



*Risk Management Series*

# Incremental Seismic Rehabilitation of Hospital Buildings

Providing Protection to People and Buildings

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Incremental  
Seismic Rehabilitation  
of Hospital Buildings

**PROVIDING PROTECTION TO PEOPLE AND BUILDINGS**



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## Executive Summary

*Earthquakes are a serious threat to hospital safety and pose a significant potential liability to hospital administrators and healthcare organizations. Hospital buildings in 39 states are vulnerable to earthquake damage. Unsafe existing buildings expose healthcare organizations to the following risks:*

- *Death and injury of patients, doctors, nurses, and staff*
- *Damage to or collapse of buildings*
- *Damage to and loss of furnishings, equipment, and other building contents*
- *Disruption of patient care and other hospital operations*
- *Loss of an indispensable community resource*

The greatest earthquake risk is associated with existing hospital buildings that were designed and constructed before the use of modern building codes. For many parts of the United States, this includes buildings built as recently as the early 1990s.

Although vulnerable hospital buildings need to be replaced with safe, new construction or rehabilitated to correct deficiencies, for some healthcare organizations new construction is limited, at times severely, by budgetary constraints, and seismic rehabilitation is expensive and disruptive. However, **incremental seismic rehabilitation**, an innovative approach that phases in a series of discrete rehabilitation actions over a period of several years, is an effective, affordable, and non-disruptive strategy for responsible mitigation action. It can be efficiently integrated into ongoing facility maintenance and capital improvement operations to minimize cost and disruption. The



strategy of incremental seismic rehabilitation makes it possible to get started now on improving earthquake safety in your healthcare organization.

This manual provides healthcare organizations with the information necessary to assess the seismic vulnerability of their buildings and to implement a program of incremental seismic rehabilitation for those buildings. The manual consists of three parts:

**Part A, Critical Decisions for Earthquake Safety in Hospitals**, is for healthcare organization senior executives, board members, hospital directors, vice presidents for facility management, and other policy makers who will decide on allocating resources for earthquake mitigation.

**Part B, Planning and Managing the Process for Earthquake Risk Reduction in Existing Hospital Buildings**, is for hospital facility managers, risk managers, and financial managers who will initiate and manage seismic mitigation measures.

**Part C, Tools for Implementing Incremental Seismic Rehabilitation in Existing Hospital Buildings**, is for facility managers, or others responsible for facility management, who will implement incremental seismic rehabilitation programs.

To get the most out of this manual:

- Communicate the importance of assessing your organization's risks and pass this manual on to the staff members responsible for facility management, risk management, and financial planning. Specify that they develop an analysis of the current seismic risk of your buildings and a strategy for risk reduction.
- Promptly initiate a program of earthquake risk reduction in your organization's buildings located in an earthquake-prone zone that were not designed and constructed to meet modern building codes.
- Consider incremental seismic rehabilitation as a cost-effective means to protect the buildings and, most importantly, the safety of patients, doctors, nurses, and staff, because it is a technically and financially manageable strategy that minimizes disruption of hospital operations.

## Foreword

The concept of seismically rehabilitating buildings in discrete segments, as resources become available or as part of a structural renovation program, was pioneered by the Federal Emergency Management Agency (FEMA) and a Virginia Polytechnic Institute/Building Technology Inc. team that, in the early 1990s, published *Existing School Buildings – Incremental Seismic Retrofit Opportunities*, FEMA 318. Lack of resources at the time, however, restricted application of this promising concept to a few states in the Pacific Northwest and to a single occupancy or use category: schools. FEMA is now pleased to make available a manual on hospitals. Further, the team is also preparing a series of manuals that will address seven additional building uses: schools (an updated version), retail establishments, multi-family dwellings, office buildings, emergency management facilities, warehousing/distribution centers, and hotels/motels. A separate manual will serve the needs of design professionals and building officials and will be applicable across all occupancy categories.

FEMA gratefully acknowledges the dedicated efforts of all members of the team: the Virginia Polytechnic Institute and State University (the prime contractor); the Project Advisory Panel; Project Consultants; Building Technology Inc.; EQE Inc.; Melvyn Green & Associates Inc.; the Institute for Crisis Disaster and Risk Management of the George Washington University; and URS Group, Inc. The FEMA Project Officers add their sincerest appreciation for the excellent support of this multi-disciplinary team.

The Federal Emergency Management Agency

## Preface

This manual is intended to assist healthcare organization personnel responsible for the funding and operation of existing hospital facilities across the United States. This publication and its companion documents are the products of a Federal Emergency Management Agency (FEMA) project to develop the concept of incremental seismic rehabilitation—that is, building modifications that reduce seismic risk by improving seismic performance and that are implemented over an extended period, often in conjunction with other repair, maintenance, or capital improvement activities.

The manual was developed after the project team analyzed the management practices of healthcare organizations located in various seismic zones in different parts of the United States. It focuses on the identified concerns and decision making practices of hospital managers and administrators.

This manual is part of a set of manuals intended for building owners, managers, and their staff:

- *Incremental Seismic Rehabilitation of School Buildings (K-12), FEMA 395*
- *Incremental Seismic Rehabilitation of Hospital Buildings, FEMA 396*
- *Incremental Seismic Rehabilitation of Office Buildings, FEMA 397*
- *Incremental Seismic Rehabilitation of Multifamily Apartment Buildings, FEMA 398*
- *Incremental Seismic Rehabilitation of Retail Buildings, FEMA 399*
- *Incremental Seismic Rehabilitation of Hotel and Motel Buildings, FEMA 400*
- *Incremental Seismic Rehabilitation of Storage Buildings, FEMA 401*
- *Incremental Seismic Rehabilitation of Emergency Buildings, FEMA 402*

Each manual in this set addresses the specific needs and practices of a particular category of buildings and owners, and guides building owners and managers through a process that will reduce earthquake risk in their building inventory. The manuals answer the question, as specifically as possible: “What is the most affordable, least disruptive, and most effective way to reduce seismic risk in existing buildings?” By using the process outlined in these manuals, building owners and managers will become knowledgeable clients for implementing incremental seismic rehabilitation specifically geared to their building use category.

In addition to this set of manuals, there is a companion manual, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420. It is intended to assist architects and engineers who provide services to building owners and contains the information necessary for providing consulting services to owners for implementing incremental seismic rehabilitation. Architects and engineers using that handbook will be effective consultants serving a knowledgeable owner. Together they will be in a position to implement an effective incremental seismic rehabilitation program.

## You may be liable for earthquake deaths and injuries in your older hospital buildings.

The 1933 Long Beach, California, Earthquake destroyed at least 70 schools and damaged 420 more, 120 of them seriously. As a direct response, California enacted the Field Act, which established strict design and construction standards for new schools in California. But what about all the existing schools that were vulnerable to earthquakes? It took over 30 years to solve this problem, but more than just the passage of time was required.

In 1966 the Attorney General of California issued an opinion indicating that school boards were responsible for ensuring non-Field Act buildings were examined, and if schools were found to be unsafe and the board did not make the necessary corrections to make them safe, **the individual school board members were personally liable.** The opinion received widespread media attention. School boards, then realizing the gravity of the situation, became quite concerned about the structural condition of their pre-Field Act public school buildings. Legislative action soon followed. The Governor signed the Greene Act in 1967, which relieved the individual school board members of personal liability *only once the board initiated the process of examining existing buildings and established an intent to carry through to completion all the steps necessary for their replacement or repair.*

This responsibility may apply to hospital building owners as well. You too may be liable for earthquake deaths and injuries in your older buildings, but can you wait 30 years to act? This manual provides you with the tools to assess your vulnerability and to find cost-effective ways to reduce your liability today.

# Introduction

## *Hospitals, Risk, and Liability*

Healthcare organizations face a wide array of risks. These risks range from malpractice to fire. Risk management for hospitals typically is driven by experience; we recognize the need for professional malpractice insurance and for sanitary precautions in food services, but the risk of catastrophic loss due to a damaging earthquake is more difficult to understand or to anticipate. Earthquakes are low-probability high-consequence events. Though they may occur only once in the life of a building, they can have devastating, irreversible consequences.

Moderate earthquakes occur more frequently than major earthquakes. Nonetheless, moderate earthquakes can cause serious damage to building contents and nonstructural building systems, serious injury to occupants and staff, and disruption of building operations. Major earthquakes can cause catastrophic damage including structural collapse and massive loss of life. Those responsible for hospital safety must understand and manage these risks, particularly risks that threaten the lives of patients, doctors, nurses, and staff.

Earthquake risk is the product of hazard exposure and building vulnerability, as shown in the following equation:

$$\text{RISK} = \text{HAZARD} \times \text{VULNERABILITY}$$

To manage earthquake risk in existing hospital buildings, one must understand the earthquake hazard and reduce building vulnerability.

This manual is designed to give decision makers the framework and information for making in-

formed decisions about investing in earthquake risk management measures. It is structured to follow the decision making process of existing planning and management practices and will help you evaluate financial, safety, and healthcare priorities.

Healthcare organizations may vary greatly in size, wealth, and technical capability. Nevertheless, they are all government regulated and subject to accreditation, and have, as a result, comprehensive long-term facility management, maintenance, and development plans. The successful implementation of improved earthquake safety should be part of a comprehensive approach to building safety and multi-hazard mitigation.

Failure to address earthquake risk leaves the healthcare organization exposed to potential losses, disruption, and liability for deaths and injuries. While purchasing insurance may protect the organization from financial losses and liability, it still leaves it susceptible to disruption as well as deaths and injuries. Only building rehabilitation can reduce losses, deaths, and injuries, as well as control liability and disruption. However, single-stage seismic rehabilitation can be expensive and disruptive. Incremental seismic rehabilitation can reduce that cost and disruption.

### ***Considering Incremental Seismic Rehabilitation***

The incremental rehabilitation approach to seismic risk mitigation focuses on improvements that will decrease the vulnerability of hospital buildings to earthquakes at the most appropriate and convenient times in the life cycle of those buildings. The approach clarifies, as specifically as possible, what is the most affordable, least disruptive, and most effective way to reduce seismic risk in your buildings.

Prior to initiating a program of incremental seismic rehabilitation, a healthcare organization must first address the following three questions:

- Are your hospital buildings located in a seismic zone?
- Are these buildings vulnerable to earthquakes?
- What can you do to reduce earthquake risk in existing vulnerable buildings?

This manual will help you find the right answers.

## How to Use This Manual

**Critical Decisions:** Healthcare organization senior executives, board members, hospital directors, and similar policy makers should read Part A. Section A.1 provides a general understanding of the earthquake hazard faced by a healthcare organization. Section A.2 provides an overview of how the seismic vulnerability of hospital buildings and resultant losses can be estimated. Section A.3 provides an overview of the actions a healthcare organization can take to reduce earthquake risk, including incremental seismic rehabilitation. Section A.4 details how to implement the concept of incremental seismic rehabilitation, including the additional benefits of integrating incremental seismic rehabilitation with other maintenance and capital improvement projects. **By understanding these four sections, the healthcare organization's top management can establish a policy of seismic risk reduction and initiate a more specific, objective, and cost-effective program of incremental seismic rehabilitation by its technical staff.**

**Program Development:** Those responsible for a healthcare organization's facility, risk, and financial management should read Parts A and B, paying particular attention to Part B. Sections B.1 through B.3 provide detailed guidance on **how the initiation of a program of incremental seismic rehabilitation can fit into the ongoing facility management process** used by the healthcare organization, and indicates specific activities you can undertake. A separate Appendix, Additional Information on Hospital Facility Management, is provided at the end of this manual for those seeking more information on hospital facility management. It contains a discussion of the specific phases of the facility management process and activities for healthcare administrators seeking further detail.

**Project Implementation:** Healthcare organization and hospital facility managers should read Part C in addition to Parts A and B. Section C.1 provides guidance on using the consulting services of architects and engineers in implementing a program of incremental seismic rehabilitation. Section C.2 discusses specific opportunities for **combining increments of seismic rehabilitation with other maintenance and capital improvement projects**. A companion manual for design professionals has been developed to provide technical guidance for the detailed design of specific rehabilitation projects.

For Healthcare  
Organization Senior  
Executives, Board  
Members & Hospital  
Directors

Part

# Critical Decisions for Earthquake Safety in Hospitals

## A.1 Is There an Earthquake Hazard for Your Hospitals?

*Earthquakes are one of the most serious natural hazards to which healthcare organizations may be exposed. Although hospital administrators face a variety of risks to occupant safety and operations that may appear more immediate, the consequences of earthquakes can be catastrophic. Therefore, despite the fact that earthquake occurrences are rare, earthquake safety should be given full consideration in design and investment for risk management and safety.*

The first step to understanding earthquake risk:

$$\text{RISK} = \text{HAZARD} \times \text{VULNERABILITY}$$

is to learn the **likelihood and severity** of an earthquake affecting your buildings.

### **The Earthquake Hazard: Where, When, and How Big**

The surface of the earth consists of solid masses, called tectonic plates, that float on a liquid core. The areas where separate plates meet each other are called faults. Most earthquakes result from the movement of tectonic plates, and seismic hazard is strongly correlated to known faults. A map of zones of seismic hazard for the United States, based on maps provided by the U.S.

### In Brief

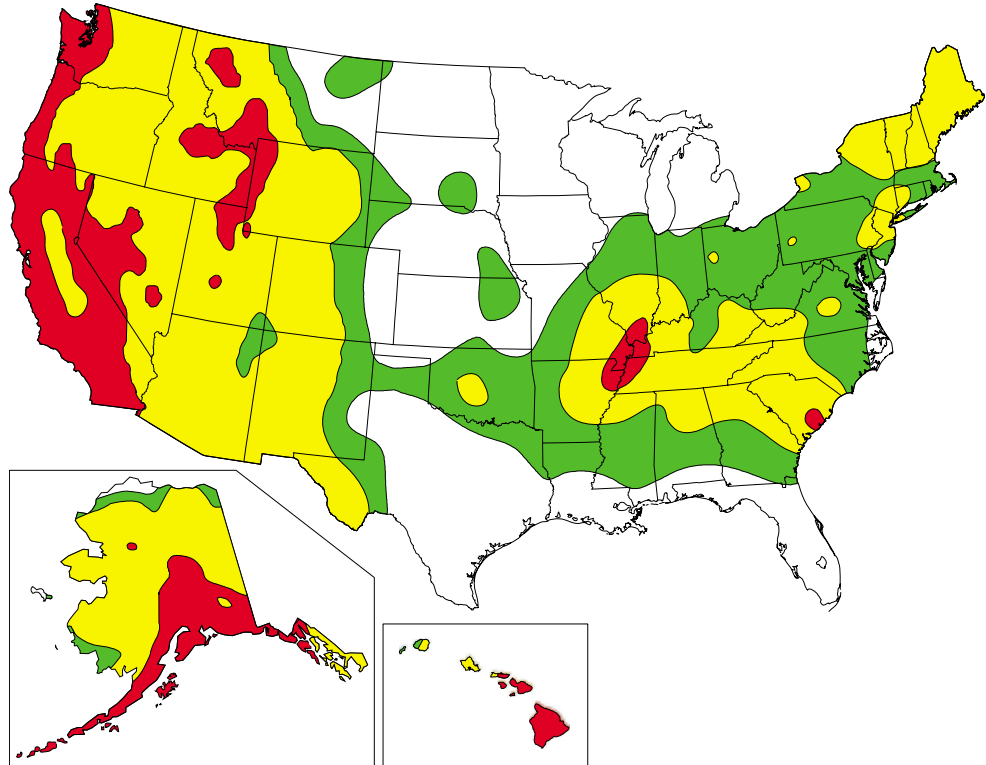
- Geographic location is the most significant factor of seismic hazard.
- Soil conditions at a particular site also influence the seismic hazard.



