Introduction

The devastating effects of recent hurricanes—especially hurricanes Charley (2004), Ivan (2004), Katrina (2005), Rita (2005), and Ike (2008)—have underscored the vulnerability of the nation's coastal areas. This guide provides local building officials and floodplain managers with information about the design and construction of hazard-resistant residential structures within the coastal environment. The primary coastal hazards this guide will highlight are high winds and flooding. The building types the guide focuses on are detached single-family, attached single-family (townhouses), and low-rise multi-family structures (i.e., those containing three or fewer stories). Many of the principles discussed herein also apply to non-residential structures; however, those structures are covered in other Federal Emergency Management Agency (FEMA) publications.

1.1 Objectives

The primary objective of this guide is to assist local officials and community decision makers in coastal areas in adopting and implementing sound mitigation measures to lower the vulnerability of buildings to disasters.

The goals of this guide are to:

- Introduce and discuss how requirements in the 2006 editions of the International Residential Code (IRC) and International Building Code (IBC) promote hazard-resistant design and construction in coastal areas
- Recommend building design and construction techniques that can improve the performance of structures during and after flooding and high-wind events
- Provide guidance for implementing flooding and high-wind mitigation best practices into the process of designing and constructing residential buildings

1.2 Target Audience

The target audience of this publication is state and local government officials working within the building sector. The guide is meant to assist them in implementing floodplain management requirements within the coastal environment. This guide describes mitigation measures and the application of building code requirements that have been successful in the past and could be implemented quickly, especially in areas recovering from a disaster. New homes and homes repaired after being damaged by flood and wind must be constructed to comply with current building codes, standards and the National Flood Insurance Program (NFIP) regulations.

1.3 Scope

This guide presents an overview of the principal planning and design considerations for improving the performance of residential buildings during flooding and high-wind events and their aftermaths. It provides information that directs local officials on where to find resources for design guidance and

also presents practical recommendations for protecting buildings and their occupants against hazards typically found in coastal zones.

Some people choose to live in high-hazard areas, while others reside there out of necessity. The intent of this guide is to provide technical information to local building officials who oversee construction in these areas. This information is FEMA's recommended best-practices for coastal construction that when implemented should improve building safety and reduce future losses. While this guide focuses primarily on new construction, the principles described herein also apply to the renovation of existing buildings. The guide emphasizes the importance of incorporating mitigation measures against flooding and high winds into the planning and design of buildings.

The guide provides readers with information about the natural forces acting upon coastal structures and the methods and processes available to protect those structures. This information is, by necessity, limited. It is ***not*** expected that the reader would be able to use this information directly to develop plans and specifications. Instead, it serves as an introduction to the fundamentals of risk mitigation planning and design. This guide will aid building officials and regulatory professionals as they interact with design professionals, procurement personnel, and project administrators. It will also help to provide a better grasp of planning and construction techniques that will aid building officials and regulatory professionals as they work to improve the safety and welfare of their coastal communities.

1.4 Using the Guide

This guide is generally divided into the following sections:

- An initial explanation of coastal hazards (Chapter 2)
- An introduction to regulatory requirements and inspection issues (Chapters 3 and 4)
- Evaluations of various components of residential building construction (Chapters 5, 6, 7, 8, 9, and 10)

While this guide is not meant to serve as a design manual, it is intended to help readers understand the general concept of mitigating coastal hazards and its applicability to building components. Whenever possible, the guide refers readers to design codes and standards and other relevant materials. Margin notes provide additional information or call attention to important concepts.

The *Local Officials Guide for Coastal Construction* is part of a family of FEMA mitigation guides and reports. These publications are referenced within the guide in order to assist the reader in finding other helpful mitigation information.

FEMA publications referred to in this guide:

- FEMA, *Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas*, FEMA 55 (3rd Edition), Washington, DC, August 2005
- FEMA, *Manufactured Home Installation in Flood Hazard Areas*, FEMA 85, Washington, DC, September 1985 (a revision is expected in 2009)

- FEMA, *Homebuilders' Guide to Earthquake Resistant Design and Construction*, FEMA 232, Washington, DC, August 2008
- FEMA, E*ngineering Principles and Practices of Retrofitting Flood-prone Structures*, FEMA 259, Washington, DC, January 2001
- FEMA, *Mitigation Assessment Team Report: Hurricane Fran in North Carolina*, FEMA 290, Washington, DC, April 1997
- FEMA, *Floodplain Management Bulletin on the Elevation Certificate*, FEMA 467-1, Washington, DC, May 2004
- FEMA, *Mitigation Assessment Team Report: Hurricane Charley in Florida*, FEMA 488, Washington, DC, April 2005
- FEMA, *Mitigation Assessment Team Report: Hurricane Ivan in Alabama and Florida*, FEMA 489, Washington, DC, August 2005
- FEMA, *Home Builder's Guide to Coastal Construction Technical Fact Sheet Series*, FEMA 499, Washington, DC, August 2005
- FEMA, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds: Providing Protection to People and Buildings*, FEMA 543, Washington, DC, January 2007
- FEMA, *Mitigation Assessment Team Report: Hurricane Katrina in the Gulf Coast*, FEMA 549, Washington, DC, July 2006
- FEMA, *Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations*, FEMA 550, Washington, DC, July 2006
- FEMA, NFIP Technical Bulletin 1: *Openings in Foundation Walls and Walls of Enclosures*, FIA-TB-1, Washington, DC, August 2008
- FEMA, NFIP Technical Bulletin 2: *Flood Damage-Resistant Materials Requirements for Buildings Located in Special Flood Hazard Areas*, FIA-TB-2, Washington, DC, August 2008
- FEMA, NFIP Technical Bulletin 5: *Free-of-Obstructions Requirements for Buildings Located in Coastal High Hazard Areas*, FIA-TB-5, Washington, DC, August 2008
- FEMA, NFIP Technical Bulletin 9: *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings*, FIA-TB-9, Washington, DC, August 2008

