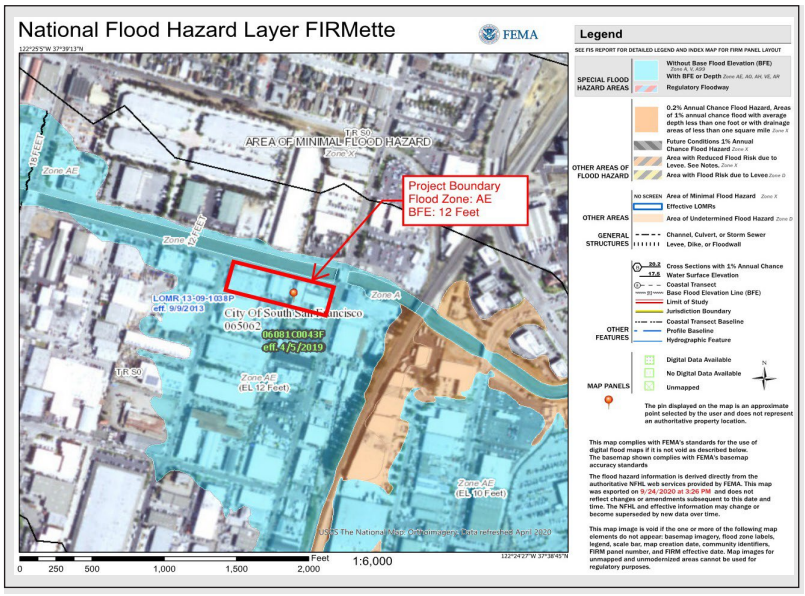


Figure 5. FEMA FIRMette with dry floodproofing project boundary identified.

STEP 10: Identify Design Wind Speed and Risk Category

Description: Include the design wind speed and appropriate risk category for the project location and building type. The design of hurricane wind mitigation is dependent on the identified wind speed.

Potential Sources: Applied Technology Council's (ATC's) Wind Speed by Location website or local wind speed maps provided by the Authority Having Jurisdiction

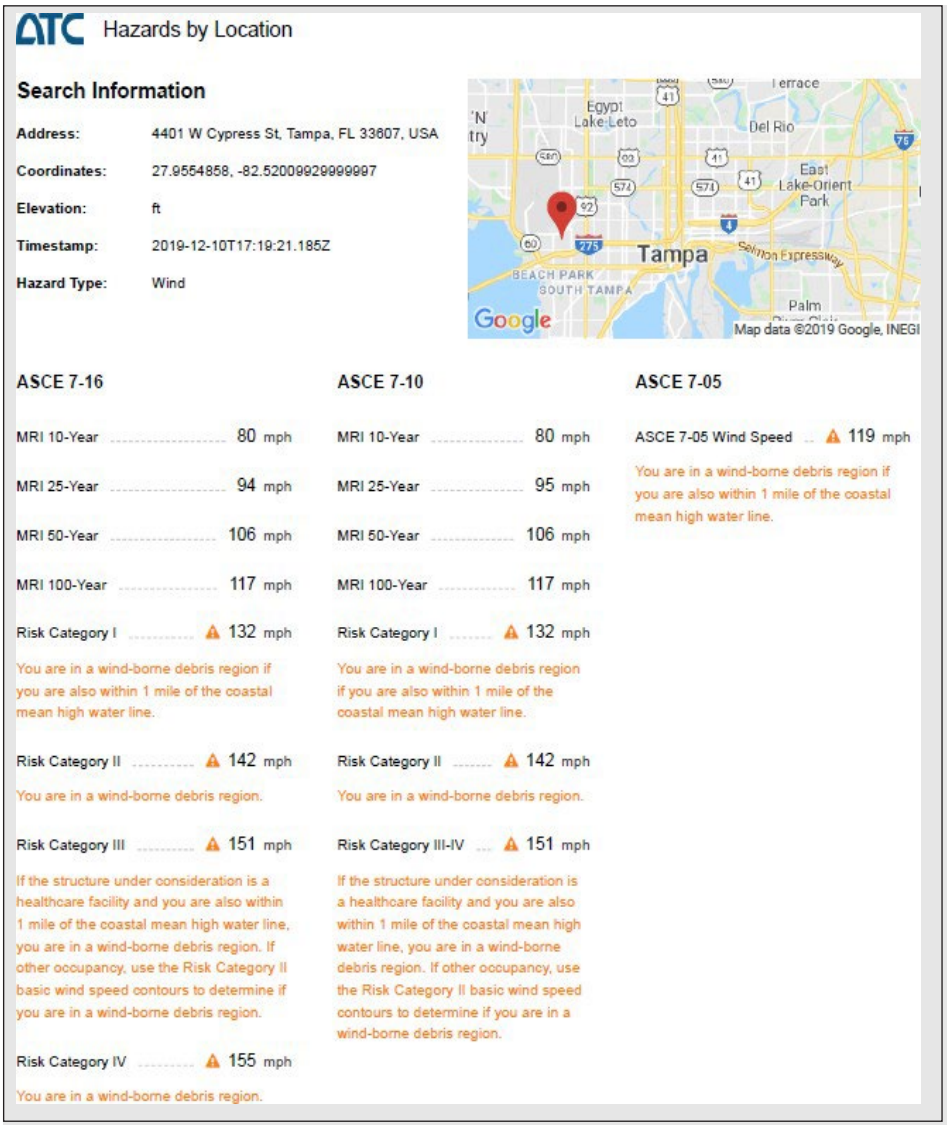
Approach: To determine the design wind speed, use ATC's Wind Speed by Location website. The results of this page (see example in **Figure 6**) should be printed and included in the application documentation. For one- and two-family residential structures, the design wind speed noted in the project application will be listed on the results page as the value for "Risk Category II" and noted in miles per hour. If the Risk Category II wind speed is greater than or equal to