### Seismic Hazard Map

Geological Survey (USGS), shows three zones from the lowest, green, to the highest, red. The white areas have negligible seismic hazard.

The USGS earthquake hazard map is based on a complex assessment of expected seismic activity associated with recognized faults. The scientific understanding of earthquakes continues to improve and has resulted in increased estimates of seismic hazard in various parts of the country over the last decade.



Hospital administrators responsible for the safety of patients, doctors, nurses, and staff need to know whether to be concerned about earthquakes. Some guidelines for determining earthquake risk in your location are:

#### ■ If your hospital is located in a red zone on the map

Earthquakes are one of the most significant risks facing your facilities.

- Take immediate action to undertake comprehensive vulnerability assessment. Professional structural engineers should perform this assessment.
- Identify and either replace or rehabilitate vulnerable existing buildings as soon as possible.

#### ■ If your hospital is located in a yellow zone

The probability of severe earthquake occurrence is sufficiently high to demand systematic investigation of your buildings.

- Assign responsibility for investigation to the risk managers and facility managers within the organization. If they are not available, seek professional engineering assistance from outside.
- Identify vulnerable buildings and schedule them for replacement, rehabilitation, or change of use.

- Also consider mitigation of nonstructural hazards, such as securing equipment and suspended lighting that could injure building occupants in an earthquake.

### ■ If your hospital is located in a green zone

- Consider low-cost mitigation strategies that protect building occupants and your investment in facilities and systems, even though the probability of an earthquake is low.

Beyond this broad seismic zone designation, expected earthquake ground motion at a particular location is further influenced by local geology and soil conditions. Geotechnical engineering studies should be done to understand fully the earthquake hazard at a particular site in red and yellow zones.

## A.2 Are Your Hospital Buildings Safe?

The second step to understanding earthquake risk:

$$\text{RISK} = \text{HAZARD} \times \text{VULNERABILITY}$$

is to learn the **expected damage and losses** that could result from an earthquake.

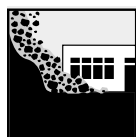
### What Happens to Hospital Buildings in Earthquakes

Earthquake fault rupture causes ground motion over a wide area. This ground motion acts as a powerful force on buildings. Buildings are principally designed to resist the force of gravity, but resistance to earthquake forces requires specialized earthquake engineering. Horizontal earthquake forces cause rapid movement of the foundation and displacement of upper levels of the structure. When inadequately designed to resist or accommodate these earthquake forces, structures fail, leading to serious structural damage and, in the worst case, total building collapse.

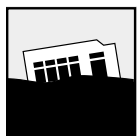
In addition to ground motion, buildings may suffer earthquake damage from the following effects:



Fault rupture under or near the building, often occurring in buildings located close to faults.



Earthquake-induced landslides near the building.



Reduction of the soil bearing capacity under or near the building.



Earthquake-induced waves in bodies of water near the building (tsunami, on the ocean and seismic seiche<sup>1</sup> on lakes).

### In Brief

- *Seismic vulnerability depends on structural type, age, condition, contents, and use of hospital buildings.*
- *Hazard exposure and building vulnerability may result in substantial death, injury, building and content damage, and serious disruption of healthcare operations.*

<sup>1</sup> A wave on the surface of a lake or landlocked bay caused by atmospheric or seismic disturbances.

### ***Building Age and Earthquake Vulnerability***

The first earthquake design legislation was enacted in 1933 for schools in California (the Field Act). Earthquake design requirements were established for hospitals in California in 1973 (the Alfred E. Alquist Hospital Seismic Safety Act). Since that time, awareness of earthquake risk has expanded across the country, and building codes have been improved because of research and experience. Since the early 1990s, most new hospitals in the United States have been constructed in accordance with modern codes and meet societal standards for safety. However, older hospital buildings should be reexamined in light of current knowledge. Some seismically active parts of the country (the Midwest) have only recently adopted appropriate seismic design standards, and in other parts of the country (the Northwest) estimates of seismic risk have been revised upward. The serious problem resides in existing vulnerable hospital buildings constructed without seismic requirements or designed to obsolete standards. The building code is not retroactive; there is no automatic requirement to bring existing buildings up to current standards. Safety in existing buildings is the responsibility of the owner/operator. That means you!

### ***Estimating Building Vulnerability***

It is possible to estimate roughly the vulnerability of a healthcare organization's portfolio of buildings and to identify problem buildings with a technique called "rapid visual screening." Healthcare organizations can produce generalized estimates of expected damage in the initial seismic risk assessment of its buildings.

Engineers have defined levels of the damage that can be expected in particular types of buildings due to varying intensities of earthquake motion. These levels of damage range from minor damage, such as cracks in walls, to total building collapse. In addition to building type, expected damage is also a function of building age and the state of maintenance. Hospitals suffering from deferred maintenance will experience greater damage than well-maintained hospitals will. For example, failure to maintain masonry parapets significantly increases the possibility of life-threatening failure in even a moderate earthquake.

After initial rapid screening, specific seismic risk assessment for individual hospital buildings requires detailed engineering analysis.

### ***Other Earthquake Losses***

While a serious concern in its own right, building failure is the direct cause of even more important earthquake losses:

- Death and injury of patients, doctors, nurses, and staff
- Destruction of hospital contents and equipment
- Disruption of the delivery of all patient care services, including the capability to provide emergency services in a disaster

The expected extent of these losses can also be estimated based on hazard and vulnerability assessments.

## A.3 What Can Be Done to Reduce Earthquake Risk in Existing Vulnerable Hospital Buildings?

*Failure to address earthquake risk leaves the healthcare organization exposed to potential losses, disruption, and liability for deaths and injuries.*

While purchasing insurance may protect healthcare organizations from financial losses and liability, it still leaves them exposed to disruption as well as deaths and injuries. Only building rehabilitation can reduce losses, deaths, and injuries and control liability and disruption.

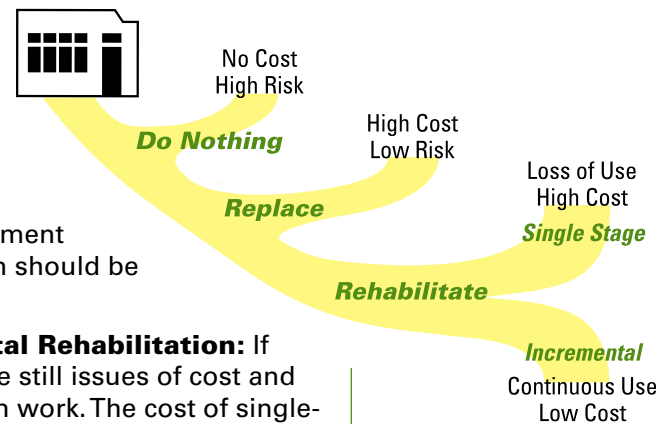
The implementation of seismic risk reduction through building rehabilitation will primarily involve the facility manager. However, to be effective it will require coordination among the facility managers, risk managers, and financial managers. This is further discussed in Part B (for Facility Managers, Risk Managers, and Financial Managers). In addition, it is the responsibility of the healthcare organization's top administrators to make sure that hazards are assessed and risk reduction measures implemented.

### Options for Seismic Risk Reduction

The most important consideration for earthquake safety in hospital buildings is to reduce the risk of catastrophic structural collapse. Most likely in existing vulnerable buildings, structural collapse poses the greatest threat to life in a major earthquake. Choosing the method of protection from structural collapse in a deficient building requires two critical decisions:

**Replace or Rehabilitate:** If you decide to replace a building, new construction is carried out according to modern codes and can be assumed to meet current safety standards. However, financial constraints, historic preservation concerns, and other community interests may make the replacement option infeasible. In that case, rehabilitation should be considered.

**Single-Stage Rehabilitation<sup>2</sup> or Incremental Rehabilitation:** If the rehabilitation option is chosen, there are still issues of cost and disruption associated with the rehabilitation work. The cost of single-stage seismic rehabilitation has proved to be a serious impediment to its implementation by many healthcare organizations. Incremental seismic rehabilitation is specifically designed to address and reduce the problems of cost and disruption.



### Estimating the Costs and Benefits of Seismic Rehabilitation of Existing Hospital Buildings

The direct and indirect costs of seismic rehabilitation of a building are:

- Engineering and design services
- Construction
- Disruption of building operations during construction

<sup>2</sup> Single-stage rehabilitation refers to completing the rehabilitation in a single continuous project.

### In Brief

- Seismic rehabilitation of existing vulnerable hospital buildings can reduce future earthquake damage.
- Incremental seismic rehabilitation is a strategy to reduce the cost of rehabilitation and related disruption of healthcare programs.

## In Brief

- Whereas single-stage seismic rehabilitation of an existing hospital building represents a significant cost, rehabilitation actions can be divided into increments and integrated into normal maintenance and capital improvement projects.
- The implementation of incremental seismic rehabilitation requires assessing the buildings, establishing rehabilitation priorities, and planning integration with other projects.

The benefits of seismic rehabilitation of a building are:

- Reduced risk of death and injury of patients, doctors, nurses, and staff
- Reduced building damage
- Reduced damage of hospital contents and equipment
- Reduced disruption of the delivery of healthcare services

Engineers have developed estimates of the reduction of earthquake damage that can be achieved with seismic rehabilitation following the Federal Emergency Management Agency's (FEMA's) current rehabilitation standards. This type of estimate, however, may significantly undervalue the benefit of seismic rehabilitation. In considering the return on seismic rehabilitation investments, it is appropriate to consider the value of damages avoided as well as the difficult-to-quantify values of deaths, injuries, and disruption of hospital functions avoided.

The primary obstacles to single-stage rehabilitation of vulnerable existing hospital buildings are the cost of rehabilitation construction work and related disruption of hospital functions. Incremental seismic rehabilitation offers opportunities to better manage the costs and reduce disruption of rehabilitation. The following section introduces and explains incremental seismic rehabilitation in more detail.

## A.4 Incremental Seismic Rehabilitation of Existing Hospitals

### Approach

Incremental rehabilitation phases seismic rehabilitation into an ordered series of discrete actions implemented over a period of several years, and whenever feasible, these actions are timed to coincide with regularly scheduled repairs, maintenance, or capital improvements. Such an approach, if carefully planned, engineered, and implemented, will ultimately achieve the full damage reduction benefits of a more costly and disruptive single-stage rehabilitation. Incremental seismic rehabilitation can be initiated in the near-term as a component of planned maintenance and capital improvement with only marginal added cost. Getting started as soon as possible on a program of earthquake safety demonstrates recognition of responsibility for hospital safety and can provide protection from liability.

### Assessment of Deficiencies

A necessary activity that must precede a seismic rehabilitation program, be it single-stage or incremental, is an assessment of the seismic vulnerability of the healthcare organization's building inventory. Facility managers can implement such an assessment using organization staff or outside engineering consultants as appropriate. The assessment should rank the building inventory in terms of seismic vulnerability and identify specific deficiencies. FEMA publishes a number of documents that can guide you through the assessment process. Portions of the assessment activities can be integrated with other ongoing facility management activities such as periodic building inspections. Facility assessments and the FEMA publications available to help you conduct them are discussed in more detail in Part B.

## Rehabilitation Strategy

The incremental seismic rehabilitation program will correct the deficiencies identified by the assessment. The order in which seismic rehabilitation increments are undertaken can be important to their ultimate effectiveness. There are three aspects to prioritizing seismic rehabilitation increments:

**Structural Priority:** An initial prioritization of seismic rehabilitation increments should be established primarily in terms of their respective impact on the overall earthquake resistance of the structure. Facility managers will begin with these priorities when determining the order of seismic rehabilitation increments to be undertaken. However, the final order of increments may deviate from this priority order depending on other planning parameters. Additional engineering analysis may be required for certain building types when deviating from the structural priority order. This subject is discussed in more detail in Part B, Section B.2, and Part C.

**Use Priority:** Healthcare organizations should consider planning alternative future uses of their existing buildings. Some vulnerable hospitals may be scheduled for demolition or changed to non-hospital uses (for example, storage or administration). Others may be scheduled for expansion and intensification of use. These considerations, among others, will influence the prioritization of seismic rehabilitation increments.

**Integration:** A major advantage of the incremental seismic rehabilitation approach is that specific work items can be integrated with other building maintenance or capital improvement projects undertaken routinely. Such integration will reduce the cost of the seismic rehabilitation action by sharing engineering costs, design costs, and some aspects of construction costs. Integration opportunities are a key consideration in adapting the sequence of actions suggested by the foregoing discussions of rehabilitation priorities. Integration opportunities are discussed in more detail in Part C, Section C.2.

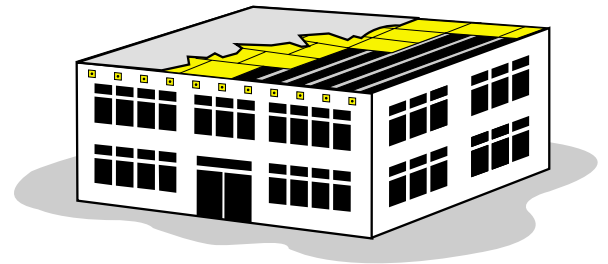
### Incremental Seismic Rehabilitation Plan

An essential feature of implementing incremental seismic rehabilitation in specific hospital buildings is the development and documentation of a seismic rehabilitation plan. The seismic rehabilitation plan will include all the anticipated rehabilitation increments and their prioritization as previously discussed. The documentation will guide the implementation of the incremental seismic rehabilitation program and should ensure that the healthcare organization does not lose sight of overall rehabilitation goals during implementation of individual increments.

