

Risk Management Series

Design Guide

for Improving Critical Facility Safety
from Flooding and High Winds

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FEMA

RISK MANAGEMENT SERIES

Design Guide *for*
Improving Critical Facility
Safety from Flooding and
High Winds


PROVIDING PROTECTION TO PEOPLE AND BUILDINGS



FEMA

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BACKGROUND

 n August 29, 2005, Hurricane Katrina caused extensive damage to the coast along the Gulf of Mexico, resulting in an unprecedented relief, recovery, and reconstruction effort. This reconstruction presents a unique opportunity to rebuild the communities and public infrastructure using the latest hazard mitigation techniques proven to be more protective of lives and property.

Critical facilities comprise all public and private facilities deemed by a community to be essential for the delivery of vital services, protection of special populations, and the provision of other services of importance for that community. This manual concentrates on a smaller group of facilities that are crucial for protecting the health and safety of the population: health care, educational, and emergency response facilities.

The *Design Guide for Improving Critical Facility Safety from Flooding and High Winds* (FEMA 543) was developed with the support of the Federal Emergency Management Agency (FEMA) Region IV in the aftermath of Hurricane Katrina. This manual recommends incorporating hazard mitigation measures into all stages and at all levels of critical facility planning and design, for both new construction and the reconstruction and rehabilitation of existing facilities. It provides building professionals and decisionmakers with information and guidelines for implementing a variety of mitigation measures to reduce the vulnerability to damage and disruption of operations during severe flooding and high-wind events. The underlying theme of this manual is that by building more robust critical facilities that will remain oper-

ational during and after a major disaster, people’s lives and the community’s vitality can be better preserved and protected.

This manual is a part of FEMA’s Risk Management Series, which provides guidelines for mitigating against multiple hazards. The series emphasizes mitigation best practices for specific building uses, such as schools, hospitals, higher education buildings, multi-family dwellings, commercial buildings, and light industrial facilities.

OBJECTIVES

The poor performance of many critical facilities in the affected areas was not unique to Hurricane Katrina. It was observed in numerous hurricanes dating back more than three decades. Several reasons may explain this kind of performance. In many cases the damaged facilities were quite old and were constructed well before the introduction of modern codes and standards. Some of the older facilities were damaged because building components had deteriorated as a result of inadequate maintenance. Many facilities occupy unsuitable buildings that were never intended for this type of use. Some newer facilities suffered damage as a result of deficiencies in design and construction or the application of inappropriate design criteria and standards.

The primary objective of this manual is to assist the building design community and local officials and decisionmakers in adopting and implementing sound mitigation measures that will decrease the vulnerability of critical facilities to major disasters.

The goals of this manual are to:

- Present and recommend the use of building design features and building materials and methods that can improve the performance of critical facilities in hazard-prone areas during and after flooding and high-wind events.
- Introduce and provide guidelines for implementing flooding and high-wind mitigation best practices into the process of design, construction, and operation and maintenance of critical facilities.

SCOPE

To aid in the reconstruction of the Gulf Coast in the wake of Hurricane Katrina, this manual presents an overview of the principal planning and design considerations for improving the performance of critical facilities during, and in the aftermath of, flooding and high-wind events. It provides design guidance and practical recommendations for protecting critical facilities and their occupants against these natural hazards. The focus is on the design for new construction, but this manual also addresses rehabilitation of existing critical facilities. It presents incremental approaches that can be implemented over time to decrease the vulnerability of buildings, but emphasizes the importance of incorporating the requirements for mitigation against flooding and high winds into the planning and design of critical facilities from the very beginning of the process.

The material and recommendations contained in this manual are applicable to many facilities, but address primarily the following critical facilities:

- Schools
- Health Care Facilities
- Fire Stations
- Police Stations
- Emergency Operation Centers (EOCs)

The information presented in this manual provides a comprehensive survey of the methods and processes necessary to protect critical facilities from natural hazards, but is necessarily limited. It is not expected that the reader will be able to use this information directly to develop plans and specifications. It is intended as an introduction to a broader understanding of the fundamental approaches to risk mitigation planning and design. This will help building officials and professionals move on to the implementation phase that involves consultants, procurement personnel, and project administrators, with a better grasp of the task in front of them—improving the safety and welfare of their communities.

