INSTRUCTORS GUIDE
FEMA P-767 CD, Earthquake Mitigation for Hospitals

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This Instructors Guide contains useful information that should be read by the Instructor before presenting this course. The first part of this Guide contains an overview and summary of the course; relevant background information; places this course in geographical context; provides recommendations on how to tailor the content to your audience; and lists the course handouts. The second part of this Guide provides the Answer Key to the Student Exercises.
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PART 1

The goal of the ***FEMA P-767 CD, Earthquake Mitigation for Hospitals*** is to promote seismic rehabilitation of hospitals, in order to reduce earthquake damage losses and business interruption following moderate to major earthquakes. This is accomplished by introducing the trainee to the effect of earthquakes to a variety of common building types and typical hospital equipment and components, identifying common structural and nonstructural seismic vulnerabilities, and identifying rehabilitation approaches and available guidelines.

The Applied Technology Council developed this training with funding provided by the Federal Emergency Management Agency. Comments and questions regarding this training should be directed to the Applied Technology Council (www.atcouncil.org).

Overview
The following is an overview of the training, which is divided into eleven sections. The number of slides and approximate presentation time is noted for each section.

Section 1 - Introduces the training course, defines applicable terminology, and introduces by case example why seismic rehabilitation of hospitals is important. (13 slides/20 minutes).

Section 2 - Introduces earthquake hazards, including ground shaking, fault rupture, and liquefaction. Discusses the difference between earthquakes occurring at plate boundaries and intra-plate occurrences and introduces seismic hazard maps. (14 slides/20 minutes). This section is generic and the presenter is strongly encouraged to add regional hazard data pertinent to the audience.

Section 3 – Introduces seismic vulnerabilities of building structures and discusses how to identify vulnerable conditions and likely earthquake behavior. Typical damage for a variety of building types is provided pictorially to illustrate expected damage to these building types. (42 slides/45 minutes).

Section 4 – Introduces seismic vulnerabilities of nonstructural components, equipment and systems, including building utilities, architectural components, medical equipment, medical gases, and furniture and contents. Discusses the cause and significance of nonstructural damage and pictorially shows representative nonstructural earthquake damage. (41 slides/45 minutes).

Section 5 – Presents a general summary of expected earthquake damage to a region experiencing a major earthquake. Discusses conditions that would likely exist following a major earthquake event for existing hospitals. A brief discussion of the design and construction process, as it relates to seismic design and performance of nonstructural components is also presented. The Section ends with the presentation of a summary of hospitals that have experienced an earthquake and the performance experienced. (33 slides/30 minutes).

Section 6 – Provides the transition of the presentation from discussing seismic risk to implementing risk reduction or mitigation measures. Discusses seismic risk reduction strategies pertinent to hospitals. (2 slides/10 minutes).

Section 7 – Introduces the process for planning and effectively managing and implementing a facility seismic mitigation program for a hospital organization. (35 slides/45 minutes).

Section 8 – Introduces seismic mitigation for building structures and its integration into a hospital facility mitigation program. Challenges and conditions unique to hospitals are also discussed. (37 slides/45 minutes).

Section 9 – Introduces seismic mitigation of nonstructural equipment, components, and contents, as well as the integration into a facility mitigation program. Discussion of design tools and resources for nonstructural mitigation is provided. Numerous examples are provided to illustrate appropriate nonstructural seismic restraints. (74 slides/60 minutes).

Section 10 – Discusses specific opportunities where earthquake mitigation can be integrated into existing hospital facility programs. (16 slides/15 minutes).

Section 11 – Conclusions and summary of the workshop including an overview of vulnerability assessment, planning for mitigation, implementing mitigation, and integrating mitigation activities into existing programs are presented. (6 slides/15 minutes).

In order to tailor this training to the particular audience and not exceed the time available, it may be necessary to pick and choose among these 11 sections. The trainer should feel free to choose among the parts as appropriate to the audience and time available.

