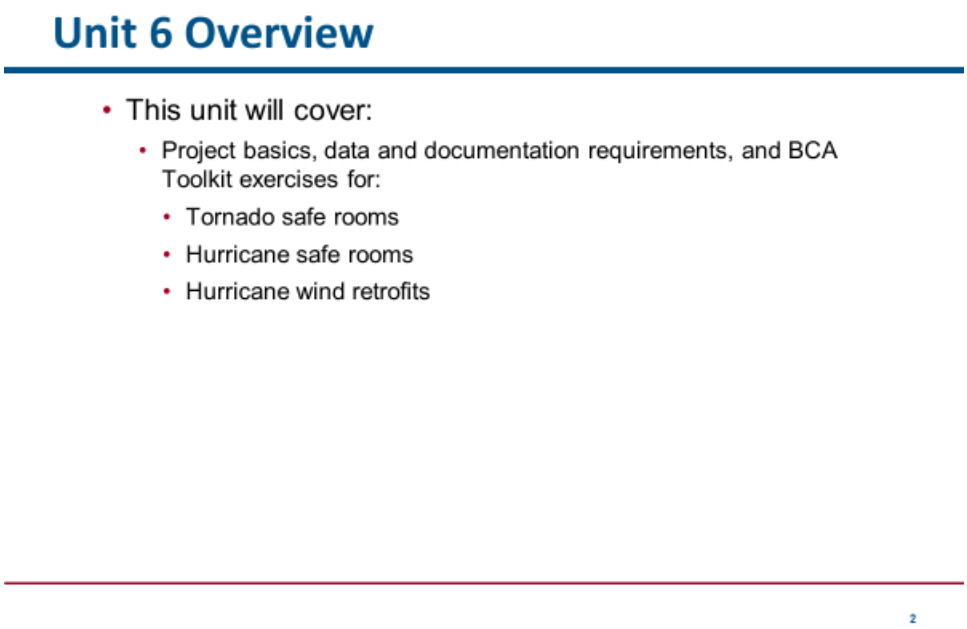
Unit 6

BCAs for Tornado Safe Rooms, Hurricane Safe Rooms, and Hurricane Wind Projects

Unit 6 Overview

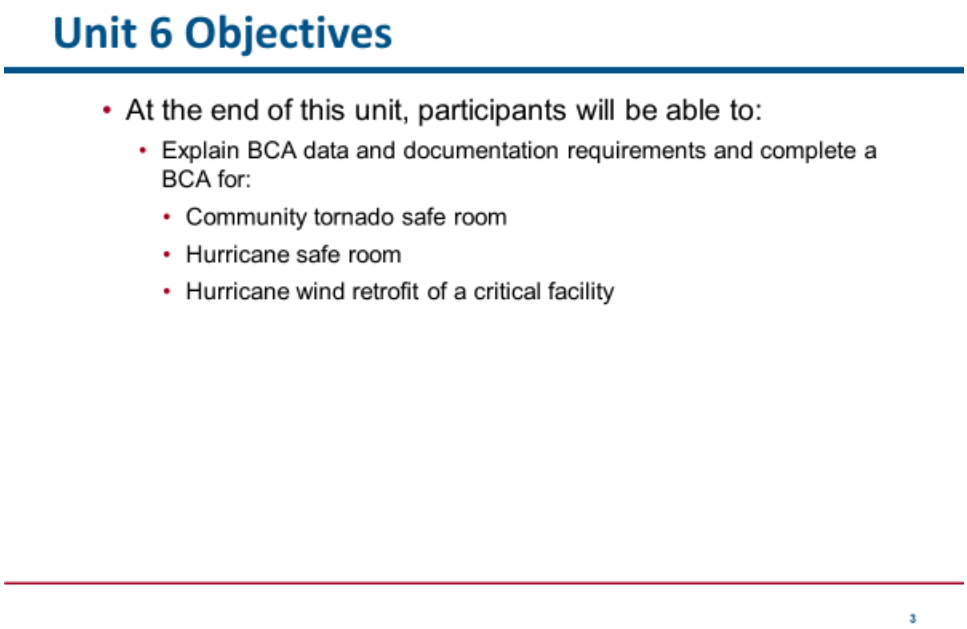


Visual 1: Unit 6 Overview

This unit will cover:

- Project basics, data and documentation requirements, and BCA Toolkit exercises for:
  - Tornado safe rooms
  - Hurricane safe rooms
  - Hurricane wind retrofits

Unit 6 Objectives



Visual 2: Unit 6 Objectives

Unit 5 has several objectives. At the end of this unit, students should be able to:

- Explain BCA data and documentation requirements for tornado safe rooms, hurricane safe rooms, and hurricane wind retrofit projects
- Complete a community tornado safe room BCA
- Complete a hurricane safe room BCA
- Complete a critical facility hurricane wind retrofit BCA

Tornado Safe Rooms

Tornado Safe Rooms

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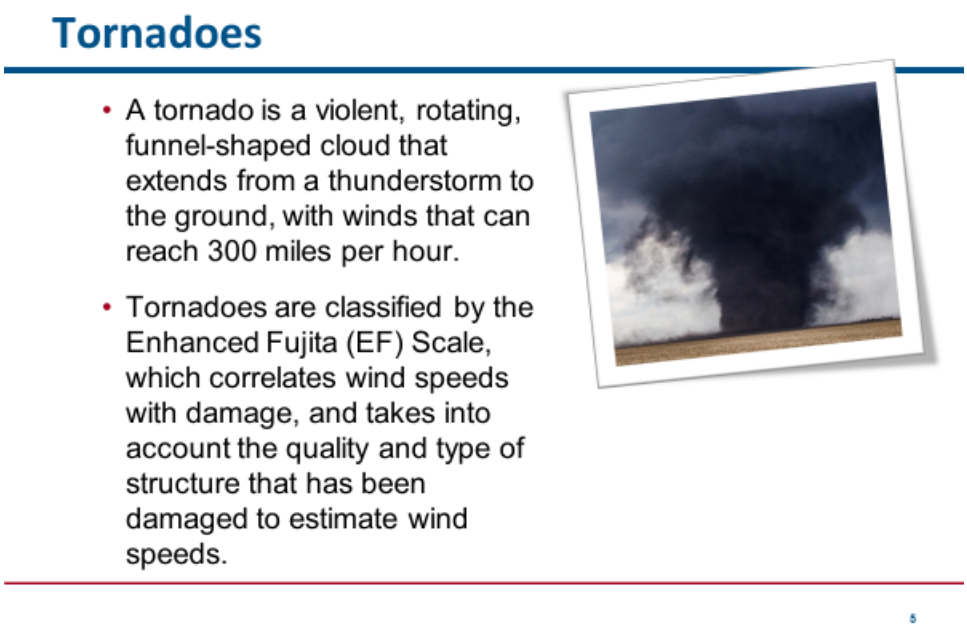
Tornadoes

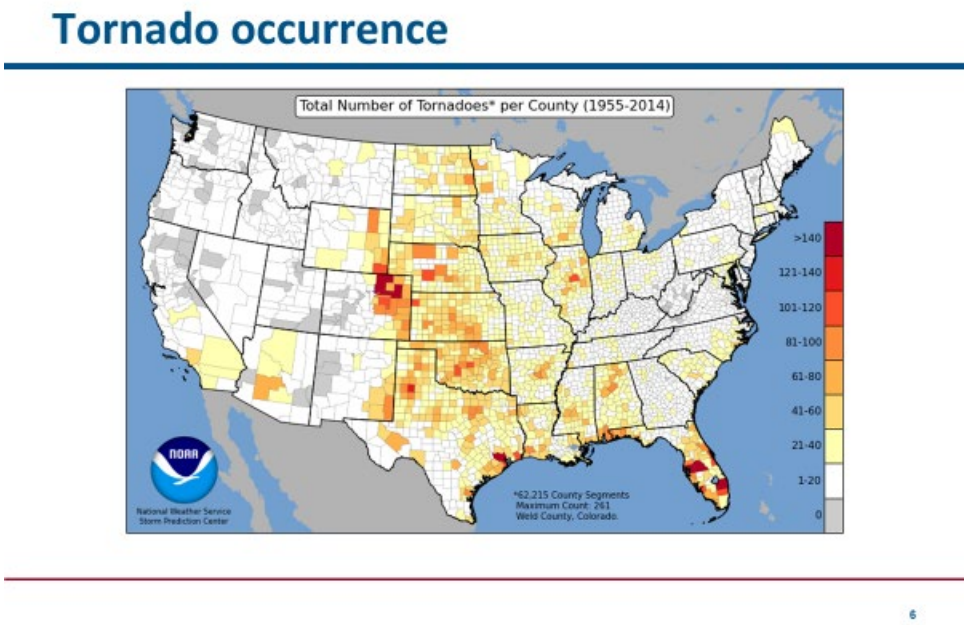


Visual 3: Tornadoes

A tornado is a violent, rotating, funnel-shaped cloud that extends from a thunderstorm to the ground, with winds that can reach 300 miles per hour.

Tornadoes are classified by the Enhanced Fujita (EF) Scale, which correlates wind speeds with damage, and takes into account the quality and type of structure that has been damaged to estimate wind speeds.