120 mph, the residential property may qualify for pre-determined benefits. If pre-calculated benefits are not being utilized (see **Step 12A**), the results page will also include some additional wind speeds at various mean recurrence intervals and risk categories that could be applicable to the required benefit-cost analysis (BCA).

> The wind speed obtained from the ATC website is sufficient for the initial application; however, it is recommended that prior to specifying or designing any hurricane mitigation, the wind speed should be verified by the Authority Having Jurisdiction. The ATC website does not account for any jurisdiction boundary lines, roadways, bodies of water or other geographical landmarks that may be used to determine a boundary between wind speed contours at a local level.

The design wind speed will be determined by the appropriate risk category associated with the building use. Building codes and design standards, such as ASCE 7 or the most recent IBC, have more detailed descriptions, but they can generally be defined as:

- **Risk Category I:** Buildings and structures, such as agricultural structures, where the risk to lives is low in the event the structure fails
- **Risk Category II:** Most residential buildings and other buildings, such as office buildings, that do not have large occupancies and are not critical to a community maintaining critical services
- **Risk Category III:** Buildings and structures housing a large number of people in one place or that house persons with limited mobility or ability to escape to a safe haven. Risk Category III includes such structures as theaters, lecture halls, elementary schools, prisons and small healthcare facilities. Risk Category III includes structures associated with utilities that are required to protect the health and safety of a community.
- **Risk Category IV:** Buildings and structures that, if severely damaged, would reduce the availability of essential community services necessary to cope with an emergency. Risk Category IV buildings and structures include hospitals, police stations, fire stations, emergency communication centers, similar emergency facilities, ancillary structures required for the operation of these facilities during an emergency and facilities containing extremely hazardous materials that would threaten the public if released (ASCE 7, IBC).



ATC Hazards by Location

Search Information

Address:	4401 W Cypress St, Tampa, FL 33607, USA
Coordinates:	27.9554858, -82.52009929999997
Elevation:	ft
Timestamp:	2019-12-10T17:19:21.185Z
Hazard Type:	Wind

ASCE 7-16

MRI 10-Year	80 mph
MRI 25-Year	94 mph
MRI 50-Year	106 mph
MRI 100-Year	117 mph
Risk Category I	⚠ 132 mph
Risk Category II	⚠ 142 mph
Risk Category III	⚠ 151 mph
Risk Category IV	⚠ 155 mph

You are in a wind-borne debris region if you are also within 1 mile of the coastal mean high water line.

You are in a wind-borne debris region.

If the structure under consideration is a healthcare facility and you are also within 1 mile of the coastal mean high water line, you are in a wind-borne debris region. If other occupancy, use the Risk Category II basic wind speed contours to determine if you are in a wind-borne debris region.

You are in a wind-borne debris region.

ASCE 7-10

MRI 10-Year	80 mph
MRI 25-Year	95 mph
MRI 50-Year	106 mph
MRI 100-Year	117 mph
Risk Category I	⚠ 132 mph
Risk Category II	⚠ 142 mph
Risk Category III-IV	⚠ 151 mph

You are in a wind-borne debris region if you are also within 1 mile of the coastal mean high water line.

You are in a wind-borne debris region.

If the structure under consideration is a healthcare facility and you are also within 1 mile of the coastal mean high water line, you are in a wind-borne debris region. If other occupancy, use the Risk Category II basic wind speed contours to determine if you are in a wind-borne debris region.