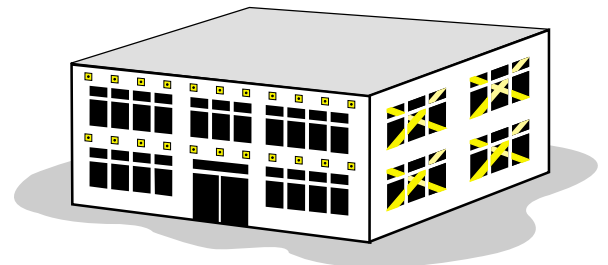
### Recommended Actions

1. Communicate the importance of assessing your organization's risks and pass this manual on to the staff members responsible for facility management, risk management, and financial planning. Specify that they develop an analysis of

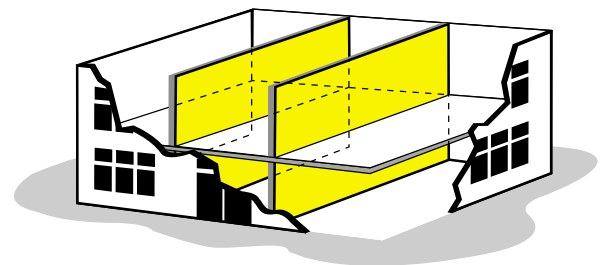
## SCHEMATIC INTEGRATION OPPORTUNITIES



Roof Work



Exterior Wall Work



Interior Work

the current seismic risk of your buildings and a strategy for risk reduction.

2. Promptly initiate a program of earthquake risk reduction in your organization's buildings located in an earthquake-prone zone that were not designed and constructed to meet modern building codes.
3. Consider incremental seismic rehabilitation as a cost-effective means to protect the buildings and, most importantly, the safety of patients, doctors, nurses, and staff, because it is a technically and financially manageable strategy that minimizes disruption of hospital activities.

**For Facility Managers,  
Risk Managers, &  
Financial Managers**

**Part**

# **Planning and Managing the Process for Earthquake Risk Reduction in Existing Hospital Buildings**

## **Introduction**

*Part B of this manual is written specifically for healthcare organization and hospital facility managers, risk managers, and financial managers concerned with the seismic safety of their buildings. The organization's senior management may have requested you, the manager, to make a recommendation to address seismic safety in hospitals or may have made the decision to address it, or there may already be a seismic safety program in place. Part B describes when and how specific activities that will accomplish the goal of seismic risk reduction can be introduced into an ongoing hospital facility management process. Part B also provides the framework and outline that can be used by the facility managers, risk managers, and financial managers in developing and communicating their recommendations to senior management.*

An incremental seismic rehabilitation program is one of several seismic risk reduction strategies that can be implemented in hospital buildings. It can be implemented separately or in combination with other seismic risk reduction actions. If you determine that such a program is appropriate for your organization, the planning and implementation of incremental seismic rehabilita-

## **In Brief**

- Planning for earthquake risk reduction in hospitals requires a coordinated and integrated effort by facility managers, risk managers, and financial managers.
- Ten specific activities can be added to the current facility management process to implement an incremental seismic rehabilitation program.
- Nine additional activities can be added to the facility management process to further reduce seismic risk.
- There are three ways to start reducing seismic risk.



tion should be integrated into the facility management processes and integrated with other seismic risk reduction actions that will complement it or support it.

### ***B.1 Integrating the Efforts of Facility Management, Risk Management, and Financial Management***

Preparing an analysis of a healthcare organization's earthquake risk reduction needs, and planning and managing such a process, benefits from an integrated effort by the organization's facility managers, risk managers, and financial managers, or by the administrators charged with those respective responsibilities. Such an integrated effort may be a departure from current practices, but such collaboration is the key to improving safety cost-effectively and with a minimum of disruption.

Facility managers currently carry out their planning activities by considering the parameters of healthcare delivery programs, medical technology, area demographics, and the physical condition and projected useful life of the existing healthcare facilities. Often they consider pressing social issues such as physical security and equity. Some of these issues become federal or local government mandates, such as asbestos and lead abatement or energy conservation. Sometimes facility managers consider the risks to hospital buildings from natural disasters such as earthquakes or windstorms.

Risk managers, relatively recent additions to many healthcare organizations, carry out their planning activities by considering three aspects: risk identification, risk reduction, and risk transfer. The latter generally involves the purchase of insurance or the contribution to a risk pool. Currently, risks in healthcare organizations are classified into three broad areas: medical risk, employee risk, and facility and environmental risk. While risk managers are keenly aware of the extreme healthcare demands that natural disasters may place on their hospital facilities, rarely do they consider the risks to the facilities and their occupants themselves from these disasters. Rather, they tend to assume that risks from natural disasters are addressed by building codes and similar regulations.

Financial managers currently deal with facilities by controlling and managing maintenance budgets, capital improvement budgets, and insurance budgets. The facility managers and risk managers present the demands on these budgets to the financial managers, but rarely are the potential tradeoffs among these budgets considered. The costs and benefits of various options of facility risk management are rarely explicitly addressed.

Addressing the problem of earthquake risk reduction requires establishing active communication among the three management functions and coordinating activities into an integrated planning and management effort. Facility and risk managers will have to consider facility risk, and financial managers will have to consider the costs and benefits of various options for managing facility risk. Specific recommendations on implementing such an effort are provided in the following sections.

## **B.2 Integrating Incremental Seismic Rehabilitation into the Facility Management Process**

### **B.2.1 A Model of the Facility Management Process for Existing Hospital Buildings**

The typical facility management process for existing hospital buildings consists of seven phases of activities: Acquisition, Current Building Use, Accreditation, Planning, Maintenance & Rehabilitation Budgeting, Maintenance & Rehabilitation Funding, and Maintenance & Rehabilitation Implementation. Each phase consists of a distinct set of activities as follows:

**Acquisition:** due diligence

**Current Use:** facility occupancy, facility operation, facility maintenance, and facility assessment

**Accreditation:** Joint Commission on Accreditation of Healthcare Organizations (JCAHO) or alternate accreditation emergency management planning

**Planning:** strategic planning and facility planning

**Budgeting:** capital budgeting, maintenance budgeting, and insurance budgeting

**Funding:** financing of capital, maintenance, and insurance budgets

**Implementation:** capital improvement and maintenance

This process is sequential, progressing from acquisition through implementation of rehabilitation in any given building. A healthcare organization that has a large inventory of buildings is likely to have ongoing activities in all of these phases in different buildings. The process is illustrated in the following diagram. The Appendix to this manual, Additional Information on Hospital Facility Management, contains a discussion of the specific phases and the activities therein for hospital administrators seeking further detail on the facility management process. This is a generalized model subject to local variation.



### **B.2.2 Elements of an Incremental Seismic Rehabilitation Program**

The following activities are considered essential elements of an incremental seismic rehabilitation program for hospitals:

1. Due Diligence Analysis
2. Seismic Screening
3. Seismic Evaluation
4. Emergency Management Planning for Accreditation
5. Developing a Risk Reduction Policy
6. Seismic Rehabilitation Planning for Specific Buildings
7. Staging Seismic Rehabilitation Increments

*Incremental Seismic Rehabilitation*

*Element 1  
Due Diligence Analysis*

*Incremental Seismic Rehabilitation*

*Element 2  
Seismic Screening*

**Initial Hospital Facility Manager/ Risk Manager Screening of Seismic Concerns**

8. Budget Packaging
9. Bond Packaging
10. Seismic Rehabilitation Project Management

**B.2.2.1 Due Diligence Analysis**

In regions of high and moderate seismicity, due diligence should include a probabilistic analysis of potential earthquake risks. Such an analysis considers damage from earthquakes of all levels of intensity, and will provide information on seismic vulnerabilities in the building. If the building is acquired, the due diligence analysis will provide information for the initiation of a full seismic assessment. Probabilistic analysis, because of its detail and scope, will be more expensive than more simplistic Probable Maximum Loss (PML) analysis.

**B.2.2.2 Seismic Screening**

Following building acquisition, seismic screening of the healthcare organization’s building inventory is the first step of the incremental seismic rehabilitation process. Seismic screening procedures can be incorporated into other facility assessment activities. Begin with a determination of the status of the archival records. If building plans are available, a document review for the determination of building structure types is the first step in seismic screening. The following chart can be used to obtain an overall view of seismic concerns based on the seismic hazard map in Part A.

Level of Seismic Concern by Typical Building Type	Level of Seismic Concern by Building Location*		
	Green	Yellow	Red
Wood Frame		Low	High
Steel Frame		Low	High
Concrete Frame	Very Low	Medium	Very High
Unreinforced Masonry	Low	High	Very High

Patterned after recommendations developed by Dr. Charles Scawthorn for the California Seismic Safety Commission’s *Earthquake Risk Management: A Toolkit for Decision Makers*.

\* Locations refer to the seismic hazard map in Part A, Section A.1.

The Federal Emergency Management Agency (FEMA) has developed FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook, Second Edition*<sup>1</sup> as guidance for seismic screening of an inventory of buildings. It describes a technique for identifying the relatively more vulnerable buildings in a large inventory so that they can be addressed in more detail.

The FEMA 154 publication is nationally applicable and addresses all building types. In some cases, the screening will suggest specific seismic rehabilitation opportunities that do not require additional engineering and risk analyses.

<sup>1</sup> To order this and other FEMA publications, you may write to FEMA, PO Box 2012, Jessup, MD 20794-2012; or you may call 1-800-480-2520, Monday - Friday, 8:00 a.m. - 5:00 p.m., eastern time; or you may fax your request to 301-362-5335.

The incorporation of seismic screening into ongoing facility assessment activities requires assigning the screening to the appropriate inspectors. If inspections are periodically carried out in the healthcare organization's buildings for other purposes such as life safety, insurance, occupational health and safety, or hazardous materials identification, it may be possible to assign the seismic screening to the same inspectors with some additional training. Alternatively, the seismic screening can be assigned to a consulting architect or engineer.

### B.2.2.3 *Seismic Evaluation*

Seismic evaluation is an engineering analysis of individual healthcare buildings. It usually follows the seismic screening, when the buildings identified as relatively more vulnerable are subjected to a more detailed analysis. However, in some cases, such as when the organization's building inventory is small, seismic evaluation of individual buildings may be the first step of the incremental seismic rehabilitation process.

Guidance for seismic evaluation of buildings is contained in standard ASCE 31, *Seismic Evaluation of Existing Buildings*,<sup>2</sup> which is based on FEMA 310, *Handbook for the Seismic Evaluation of Existing Buildings—A Prestandard*. The standard provides engineering guidance on how to evaluate categories of buildings in order to identify deficiencies and determine effective rehabilitation measures.

Seismic evaluation can be done by the healthcare organization's professional staff or by a consulting engineer.

### B.2.2.4 *Emergency Management Planning for Accreditation*

During the Accreditation Phase, seismic screening (B.2.2.2) and seismic evaluation (B.2.2.3) can support and enhance the demonstration of compliance with JCAHO's Environment of Care (EC) standards EC.1.4 and EC.2.4 (amended and expanded in January 2001). The EC standards require hospital, ambulatory care, behavioral health, home care, and long term care organizations to develop and implement a management plan that ensures effective response to emergencies affecting the delivery of healthcare.

The American Society for Healthcare Engineering (ASHE) has developed a tool, entitled *Hazard Vulnerability Analysis*,<sup>3</sup> to help healthcare organizations develop an emergency management plan. It is a simple matrix that lists a variety of hazards, including earthquake, and requires the rating of each in terms of its probability (on a 4-point scale from "none" to "high"), risk (on a 5-point scale from "low disruption" to "life threat"), and preparedness (on a 3-point scale from "poor" to "good"). The values on each scale are multiplied to arrive at a total value for each hazard. The tool instructs: "Determine a value below which no action is necessary. Acceptance of risk is at the discretion of the organization."

Seismic screening and seismic evaluation can add more sophisticated earthquake vulnerability analysis to the emergency management plan required for JCAHO accreditation.

## *Incremental Seismic Rehabilitation*

### *Element 3 Seismic Evaluation*

## *Incremental Seismic Rehabilitation*

### *Element 4 Emergency Management Planning for Accreditation*

<sup>2</sup> ASCE 31 can be obtained from the American Society of Civil Engineers at 1-800-548-2723.

<sup>3</sup> Healthcare Facilities Management Series, Management Monograph #055920, Susan B. McLaughlin, February 2001, ASHE of the American Hospital Association.

**Emergency management plans** are required to address the four phases of emergency management activities:

- Mitigation
- Preparedness
- Response
- Recovery

The official JCAHO newsletter, *Perspectives*, dated December 2001, includes the following definition of an emergency:

“It is a natural or manmade event that suddenly or significantly

- disrupts the environment of care (for example, damage to the organization’s buildings, and grounds due to severe windstorms, tornadoes, hurricanes, or earthquakes);
- disrupts care and treatment (for example, loss of utilities—power, water, telephones—due to floods, civil disturbances, accidents, or emergencies within the organization or in its community); or
- changes or increases demands for the organization’s services (for example, bioterrorist attack, building collapse, or airplane crash in the organization’s community).”

The newsletter continues with the following discussion of mitigation, which is one part of the emergency management plan:

“Mitigation activities lessen the severity and impact of a potential emergency. Mitigation begins by identifying potential emergencies (hazards) that may affect the organization’s operations or the demand for its services, followed by implementing a strategy that supports the perceived areas of vulnerability within the organization.”

#### Incremental Seismic Rehabilitation

##### Element 5

#### Developing a Risk Reduction Policy

##### B.2.2.5 Developing a Risk Reduction Policy

Convince the board of directors to adopt a clear policy statement supporting seismic risk reduction. Such a policy should, at a minimum, establish seismic performance objectives for the healthcare organization’s buildings. Seismic performance objectives define the target performance of a building following an earthquake of a specified intensity. The policy and objectives should be developed and documented as part of the seismic rehabilitation planning process.

#### Incremental Seismic Rehabilitation

##### Element 6

#### Seismic Rehabilitation Planning for Specific Buildings

##### B.2.2.6 Seismic Rehabilitation Planning for Specific Buildings

FEMA has developed engineering guidance to plan seismic rehabilitation for specific buildings, including FEMA 356, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, which includes specific techniques for analyzing and designing effective seismic rehabilitation. The planning task entails four specific facility planning **subtasks**:

- 1. Establish seismic target performance levels.** With cooperation between hospital staff and central administration, establish the performance level desired in each of the healthcare organization’s buildings following an earthquake. Performance levels used in FEMA 356 are, in declining level of protection:
  - Operational
  - Immediate Occupancy
  - Life Safety
  - Collapse Prevention

This is an expansion of the two performance levels, Immediate Occupancy and Life Safety, included in ASCE 31, *Seismic Evaluation of Existing Buildings*.