Tornado occurrence

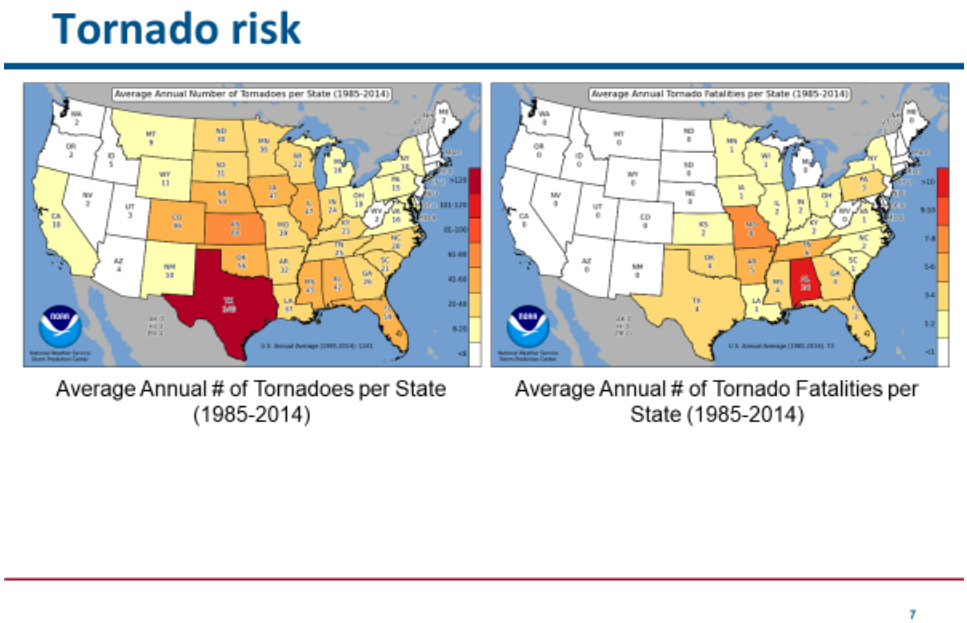


Visual 4: Tornado occurrence

The map in the image shows the total number of tornadoes per county between 1955 and 2014.

Source: National Oceanic and Atmospheric Administration (NOAA)

Tornado risk



Visual 5: Tornado risk

The maps in the image show (1) the average annual number of tornadoes per state between 1955 and 2014 and (2) the average annual tornado fatalities per state between 1955 and 2014.

Source: National Oceanic and Atmospheric Administration (NOAA)

EF scale classifications

Enhanced Fujita (EF) scale classifications

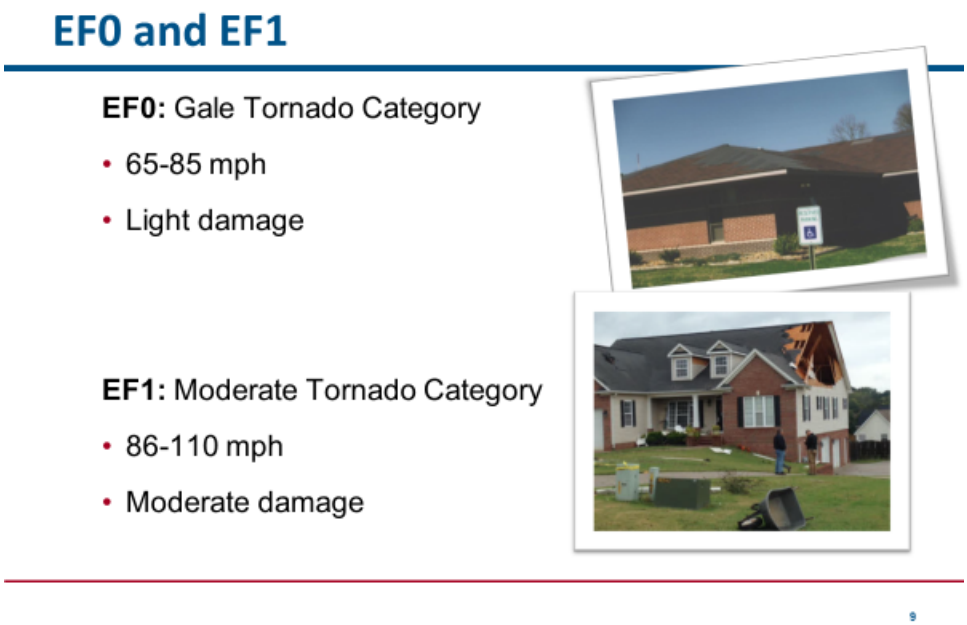
Category	3-Second Wind Gust
EF0	65-85 mph
EF1	86-100 mph
EF2	111-135 mph
EF3	136-165 mph
EF4	166-200 mph
EF5	>200 mph

Visual 6: EF scale classifications

The slide shows the Enhanced Fujita (EF) scale classifications.

- A category EF0 tornado has a 3-second wind guest between 65-85 mph.
- A category EF1 tornado has a 3-second wind guest between 86-100 mph.
- A category EF2 tornado has a 3-second wind guest between 111-135 mph.
- A category EF3 tornado has a 3-second wind guest between 136-165 mph.
- A category EF4 tornado has a 3-second wind guest between 166-200 mph.
- A category EF5 tornado has a 3-second wind guest greater than 200 mph.