1.5 Coastal Construction versus Inland Construction

Coastal structures are subject to extreme hazards and loads. Due to the intensity of these conditions, coastal construction involves additional design considerations:

- Wave action exerts tremendous loads upon the foundations of coastal structures. Such loadings have been known to cause significant damage to these structures.
- Erosion and scour can remove soil, causing undermining of some foundations of residential buildings and increasing the unbraced length on open foundations. Subsidence and rising sea and water levels can potentially increase flood depths, creating additional flood loads on the residential structure.
- Waterborne debris can exert an impact and produce repetitive loads not seen in inland residential construction.
- Wind speeds are typically higher in coastal areas and require stronger engineered building connections and more closely spaced fasteners of building sheathing, siding, and roof systems.
- Wind-driven rain, airborne salts, corrosion, and decay are constant concerns within coastal areas.

To address such differences in loading criteria, homes in coastal areas must be designed and built to withstand extreme conditions. This guide outlines the minimum building requirements for structures and suggests best practices to improve a structure's resistance to future storm events. Exceeding these minimum requirements can result in several economic benefits:

- Reduced damage during coastal storm events
- Reduced building maintenance
- Longer building lifetime
- Improved Community Rating System (CRS) score
- Reduced insurance premiums

Although this guide discusses in detail building design and construction issues, it also addresses other aspects of coastal construction such as planning, zoning, and achieving compliance with local ordinances. These considerations are also important because even a well-built building can sustain significant damage or collapse if it is poorly sited. The impacts of erosion and scour should be seriously considered during the planning process.

1.6 Building Codes

This guide primarily references two codes: The International Building Code (IBC) and the International Residential Code (IRC). Achieving familiarity with other relevant materials from the American Society of Civil Engineers (ASCE) and regulations from the NFIP is important when implementing a comprehensive approach to coastal residential construction. The state in which the local official is working may use other codes or standards on either a state or local level. If your location does not use these codes, this guide will still provide insight into best practices in coastal construction methods and suggest appropriate design considerations.

Codes referred to in this guide are:

- International Code Council, *International Building Code*, Country Club Hills, IL, 2006
- International Code Council, *International Residential Code*, Country Club Hills, IL, 2006
- International Code Council, *International Existing Building Code*, Country Club Hills, IL, 2006
- NFPA, *Building Construction and Safety Code*, NFPA 5000, Quincy, MA, 2005

Standards referred to in this guide are:

- American Society of Civil Engineers, Structural Engineering Institute, *Minimum Design Loads for Buildings and Other Structures*, ASCE/SEI 7-05, Reston, VA, 2005
- American Society of Civil Engineers, Structural Engineering Institute, *Flood Resistant Design and Construction*, ASCE/SEI 24-05, Reston, VA, 2005
- American Concrete Institute/American Society of Civil Engineers/The Masonry Society, *Building Code Requirements for Masonry Structures*, ACI 530/ASCE 5/TMS 402, Farmington Hills, MI, updated 2008
- American Forest & Paper Association, *Wood Frame Construction Manual for One- and Two-Family Dwellings* (WFCM), Washington, DC, 2001
- American Iron and Steel Institute, *Standard for Cold-Formed Steel Framing: Prescriptive Method for One- and Two-Family Dwellings (COFS/PM) with supplement to Standard for Cold-Formed Steel Framing – Prescriptive Method for One- and Two-Family Dwellings*, AISI S 230-07, Washington, DC, updated 2007
- American National Standards Institute (ANSI)/Single Ply Roofing Industry (SPRI), *Wind Design Standard for Ballasted Single-Ply Roofing Systems*, ANSI/SPRI RP-4, Waltham, MA, 2002
- ANSI/Door and Access Systems Manufacturers Association (DASMA), *Standard Method for Testing Sectional Garage Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference*, ANSI/DASMA 108, Waltham, MA

- American Society for Testing and Materials (ASTM), *Standard Test Method for Wind-Resistance of Asphalt Shingles* (Fan-Induced Method), ASTM D3161, West Conshohocken, PA
- ASTM, *Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)*, ASTM D7158, West Conshohocken, PA
- ASTM, *Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference*, ASTM E330, West Conshohocken, PA
- ASTM, *Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems, Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials*, ASTM E1886, West Conshohocken, PA
- ASTM, *Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes*, ASTM E1996, West Conshohocken, PA
- ASTM, Standard Practice for Installation of Exterior Windows, Doors, and Skylights, ASTM E2112, West Conshohocken, PA
- American Architectural Manufacturers Association/Window & Door Manufacturers Association/ Canadian Standards Association, Standard/Specification for Windows, Doors, and Unit Skylights, AAMA/WDMA/CSA 101/I.S. 2/A440, Schaumburg, IL, March 2007
- National Fire Protection Association (NFPA), *Model Manufactured Home Installation Standar*d, NFPA 225, Quincy, MA, 2005

Additional resources referred to in this guide:

- International Code Council, and FEMA, *Reducing Flood Losses Through the International Code Series: Meeting the Requirements of the National Flood Insurance Program* (2nd Edition), Country Club Hills, IL, 2005
- American Institutes for Research, *Evaluation of the National Flood Insurance Program*, December 2006
- Applied Technology Council, ATC-45 *Field Manual: Safety Evaluation of Buildings After Wind Storms and Floods*, Redwood City, CA, 2007
- North Carolina State University/Oregon State University, *Behavior or Breakaway Walls Subjected to Wave Forces: Analytical and Experimental Studies*, Tung et al., Raleigh, NC, 1999