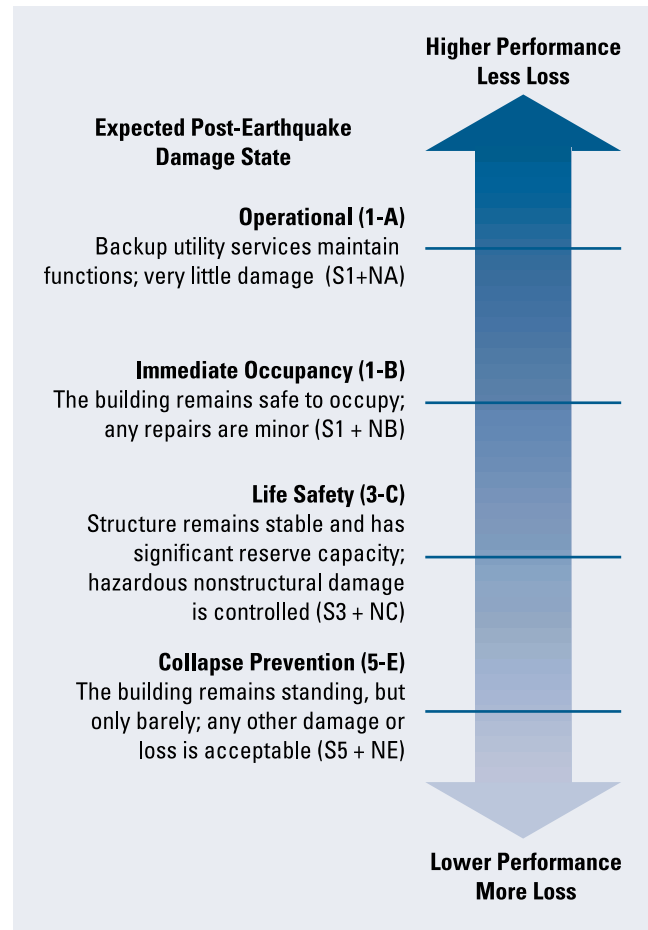
The figures adapted from FEMA 356 on this and the following page demonstrate the use of these performance levels. Reasonable objectives and expectations should be considered for moderate, severe, and rare great earthquakes.

- 2. Prioritize rehabilitation opportunities:** Carry out additional engineering and risk analysis in order to prioritize the seismic rehabilitation opportunities identified in the seismic evaluation in terms of risk reduction. ASCE 31 and FEMA 356 include lists of seismic rehabilitation measures as a function of common building types. Priorities for these measures are established in terms of respective contribution to the overall earthquake resistance of the structure.

Apply a “worst first” approach. Attend to heavily used sections of the most vulnerable buildings housing the greatest number of occupants, as well as to areas housing critical functions and equipment. For example, higher priorities may be given to rehabilitation of hospital areas where patients and staff spend most of their time, and to corridors, stairs and exits, which will facilitate the evacuation of the building in an earthquake.

- 3. Define increments:** Break down the specific seismic rehabilitation opportunities into discrete incremental rehabilitation measures that make sense in engineering and construction terms. When establishing increments, consider scheduling to minimize the disruption to normal hospital operations.
- 4. Integrate with other rehabilitation work:** Link each incremental rehabilitation measure with other related facility maintenance or capital improvement work. The related work classifications may differ from one healthcare organization to another, but will fall into the following generic categories:
- Building envelope improvements
  - Interior space reconfiguration
  - Life safety and accessibility improvements
  - Refinishing and hazardous materials removal
  - Building systems additions, replacements, and repairs
  - Additions to existing buildings
  - Medical technology improvements
  - Patient care improvements

## Target Building Performance Levels and Ranges



Adapted from FEMA 356, Figure C1-2

### Damage Control and Building Performance Levels

Target Building Performance Levels				
Lower Performance More Loss		Higher Performance Less Loss		
Overall Damage	Collapse Prevention Level (5-E)	Life Safety Level (3-C)	Immediate Occupancy Level (1-B)	Operational Level (1-A)
	Severe	Moderate	Light	Very Light
<b>General</b>	Little residual stiffness and strength, but load-bearing columns and walls function. Large permanent drifts. Some exits blocked. Infills and unbraced parapets failed or at incipient failure. Building is near collapse.	Some residual strength and stiffness left in all stories. Gravity-load-bearing elements function. No out-of-plane failure of walls or tipping of parapets. Some permanent drift. Damage to partitions. Building may be beyond economical repair	No permanent drift. Structure substantially retains original strength and stiffness. Minor cracking of facades, partitions, and ceilings as well as structural elements. Elevators can be restarted. Fire protection operable.	No permanent drift. Structure substantially retains original strength and stiffness. Minor cracking of facades, partitions, and ceilings as well as structural elements. All systems important to normal operations are functional.
<b>Nonstructural Components</b>	Extensive damage.	Falling hazards mitigated but many architectural, mechanical, and electrical systems are damaged	Equipment and contents are generally secure, but may not be operable due to mechanical failure or lack of utilities.	Negligible damage occurs. Power and other utilities are available, possibly from standby sources.
<b>Comparison with performance intended for buildings designed under the NEHRP Provisions for the Design Earthquake</b>	Significantly more damage and greater risk.	Somewhat more damage and slightly higher risk.	Less damage and lower risk.	Much less damage and lower risk.

Adapted from FEMA 356, Table C1-2

Opportunities for project integration are listed in Part C, Section 2 of this manual. Some examples of the opportunities you can use to link projects are: when accessing concealed areas, when removing finishes and exposing structural elements, when performing work in a common location, when sharing scaffolding and construction equipment, and when sharing contractors and work force.

The four subtasks described above form an iterative process. The definition and related cost estimation of increments, as well as the integration with other maintenance and capital improvement projects (subtasks 3 and 4), may lead to a revision of target performance levels (subtask 1) or to specific analysis carried out as part of subtask 2.

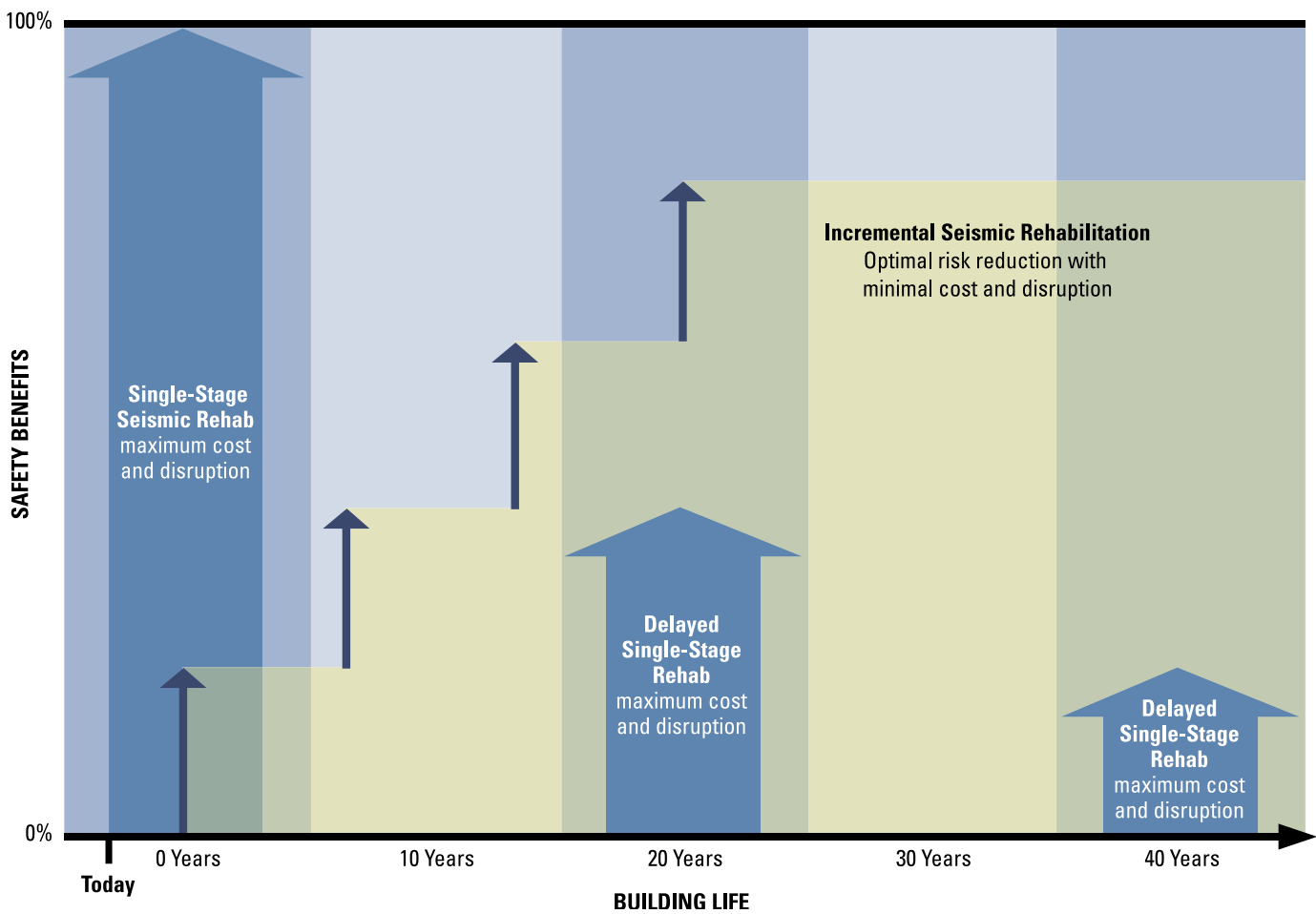
**B.2.2.7 Staging Seismic Rehabilitation Increments**

Determine the number and scope of incremental stages that will be undertaken and the length of time over which the entire rehabilitation strategy will be implemented.

Estimates of seismic damage can be quantified in terms of percentage of building value damaged. Annual seismic damage is calculated as the probable damage that can result in any year from all possible earthquakes. The benefits of seismic rehabilitation are quantified as the reduction in annual seismic damage resulting from specific rehabilitation actions (also quantified in terms of percentage of building value). A generalized life-cycle benefit analysis shows that incremental approaches can return a substantial portion of the expected benefits of single-stage seismic rehabilitation carried out now.

*Incremental Seismic Rehabilitation*

*Element 7*  
**Staging Seismic Rehabilitation Increments**



The schematic diagram above illustrates such a life-cycle benefit analysis. The three wide arrows represent the benefits of single-stage rehabilitation occurring at three points in time: now, in 20 years, and in 40 years. Clearly, the largest benefit derives from a single-stage rehabilitation done now, and it is designated as 100%. The benefits of single-stage rehabilitation done in the future must be discounted and expressed as some percentage lower than 100%, as represented by the decreased arrows. The stepped portion of the diagram represents incremental rehabilitation starting soon and completed in four increments over 20 years. The benefits of the future incre-



ments must also be discounted, and the benefit of the completed incremental rehabilitation is therefore expressed as a percentage lower than 100%, but higher than the single-stage rehabilitation in year 20. Reducing the overall duration of the incremental rehabilitation will increase its benefit, and extending the duration will decrease it.

Incremental seismic rehabilitation affords great flexibility in the sequence and timing of actions when the following precautions are kept in mind:

- It is important to get started as soon as possible. Any early reduction of risk will provide benefit over the remaining life of the building. Delaying action extends risk exposure. The incremental approach can be more effective than a delayed, single-stage rehabilitation, as long as one gets started soon.
- Even if the completion of the incremental program takes 10 or 20 years, most of the risk reduction benefit is realized.
- There is a wide margin of error. For example, you may unintentionally increase the probability of damage in the first few years due to an initial rehabilitation increment that inadvertently makes the building more vulnerable to damage, and still realize the benefit of risk reduction if you complete the incremental rehabilitation over a reasonable period.

### *Incremental Seismic Rehabilitation*

#### *Element 8 Budget Packaging*

#### *B.2.2.8 Budget Packaging*

The hospital directors and facility managers should carefully plan how to present the incremental seismic rehabilitation budgets, given the political and financial realities of the healthcare organization, and Medicare's depreciation schedules.

The facility capital improvements and maintenance budget proposals, generated both locally at the facility and centrally at organization headquarters, are results of the facility planning process. The budget, however, is also a vehicle for establishing funding priorities, through a board decision, a bond issue, or other process. It is unlikely for healthcare organizations in most parts of the United States to be able to raise funds for a comprehensive seismic rehabilitation program of all their hospitals. While the incremental rehabilitation approach appears to be a viable alternative, in some organizations it may be necessary to "package" incremental seismic rehabilitation with other work in order to get it funded.

In regions of moderate seismicity and low seismic awareness (parts of New York and New England, for example), it may be useful to concentrate on rehabilitation measures that also reduce the risk of loss due to other natural or man-made forces, such as high winds or terrorist attack. Such a multi-hazard approach will help justify mitigation investments.

For those parts of the country where the understanding of earthquake risk is limited, it may be necessary and appropriate to combine seismic rehabilitation costs with normal maintenance budgets.

#### *B.2.2.9 Bond Packaging*

Since a bond issue is one of the three financing mechanisms for seismic rehabilitation (in addition to revenue and interest income), one must ensure that bond-financed incremental seismic rehabilitation does not include categories of work precluded by law or regulation.

### *Incremental Seismic Rehabilitation*

#### *Element 9 Bond Packaging*

Experience with bond-financed incremental seismic rehabilitation has been limited to school districts, and the most extensive is that of the Seattle Public Schools program. Seattle’s experience may be of interest to some office building owners. Seattle Public Schools used two types of bonds to fund its program. Capital Levy Bonds were used to fund projects with smaller seismic rehabilitation increments categorized as repair and major maintenance. Capital Improvement Bonds were used to fund major projects categorized as modernization of hazardous buildings. This distinction was necessary because of Washington state law. Similar distinctions may be required in other parts of the country.

**B.2.2.10 Seismic Rehabilitation Project Management**

The implementation of the selected incremental seismic rehabilitation measures in combination with other building work may require added attention to project design and bid packaging.

- Fully brief or train in-house architects/engineers or outside consultants preparing the bid documents on the rationale behind the rehabilitation measures, in order to assure that the seismic risk reduction objectives are achieved.
- Ensure the continuity of building documentation from the analysis and design stages through construction and as-built drawings.
- Conduct a pre-bid conference to fully explain to all prospective bidders the seismic risk reduction objectives and the rationale for their selection.

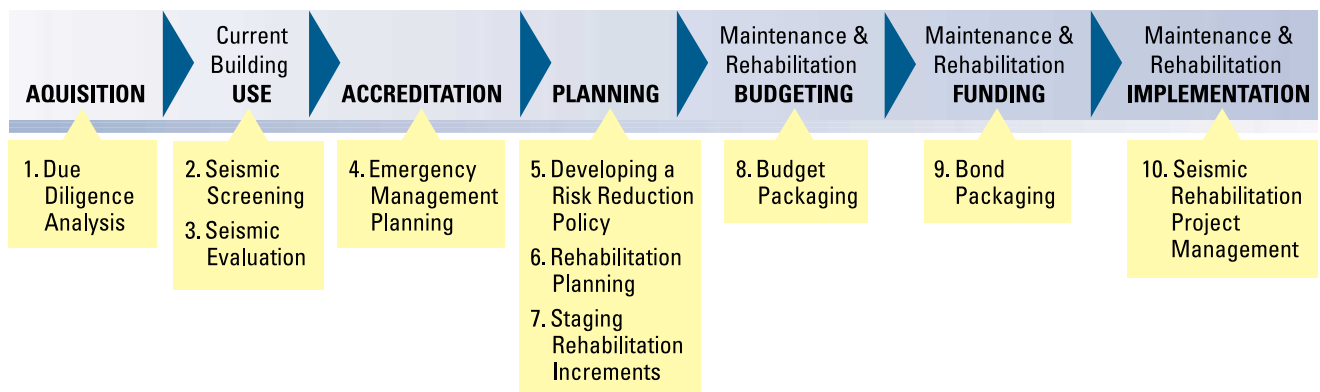
Federal and state mandates and programs represent opportunities for seismic rehabilitation. Externally, federal and state programs may establish requirements affecting the implementation phase that have implications for healthcare facilities (e.g., Americans with Disabilities Act [ADA] and Occupational Safety and Health Administration [OSHA] requirements). Additionally, governmental funding programs may mandate facility requirements, such as energy conservation, in participating healthcare organizations. However, there are currently no seismic rehabilitation mandates or implications in any federal or state programs related to non-federal hospitals outside of California.