EF0 and EF1

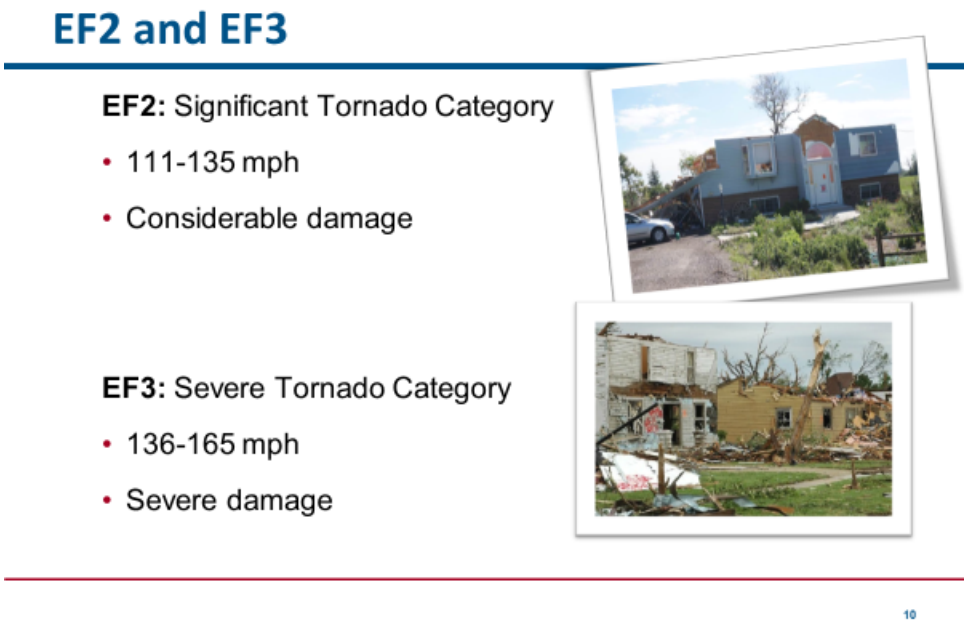


Visual 7: EF0 and EF1

EF0: Gale Tornado Category
- 65-85 mph
- Light damage

EF1: Moderate Tornado Category
- 86-110 mph
- Moderate damage

EF2 and EF3

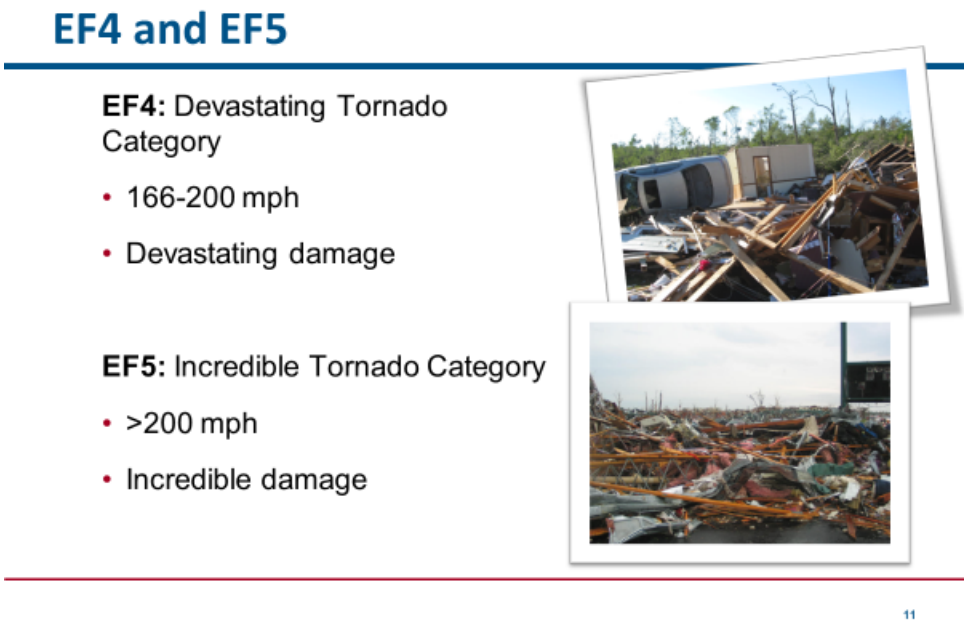


Visual 8: EF2 and EF3

EF2: Significant Tornado Category
- 111-135 mph
- Considerable damage

EF3: Severe Tornado Category
- 136-165 mph
- Severe damage

EF4 and EF5

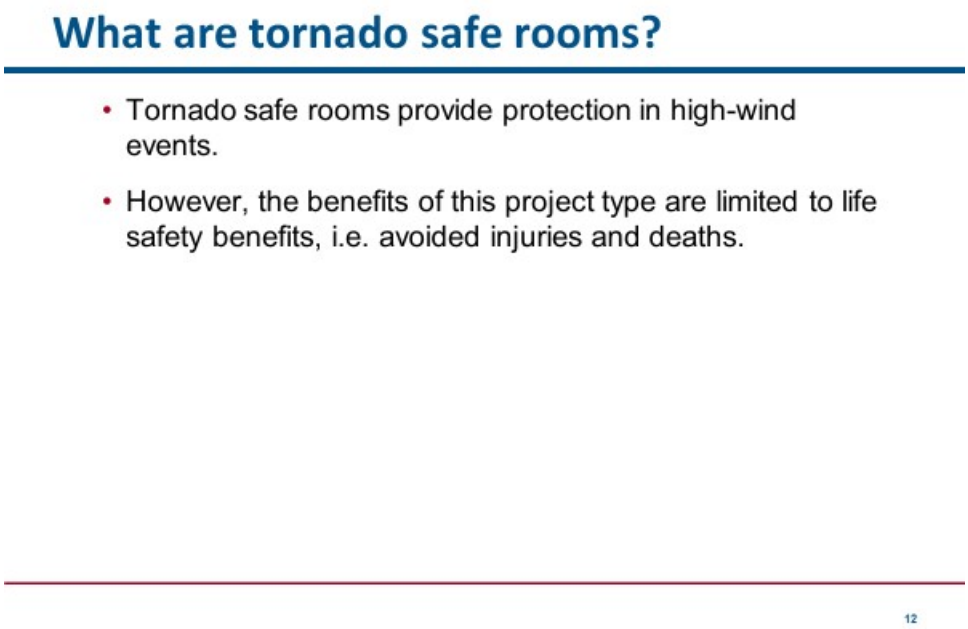


Visual 9: EF4 and EF5

EF4: Devastating Tornado Category
- 166-200 mph
- Devastating damage

EF5: Incredible Tornado Category
- >200 mph
- Incredible damage

Tornado safe rooms



Visual 10: What are tornado safe rooms?

Tornado safe rooms provide protection in high-wind events.

However, the benefits of this project type are limited to life safety benefits, i.e. avoided injuries and deaths.

Tornado safe room types

Visual 11: Tornado safe room types

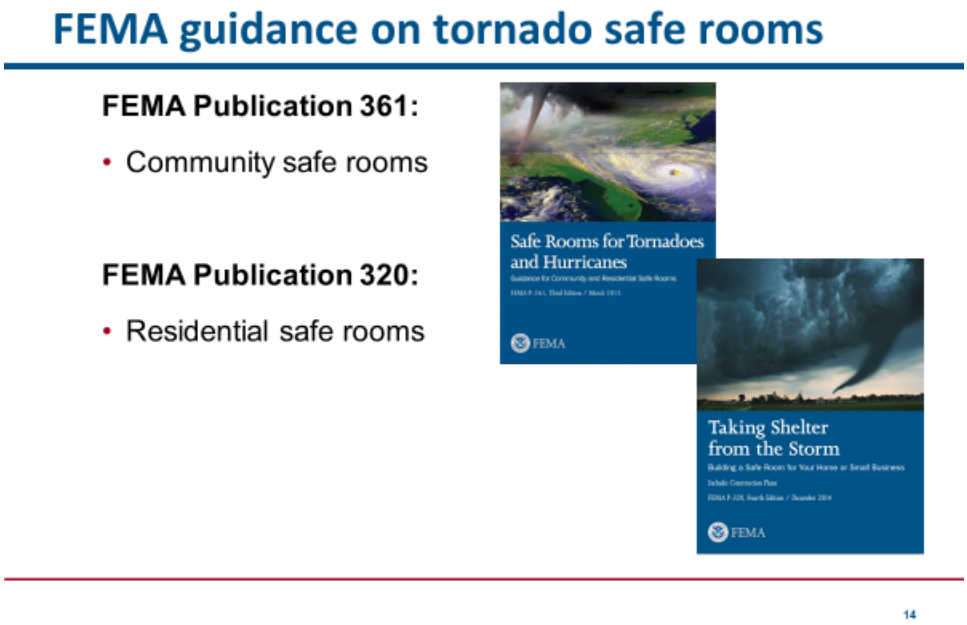
Residential Safe Room

- Provides a place of refuge for the people who live in the home
- Various types/designs

Community Safe Room

- Constructed to protect a large number of people

FEMA guidance on tornado safe rooms



Visual 12: FEMA guidance on tornado safe rooms

FEMA Publication 361:

- Community safe rooms

FEMA Publication 320:

- Residential safe rooms

Pre-calculated benefit

Pre-calculated benefit

- For residential tornado safe rooms, FEMA has developed a pre-calculated benefit.
- If the total project cost per property does not exceed the values in the table, the project is cost-effective and does not need a separate BCA.

Aggregate Benefits By State (Abridged List)			
Alabama	$13,336.96	Nebraska	$9,921.78
Arkansas	$16,717.85	North Carolina	$5,723.26
Georgia	$5,290.98	Ohio	$11,469.38
Illinois	$13,685.72	Oklahoma	$18,366.36
Iowa	$14,962.87	Pennsylvania	$4,065.90
Indiana	$18,126.34	South Carolina	$6,139.38
Kansas	$14,005.75	South Dakota	$5,230.17
Kentucky	$13,554.96	Tennessee	$13,579.58
Louisiana	$9,921.94	Texas	$5,421.32
Michigan	$6,522.49	Virginia	$3,936.05
Missouri	$15,654.96	West Virginia	$4,973.50
Mississippi	$20,067.64	Wisconsin	$9,025.48
Minnesota	$7,092.39		

For more information, see the Job Aid.

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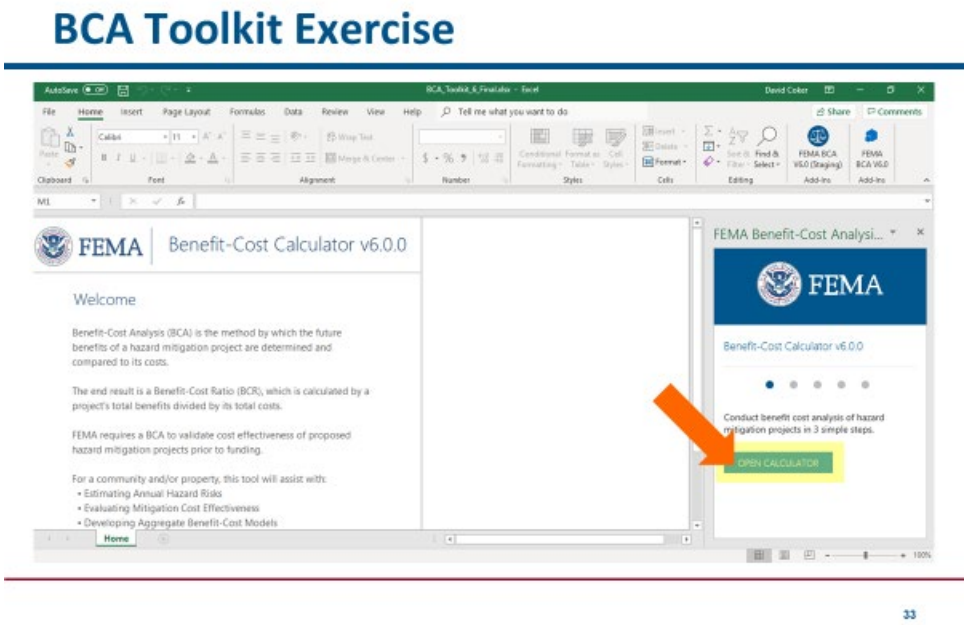
Visual 13: Pre-calculated benefit

For residential tornado safe rooms, FEMA has developed a pre-calculated benefit.

If the total project cost per property does not exceed the values in the table in the Job Aid, the project is cost-effective and does not need a separate BCA.

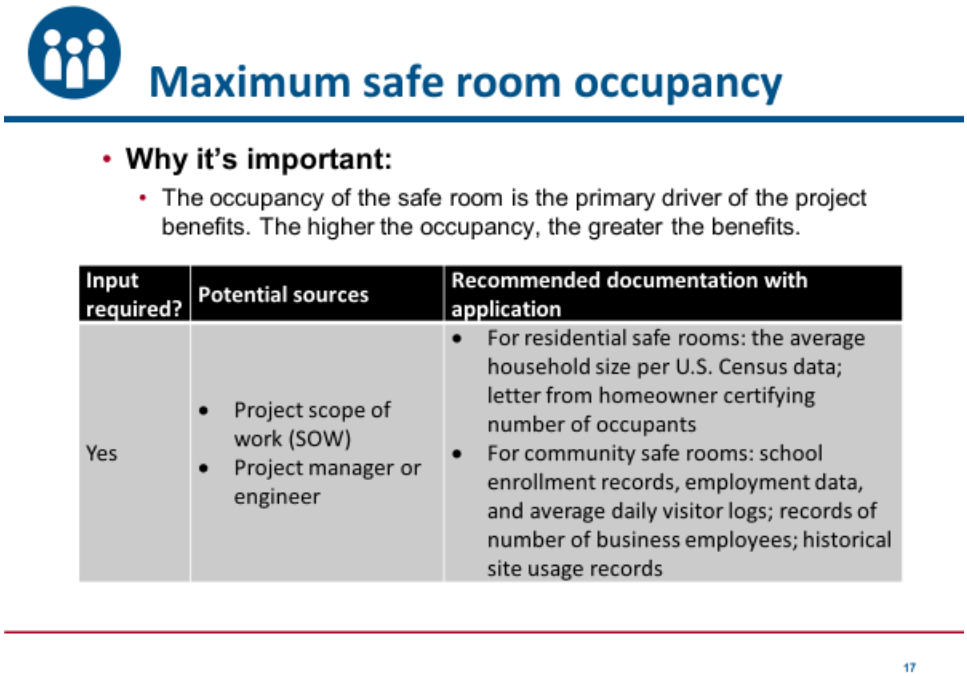
Applicants must use the Expedited Hazard Mitigation Grant Program (HMGP) Application for Residential Safe Rooms to apply pre-calculated benefits under HMGP. See the Job Aid for more details.