ASCE 7-05

ASCE 7-05 Wind Speed	⚠ 119 mph

You are in a wind-borne debris region if you are also within 1 mile of the coastal mean high water line.

Figure 6. Example of ATC's Wind Speed by Location Website printout.

STEP 11: Identify the Wind Exposure Category

Description: The exposure category refers to the roughness of the area around the building since more obstructions can effectively slow down or disrupt the wind sufficiently to reduce the wind loads on the building.

References: ASCE 7-16 (or most recent version) – Minimum Design Loads for Buildings and Other Structures

Approach: The wind exposure category should be determined during the hurricane retrofit building assessment. Photographs should be taken from all four directions facing away from the house, and the wind exposure selection is based upon the least obstructed direction. If a hurricane retrofit building assessment cannot effectively determine the wind exposure category, aerial images from websites can be used to document the selection of the wind exposure category. The assistance of a licensed engineer, architect or building official may be required to help determine the exposure category for the structure.

The wind exposure category is a key component when developing the wind forces, selecting appropriate building materials and performing the BCA. A simplified procedure is used for the BCA, which has narrowed the exposure category to two categories (B and C). Depending on the location of the house, a third Exposure Category (D) may be applicable and should be determined by a licensed design professional as it may increase the design requirements of the building components. For houses located in Exposure Category D, the selection of Exposure C should be used in the BCA. The categories are explained further below.

- **Exposure B:** Applies to urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. The aerial photograph in **Figure 7** demonstrates an example of an area that would be classified as Exposure B.
- **Exposure C:** Applies to flat open terrain with scattered obstructions and areas adjacent to water surfaces in hurricane-prone regions; the scattered obstructions are generally less than 30 feet tall. This category includes flat open country, grasslands and shorelines in hurricane-prone regions[1]. The aerial photograph in **Figure 8** demonstrates an example of an area that would be classified as Exposure C.

Figure 7. An aerial photograph of an area with Wind Exposure Category B.

Figure 8. An aerial photograph of an area with Wind Exposure Category C.

[1] The FEMA BCA Tool includes two wind exposure categories: Category B and Category C. Building codes and ASCE 7 also include Category D for waterfront locations. For BCA purposes, waterfront locations should utilize Category C. When performing the actual design for the wind retrofit, the designer should utilize the code-required exposure category.

STEP 12: Cost-Effective Analysis

Description: Cost-effectiveness must be demonstrated to obtain FEMA funding. For residential hurricane wind mitigation projects, it may be possible to demonstrate the cost-effectiveness based on pre-calculated benefits (see **Step 12A**). If the project is non-residential or does not meet the requirements needed to utilize pre-calculated benefits, a BCA is required to assess the cost-effectiveness of the project. A BCA is a quantitative procedure that assesses the cost-effectiveness of a hazard mitigation measure over the useful life of the project by comparing the potential avoided damages (benefits) associated with the mitigation measure to the cost of a project in current dollars. This section provides guidance on the following:

- **Step 12A:** Pre-Calculated Mitigation Benefits
- **Step 12B:** Benefit-Cost Analysis Tool – Modeled Damages
- **Step 12C:** Benefit-Cost Analysis Tool – Historical or Professional Expected Damages
- **Step 12D**: Additional Benefits for a Benefit-Cost Analysis

> All BCA inputs must be **justified and documented**. When appropriate FEMA default/standard values are used, they should be clearly stated.

FEMA will only consider applications that use a FEMA-approved methodology to demonstrate cost-effectiveness. FEMA provides BCA software that allows applicants to calculate a project benefit-cost ratio (BCR). The BCR is a calculation of the project benefits divided by the project costs. Projects for which benefits exceed costs (a BCR of 1.0 or greater) are considered cost-effective. FEMA requires the use of the BCA Tool to verify calculations are consistent with Office of Management and Budget Circular A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. The BCA must be performed using the most current version of the BCA Tool. Benefits may include avoided damage, loss of function and displacement. In the case of wind mitigation projects, these include:

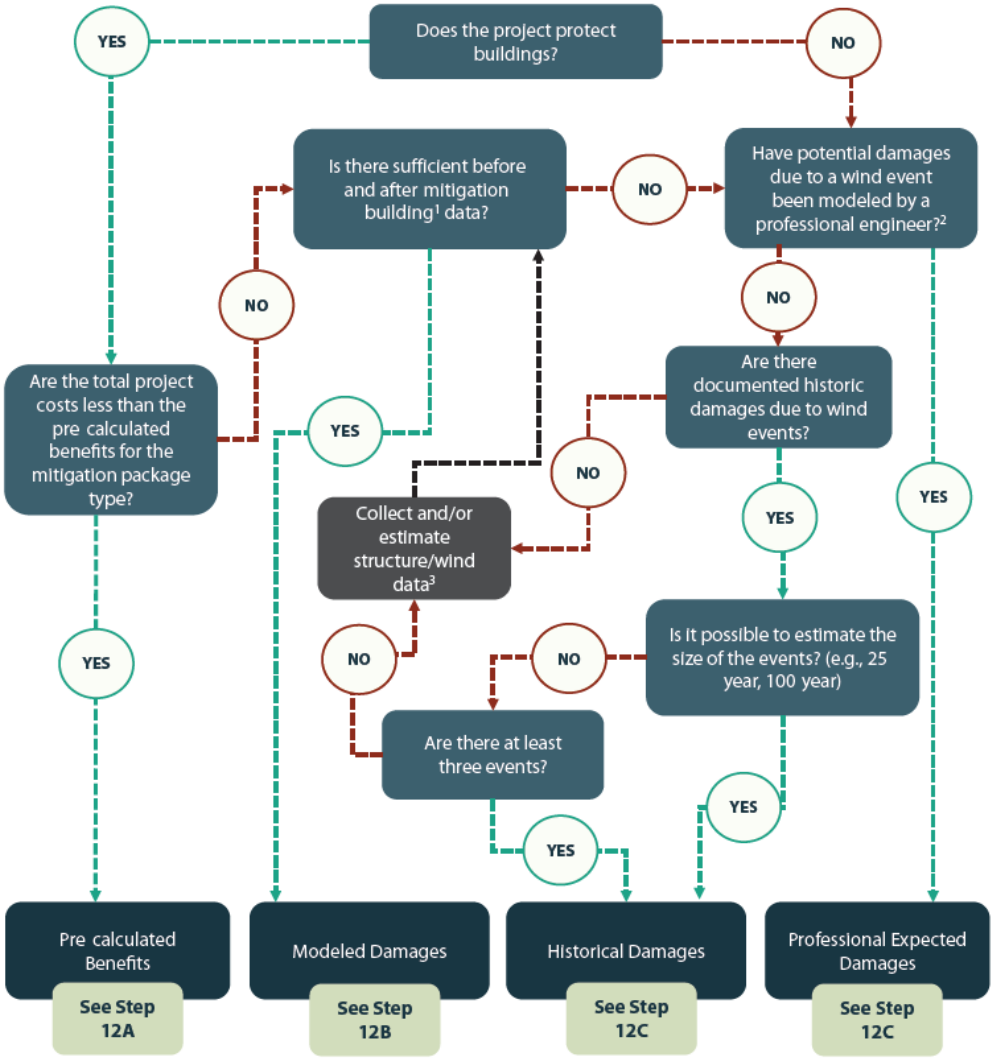
- Avoided physical damage to the structure and contents
- Avoided displacement costs – the costs required to move and reside in a temporary location while repairs are performed on the structure
- Avoided life safety damages (injuries or casualties)
- Avoided loss of rental income
- Avoided volunteer labor time that typically supports cleanup and repair work
- Avoided loss of business income or net revenue (for commercial properties)
- Avoided loss of public services (for public properties)
- Avoided loss of life or delay in essential services (critical services)
- Avoided loss of service (for utilities)
- Avoided loss of function (for roads and bridges)

This supplement only provides a recommended approach to documenting cost-effectiveness. For detailed guidance on using the FEMA BCA Tool, refer to the FEMA BCA Reference Guide and FEMA Supplement to the BCA Reference

Guide. For additional questions, contact the BC Helpline at *bchelpline@fema.dhs.gov* or at *1-855-540-6744*. Provide a .pdf of the BCA report and an export of the BCA .zip file.

The FEMA BCA Tool includes embedded Help Content. Click on the information button within the tool to access the Help Content.

Approach: There are several methods to evaluate cost-effectiveness. The method used will depend on the project type and the data collected in the previous steps of this supplement. Use the flowchart in **Figure 9** to analyze the data available for the project site and determine the recommended approach.



NOTES

1 Building data refers to structural building data for before- and after-mitigation conditions. See Steps 2 and 10.

2 If professional expected damages are used, the application must include the recurrence interval in the models and the model results must be included as documentation.

3 Review the BCA Reference Guide and supplement prior to data collection to verify that sufficient and relevant data for a BCA is collected for before-mitigation and after-mitigation conditions. At least one known frequency event or three unknown frequency events are required for historical flood losses. Once data are collected, return to process flow to determine the appropriate BCA approach.

Figure 9. Flowchart for determining the appropriate BCA frequency and damage relationship in the FEMA BCA Tool.