The presentation times above total nearly six hours. Past presentations given have totaled 7-8 hours with breaks (excluding lunch). Depending on your audience and how you run

the training (will you allow yourself to be interrupted with questions, or will you hold questions/ discussion to the end?) the complete training might be compressed to 4 hours, or could take all day. It is recommended that the less technical the audience, the more you should compress the training, possibly removing parts from sections 3, 4, 8 & 9 thereby focusing more on the planning and integration processes of risk reduction and mitigation. Remember that you will need to budget time for lunch and breaks.

The following provides a brief discussion on background information related to this workshop, who the intended audience should be, and recommended handout materials.

Background

There is a significant amount of guideline material addressing seismic rehabilitation measures available, but much of it is not specific to hospitals as it resides in various places and in various forms. Therefore, the focus of this training is to provide an overall context for identifying and prioritizing structural and nonstructural vulnerabilities, and introducing a process for planning, managing, and implementing a seismic mitigation program that is specific to a hospital organization's existing operational processes and activities. The workshop has been developed based on FEMA 396. It is strongly recommended that instructors contemplating the presentation of this training course read FEMA 396.

Audience

This training is intended for those involved in facility management of hospitals, and others involved in making policy decisions regarding seismic rehabilitation of hospitals. This training assumes a low to moderate level of familiarity with seismic hazards and building construction. The audience may at times include insurance persons and some additional explanation of terminology and concepts may be necessary for these audiences. It is also understood that the audience may include one or many of the audience types named above. While the entire training is meant to be presented to all of these audiences, some of the eleven presentation sections might be removed or reduced for a particular audience. The trainer should review all sections before the training is held, determine the composition of the audience, and tailor the training accordingly.

Handout Materials

The FEMA P-767 CD contains:

1. The presentation slides (P-767 Earthquake Mitigation for Hospitals, Sections 1 through 11).

If funding is available, it is recommended that a handout of the slide set be printed (2 to 3 slides per page) and provided as a handout for workshop participants. Participants can then make appropriate notes within the handout.

Additional handout materials to consider providing to the attendee's are the FEMA documents referenced throughout the presentation slides, particularly on nonstructural components. These documents are free and can be ordered in bulk directly from FEMA and are listed below. It is encouraged that the workshop be coordinated with the local

State Earthquake Program Director as well as the FEMA regional Earthquake Program or Educational Director.

FEMA documents suggested as handouts:

2. FEMA 396, *Risk Management Series, Incremental Seismic Rehabilitation of Hospital Buildings, Providing Protection to People and Buildings*, December 2003.
3. FEMA 74, *Earthquake Hazard Mitigation for Nonstructural Elements, A Practical Guide,* September 1994. An updated version or e-doc of FEMA 74 is scheduled for release in 2010 from FEMA's web site.
4. FEMA 154-CD, *Rapid Visual Screening of Building for Potential Seismic Hazards, Edition 2*, July 2005.
5. FEMA 412, *Installing Seismic Restraints for Mechanical Equipment*, August 2005.
6. FEMA 413, *Installing Seismic Restraints for Electrical Equipment,* January 2004.
7. FEMA 414, *Installing Seismic Restraints for Duct and Pipe,* December 2004.

PART 2
STUDENT EXERCISE ANSWER KEY

Section 1: Introduction
Identify whether the following statements are true (T) or false (F).

(T) F 1.1 Earthquake risk to a facility is a function of both the hazard and the vulnerability.

T (F) 1.2 Only major structural damage to a facility can result in evacuation and long-term disruption of facilities.
Nonstructural damage, such as fire sprinkler water leakage, can also result in evacuation and long-term disruption to hospital operations.

Section 2: Earthquake Hazards
Identify whether the following statements are true (T) or false (F).

T (F) 2.1 Major earthquakes only occur along plate boundaries where large crustal blocks move past one another.
Earthquakes also occur away from plate boundaries, particularly in the central and eastern US. Earthquakes on the New Madrid Seismic Zone are intraplate events.

T (F) 2.2 Most areas of the country require no consideration for earthquake design under the International Building Code (IBC) because the seismic hazard is very low.
Very few areas of the county are completely exempt from all earthquake design provisions under the IBC. Dependent upon the facility occupancy importance (hospital, fire, police, etc.), critical facilities in moderate and low seismic hazard regions require seismic design.