BCA Toolkit Exercise



We will now show how to complete a tornado safe room BCA in the BCA Toolkit. The following slides describe the data inputs, sources, and documentation requirements.

Maximum safe room occupancy



Visual 14: Maximum safe room occupancy

Why it's important:

- The occupancy of the safe room is the primary driver of the project benefits. The higher the occupancy, the greater the benefits.

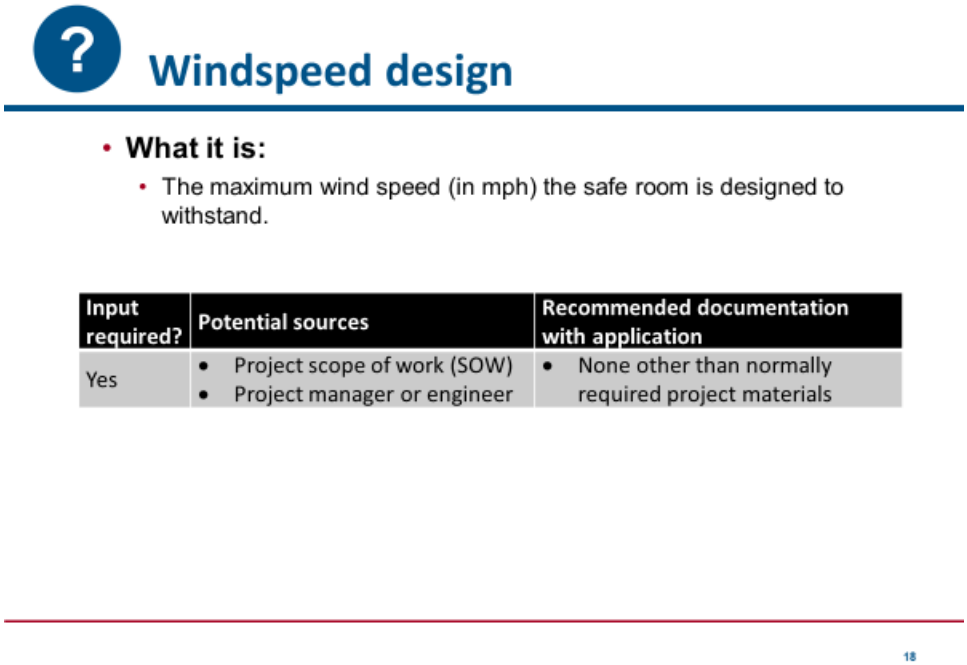
Source(s):

- Project SOW
- Project engineer

Recommended BCA documentation with application:

- For residential safe rooms: the average household size per U.S. Census data; letter from homeowner certifying number of occupants
- For community safe rooms: school enrollment records, employment data, and average daily visitor logs; records of number of business employees; historical site usage records

Windspeed design



Visual 15: Windspeed design

What it is:

- The maximum wind speed (in mph) the safe room is designed to withstand.

Why it's important:

- The design wind speed of the safe room determines the level of protection, i.e. the project effectiveness.

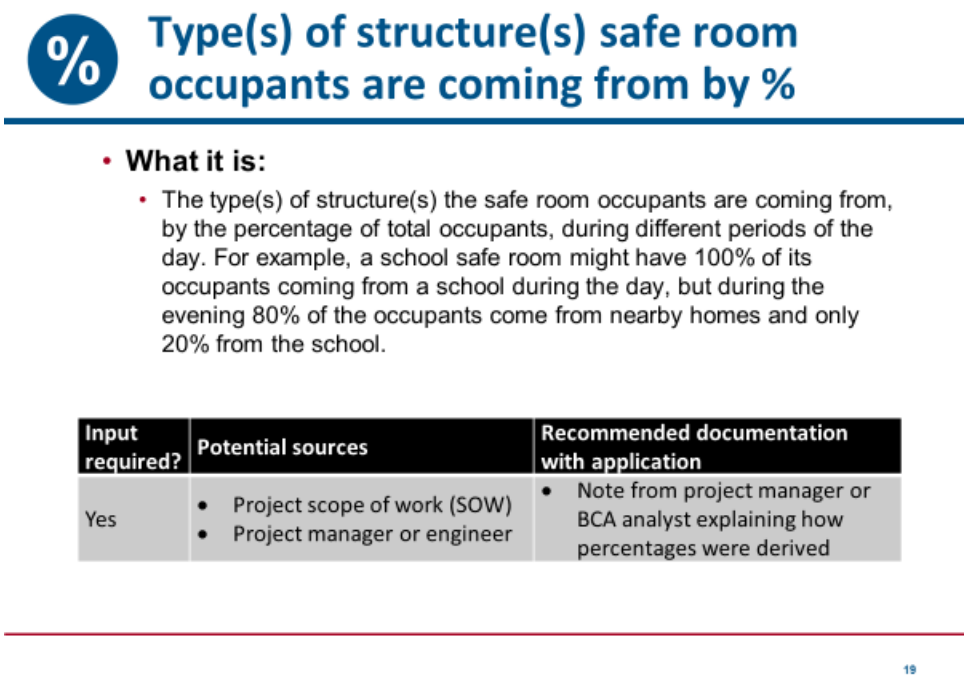
Source(s):

- Project SOW
- Project engineer

Recommended BCA documentation with application:

- None other than normally required project materials

Type(s) of structure(s) safe room occupants are coming from by %



Visual 16: Type(s) of structure(s) safe room occupants are coming from by %

What it is:

- The type(s) of structure(s) the safe room occupants are coming from, by the percentage of total occupants, during different periods of the day. For example, a school safe room might have 100% of its occupants coming from a school during the day, but during the evening 80% of the occupants come from nearby homes and only 20% from the school.

Why it's important:

- The BCA Toolkit compares the expected injury/death rates within the evacuated structure type(s) to the expected injury/death rates if those people were in the proposed safe room. These are the benefits of the project.

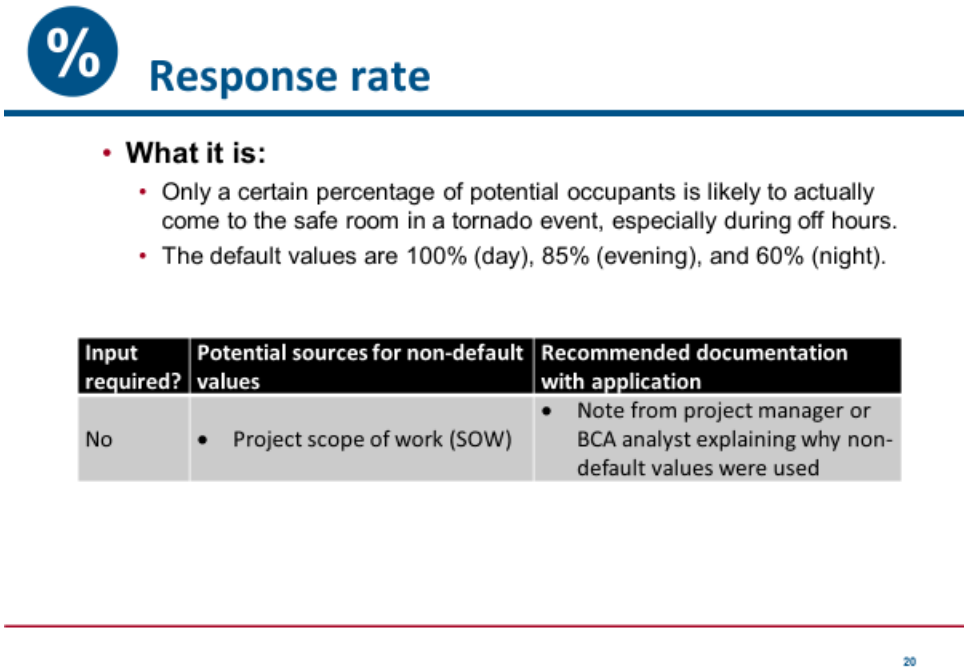
Source(s):

- Project SOW

Recommended BCA documentation with application:

- Note from project manager or BCA analyst explaining how percentages were derived

Response rate



Visual 17: Response rate

What it is:

- Only a certain percentage of potential occupants is likely to actually come to the safe room in a tornado event, especially during off hours.
- The default values are 100% (day), 85% (evening), and 60% (night).

Why it's important:

- The BCA Toolkit uses expected response rates to calculate an average occupancy for the safe room.