STEP 12A: Pre-Calculated Mitigation Benefits

Description: Residential Wind Retrofit and Non-Residential Wind Retrofit projects may be able to demonstrate cost-effectiveness using pre-calculated benefits that do not require the use of the FEMA BCA Tool.

Approach: Determine if your structure qualifies as a residential structure or non-residential structure by referring to FEMA's Pre-Calculated Benefits Resources. A structure may be characterized as residential or non-residential based on the governing code. In general, residential structures are considered single-family homes, two-family houses (duplexes) or buildings with three or more townhouse units that are three stories above grade or less; these structures are governed by the IRC. Any structure not governed by the IRC is considered non-residential and is governed by the IBC. Condominiums and apartment complexes are considered non-residential.

References:

- **Residential Hurricane Wind Retrofits:** Refer to FEMA's job aid Cost Effectiveness Determination for Residential Hurricane Wind Retrofit Measures and HMA Unified Guidance Part IV, Section I.10. These resources provide the pre-determined benefits for intermediate and advanced mitigation packages for locations where the design wind speed exceeds 120 mph. The job aid also provides a list of counties that have been identified as being seaward of the 120-mph wind contour. If the project costs for the mitigation project are less than or equal to the costs listed in **Table 1**, the project is considered cost-effective.

Table 1: The maximum project costs for different residential wind retrofit mitigation project types.

Mitigation Package Type	Roof Replacement Project	Maximum Costs
Intermediate Protection	No	$13,153
Intermediate Protection	Yes	$24,920
Advanced Protection	No	$40,252
Advanced Protection	Yes	$52,018

- **Non-Residential Hurricane Wind Retrofits:** Refer to FEMA's memo Non-Residential Wind Retrofit Cost-Effectiveness Determination Memo. This memo outlines the requirements for utilizing the hurricane wind retrofit pre-calculated benefit for non-residential structures. For non-residential structures, the hurricane wind retrofit must include improvements to (1) opening protection, (2) roof retrofits and (3) load path. These elements must be brought into compliance with the IBC, IEBC, ASCE 7, FEMA P-577 and any locally enforced building codes after completion of a structural vulnerability assessment. The total cost of the retrofits must be equal to or less than 10% of the building replacement value (BRV). The BRV is not the fair market value of the structure but the cost to construct a structure of equivalent size and function in current dollars. For projects in Puerto Rico or the U.S. Virgin Islands, the threshold for cost-effectiveness is increased to 25% of the BRV owing to increased wind risk.

STEP 12B: Benefit-Cost Analysis Tool – Modeled Damages

Description: If the proposed hurricane wind retrofit project does not meet the criteria for utilizing the pre-calculated benefits but still primarily protects structures, using modeled damages is suitable as it only calculates damages to structures.

References: FEMA's Benefit-Cost Analysis Reference Guide, Supplement to the Benefit-Cost Analysis Reference Guide, FEMA BCA Tool (including Help Content within the Tool), Appendix C of FEMA P-804 (Using the Hurricane Wind Module for Determining Cost-Effectiveness of Retrofit Project)

Approach: The following describes the essential hurricane wind data required to estimate avoided physical damages using modeled damages in the BCA Tool. If **Step 1** through **Step 11** of this supplement are followed and all data gathered, there should be minimal additional data collection needed to complete the Modeled Damages BCA. The BCA is to be performed utilizing the most current edition of FEMA's BCA Tool. Appendix C of FEMA P-804 (Using the Hurricane Wind Module for Determining Cost-Effectiveness of Retrofit Project) provides instructions on how to properly complete a Wind Retrofit BCA.

To verify the information entered in the BCA software, the following supporting information needs to be provided.

1. The project hazard type should be Hurricane Wind.
2. The mitigation action type should include either openings protection (i.e., shutters, impact-resistant glazing, doors), roof retrofits, load path improvements or any combination of the three.
3. Project useful life – FEMA-approved values can be found in the BCA Reference Guide or within the BCA Help Content.
4. Project cost – Refer to **Step 5**.
5. Provide the annual maintenance cost associated with maintaining the effectiveness of the components installed as part of the mitigation project.
6. Wind hazard information – Refer to **Step 10**.
    - The structure latitude/longitude is used by the tool to automatically populate the probable wind speeds for several estimated wind events (estimated based on recurrence intervals).
    - If the project does not have an exact address or the user has more detailed wind speed information, there is an option to override the default values and manually enter wind speed values. Any non-default values must be justified with supporting documentation.
    - Indicate the wind exposure category – Refer to **Step 11**.
7. Structural information – Refer to **Step 2**.
    a. Property structure type (residential or non-residential)
    b. Provide the total structure area
    c. Specify the structure use (e.g., hospital, college/university, single-family dwelling)

d. Provide the total BRV. The BCA Tool will automatically calculate the BRV based on the structure type, area and use; however, this value may be overridden and manually entered. Any non-default values must be justified with supporting documentation.