2.3 Which of the following are earthquake hazards?
(Circle all that apply)

(a.) Fault Rupture
b. Typhoon
c. Riverine Flooding
(d.) Landslide

Section 3: Building Structural Vulnerability

3.1 Rank the following building types in terms of expected earthquake performance from 1 to 4, where 1 is the best performance and 4 is the worst.

_3_ Concrete Tilt-up

_4_ Unreinforced Masonry

_1_ Steel Braced Frame

_2_ Steel Moment Frame

3.2 Identify the conditions shown in each of the following illustrations, as follows: Soft Story, Adjacent Building Pounding, Plan Irregularity, Vertical Setback, and Diaphragm Discontinuity

Soft Story

Vertical Set-back

Plan Irregularity

Adj. Bldg. Pounding

Diaphragm Discontinuity

Plan Irregularity

Plan Irregularity

Vertical Set-back

Adj Bldg. Pounding

3.3 List four seismic performance predictors for buildings.

Building Type, Building Age, Quality of Construction, Design Code, Plan Irregularities, Vertical Irregularities (Set-backs, Soft Story), Diaphragm Discontinuities, Adjacent Building Pounding

Section 4: Nonstructural Vulnerability to Earthquakes

4.1 Name two nonstructural components included in each of the following categories:

Building Utilities: *Emergency Generator, Fire Pump, HVAC, Boiler, etc.*

Architectural Components: *Partition Walls, Ceilings, Light Fixtures, Parapets*

Medical Equipment: *CT Scans, MRI, Pharmacy*

Furniture & Contents: *Computers, Bookcases, File Cabinets, TVs, Carts*

Identify whether the following statements are true (T) or false (F).

(T) F 4.2 Shaking and displacement are the two primary causes of damage to nonstructural components.

T (F) 4.3 Anchorage and bracing for nonstructural components is typically designed by a structural engineer to resist seismic forces.
Anchorage for nonstructural components often does not occur, or is not an engineered solution. Often times the seismic design is delegated to the specific trade construction contractor to interpret, design and construct.

Section 5: Earthquake Performance Expectations for the Midwest

Identify whether the following statements are true (T) or false (F).

T (F) 5.1 Buildings tagged as Yellow or Green following an earthquake are completely safe for re-occupancy.
Restrictions are placed on the re-occupancy of buildings that are tagged as Yellow.

T (F) 5.2 Building code seismic design provisions are intended to prevent earthquake damage and property loss.
Building code provisions are intended to provide life safety and do not prevent damage or property loss.

Section 6: Overview of Seismic Risk Reduction

6.1 Match each of the following seismic risk reduction techniques with their relative costs and risks.

Do Nothing	High Cost, Low Risk
Replace	Continuous Use, Lower Cost
Rehabilitate	No Cost, High Risk
Incremental	Loss of Use, High Cost

Section 7: Planning and Managing the Process of Seismic Risk Reduction

Identify whether the following statements are true (T) or false (F).

(T) F 7.1 Planning for seismic performance of new facilities should include a dedicated effort to determine the level of earthquake performance desired for the facility.

T (F) 7.2 An effective risk reduction policy does not need to establish seismic performance objectives.

(T) F 7.3 Nonstructural mitigation of many components can be easily incorporated into existing maintenance programs.

T (F) 7.4 Incremental seismic strengthening is not recommended when one floor of a wing is undergoing remodeling/renovation as the other floors of the wing have not been seismically addressed.
Any time a space is scheduled for remodeling or renovation, there is an opportunity to also design and construct seismic strengthening improvements for both the building structure and nonstructural equipment, components, and systems within the space. It is the most cost-effective mitigation that can be performed.

Section 8: Structural Mitigation

Identify whether the following statements are true (T) or false (F).

(T) F 8.1 Seismic mitigation of buildings is most cost effective or economical if addressed when earthquake provisions are incorporated into the design and construction of a new facility.