**B.2.3 Integration into the Hospitals Facility Management Process**

The following diagram illustrates the integration of the 10 elements discussed in the preceding sections (B.2.2.1 through B.2.2.10) into the healthcare facility management process. The elements are shown in the phase of the management process in which they are most likely to be implemented.

*Incremental Seismic Rehabilitation*

*Element 10  
Seismic Rehabilitation Project Management*



### ***B.3 Opportunities for Seismic Risk Reduction in Support of Integrating Incremental Seismic Rehabilitation into the Facility Management Process***

The following nine opportunities for seismic risk reduction will support the integration of an incremental seismic rehabilitation program:

1. Responding to Occupant Concerns
2. Emergency Management/Response Planning
3. Emergency Management/Mitigation Planning
4. Developing a Risk Reduction Policy
5. Incorporating Federal and State Mandates and Programs
6. Coordinating with Risk and Insurance Managers
7. Becoming Familiar with Applicable Codes
8. Establishing and Maintaining a Roster of Design Professionals
9. Negotiating Code Enforcement

These opportunities are created by internal and external factors that typically influence the healthcare facility management process. Internal factors are generated within the healthcare organization and its administration. External factors are imposed on organizations by outside pressures, such as the government, insurance regulations and practices, or the financial climate. The following factors may influence each respective phase:

**Acquisition:** internally generated purchase forms that guide purchase decisions

**Current Use:** external state licensure, health insurance, property and liability insurance, federal and state programs, and emergency management and internal occupant concerns

**Accreditation:** external accreditation procedures

**Planning:** internal board policies, and external government mandates and health insurance requirements

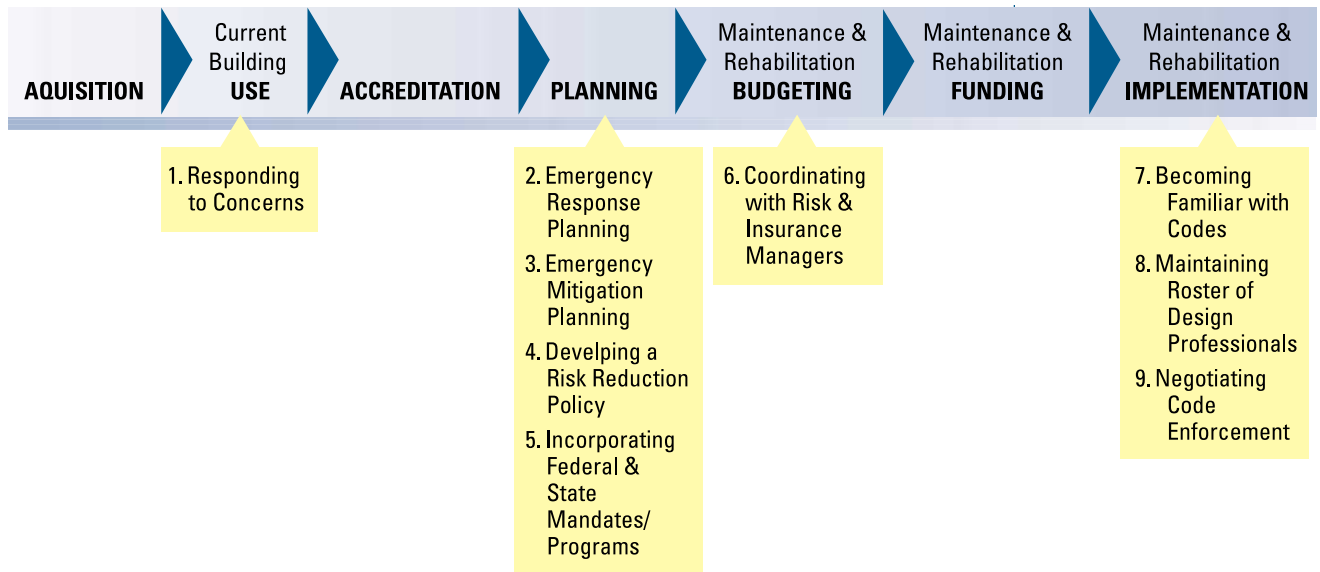
**Budgeting:** internal budgetary constraints and risk management

**Funding:** external economic conditions, federal and state programs, and bond financing regulations

**Implementation:** external federal and state mandates and programs, codes and code enforcement

The Appendix to this manual, *Additional Information on Hospital Facility Management*, contains a discussion of the specific phases and the related internal and external influences for those seeking more information on the facility management process.

The following diagram illustrates the integration of these opportunities into the hospital facility management process. The opportunities are shown in the phase of the management process in which they are most likely to be implemented. Each opportunity is discussed in detail in the following sections (B.3.1 through B.3.9).



### **B.3.1 Responding to Occupant Concerns**

Track all staff and patient concerns that relate to earthquake vulnerability, and make sure they are understood and considered in the **planning** phase.

Be alert to occupant concerns, especially the safety concerns of the staff. They can be a source of considerable influence on risk managers as well as a potentially significant pressure on the facility management process. Occupant concerns may become the vehicle for channeling internal pressures of all kinds, including policies adopted by the Board, into capital improvements and maintenance actions.

### **B.3.2 Emergency Management/Response Planning**

Establish a liaison with emergency management agencies and volunteer agencies, such as the Red Cross.

State or local emergency management agencies usually assign specific roles that specific hospital buildings must perform in case of natural and manmade disasters, including earthquakes. This may affect the occupancy activities by requiring periodic exercises involving building occupants. Emergency management plans related to the role of hospital facilities in a disaster may be general and broad, or detailed and specific.

Become familiar with the role of regional hospital buildings in the local emergency response plans, and if it is a significant role, become active in the emergency planning process. Define the role in specific detail, assigning exact functions to particular facilities. The role of specific hospital buildings in the local emergency response plans should affect seismic performance objectives and the priority of specific seismic rehabilitation measures. Therefore, there should be full coordination between a healthcare organization's emergency planning and facility planning functions.

Currently there are no seismic rehabilitation mandates or implications in any federal or state programs related to existing hospitals outside of California. In California, healthcare systems are subject to Senate Bill 1953 (SB1953) that has established three interim milestone dates (January 1, 2002; January 1, 2008; and January 1, 2030) for progressively bringing all hospital buildings into full seismic compliance with California Building Codes by January 1, 2030.

### ***B.3.3 Emergency Management/Mitigation Planning***

Establish a liaison with emergency management mitigation planners at the state and local levels.

Endeavor to incorporate the hospital building earthquake mitigation into the state's mitigation plan, and to recognize the healthcare organization's incremental seismic rehabilitation measures as elements of the mitigation plan.

Federal resources and funds are available to states for the support of disaster mitigation planning activities. Federal matching funds may be available for the implementation of mitigation following a presidentially declared disaster. These resources are available through the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 100-707). Healthcare organizations should make every effort to obtain these resources.

### ***B.3.4 Developing a Risk Reduction Policy***

Convince the board of directors to adopt a clear policy statement supporting seismic risk reduction. Such a policy should, at a minimum, establish seismic performance objectives for the healthcare organization's buildings. Seismic performance objectives define the target performance of a building following an earthquake of a specified intensity. The policy and objectives should be developed and documented as part of the seismic rehabilitation planning process.

### ***B.3.5 Incorporating Federal and State Mandates and Programs***

Become familiar with the seismic rehabilitation requirements imposed on the healthcare organization's hospitals by federal and state programs, currently or under discussion for the future, and take them into account in planning activities.

### ***B.3.6 Coordinating with Risk and Insurance Managers***

Establish coordination between the facility management and risk management functions in the healthcare organization.

The healthcare organization's risk and insurance management may have a direct or indirect role in the budgeting phase of the facility management process with regard to decisions related to insurance as well as other budget categories.

In areas of seismic risk, the risk of building loss or damage, the risk of occupant death or injury, and the risk of healthcare organization liability must all be assessed. The decision of whether to seek earthquake property and casualty insurance coverage and general liability coverage must be made. Insurance companies that offer such coverage do not usually offer incentives to customers to undertake loss reduction measures in the form of seismic rehabilitation. However, this situation might change, and the question may be subject to negotiation with some companies. Insurance carriers are more than willing, when asked, to provide building owners with Loss Control and Prevention Reports that include recommendations for loss prevention.

The organization's risk manager should be fully informed on individual hospitals' approaches to seismic risk reduction, and should be a participant in the planning process. This may entail the establishment of new communication lines between central organization staff and local hospital staff.

If seismic risk is covered by the organization's insurance carrier or by an insurance pool, it may be possible to negotiate a rate reduction, deductible reduction, or increased maximum benefit. On the other hand, the insurer may require some seismic rehabilitation as a condition of coverage. Additionally, a regional or statewide risk and insurance pool in which an organization may participate could become an active participant in its facilities assessment and planning processes.

### ***B.3.7 Becoming Familiar with Applicable Codes***

Become familiar with the seismic rehabilitation requirements imposed in your building inventory's jurisdictions by building codes or other codes and ordinances, currently or under discussion for the future such as rehabilitation codes, and take them into account in planning activities.

### ***B.3.8 Establishing and Maintaining a Roster of Design Professionals***

Develop and maintain a roster of architects, engineers, and other consultants with expertise in the fields of seismic assessment of buildings, seismic design, and risk analysis to quickly make use of their specialized expertise when needed. Such qualified professionals can be identified with the assistance of professional societies such as the American Society of Civil Engineers, the American Institute of Architects, or the Earthquake Engineering Research Institute.

### ***B.3.9 Negotiating Code Enforcement***

Discuss the organization's planned incremental seismic rehabilitation actions with the applicable code enforcement authorities.

Building codes impose requirements on the implementation phase in cases of repair, alteration, or addition to existing buildings. These requirements may be enforced by a state or local agency. Such requirements can add costs to a project and jeopardize feasibility if not taken into account.

Although additions must comply with building code seismic requirements, few codes mandate seismic rehabilitation in repair and alteration projects. Incremental seismic rehabilitation is consistent with most building code requirements applicable to existing buildings.

If applicable, negotiate with code enforcement authorities an optimization of life safety and risk reduction when undertaking seismic rehabilitation. Some code enforcement agencies negotiate required life safety and other improvements with owners of existing buildings who undertake voluntary building rehabilitation. Such negotiations attempt to strike a compromise between safety, feasibility, and affordability.

## **B.4 Preparing a Plan for the CEO and the Board**

This section provides guidance to healthcare facility managers, risk managers, and financial managers when preparing a proposal for a seismic safety program in response to top management's request.

### **B.4.1 Getting Started**

The facility, risk, and financial managers of the healthcare organization should prepare a proposal for a seismic risk reduction program. This proposal should be based on an analysis of each of the elements of an incremental seismic rehabilitation program (B.2.2) and opportunities for seismic risk reduction (B.3) as discussed above, and additional components (B.5) discussed below. The proposal should include the following elements:

- A discussion of each recommendation in Part B from the perspective of the organization's current facility management, risk management, and financial management practices. This may take the form of a comprehensive rewriting of Part B.
- A specific plan and recommendation for initiating the first two steps following building acquisition, **Seismic Screening** and **Seismic Evaluation**. The plan should include a budget and schedule of activities.
- A request for the budget for these first steps.

### **B.4.2 Getting Started Plus**

If the necessary resources are available to the facility manager, perform a rapid visual screening, as outlined in B.2.2.2, prior to preparing the program proposal. Then, expand the proposal based on the known inventory of potentially vulnerable buildings as determined in the screening process.

### **B.4.3 Getting Started with a Jump Start**

If the organization has a current 5-year capital improvement plan or its equivalent, add the following details to the proposal discussed above:

- Identify existing buildings currently included for rehabilitation in the current 5-year plan.
- Perform a preliminary review of their seismic vulnerabilities, as outlined in B.2.2.2.
- Using Part C of this manual, identify potential seismic rehabilitation increments that could be integrated with the rehabilitation program.
- Add a FEMA 356, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, seismic rehabilitation design task to the rehabilitation projects.

## **B.5 Additional Components of a Comprehensive Earthquake Safety Program**

In addition to integrating an incremental seismic rehabilitation program into the hospital facility management process and integrating opportunities to support and implement such a program, there are additional activities that can become part of a comprehensive earthquake safety program for hospitals. These activities can be implemented at any time.

### **B.5.1 Building Contents Mitigation**

Initiate housekeeping or maintenance measures to reduce or eliminate risks from earthquake damage to equipment, furnishings, and unsecured objects in buildings. Work may include such tasks as:

- Fastening laboratory equipment
- Anchoring file cabinets, storage shelves, and other large furnishings
- Restraining objects on shelves
- Securing the storage of hazardous materials such as chemicals

FEMA has developed materials that contain information on contents mitigation. These include FEMA 74, *Reducing the Risk of Nonstructural Earthquake Damage: A Practical Guide*, and FEMA 241, *Identification and Reduction of Nonstructural Earthquake Hazards in Schools*. (While the latter is addressed primarily to schools, it is equally applicable to other facility types.)

### **B.5.2 Earthquake Drills**

Introduce earthquake drills and appropriate earthquake preparedness materials into the regular hospital emergency preparedness program. These drills should address the influx of patients and casualties as well as hospital building failure. Knowing what to do and where to go in an emergency can be critical to life safety in earthquakes.







**For Facility Managers**

**Part**

# **Tools for Implementing Incremental Seismic Rehabilitation in Existing Hospital Buildings**

## ***Introduction***

*A healthcare organization or hospital facility manager charged with the responsibility of implementing a program of incremental seismic rehabilitation may be entering unfamiliar territory. Part C of this manual is intended to provide the facility manager with information and tools regarding building systems maintenance, repair, and rehabilitation that should be of assistance in implementing such a program.*

A program of incremental seismic rehabilitation is likely to be more affordable and less disruptive if specific increments of seismic rehabilitation are integrated with other maintenance and capital improvement projects that would be undertaken regardless of whether or not seismic issues were being addressed.

## ***Guide to Sections C.1 and C.2***

Section C.1, How to Use Engineering Services, provides the facility manager with practical information on the special services offered by seismic rehabilitation professionals. Several essential activities must be carried out by the facility manager in order to successfully implement a program of incremental seismic rehabilitation. (These activities are identified and discussed in Part B of this manual.) Some of these activities may require professional architec-

tural and engineering services that differ from or exceed the traditional services usually retained by healthcare organizations.