> If there is not sufficient building information or if the entity being mitigated is not a building (e.g., a power pole), the user must use historical or professionally estimated damages, as described in Step 12C. Historical or professionally estimated damages may also be used to document historical or expected loss of function to utilities or critical services.

8. Before- and after-mitigation building properties vary depending on the type of construction of the structure. The following are required for each of the different construction types – Refer to **Step 2** and examples in **Figure 10** and **Figure 11**. The information should be provided by the licensed engineer, architect or building inspector who performed the hurricane retrofit building assessment. For structures, the building property information will include:
   - Type of construction (e.g., wood, steel, concrete)
   - Building type (e.g., steel moment frame, concrete shear wall, unreinforced masonry bearing walls)
   - Occupancy class or use (e.g., hospital, school, library) – non-residential only
   - Opening protection properties before-mitigation (e.g., shutters, impact-resistant glazing)
   - Window area, which refers to the number of openings in the structure (e.g., **low** – less than 20% of the surface area, **medium** – between 20 and 40% of the surface area, **high** – greater than 40% of the surface area)
   - Type of garage doors or openings (e.g., rating type, standard, weak)
   - Roof cover type (e.g., BUR or SPM)
   - Roof shape (e.g., gabled or hip)
   - Roof deck age (e.g., old, new, average)
   - Roof includes a secondary waterproofing membrane
   - Source of the wind debris (e.g., residential debris, residential/commercial mix, varies by direction)
   - Roof-deck attachment (e.g., standard, superior)
   - Roof-wall connection for the roof structure and deck (e.g., toenail, strap, attachment spacing)

Example:

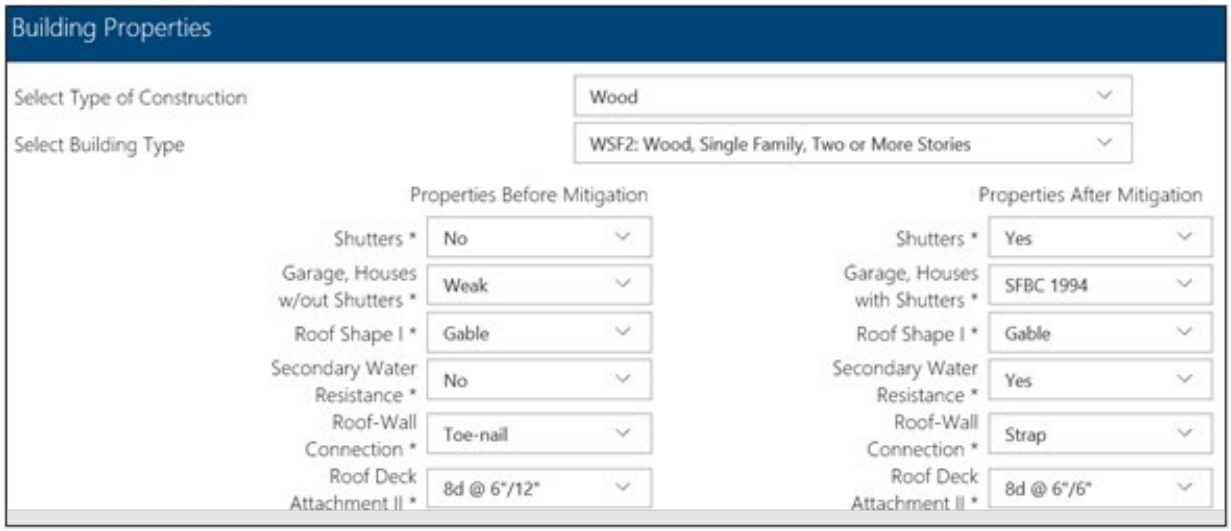


Figure 10. Example of building properties for wood, residential structures in the Hurricane Wind Mitigation BCA module.