Source(s) for non-default values:

- Project scope of work (SOW)

Recommended BCA documentation with application:

- Note from project manager or BCA analyst explaining why non-default values were used

Hurricane safe rooms

Hurricane Safe Rooms

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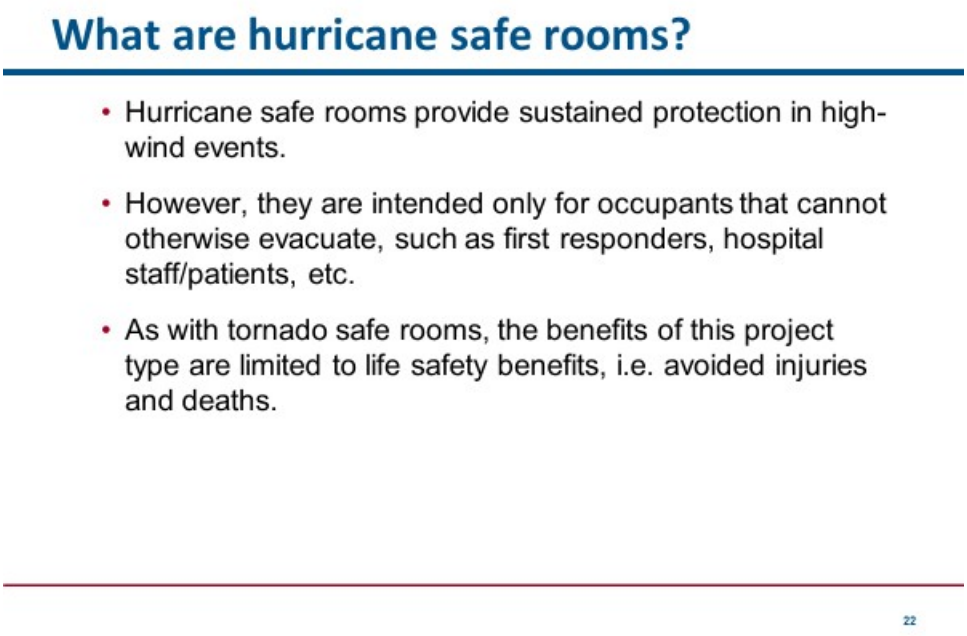
Hurricane safe rooms



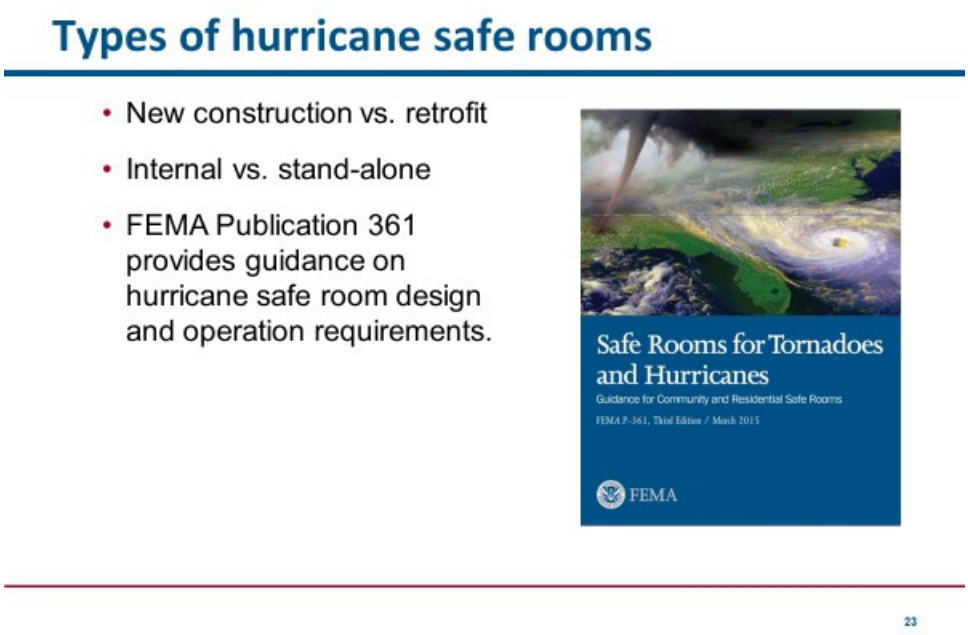
Visual 18: What are hurricane safe rooms?

Hurricane safe rooms provide sustained protection in high-wind events.

However, they are intended only for occupants that cannot otherwise evacuate, such as first responders, hospital staff/patients, etc.

As with tornado safe rooms, the benefits of this project type are limited to life safety benefits, i.e. avoided injuries and deaths.

Hurricane safe rooms



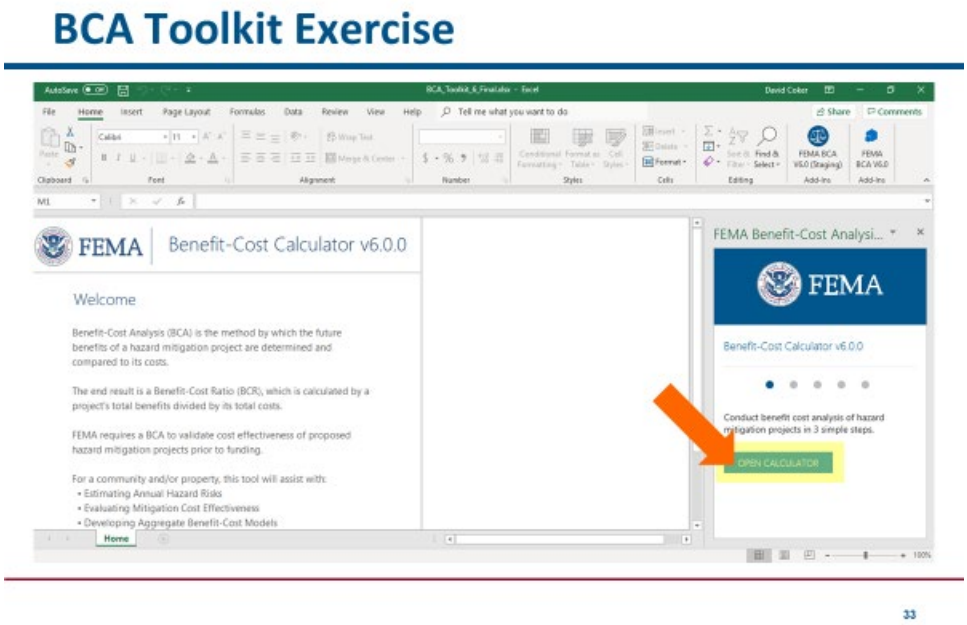
Visual 19: Types of hurricane safe rooms

There are multiple ways to construct a hurricane safe room:

- New construction vs. retrofit
- Internal vs. stand-alone

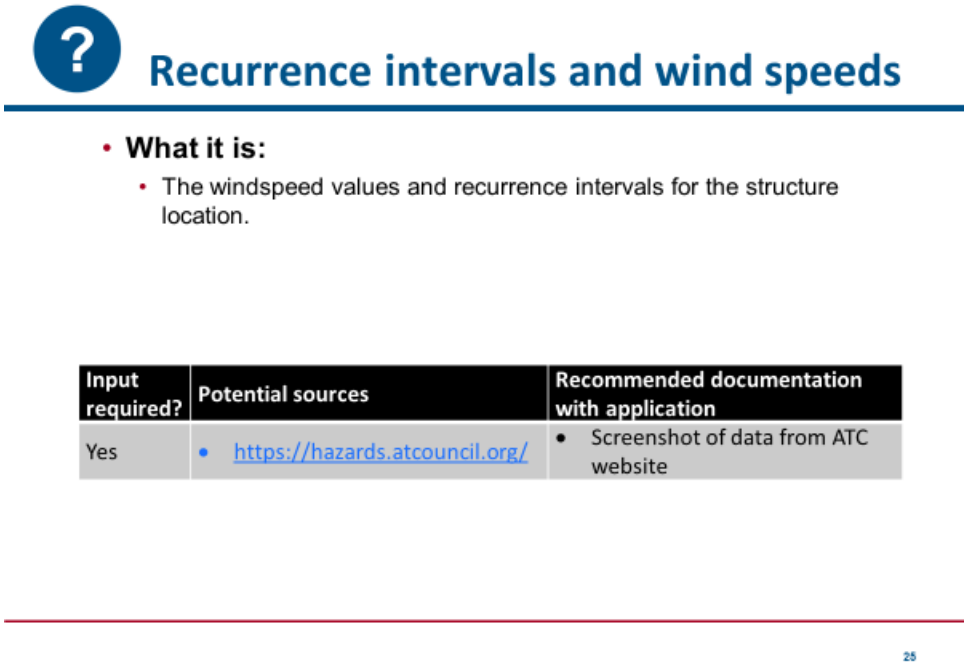
FEMA Publication 361 provides guidance on hurricane safe room design and operation requirements.

BCA Toolkit Exercise



Hurricane safe room BCAs are almost identical to tornado safe room BCAs. The only real difference is that you have to input the wind speed and recurrence interval data for the location, which we will discuss on the next slide.

Recurrence intervals and wind speeds



Visual 20: Recurrence intervals and wind speeds

What it is:

- The windspeed values and recurrence intervals for the structure location.