Section C.2, *Discovering Integration Opportunities for Incremental Seismic Rehabilitation*, provides the facility manager with a set of tools to link specific increments of seismic rehabilitation with specific maintenance and capital improvement projects. These tools will assist the facility manager in defining appropriate scopes of work for projects that will include incremental seismic rehabilitation actions.

A companion document, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420, provides design professionals with additional technical guidance for the detailed design of specific rehabilitation projects.

## In Brief

■ **Engineering services should be retained for three specific phases: seismic screening and evaluation, incremental seismic rehabilitation planning and design, and construction period support.**

■ **Continuity of building documentation is of special importance.**

## C.1 How to Use Engineering Services

To successfully implement integrated incremental seismic rehabilitation, a healthcare organization or hospital facility manager should retain engineering services for three specific phases:

- Seismic screening and evaluation
- Incremental seismic rehabilitation planning and design
- Construction period support

### *Seismic Screening and Evaluation*

Seismic screening and evaluation of the healthcare organization's building inventory begins with a review of archival drawings and specifications, if available, to determine the types of construction used. This determination is essential for all subsequent phases. If drawings and specifications are not available, this determination must be made on the basis of visual inspection.

Following this review, building inventories should be screened in a process based on FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook, Second Edition*. The goal of the screening is to identify vulnerabilities in the inventory. Buildings that have little or no vulnerability are separated out.

For the buildings identified as vulnerable, the next category of service is a detailed seismic evaluation using ASCE 31, *Seismic Evaluation of Existing Buildings*, which is based on FEMA 310, *Handbook for the Seismic Evaluation of Existing Buildings: A Prestandard*. Smaller healthcare organizations with few buildings may begin with this evaluation, which addresses individual buildings and identifies both structural and nonstructural deficiencies that require rehabilitation. The output of each building evaluation is a list, possibly prioritized, of needed specific rehabilitation actions.

A hospital or healthcare organization may retain the services of a single engineering firm to perform both the screening and evaluation, or it can retain a firm for screening and one or more firms for building evaluation.

### *Incremental Seismic Rehabilitation Planning and Design*

A complete seismic rehabilitation plan covering all the deficiencies identified in the evaluation should be prepared for each building that has been evaluated. This can be done using ASCE 31 and FEMA 356, *Seismic Rehabilitation of Buildings*. However, in incremental seismic rehabilitation the correction of all the deficiencies is not implemented at once, but rather in discrete increments over a period of time. In order to accomplish this, it is necessary to carry out four specific steps:

- Establish target seismic performance levels
- Prioritize seismic rehabilitation opportunities
- Define increments
- Integrate seismic rehabilitation into maintenance and capital improvement programs

Each of these steps is amplified in the discussion of the hospital facility planning phase in Section B.2.

The potential for unintentional weakening of the building as the result of a particular increment should be analyzed carefully and must be avoided. This subject is discussed in more detail in the companion document, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420.

Seismic rehabilitation planning and design may be carried out by the same engineering firm that performed the evaluation, or by a separate firm. Close coordination with the healthcare organization's risk management functions is a prerequisite for the successful implementation of performance objectives and prioritization steps. The definition of increments and integration of activities will also require close coordination with financial managers so as to be consistent with budgeting and funding processes, as discussed in Part B. The contractual agreement covering this work should reflect the fact that some of the work is implemented immediately and some of the work is left to the future.

### **Construction Period Support**

Construction period support for incremental seismic rehabilitation is much the same as for any other construction project. The plans and specifications should be implemented correctly, and all specified quality control measures should be followed. All substitutions or changes should be carefully analyzed by the design professionals in terms of their seismic implications. Particular attention should be paid to the proper bracing and anchorage of nonstructural elements undergoing rehabilitation.

### **Continuity of Building Documentation**

Assuring the continuity of building documentation is of particular importance for incremental seismic rehabilitation. The rehabilitation of each individual building may be staged over a period of several years or decades as discussed in Section B.2. The screening, evaluation, planning, and design may be split among several engineering firms. Institutional memory may disappear as healthcare organization personnel, and even building ownership, changes. It is therefore essential that the hospital facility manager document all aspects and requirements of seismic rehabilitation from the earliest building screening through evaluation, seismic rehabilitation planning, and completion of each increment of seismic rehabilitation, paying special attention to the scheduling of follow-up requirements and actions over time.

### **Fees for Professional Services**

The professional services required to implement incremental seismic rehabilitation, as discussed above, clearly exceed the scope of traditional architectural/engineering design services. An appropriate fee structure for these new services will need to be developed and integrated into the budgeting process.

## In Brief

- Opportunities to add seismic rehabilitation increments exist within most major maintenance and capital improvement activities.
- This section identifies these opportunities.

## C.2 *Discovering Integration Opportunities for Incremental Seismic Rehabilitation*

### *Introduction*

In order to benefit from opportunities to integrate incremental seismic rehabilitation with other maintenance and capital improvement activities, it is useful to discuss these activities as they are typically undertaken in healthcare organizations. Most healthcare organizations are familiar with their particular building inventories and the related patterns of maintenance and capital improvement. A significant parameter of patterns of maintenance and capital improvement is the category of the building in terms of the level of care provided therein. Tertiary care is considered the highest level of care, and includes the full range of technological and specialty care (such as open heart surgery and cancer) in addition to a Level 1 Trauma Center with a list of medical disciplines on site 24 hours per day. Secondary care is provided by a facility such as a 20-bed rural hospital. Primary care is healthcare that can be provided by “your primary care physician,” involving the lowest level of technology (for example, a long-term care facility).

Aggregate national data are of no particular relevance to a given organization, but may be of general interest and are summarized in the sidebar on the opposite page.

### *Categories of Maintenance and Capital Improvement Projects*

Healthcare organizations often categorize maintenance and capital improvement projects in the following ten categories:

1. Patient care improvements
2. New technology accommodation
3. Fire and life safety improvements
4. Roofing maintenance and repair/re-roofing
5. Exterior wall and window maintenance/façade modernization
6. Underfloor and basement maintenance and repair
7. Heating, Ventilating, and Air Conditioning (HVAC) improvements
8. Energy conservation/weatherization/air conditioning
9. Hazardous materials abatement
10. Building additions

These categories reflect groupings of building elements, administrative and funding categories, or other parameters. Some healthcare organizations may use other categorizations of maintenance and capital improvement work. The purpose of this discussion is not to impose any specific categorization of work, but simply to demonstrate the characteristics of a given item of planned work that may make it especially suitable for integration with particular incremental seismic rehabilitation measures. These pairings of seismic rehabilitation measures with other categories of work are referred to in this section as “integration opportunities.” Facility managers using this manual are encouraged to modify the work categories to suit their own practices.

## Work Descriptions and Matrices of Seismic Performance Improvement Opportunities

Nine sections, C.2.1 through C.2.9, provide the facility manager with information used to identify incremental seismic rehabilitation opportunities that can be combined with maintenance and capital improvement projects. The information becomes a tool, a technical framework or basis for action, that can be communicated to the architect or engineer selected to work on any project resulting from an integration opportunity.

These sections present the expanded descriptions of each of the work categories defined above in a consistent format. Each category is described in terms of:

- General description
- Physical description
- Associated incremental rehabilitation work
- Performance of the work
- Special equipment
- Impact on building use

Matrices of possible specific integration opportunities, one matrix for each work category (Tables C-1 through C-6), accompany the descriptions of the first six categories of maintenance and capital improvement projects. These include:

- Patient care improvements
- New technology accommodation
- Fire and life safety improvements
- Roofing maintenance and repair/re-roofing
- Exterior wall and window maintenance/façade modernization
- Underfloor and basement maintenance and repair

The integration opportunities for the next three categories of work are defined by reference to one or more of the six matrices.

Note that “building additions” is a special category of typical capital improvement. Additions, often of parking structures and storage structures, have been made to many hospitals over the course of their useful lives. Many hospital buildings constructed today are planned to accommodate future additions, both horizontally and vertically. Current additions will be designed to meet the seismic requirements of the building code. Additions may also offer opportunities to strengthen an adjacent building or buildings. These opportunities require careful design and analysis, and they are not specifically identified in the integration opportunities matrices (Tables C-1 through C-6). Furthermore, inadequately designed additions, without proper joints or connections to the existing building, could actually cause damage in an earthquake, as different sections of the building pound against each other.

The seismic performance improvements shown in the matrices fall into three categories:

- Indicates improvements that can be implemented when the integration opportunity arises, on the basis of a quick evaluation by a design professional. These types of improvements address

## Generalized Maintenance and Capital Improvement Data

Whitestone Research (a private market research organization) indicates that expenditures for maintenance and repairs over a building’s life exceed replacement costs for most building types and configurations including hospital facilities.

The predominant categories of maintenance and repair activities for general hospitals are, first, mechanical systems, followed by interior construction, plumbing systems, interior finishes, and electrical systems. The only other significant cost repair category is roofing (only for low-rise buildings). All these activities offer opportunities for integration with incremental seismic rehabilitation work.

The timing of the work is also highly predictable. The top 8 years of expense account for about 50% of building replacement. With regularity, years 10, 15, 20, 25, 30, 40, 45, and 50 are the highest expense years, in roughly increasing order, with year 50 incurring about 10.5% of replacement costs for outsourced repair and renovation expenses.

These patterns suggest significant opportunity (and tendency) to implement strategies such as incremental rehabilitation at specific points over the service life of a hospital building. They also imply specific target periods when the strategies could most likely be considered and implemented. Building age becomes a very important characteristic for incremental seismic rehabilitation.

deficiencies that may be identified in an ASCE 31, *Seismic Evaluation of Existing Buildings*, Tier 1 analysis.

- Indicates improvements that can be implemented when the integration opportunity arises and that require engineering design. These types of improvements address deficiencies that may be identified in an ASCE 31 Tier 1 or Tier 2 analysis.
- Indicates improvements that require engineering analysis to determine if they should be implemented when the integration opportunity arises to avoid unintentionally increasing the seismic vulnerability by redistributing loads to weaker elements of the structural system (sequencing requirements).

The absence of any of these symbols in a matrix cell indicates that the improvement in question is not applicable to the particular structural type. The specific placement of each of these symbols (■, □, ☒) or the absence of a symbol is based on professional judgment considering typical construction. However, exceptions leading to changes in these categories may arise in specific buildings.

Integration opportunities for incremental seismic rehabilitation are a function of three levels of seismicity: low, moderate, and high. The definitions of these levels are those used in ASCE 31, *Seismic Evaluation of Existing Buildings*, and FEMA 356, *Seismic Rehabilitation of Buildings*. They include both seismic zonation and soil conditions. The soil conditions at the site may affect the level of seismicity and must be taken into account. For example, soft soil may amplify seismic forces on some buildings. The method for determining the level of seismicity is given in Section 2.5 of ASCE 31. Significantly fewer seismic improvements are recommended for low levels of seismicity than for the higher levels because seismic vulnerability is lower. The seismic improvements recommended for moderate and high levels of seismicity are the same in number, but differ in the details of the improvements to reflect the different magnitudes of seismic loads encountered in the two levels.

Incremental seismic rehabilitation integration opportunities for each category of work are a function of building structure type. This manual uses five broad structural types, selected to be meaningful to hospital facility managers. The materials used for the building's vertical load-resisting system can be used to categorize the following structural types:

- Wood
- Unreinforced masonry
- Reinforced masonry
- Concrete
- Steel

The latter two structural types, concrete and steel, are broken down further into those with wood floors and roofs (flexible diaphragms) and concrete floors and roofs (rigid diaphragms). This breakdown covers an important parameter that determines how lateral loads are distributed to load-resisting elements of the structures. Structures with flexible diaphragms distribute earthquake loads based on proportional or tributary area between shear-resisting elements (shear walls or frames). Flexible diaphragms allow a straightforward analysis of loads in each shear element. Structures with rigid diaphragms distribute earthquake loads based on the relative rigidity of the individual shear-resisting elements. Rotational (twisting) forces may be introduced that must also be resisted by these and other elements. Rigid dia-

phragms require more detailed analysis that may have to be conducted for each increment of the proposed strengthening program.

The facility manager using this section to identify incremental seismic rehabilitation integration opportunities in a particular building should use Sections C.2.1 through C.2.9 and the matrices therein as follows:

- Determine the category of maintenance or capital improvement under consideration, and go to the section that corresponds most closely to that category.
- Determine the level of seismicity applicable to the building by considering the seismic map and the soil conditions, and identify the applicable rows of the matrix.
- Determine which of the seven structural categories most closely fits the building, and identify the applicable column of the matrix.
- List all the nonstructural and structural seismic improvements identified in the matrix column and rows.
- Note the category of each improvement (■, □, or ☒).

The facility manager should present to the architect or engineer the annotated list of all the nonstructural and structural seismic improvements identified for consideration and inclusion in the respective scope of design work. The architect or engineer should design the project using the companion document, *Engineering Guideline for Incremental Seismic Rehabilitation*, FEMA 420, which includes more detailed guidance on incremental seismic design. The architect or engineer designing the incremental seismic rehabilitation program will most likely break down the seven structural type categories into further subcategories, as used in ASCE 31 or FEMA 356. These categories and subcategories are discussed in detail in FEMA 420.

### **Definitions of Seismic Performance Improvements**

The seismic performance improvements, both nonstructural and structural, that are included in the matrices of integration opportunities described in the preceding paragraphs and included in Sections C.2.1 through C.2.6, are all extracted from a generic list of seismic performance improvements. The generic list is presented in Section C.2.10, which includes brief related explanations for each item on the list. The user of this manual can identify specific seismic performance improvements in the respective project category matrices, and may then refer to these definitions for additional explanation of the involved activities.

The generic nonstructural improvements in C.2.10 are numbered from 1 to 22 for ease of reference. The improvements selected from this list for inclusion in each of the matrices in C.2.1 through C.2.6 are presented in the same order and retain their respective number. This explains the occasional skipping of a number when a specific nonstructural improvement is omitted because it is not applicable in the particular matrix.

The generic structural improvements in C.2.10 are arranged in the order of structural subsystems and elements. The improvements selected from this list for inclusion in each of the matrices in C.2.1 through C.2.6 are presented in the same order.



### C.2.1 Patient Care Improvements

**General Description of the Work:** Patient care improvements, in general, are moving in the direction of outpatient care, which involves changes in the character of interior spaces. Remodeling to improve patient care work has the potential to involve any interior or exterior wall or element. This work may involve simple work on a single wall or the entire space reconfiguration of the patient areas in a hospital. The installation of conduit, cables, and wiring to accommodate new communications technology may involve the reconfiguration of concealed spaces under floors, above ceilings, and inside wall cavities and chases located throughout the building.

Patient care improvements in tertiary care hospitals are often generated by reorganization within specific departments. Other improvements may either be included in the long-range strategic plans of the healthcare organization, be required for Joint Commission on Accreditation of Healthcare Organizations (JCAHO) accreditation, or be triggered by federal, state, or health insurance mandates.