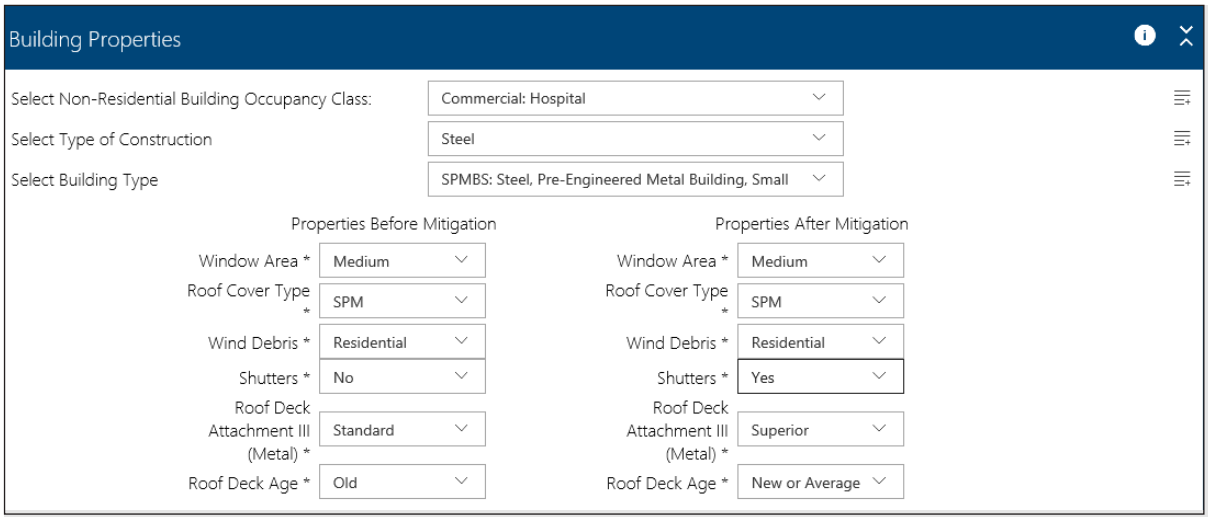


Figure 11. Example of building properties for steel, non-residential Hurricane Wind Mitigation BCA module.

STEP 12C: Benefit-Cost Analysis Tool – Historical or Professional Expected Damages

Description: The BCA Tool Damage Frequency Assessment (DFA) module calculates project benefits and costs for proposed mitigation projects for any hazard. The DFA module compares user-entered damages/losses and the frequency that they occur in the before-mitigation scenario versus the after-mitigation scenario to calculate benefits based on avoided damages. The DFA module is used when the user has hazard data for historical damages or professional expected damages.

References: FEMA's Benefit-Cost Analysis Reference Guide, Supplement to the Benefit-Cost Analysis Reference Guide, FEMA BCA Tool (including Help Content within the Tool)

Approach: The DFA module calculates project benefits for proposed hazard mitigation projects based on either documented historical damages (such as physical damages or loss of function) or professional expected damages (estimated damages that have not yet occurred or that occurred but not to the extent possible) from at least one known frequency event. If recurrence intervals are not known and there are historical damage data from at least three events, the DFA module can estimate a recurrence interval. Otherwise, additional data collection or analysis will be needed. The calculation compares before- and after-mitigation conditions. An example calculation is shown in Table 2.

- **Before-mitigation:** Based on existing conditions at the site. To demonstrate the current risk, actual historical damages, or professional expected damages for certain severity events (e.g., 10-year event, 50-year event) can be entered into the DFA module to perform a BCA.
- **After-mitigation:** Demonstrates the residual risk for each hazard event. Because no wind mitigation project will ever be entirely effective, there will always be some expected damages after mitigation. The amount of expected damages should be reflective of the project's proposed level of protection.

Table 2. Before- and after-mitigation estimated damages.

Recurrence Interval	Before-Mitigation Damages			After-Mitigation Damages		
	Building (Structural)	Contents (Nonstructural)	Loss of Function	Building (Structural)	Contents (Nonstructural)	Loss of Function
25-year	$1,000	$5,000	$35,000	$0	$0	$0
100-year	$10,000	$22,500	$100,000	$1,000	$2,252	$0
200-year	$45,000	$50,000	$350,000	$2,500	$10,000	$35,000

Potential Sources:

- Insurance claims, receipts from repair of hurricane wind damages, FEMA Public Assistance projects, BureauNet data, documentation of lost service from a utility provider, Public Works department
- Results of structural models developed and certified by a professional engineer

STEP 12D: Additional Benefits for a Benefit-Cost Analysis

Description: There are several benefits that could be counted for a project. Any or all the benefits can be used to demonstrate that a project is cost-effective, or, in other words, has a BCR greater than 1.0. Once the initial BCA information is collected and a preliminary analysis is performed, additional benefits may be analyzed if needed.

Approach:

Answer the following questions:

1. Do the services that the structure provides have to be temporarily relocated? Displacement costs are based on the length of time the building is out of service, a one-time cost for setting up and moving to moving a temporary facility to continue operations, and monthly costs for occupying the temporary facility (rent). The BCA Tool will use FEMA standard values to automatically calculate the avoided losses to contents and avoided displacement costs. If different values are used, supporting documentation must be provided.
2. Does the building include any rental property for which the owner receives income? What is the cost of rent income per month?
3. Is there a business run out of the building? How much income does that business bring in per month?
4. Does the project prevent loss of service to a utility?
5. Are there any non-critical government services provided from the building such as a permit office or library?
6. Are there any critical services provided by the building such as police, fire, or medical services?