Source(s):

- https://hazards.atcouncil.org/

Recommended BCA documentation with application:

- Screenshot of data from ATC website

Hurricane wind retrofits

Hurricane Wind Retrofits

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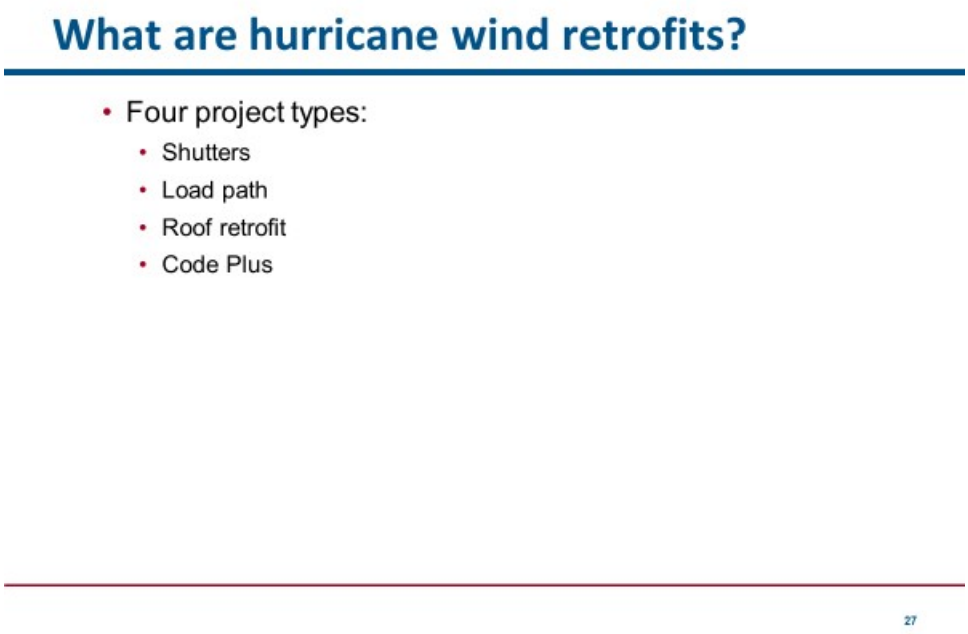
Hurricane wind retrofits

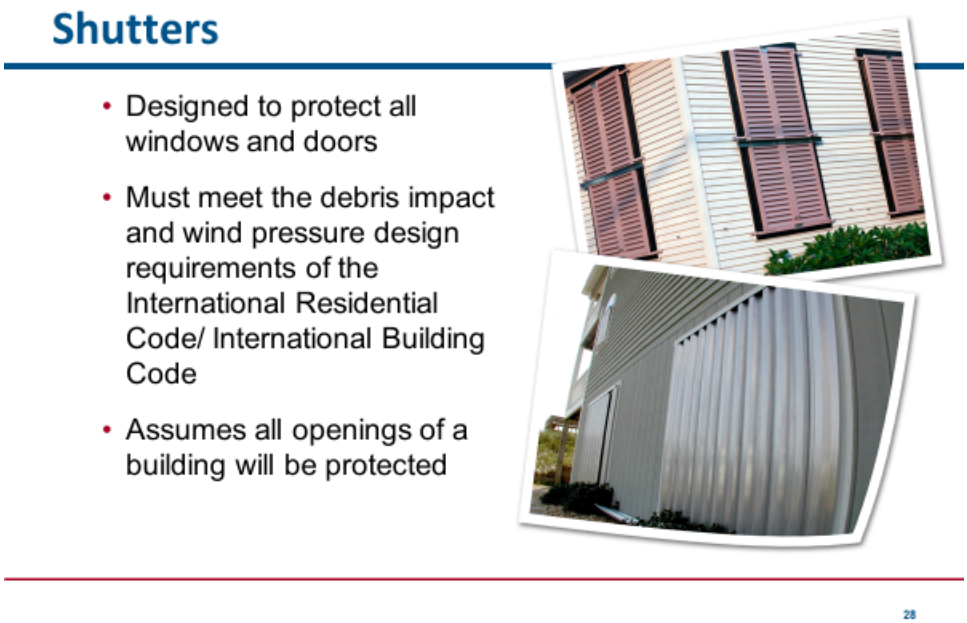


Visual 21: What are hurricane wind retrofits?

Four project types:

- Shutters
- Load path
- Roof retrofit
- Code Plus

Shutters



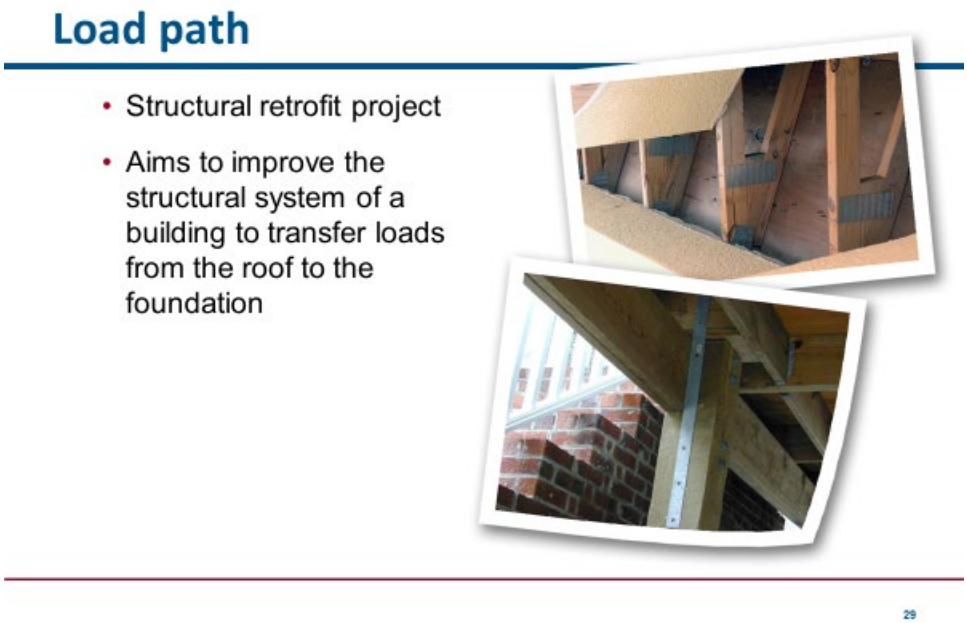
Visual 22: Shutters

Hurricane shutter projects are designed to protect all windows and doors.

They must meet the debris impact and wind pressure design requirements of the International Residential Code/ International Building Code.

This project type assumes all openings of a building will be protected.

Load path



Visual 23: Load path

Retrofitting a building's load path is a structural retrofit project.

It aims to improve the structural system of a building to transfer loads from the roof to the foundation.

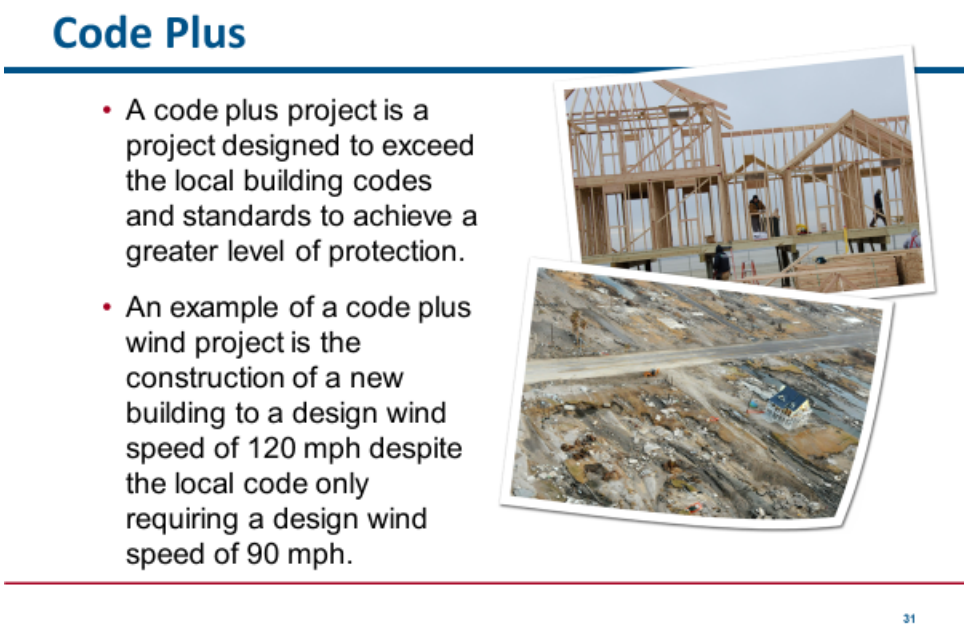
Roof retrofit

Visual 24: Roof retrofit

This is also a structural retrofit project.

It aims to secure the building envelope and integrity during a wind event.

Code Plus

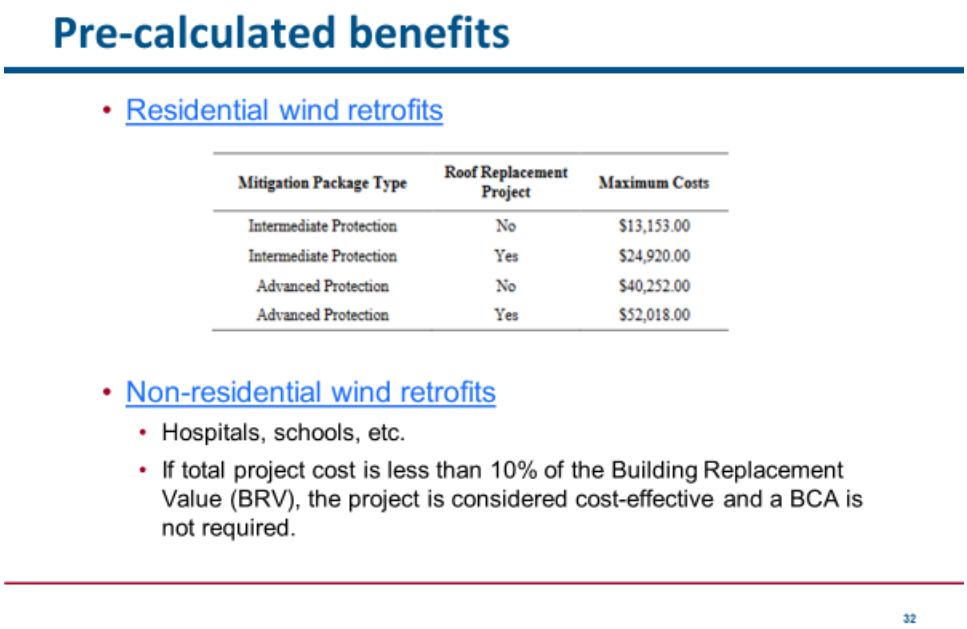


Visual 25: Code Plus

A code plus project is a project designed to exceed the local building codes and standards to achieve a greater level of protection.