**Physical Description of the Work:** This work may include reconfiguration of spaces and creation of new spaces anywhere in the building. Items include:

- Removing walls and ceilings
- Constructing new walls and partitions
- Installing replacement finishes
- Installing ductwork, piping, and communications networks

Access to spaces behind finishes and new wall construction provide various opportunities for seismic rehabilitation work.

**Associated Incremental Seismic Rehabilitation Work:** Incremental seismic rehabilitation associated with this work may include adding or strengthening shear walls and bracing, improving beam/column connections and diaphragm to wall anchorage, and adding or improving bracing and fastening of equipment.

**Performance of the Work:** This work is usually performed by skilled construction personnel employed by either the healthcare organization or a contractor. Usually architectural/engineering (A/E) design is used for major remodeling.

**Special Equipment:** Special equipment required for access to work areas for any seismic rehabilitation construction will typically be available during any remodeling work.

**Impact on Building Use:** Major remodeling will require the space to be vacated during the course of construction. However, some localized patient care improvements may be carried out while the space is occupied.

**Table C-1: Patient Care Improvements**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry <sup>1</sup>		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
3		✓	✓	n/a	n/a	Bracing and Detailing of Sprinkler and Piping	■	■	■	■	■	■	■
4		✓	✓	n/a	n/a	Suspension and Bracing of Lights	■	■	■	■	■	■	■
5		✓	✓	n/a	n/a	Fastening and Bracing of Ceilings	■	■	■	■	■	■	■
6	✓	✓	✓	n/a	n/a	Anchorage and Bracing of Emergency Lighting	■	■	■	■	■	■	■
7		✓	✓	n/a	n/a	Attachment and Bracing of Cabinets and Furnishings	■	■	■	■	■	■	■
8		✓	✓	n/a	n/a	Fastening and Bracing of Equipment (Mechanical and Electrical)	■	■	■	■	■	■	■
9		✓	✓	n/a	n/a	Support and Detailing of Elevators		■	■	■	■	■	■
10	✓	✓	✓	n/a	n/a	Bracing or Reinforcing Masonry Walls at Interior Stairs		■	■	■	■	■	■
11		✓	✓	n/a	n/a	Attachment and Bracing of Large Ductwork	■	■	■	■	■	■	■
13		✓	✓	n/a	n/a	Restraint of Hazardous Materials Containers	■	■	■	■	■	■	■
14		✓	✓	n/a	n/a	Bracing of Interior Partitions (Masonry & Wood)	■	■	■	■	■	■	■
16	✓	✓	✓	n/a	n/a	Glazing Selection and Detailing	■	■	■	■	■	■	■
17		✓	✓	n/a	n/a	Underfloor Bracing of Computer Access Floor	■	■	■	■	■	■	■
20		✓	✓	n/a	n/a	Anchorage of Steel Stud Backup		■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All		Collector and Drag Element Improvement	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Foundation		Anchor Bolts	■						
n/a		✓	✓	Foundation		Cripple Stud Bracing	■						
n/a		✓	✓	Foundation		New Foundations	■						
n/a		✓	✓	Horizontal Elements	Diaphragms	Mezzanine Anchorage and Bracing		■	■	■	■	■	■
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Openings	□	□	□	□		□	
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Re-entrant Corners	□	□	□	□	⊗	□	⊗
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	⊗	■	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Capacity/Stiffness				□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Continuity				□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Connections				□	□	□	□
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Capacity/Stiffness				□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Connection				□	□	□	□
n/a		✓	✓	Vertical Elements	Shear Walls	Capacity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Continuity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Extension of Wood Interior Walls to Roof	■	■	■				
n/a		✓	✓	Vertical Elements	Shear Walls	Lateral Stability		■	■	□	□	□	□
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use. Structural improvements are not numbered, but rather, organized by structural element and sub-system.

- Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional
- Work requiring engineering design.
- ⊗ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof should use the concrete building, concrete diaphragm for options.

### C.2.2 New Technology Accommodation

**General Description of the Work:** New medical technologies usually require more and different space. New technology accommodation work has the potential to involve any interior or exterior wall or element. This category may involve simple work on a single wall or the entire space reconfiguration of a portion of the building such as a surgical suite or a laboratory. The installation of new equipment, ducts, pipes, conduit, cables, and wiring may involve the reconfiguration of concealed spaces under floors, above ceilings, and inside wall cavities and chases located throughout the building.

The new technologies required in tertiary care hospitals are usually so extensive in scope that existing older buildings cannot accommodate them due to inadequate ceiling heights and spatial relationships. In this case, the preferred solution is a building addition, with or without the demolition of part of the existing building. The addition is required to comply with the building code's seismic requirements. Integration opportunities are minimal for the existing portions of the building.

New technology accommodation in secondary and primary care hospitals may be feasible within the existing building.

New technology accommodation is usually a major activity and is included in the long-range strategic plans of the healthcare organization. Frequently this work is in response to changing community healthcare requirements. It may also be triggered by federal, state, or health insurance mandates.

Some codes may also require seismic rehabilitation when a building experiences a significant amount of damage in a disaster such as fire, flood, or earthquake.

**Physical Description of the Work:** This work may include reconfiguration of spaces and creation of new spaces anywhere in the building. Items include:

- Removing walls and ceilings
- Constructing new partitions
- Installing replacement finishes
- Installing ductwork, piping, and communications networks for new technology

Access to spaces behind finishes and new wall construction provide various opportunities for seismic rehabilitation work.

**Associated Incremental Seismic Rehabilitation Work:** Incremental seismic rehabilitation associated with this work may include adding or strengthening shear walls and bracing, improving beam/column connections and diaphragm to wall anchorage, and adding or improving bracing and fastening of equipment.

**Performance of the Work:** This work is usually performed by skilled construction personnel employed by either the healthcare organization or a contractor. Usually A/E design is used for major remodeling.

**Special Equipment:** Special equipment required for access to work areas for any seismic rehabilitation construction will typically be available during any remodeling work.

**Impact on Building Use:** Major remodeling will require the space to be vacated during the course of construction.

**Table C-2: New Technology Accommodation**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry'		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
3		✓	✓	n/a	n/a	Bracing and Detailing of Sprinkler and Piping	■	■	■	■	■	■	■
4		✓	✓	n/a	n/a	Suspension and Bracing of Lights	■	■	■	■	■	■	■
5		✓	✓	n/a	n/a	Fastening and Bracing of Ceilings	■	■	■	■	■	■	■
6	✓	✓	✓	n/a	n/a	Anchorage and Bracing of Emergency Lighting	■	■	■	■	■	■	■
7		✓	✓	n/a	n/a	Attachment and Bracing of Cabinets and Furnishings	■	■	■	■	■	■	■
8		✓	✓	n/a	n/a	Fastening and Bracing of Equipment (Mechanical and Electrical)	■	■	■	■	■	■	■
9		✓	✓	n/a	n/a	Support and Detailing of Elevators		■	■	■	■	■	■
10	✓	✓	✓	n/a	n/a	Bracing or Reinforcing Masonry Walls at Interior Stairs		■	■	■	■	■	■
11		✓	✓	n/a	n/a	Attachment and Bracing of Large Ductwork	■	■	■	■	■	■	■
13		✓	✓	n/a	n/a	Restraint of Hazardous Materials Containers	■	■	■	■	■	■	■
14		✓	✓	n/a	n/a	Bracing of Interior Partitions (Masonry & Wood)	■	■	■	■	■	■	■
16	✓	✓	✓	n/a	n/a	Glazing Selection and Detailing	■	■	■	■	■	■	■
17		✓	✓	n/a	n/a	Underfloor Bracing of Computer Access Floor	■	■	■	■	■	■	■
20		✓	✓	n/a	n/a	Anchorage of Steel Stud Backup		■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All		Collector and Drag Element Improvement	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Foundation		Anchor Bolts	■						
n/a		✓	✓	Foundation		Cripple Stud Bracing	■						
n/a		✓	✓	Foundation		New Foundations	■						
n/a		✓	✓	Horizontal Elements	Diaphragms	Mezzanine Anchorage and Bracing		■	■	■	■	■	■
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Openings	□	□	□	□		□	
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Re-entrant Corners	□	□	□	□	⊗	□	⊗
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	⊗	■	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Capacity/Stiffness			□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Continuity			□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Connections			□	□	□	□	□
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Capacity/Stiffness			□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Connection			□	□	□	□	□
n/a		✓	✓	Vertical Elements	Shear Walls	Capacity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Continuity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Extension of Wood Interior Walls to Roof	■	■	■				
n/a		✓	✓	Vertical Elements	Shear Walls	Lateral Stability		■	■	□	□	□	□
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use.

Structural improvements are not numbered, but rather, organized by structural element and sub-system.

■ Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional.

□ Work requiring engineering design.

⊗ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof or floors should use the concrete building, concrete diaphragm for options.

### **C.2.3 Fire and Life Safety Improvements**

**General Description of the Work:** Fire and life safety improvements may involve the following building elements:

- Corridors and doors
- Stairs
- Lobbies
- Exits
- Alarm systems
- Standpipes
- Automatic fire sprinkler systems

In hospitals, this work will usually be scheduled as part of the normal planning process. Only if the work is in response to a disaster, such as a fire, will the work be unplanned. However, a building disaster that requires some construction may provide an opportunity to integrate seismic safety improvements.

This category of work is usually mandated rather than routine. It may be mandated by a JCAHO inspection, a fire marshal inspection, or other federal or state agency, and it usually refers to the National Fire Protection Association (NFPA) *Life Safety Code*<sup>®</sup>. It may also be part of a general modernization program. Some codes may also require seismic rehabilitation when a building experiences a significant amount of damage in a disaster such as fire, flood, or earthquake.

**Physical Description of the Work:** Fire and life safety improvements usually involve the building's means of egress, which will affect specific internal spaces. Often the work is near the center of the building, such as in the corridors and stairwells. In some cases, it may affect spaces on the building perimeter, such as lobbies, entrances, and stairways. Items include:

- Removing and replacing corridor wall finishes, doors, transoms, and equipment (e.g., cabinets) to provide access to walls and ceilings
- Installing new walls or altering existing walls at fire separations and stairway enclosures
- Installing new stairways either within the building or on the exterior, which may require removing part of a floor and constructing new walls
- Installing alarms, standpipes, or sprinklers to provide access to concealed spaces

**Associated Incremental Seismic Rehabilitation Work:** Incremental seismic rehabilitation work associated with fire and life safety improvements may include adding or strengthening shear walls and bracing, improving beam/column connections and diaphragm to wall anchorage, and adding or improving bracing and fastening of equipment.

**Performance of the Work:** Typically this work involves skilled construction personnel. These may be healthcare organization personnel or contractors. In some cases an A/E firm is involved.

**Special Equipment:** No special equipment is required for this task except for scaffolding to provide access to the work areas.

**Impact on Building Use:** Typically this work must be carefully coordinated and scheduled if done around occupants to preserve the comfort and safety of patients and staff and to maintain staff efficiency.

**Table C-3: Fire and Life Safety Improvements**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry <sup>1</sup>		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
3		✓	✓	n/a	n/a	Bracing and Detailing of Sprinkler and Piping	■	■	■	■	■	■	■
4		✓	✓	n/a	n/a	Suspension and Bracing of Lights	■	■	■	■	■	■	■
5		✓	✓	n/a	n/a	Fastening and Bracing of Ceilings	■	■	■	■	■	■	■
6	✓	✓	✓	n/a	n/a	Anchorage and Bracing of Emergency Lighting	■	■	■	■	■	■	■
7		✓	✓	n/a	n/a	Attachment and Bracing of Cabinets and Furnishings	■	■	■	■	■	■	■
8		✓	✓	n/a	n/a	Fastening and Bracing of Equipment (Mechanical and Electrical)	■	■	■	■	■	■	■
9		✓	✓	n/a	n/a	Support and Detailing of Elevators		■	■	■	■	■	■
10	✓	✓	✓	n/a	n/a	Bracing or Reinforcing Masonry Walls at Interior Stairs		■	■	■	■	■	■
11		✓	✓	n/a	n/a	Attachment and Bracing of Large Ductwork	■	■	■	■	■	■	■
13		✓	✓	n/a	n/a	Restraint of Hazardous Materials Containers	■	■	■	■	■	■	■
14		✓	✓	n/a	n/a	Bracing of Interior Partitions (Masonry and Wood)	■	■	■	■	■	■	■
16	✓	✓	✓	n/a	n/a	Glazing Selection and Detailing	■	■	■	■	■	■	■
20		✓	✓	n/a	n/a	Anchorage of Steel Stud Backup		■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All Elements		Collector and Drag Element Improvement	□	□	□	□	☒	□	☒
n/a		✓	✓	Horizontal Elements	Diaphragms	Mezzanine Anchorage and Bracing		■	■	■	■	■	■
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	☒	■	☒
n/a		✓	✓	Vertical Elements	Braced Frames	Capacity/Stiffness			□	□	☒	□	☒
n/a		✓	✓	Vertical Elements	Braced Frames	Continuity			□	□	☒	□	☒
n/a		✓	✓	Vertical Elements	Braced Frames	Connections			□	□	□	□	□
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Capacity/Stiffness			□	□	☒	□	☒
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Connection			□	□	□	□	□
n/a		✓	✓	Vertical Elements	Shear Walls	Capacity	■	□	□	□	☒	□	☒
n/a		✓	✓	Vertical Elements	Shear Walls	Continuity	■	□	□	□	☒	□	☒
n/a		✓	✓	Vertical Elements	Shear Walls	Extension of Wood Interior Walls to Roof	■	■	■				
n/a		✓	✓	Vertical Elements	Shear Walls	Lateral Stability		■	■	□	□	□	□
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use. Structural improvements are not numbered, but rather, organized by structural element and sub-system.

- Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional.
- Work requiring engineering design.
- ☒ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof or floors should use the concrete building, concrete diaphragm for options.

Category 4  
**Roofing  
 Maintenance and  
 Repair/Re-roofing**

### **C.2.4 Roofing Maintenance and Repair/Re-roofing**

**General Description of the Work:** This category of work includes repair or replacement of any or all of the following elements:

- Roof drainage system
- Eaves and fascias
- Flashing and vents
- Roofing membrane
- Insulation
- Walking surface and ballast
- Parapets and caps
- Roof-mounted equipment
- Roof deck

Most roof maintenance and repair work is done either in response to a failure or as scheduled periodic maintenance or preventive maintenance work. Most seismic rehabilitation integration opportunities for this work category will relate to either scheduled or preventive maintenance. Placement of roof-mounted equipment usually relates to other work categories such as new technology accommodation, patient care improvements, or HVAC improvement.

In some jurisdictions, an application for a re-roofing permit triggers a code requirement to implement specific seismic rehabilitation such as parapet bracing.

**Physical Description of the Work:** Work on the roof may be localized to specific areas, may extend to the entire perimeter of the roof, or may involve the complete roof surface or large portions of it. Work may be limited to the roofing membrane or may include work on the substrate, deck, and supporting system.