LOSS OF SERVICE TO CRITICAL FACILITIES

Description: The BCA Tool will account for the loss of service for critical facilities such as fire stations, hospitals, police stations and other facilities. Under each facility type, specific information is required to determine the monetary damages incurred if the facility is closed because of wind damage. The following is a list of information that will allow the loss of service to be calculated.

References: Supporting documentation for loss of service calculations can include Census data, local maps, mapping or GIS programs, facility operations management reports, emergency plans for the facility or documents such as annual reports.

Approach: To calculate loss of service, provide the following information for each facility type:

- **Fire Stations**
  - Type of service area served by the fire station (e.g., urban, suburban, rural, wilderness)
  - Number of people served by the fire station
  - Distance to the next closest fire station that would provide fire protection to the jurisdiction normally served by this fire station (in miles)
  - Distance in miles to the next closest fire station that would provide emergency medical services for the jurisdiction normally served by this fire station (in miles), if applicable
- **Hospitals**
  - Number of people served by the hospital
  - Distance to the next closest hospital (alternate hospital) that would treat the population served in the event this hospital was inoperative (in miles)
  - Number of people served by the alternate hospital
- **Police Stations**
  - Type of area served by this police station (e.g., metropolitan, city, rural)

  - Number of people served by this police station
  - Number of police officers working at the police station
  - Number of police officers that would serve the same area if the station were shut down due to a disaster
- **Other Facilities**
  - Service name (type of service)
  - Total annual budget, operating costs, or revenue (must be provided with supporting documentation)

STEP 13: Environmental and Historic Preservation Considerations

Description: Environmental and, particularity, historic preservation compliance will need to be considered as part of the application process for hurricane wind retrofit mitigation. The assistance of a licensed professional engineer, architect or contractor may be required to help obtain the necessary information about EHP compliance. Refer to the EHP Supplement Job Aids.

Resources

Below is a comprehensive list of resources identified throughout this supplement. Not all these resources are necessary for every hurricane wind retrofit project but are provided to ease identification of source material.

PROGRAM AUTHORITIES

- The Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended, 42, U.S.C. 4001 et seq.
- 44 Code of Federal Regulation, Part 206, Subpart N
- 2 Code of Federal Regulations, Part 200

PROGRAM GUIDANCE

- FEMA Hazard Mitigation Assistance Guidance (and Hazard Mitigation Assistance Guidance Addendum)
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide

TECHNICAL GUIDANCE AND STANDARDS

- American Concrete Institute (ACI), Building Code Requirements for Structural Concrete and Commentary
- ACI/ASCE/The Masonry Society (TMS), Building Code Requirements and Specifications for Masonry Structures (ACI 530-13/ASCE 5-13/TMS 402-13)
- American Iron and Steel Institute (AISI), Cold-Formed Steel Design Manual (AISI S100-16)
- American Iron and Steel Institute (AISI), North American Specification for the Design of Cold-Formed Steel Structural Members (AISI S100-12)
- American National Standards Institute (ANSI)/American Institute of Steel Construction (AISC), Specifications for Structural Steel Buildings (ANSI/AISC 360-16)

- ANSI/American Forest & Paper Association (AF&PA), National Design Specification for Wood Construction (NDS-2018)
- American Society of Civil Engineers (ASCE) Structural Engineering Institute's (SEI) ASCE/SEI 7-16, Minimum Design Loads for Buildings and Other Structures (or latest version)
- FEMA P-424, Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds
- FEMA P-543, Design Guide for Improving Critical Facility Safety from Flooding and High Winds
- FEMA P-577, Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds
- FEMA P-787, Catalog of FEMA Building Science Branch Publications and Training Courses
- International Building Code (IBC) 2018 (or most recent version)
- International Existing Building Code (IEBC) 2018 (or most recent version)
- International Residential Code (IRC) 2018 (or most recent version)

ADDITIONAL TOOLS AND RESOURCES

- FEMA's How to Find Your FIRM and Make A FIRMette
- FEMA's Map Service Center
- FEMA Benefit-Cost Analysis (BCA) Tool
- Cost Estimating Principles for Hazard Mitigation Assistance Applications
- FEMA's National Flood Hazard Layer
- Hazard Mitigation Assistance Application Development Scope of Work Examples
- Hazard Mitigation Assistance Application Development Engineering Case Studies
- EHP Review Supplements
- FEMA Hazard Mitigation Assistance Job Aids