An example of a code plus wind project is the construction of a new building to a design wind speed of 120 mph despite the local code only requiring a design wind speed of 90 mph.

Pre-calculated benefits for hurricane wind retrofits



Visual 26: Pre-calculated benefits for hurricane wind retrofits

Residential wind retrofits

Mitigation Package Type	Roof Replacement Project	Maximum Costs
Intermediate Protection	No	$13,153.00
Intermediate Protection	Yes	$24,920.00
Advanced Protection	No	$40,252.00
Advanced Protection	Yes	$52,018.00

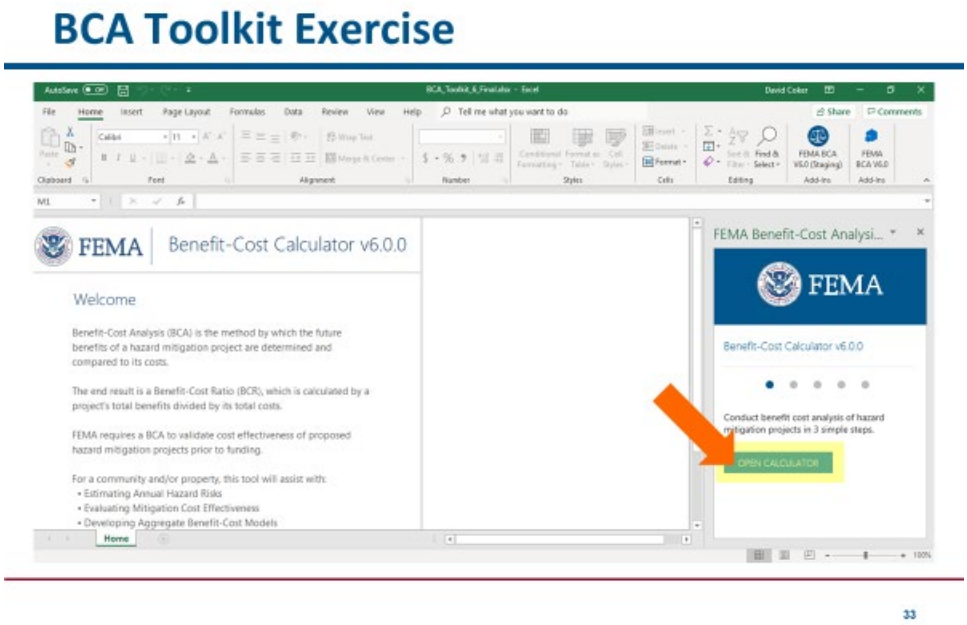
Figure 1: Pre-calculated benefit for residential hurricane wind retrofits

See the Job Aid in the link for details.

Non-residential wind retrofits

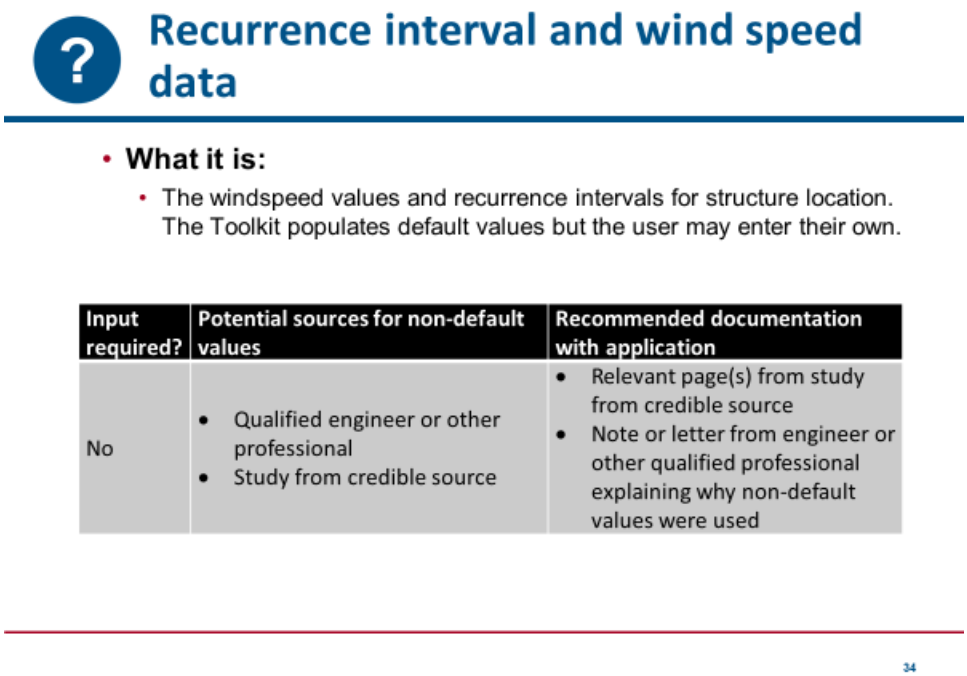
- Hospitals, schools, etc.
- If total project cost is less than 10% of the Building Replacement Value (BRV), the project is considered cost-effective and a BCA is not required.
- For Puerto Rico and the U.S. Virgin Islands, if the total project cost is less than 25% of the BRV the project is cost-effective.
- See memo for details.

BCA Toolkit Exercise



We will show how to complete a hurricane wind retrofit BCA in the BCA Toolkit. The following slides show the data inputs, sources, and documentation requirements.

Recurrence interval and wind speed data



Visual 27: Recurrence interval and wind speed data

What it is:

- The windspeed values and recurrence intervals for structure location. The Toolkit populates default values but the user may enter their own.

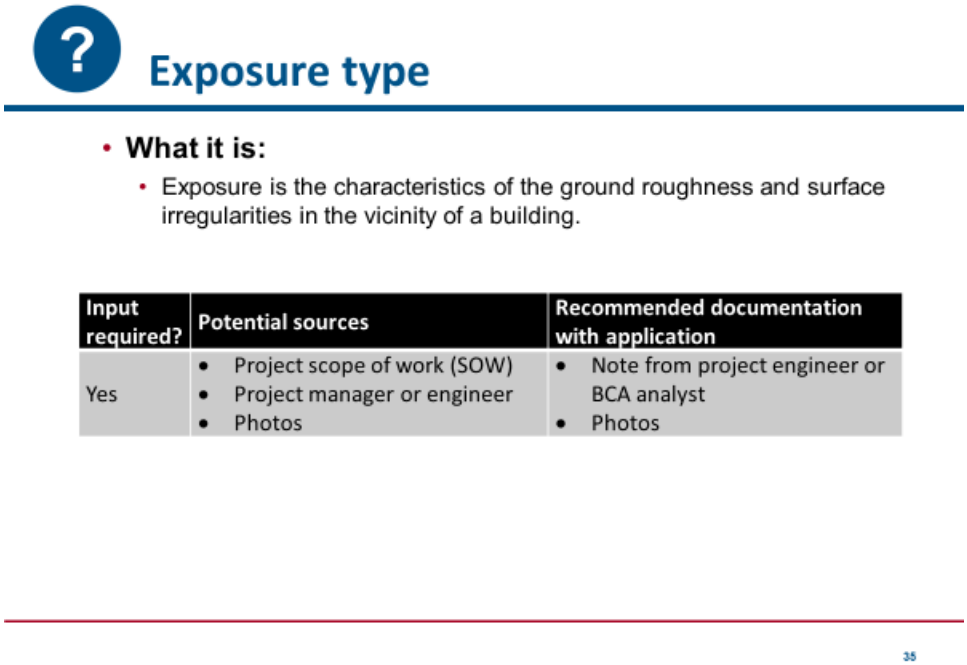
Potential source(s) for non-default values:

- Project Scope of Work (SOW)
- Project engineer
- Photos

Recommended BCA documentation with application:

- Relevant page(s) from study from credible source
- Note or letter from engineer or other qualified professional explaining why non-default values were used

Exposure type



Visual 28: Exposure type

What it is:

- Exposure is the characteristics of the ground roughness and surface irregularities in the vicinity of a building.

Why it's important:

- The debris exposure type determines what type of debris might impact the building in a hurricane event, which helps estimate future damages.