TARGET AUDIENCE

This manual describes various mitigation measures that have been successful in the past and could be implemented quickly, especially in areas recovering from a disaster. The intended audience comprises the people who own, operate, design, build, and maintain critical facilities in hazard-prone areas. This includes planning, building design, and construction professionals working for private organizations, State and local government officials working in the building sector, and relevant technical and management personnel involved with the operation of critical facilities.

TRAINING

In tandem with the publication of this manual, FEMA has developed a companion training course targeted to building design professionals and facility managers interested in improving the functionality of critical facilities in natural disasters. For transfer of its content, FEMA will promote a series of workshops directed at these professionals and others involved in planning, design, construction, rehabilitation, and management of critical facilities in areas exposed to flooding and high winds.

The training course emphasizes the best practices in mitigating against flooding and winds hazards. It is organized around a series of exercises, starting with vulnerability analysis, and progressing through assessment of risks, assessment of building systems performance (especially the effects of physical damage on the facility's functionality), and the selection of appropriate mitigation measures to be incorporated into the design of critical facilities.

The expansive scope of reconstruction activities in the aftermath of Hurricane Katrina requires that this course be initially offered and delivered only to affected communities in the Gulf States. However, the relevance and usefulness of this course extends far beyond the hurricane-prone regions, to areas exposed to other wind hazards, as well as areas subject to all types of coastal and riverine flooding.

ORGANIZATION AND CONTENTS

This manual is divided into four main chapters.

Chapter 1 presents an overview of the principal design considerations to help owners, managers, and designers when determining the location, building characteristics, and hazard resistance of critical facilities. It outlines the basic principles and design tools for improving the safety of critical facilities exposed to flooding and high winds. It also provides guidelines for facility managers and building professionals on how to coordinate the process of planning and design of critical facilities.

Chapter 2 discusses the nature of flood forces and their effects on buildings. It outlines the procedures for risk assessment, and describes current mitigation methods for reducing the effects of flooding. It underlines the need to avoid high-risk areas for the construction of new critical facilities, and encourages the application of mitigation measures when critical facilities must remain in high-risk areas. This chapter provides extensive review of the requirements of the National Flood Insurance Program (NFIP), model building codes and other standards, as well as new FEMA policy updates resulting from the experiences of Hurricanes Katrina and Rita.

Chapter 3 discusses the effects of wind forces on the structural and nonstructural building components of critical facilities. By reviewing numerous examples of wind-induced damage to these facilities, it points out the best practices pertaining to new construction and rehabilitation of existing facilities. It concentrates on building components most critical for protecting the uninterrupted operation of critical facilities and provides detailed guidelines for improving their design and construction in hurricane- and tornado-prone areas.

Chapter 4 discusses the performance of hospital, schools, and emergency response facilities (i.e., EOCs, and police and fire rescue stations) during Hurricane Katrina. This chapter emphasizes the lessons learned about the adverse effects on the functionality of critical facilities arising from damage to buildings and contents, especially the ways that various types of physical damage disrupted their operations.

Appendix A contains a list of acronyms and Appendix B contains a glossary of terms that appear in this manual. Appendix C contains an overview of the FEMA grant programs available for funding construction or rehabilitation of critical facilities.

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For this manual, the following individuals are acknowledged:

Authors:

Rebecca C. Quinn, RCQuinn Consulting, Inc.

Thomas L. Smith, TLSmith Consulting

Bogdan Srdanovic, URS

William Coulbourne, URS

Jon Heintz, ATC

Lisa Scola, PBS&J

Wilbur H. Tusler, Consultant

Douglas A. Ramirez, PBS&J

William Brown, PBS&J

Pedro Escobar, PBS&J

Shaddy Shafie, PBS&J

Scott Sundberg, URS

Milagros Nanita Kennett, FEMA, Project Officer, Risk
Management Series Publications

Contributors:

Shabbar Saifee, FEMA, Project Monitor

Eric Letvin, URS, Project Manager

Mark Matulik, Consultant

Lawrence Frank, URS

John Squerciati, Dewberry

Wanda Rizer, design4impact

Mike Robinson, PBS&J

Manuel Perotin, PBS&J

Susan Patton, URS

Rob Fernandez, URS

Janet Frey, URS

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This manual will be revised periodically and FEMA welcomes comments and suggestions for improvements in future editions. Please send your comments and suggestions via e-mail to: RiskManagementSeriesPubs@dhs.gov

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