T (F) 8.2 Seismic mitigation is often not feasible for hospital facilities because of the interruption – noisy, dirty, no swing space for relocation nature of structural strengthening.
While these are elements of construction, they are manageable if properly planned through an incremental mitigation program.

Section 9: Nonstructural Mitigation
Identify whether the following statement is true (T) or false (F).

T (F) 9.1 Nonstructural mitigation is only recommended for items that pose a life safety hazard.
Hospitals contain a vast array of nonstructural components that both support a clean environment for patients and staff as well as for performing medical activities, such that nearly all nonstructural components in a hospital would require functionality following a major earthquake event.

Identify the best retrofit strategy for each of the following nonstructural components:

9.2 Tall bookcases that are located in a primary egress corridor that are unrestrained and can possibly overturn and obstruct egress.

a. Ignore the problem because large ground motion is unlikely to occur.
b. Anchor the top of the bookcase to the adjacent wall to prevent overturning.
(c.) Relocate the bookcases from the corridor.

9.3 Emergency generator and the fuel oil day tank are sitting directly on a concrete equipment pad. Neither is anchored.

a. Install non-seismic vibration isolators to provide flexibility.
b. Install chains across the generator to restrict movement. Leave day tank unanchored.
(c.) Hire qualified seismic engineer and contractor to design and install the restraints for the generator and the day tank due to the critical nature of each.

9.4 Automatic transfer switch is located in an unoccupied basement mechanical room. The cabinet is tall and narrow and has no anchorage.

a. Anchorage is not required because the basement is unoccupied. Therefore there is no life safety hazard.
(b.) Install base anchorage for the cabinet to prevent overturning.
c. Install a chain around the cabinet to the nearest partition wall to limit how far it can move/rotate.

9.5 When should seismic mitigation activities be undertaken? (Circle all that apply)

(a.) During new construction
(b.) During remodeling/renovation of a room or area of a facility
(c.) During component or system replacement

Section 10: Integration Opportunities for Structural & Nonstructural Mitigation
Identify whether the following statements are true (T) or false (F).

(T) F 10.1 Nonstructural strengthening of architectural components integrates well into typical remodeling projects because ceilings, light fixtures, and walls are exposed and readily accessible.

T (F) 10.2 Nonstructural mitigation for cabinets, bookcases, and bench-top equipment should be designed by an engineering professional to ensure the adequacy of the seismic restraints.
Prescriptive designs are typically adequate and engineered solutions are not required for these types of nonstructural components.

(T) F 10.3 Hazardous material abatement projects provide opportunities for seismic strengthening because the areas are typically vacant and exposed for work.

FEMA P-767 CD, Earthquake Mitigation for Hospitals Workshop

Part 1 – Introduction

Workshop Overview

- Topics to be addressed today
  - Seismic safety improvements for hospitals
  - Seismic hazard and vulnerability
    - Structural
    - Non-structural
  - Process to reduce risk of earthquake damage
  - Structural and nonstructural mitigation
  - Integration opportunities for mitigation

Workshop Overview

- Workshop schedule
  - Presentations
  - Breaks
  - Lunch

Audience Characteristics

- Audience self introductions
- Questions for all: Is anyone:
  - Purchasing an existing facility?
  - Assessing your facilities?
  - Remodeling your facilities?
  - Constructing a new facility?

INTRODUCTION

Seismic Risk for Hospitals

RISK = f (HAZARD, VULNERABILITY)