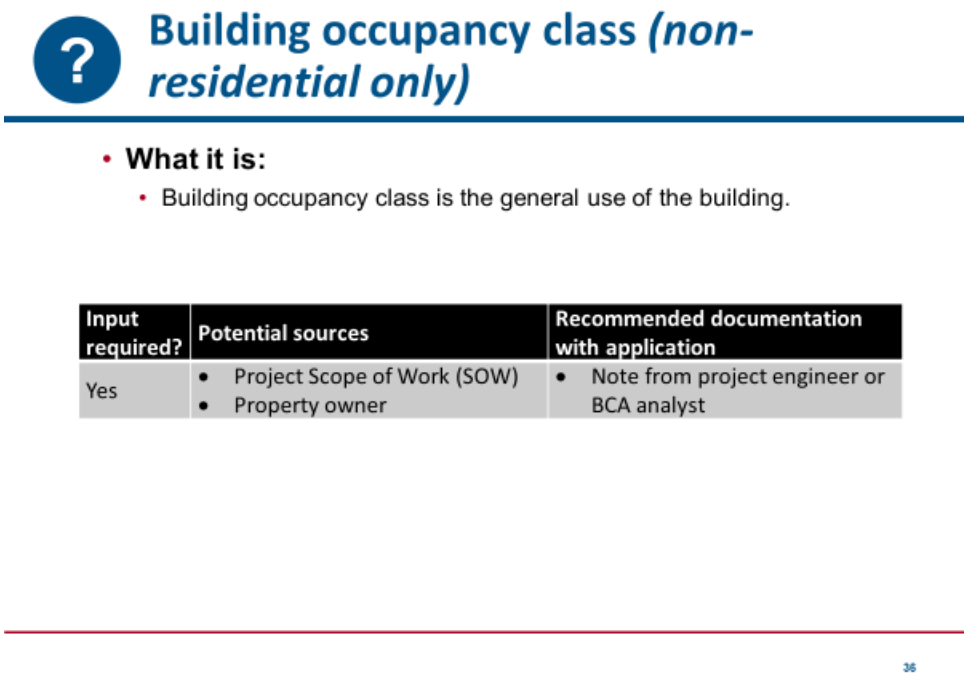
Source(s):

- Project Scope of Work (SOW)
- Project engineer
- Photos

Recommended BCA documentation with application:

- Note from project engineer or BCA analyst
- Photos

Building occupancy class *(non-residential only)*



Visual 29: Building occupancy class (non-residential only)

What it is:

- Building occupancy class is the general use of the (non-residential) building.

Why it's important:

- The occupancy class determines the default contents value and displacement cost multipliers.

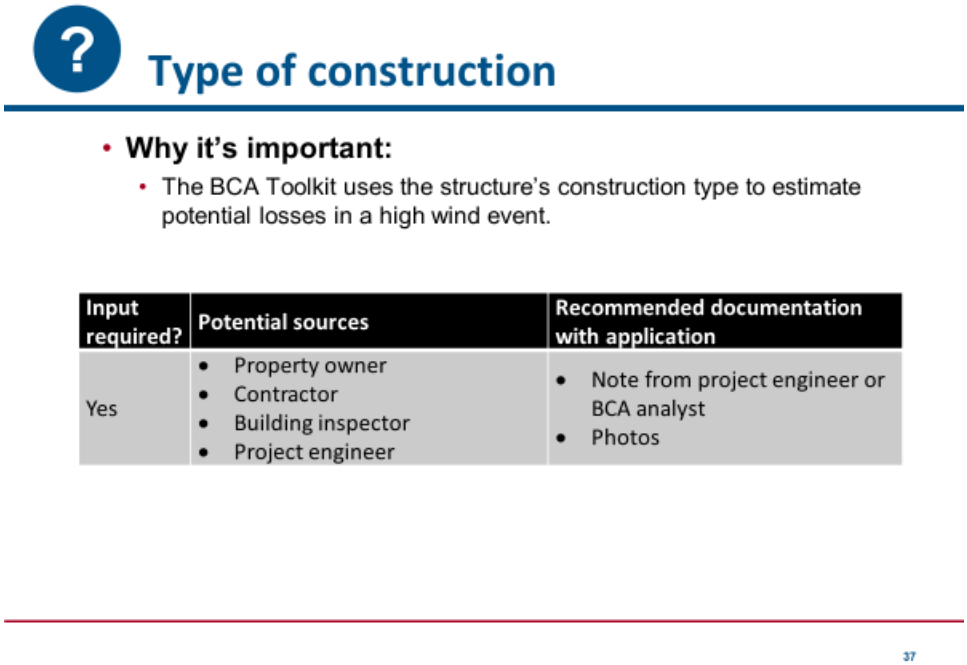
Source(s):

- Project Scope of Work (SOW)
- Property owner

Recommended BCA documentation with application:

- Note from project engineer or BCA analyst

Type of construction



Visual 30: Type of construction

Why it's important:

- The BCA Toolkit uses the structure's construction type to estimate potential losses in a high wind event.

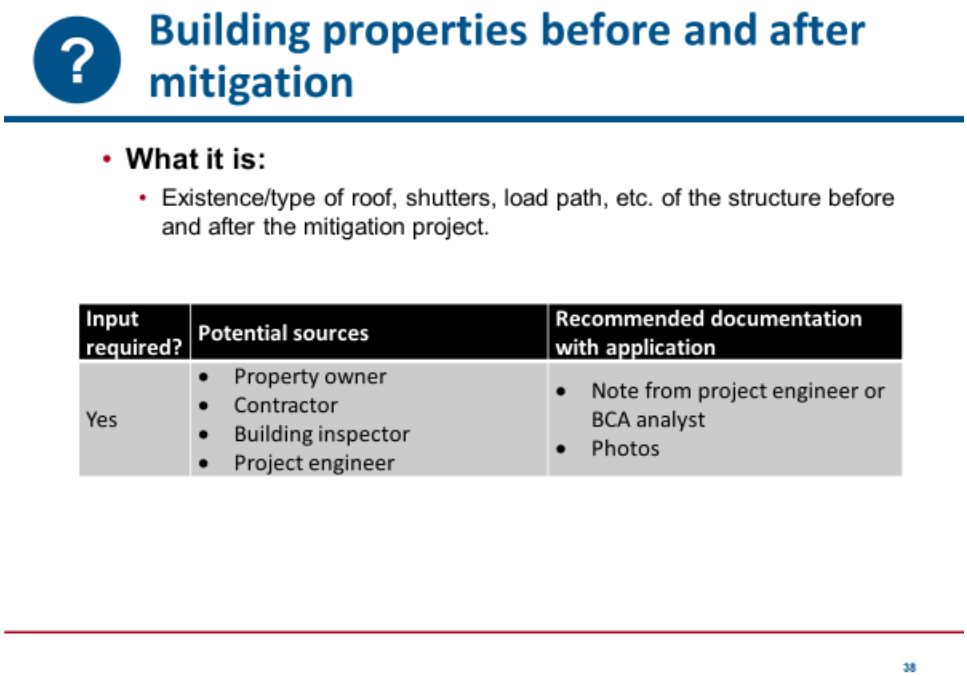
Source(s):

- Property owner
- Contractor
- Building inspector
- Project engineer

Recommended BCA documentation with application:

- Note from project engineer or BCA analyst
- Photos

Building properties before and after mitigation



Visual 31: Building properties before and after mitigation

What it is:

- Existence/type of roof, shutters, load path, etc. of the structure before and after the mitigation project.

Why it's important:

- The BCA Toolkit compares estimated losses before mitigation to estimated losses after mitigation. These are the benefits of the project.

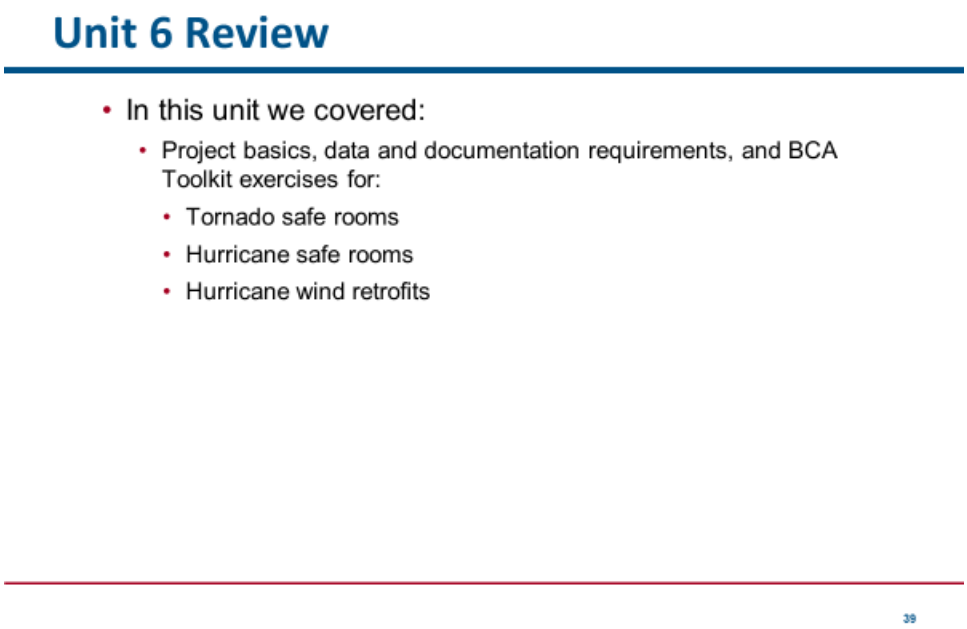
Source(s):

- Project Scope of Work (SOW)
- Project engineer

Recommended BCA documentation with application:

- None other than normally required project materials

Unit 6 Review



Visual 32: Unit 6 Review

In this unit we covered:

- Project basics, data and documentation requirements, and BCA Toolkit exercises for:
  - Tornado safe rooms
  - Hurricane safe rooms
  - Hurricane wind retrofits