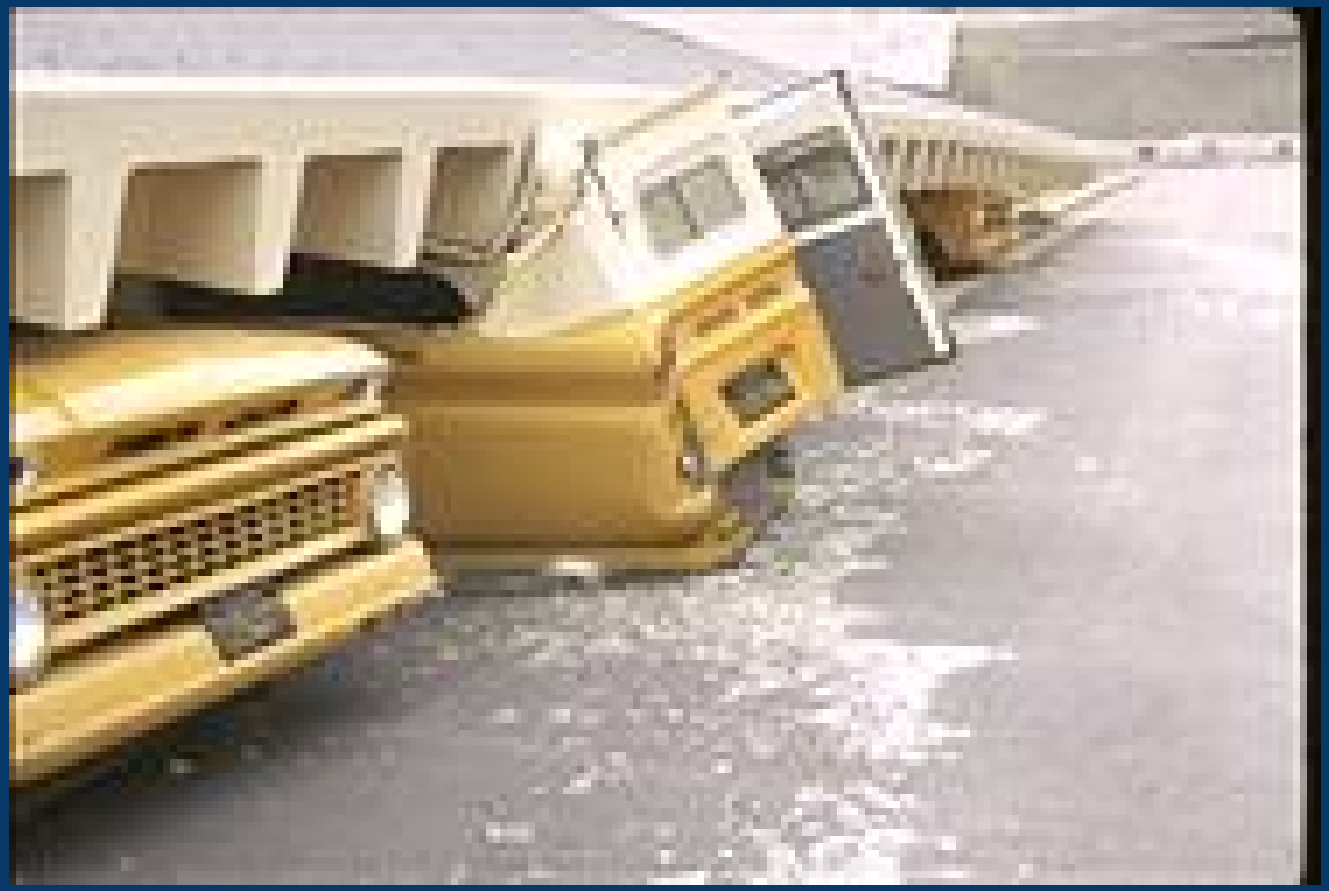
Risk is a function of both the potential hazard (seismic ground motion) and vulnerability (lack of seismic preparedness in structural and nonstructural systems)

Deaths and Injuries of Staff and Patients

Collapse of Buildings or Parts of Buildings

Damage to Buildings, Equipment Furnishings and Contents

Disruption of Medical Service to Surge of Earthquake Victims



Long Term Disruption of Medical Services to Patients

Earthquake Hazard Overview

RISK = f (HAZARD, VULNERABILITY)

Photo Credits

- Degenkolb Engineers
- Lee, Burkhart, Liu Architects of Santa Monica
- URS Corporation (FEMA 577, *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds*)
- Personal files of Mel Green, Mike Griffin, and Maryann Phipps, consultants to the Applied Technology Council