**Associated Incremental Seismic Rehabilitation Work:** Incremental seismic rehabilitation associated with roofing maintenance and repair may include strengthening diaphragms, improving diaphragm/wall connections, bracing parapets and chimneys, and improving equipment attachment and bracing.

**Performance of the Work:** Repair work on the roof is often performed by hospital maintenance staff or healthcare organization staff. Outside contractors may be used for more extensive work.

An A/E firm is typically used in connection with the installation of mechanical, electrical, telecommunication, or similar equipment. Also, healthcare organizations often use the services of an A/E for preparation of re-roofing specifications and bid documents.

**Special Equipment:** Scaffolding is sometimes used in connection with roof work. Cranes or hoists may be used to lift materials or equipment.

**Impact of Work on Building Use:** Work on the roof generally does not interrupt building use, except for complete re-roofing including the deck. Work on rooftop equipment in hospitals may require shutting down specific portions of the building.

**Table C-4: Roofing Maintenance & Repair/Re-roofing**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry <sup>1</sup>		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
1	✓	✓	✓	n/a	n/a	Anchorage of Canopies at Exits	■	■	■	■	■	■	■
2		✓	✓	n/a	n/a	Anchorage and Detailing of Rooftop Equipment	■	■	■	■	■	■	■
11	✓	✓	✓	n/a	n/a	Attachment and Bracing of Large Ductwork	■	■	■	■	■	■	■
12		✓	✓	n/a	n/a	Bracing of Parapets, Gables, Ornamentation, and Appendages	■	■	■	■	■	■	■
22		✓	✓	n/a	n/a	Bracing or Removal of Chimneys	■	■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All Elements		Load Path and Collectors	□	□	□	□	☒	□	☒
n/a		✓	✓	Horizontal Elements	Diaphragms	Attachment and Strengthening at Boundaries	■	■	■	■	☒	■	☒
n/a		✓	✓	Horizontal Elements	Diaphragms	Strength/Stiffness	■	■	■	■	☒	■	☒
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Openings	□	□	□	□		□	
n/a		✓	✓	Horizontal Elements	Diaphragms	Strengthening at Re-entrant Corners	□	□	□	□	☒	□	☒
n/a		✓	✓	Horizontal Elements	Diaphragms	Topping Slab for Precast Concrete		□	□		☒		☒
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	☒	■	☒
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use. Structural improvements are not numbered, but rather, organized by structural element and sub-system.

- Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional.
- Work requiring engineering design.
- ☒ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof should use the concrete building, concrete diaphragm for options.



Category 5  
**Exterior Wall  
 and Window  
 Maintenance/Façade  
 Modernization**

### **C.2.5 Exterior Wall and Window Maintenance/Façade Modernization**

**General Description of the Work:** Exterior wall and window maintenance may involve the following activities:

- Pointing
- Patching
- Painting
- Caulking

This category of work may also include major projects such as:

- Window repair and replacement
- Refinishing with new cladding or material

Most exterior wall maintenance and repair work is done in response to failure or as scheduled periodic maintenance or preventive maintenance work. Caulking and window repair and replacement are also often linked to energy conservation/weatherization work.

Federal or state mandates that require energy conservation improvements may lead to window repair or replacement.

**Physical Description of the Work:** Work is usually carried out throughout an entire hospital, or hospital wing, as a scheduled maintenance activity, although localized patching work is possible. Work may include:

- Repainting brick exterior walls
- Replacing windows
- Replacing curtain walls
- Improving energy conservation

**Associated Incremental Seismic Rehabilitation Work:** Strengthening of shear walls and improvement of diaphragm/wall connections.

**Performance of the Work:** Exterior wall and window work may be performed by skilled construction personnel on the hospital or healthcare organization's staff or by an outside contractor. In many cases an A/E or curtain wall consultant may be involved to provide design, specifications, bid process, and construction administration services.

**Special Equipment:** Access to higher exterior areas may require scaffolding or swing stages. This access may provide economical opportunities for the integration of seismic rehabilitation measures.

**Impact on Building Use:** Since most of the work is being performed from the building exterior, it may be possible to accomplish the work at any time. However, some of the seismic rehabilitation measures may be noisy or require access from the interior, so this work may have to be done when the building, or wing, is vacant.

**Table C-5: Exterior Wall and Window Work**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry'		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
1	✓	✓	✓	n/a	n/a	Anchorage of Canopies at Exits	■	■	■	■	■	■	■
12	✓	✓	✓	n/a	n/a	Bracing of Parapets, Gables, Ornamentation, and Appendages		■	■	■	■	■	■
15		✓	✓	n/a	n/a	Shut-Off Valves	■	■	■	■	■	■	■
16	✓	✓	✓	n/a	n/a	Glazing Selection and Detailing	■	■	■	■	■	■	■
18	✓	✓	✓	n/a	n/a	Cladding Anchorage		□	□	□	□	□	□
19		✓	✓	n/a	n/a	Anchorage of Masonry Veneer	■	■	■	■	■	■	■
20		✓	✓	n/a	n/a	Anchorage of Steel Stud Backup		■	■	■	■	■	■
21		✓	✓	n/a	n/a	Anchorage of Exterior Wythe in Cavity Walls		■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All Elements		Collector and Drag Element Improvement	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Foundation		Anchor Bolts	■						
n/a		✓	✓	Foundation		Cripple Stud Bracing	■						
n/a		✓	✓	Horizontal Elements	Diaphragms	Attachment and Strengthening at Boundaries	■	■	■	■	⊗	■	⊗
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	⊗	■	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Capacity/Stiffness	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Continuity	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Connections	□	□	□	□	□	□	□
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Capacity/Stiffness	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Connection	□	□	□	□	□	□	□
n/a		✓	✓	Vertical Elements	Shear Walls	Capacity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Continuity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Lateral Stability		■	■	□	□	□	□
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use. Structural improvements are not numbered, but rather, organized by structural element and sub-system.

- Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional.
- Work requiring engineering design.
- ⊗ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof or floors should use the concrete building, concrete diaphragm for options.

### **C.2.6 Underfloor and Basement Maintenance and Repair**

**General Description of the Work:** Underfloor and basement maintenance may involve the following activities:

- Repair of deterioration
- Repair of termite damage
- Equipment replacement

This work is most likely to be significant in smaller hospitals providing primary and possibly secondary care. In larger hospital and tertiary care facilities, basements are likely to be similar to any other floor, and underfloor and basement work may therefore be much more extensive, closer in nature to New Technology Accommodation.

Most underfloor repair activities will be in response to a problem. The solution may be immediate or assigned to the capital improvements budget. For example, settlement and resulting underpinning repair may be the result of a floor problem and require immediate intervention.

Usually there are no mandates or code issues involved with underfloor repair work. Safety is the usual driving force.

**Physical Description of the Work:** Work includes:

- Replacing deteriorated wood elements
- Repairing cracked or bowed walls
- Repairing damaged or deteriorated floors, underpinning where buildings have settled
- Replacing basement equipment

**Associated Incremental Seismic Rehabilitation Work:** Incremental seismic rehabilitation work associated with underfloor and basement work may include adding cripple stud bracing, improving foundation anchorage, adding new foundations, and improving floor to wall anchorage.

In the case of larger hospitals and tertiary care facilities, this work may include the incremental seismic rehabilitation work associated with C.2.2, New Technology Accommodation. See Table C-2 in addition to Table C-6.

**Performance of the Work:** The work is often performed by healthcare organization staff or by outside contractors. Major design work will often require A/E services.

**Special Equipment:** Special equipment is usually not required for underfloor work. However, access to the area must be available.

**Impact on Building Use:** Except for equipment replacement, the work may be done at any time, independent of building use.

**Table C-6: Underfloor and Basement Work**

Number*	Level of Seismicity			Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure						
	L	M	H				Wood	Masonry <sup>1</sup>		Concrete		Steel	
							Unreinforced Masonry	Reinforced Masonry	Wood Diaphragm	Concrete Diaphragm	Wood Diaphragm	Concrete Diaphragm	
<b>Nonstructural</b>													
8		✓	✓	n/a	n/a	Fastening and Bracing of Equipment (Mechanical and Electrical)	■	■	■	■	■	■	■
13		✓	✓	n/a	n/a	Restraint of Hazardous Materials Containers	■	■	■	■	■	■	■
15		✓	✓	n/a	n/a	Shut-Off Valves	■	■	■	■	■	■	■
<b>Structural</b>													
n/a		✓	✓	All Elements		Collector and Drag Element Improvement	□	□	□	□	⊗	□	⊗
n/a		✓	✓	Foundation		Anchor Bolts	■						
n/a		✓	✓	Foundation		Anchorage	■	□	□	□	□	□	□
n/a		✓	✓	Foundation		Cripple Stud Bracing	■						
n/a		✓	✓	Foundation		New Foundations	■	□	□	□	□	□	□
n/a		✓	✓	Foundation		Pile Cap Lateral Load		■	■	□	□	□	□
n/a		✓	✓	Foundation		Uplift	■	■	■	□	□	□	□
n/a	✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	■	■	■	■	⊗	■	⊗
n/a		✓	✓	Vertical Elements	Braced Frames	Connections						□	□
n/a		✓	✓	Vertical Elements	Moment Frames	Beam Column Connection						□	□
n/a		✓	✓	Vertical Elements	Shear Walls	Capacity	■	□	□	□	⊗	□	⊗
n/a		✓	✓	Vertical Elements	Shear Walls	Continuity	■	□	□	□	⊗	□	⊗
n/a	✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall		■	■	■	□	■	□

\* Nonstructural improvements are numbered for ease of use. Structural improvements are not numbered, but rather, organized by structural element and sub-system.

- Work that may be included in the building rehabilitation/maintenance/repair project on the basis of a quick evaluation by a design professional.
- Work requiring engineering design.
- ⊗ Work requiring detailed engineering analysis and evaluation of sequencing requirements. The "x" designates work that could redistribute loads, overstressing some elements.

Note 1: Masonry buildings with a concrete roof or floors should use the concrete building, concrete diaphragm for options.

### C.2.7 HVAC Improvements

**General Description of the Work:** HVAC improvements are often driven by the changing needs for sterile environments, and thus are related to both New Technology Accommodation and Patient Care Improvements. The installation of conduit, cables, wiring, ductwork, and HVAC equipment may involve the reconfiguration of concealed spaces under floors, above ceilings, and inside wall cavities and chases located in specific areas throughout the building.

**Physical Description of the Work:** The physical work involved in HVAC improvements is likely to be localized. Items include:

- Installing HVAC equipment, which should meet the anchorage requirements for seismic forces and may provide access to areas for other work
- Installing ducts or piping to specific spaces

**Associated Incremental Seismic Rehabilitation Work:** This work may include the incremental seismic rehabilitation work associated with the following other project categories discussed earlier:

- C.2.1, Patient Care Improvements
- C.2.2, New Technology Accommodation

See Tables C-1 and C-2 for integration opportunities.

**Performance of the Work:** The work may be performed by healthcare organization personnel or by outside contractors depending on the project size or complexity. The services of an A/E will be required to ensure sterile environments.

**Special Equipment:** Special equipment may be required to provide access to the work, including scaffolding or a crane or lift.

**Impact on Building Use:** Typically this work must be carefully coordinated and scheduled if done around occupants.

### C.2.8 Energy Conservation/Weatherization/Air Conditioning

**General Description of the Work:** Energy conservation/weatherization and air conditioning projects may include the following items:

- Exterior envelope work
- Insulation
- Windows
- Electrical and HVAC equipment
- Ducts and piping

Building elements affected may include exterior walls, ceilings, attic spaces, roofs, and basements.

These improvements may be in response to the healthcare organization's long-range strategic plan, special state or federal funding, or as part of other routine equipment replacement. In all cases, the intent is not only to save energy but also to reduce operating costs and improve occupant comfort.

Federal or state mandates may be factors leading to energy conservation improvements. If special grants are available, they can be made part of the capital improvement program. Local building code requirements may also encourage energy conservation improvements.

**Physical Description of the Work:** The physical work involved in energy conservation improvements may be localized or involve the entire building. Items include:

- Improving or replacing windows
- Installing new insulation in exterior walls
- Installing new insulation in the attic, which may permit access to the ceiling space
- Installing new insulation on the roof deck, which may be coordinated with other roof-top work
- Installing HVAC equipment, which should meet the anchorage requirements for seismic forces and may provide access to areas for other work
- Adding air conditioning, which may include the installation of ducts or piping to spaces throughout the building

**Associated Incremental Seismic Rehabilitation Work:** This work may include the incremental seismic rehabilitation work associated with the following other project categories discussed earlier:

- C.2.1, Patient Care Improvements
- C.2.2, New Technology Accommodation
- C.2.4, Roofing Maintenance and Repair/Re-roofing
- C.2.5, Exterior Wall and Window Maintenance/Façade Modernization

See Tables C-1, C-2, C-4, and C-5 for integration opportunities.

**Performance of the Work:** The work may be performed by healthcare organization personnel or by outside contractors depending on the project size or complexity. Whether the services of an A/E are required will depend on the nature of the work.

**Special Equipment:** Special equipment may be required to provide access to the work, including scaffolding or a crane or lift.

**Impact on Building Use:** Some of this work may be done at any time of year from the roof. Most window or interior work must be accomplished when the hospital is in use. Typically this work must be carefully coordinated and scheduled if done around occupants in order to preserve the comfort and safety of patients and staff and to maintain staff efficiency.

### **C.2.9 Hazardous Materials Abatement**

**General Description of the Work:** The presence of hazardous materials may involve abatement of:

- Asbestos
- Lead paint
- Radon

Most healthcare organizations have had asbestos abatement programs for some time and radon programs more recently. Lead paint has also been recognized as a hazard for some time, but only recently has it been included in government programs for abatement.

Hazardous materials abatement programs may be triggered by JCAHO accreditation requirements, federal requirements or mandates, or state regulations.

*Category 9  
Hazardous Materials  
Abatement*

**Physical Description of the Work:** Hazardous materials abatement may include the removal of finishes such as plaster, ceiling materials, and flooring throughout the building. It may include removal of the adhesives used. Asbestos abatement may include the removal or encapsulation of insulation on pipes and ducts. Lead paint abatement may include removal of the paint and finishes or encapsulation of the component containing the lead paint. Radon abatement may require installation of ventilation systems or other work in the basement.

**Associated Incremental Seismic Rehabilitation Work:** In some cases, the extent of the work may provide access to interior spaces that will provide a seismic rehabilitation opportunity. Seismic rehabilitation work could follow the hazard mitigation work before the finishes are reinstalled. This work may include the incremental seismic rehabilitation work associated with the following other project categories discussed earlier:

- C.2.1, Patient Care Improvements
- C.2.2, New Technology Accommodation

See Tables C-1 and C-2 for integration opportunities.

**Performance of the Work:** The work is typically performed by specialty contractors or specially trained healthcare organization staff.

**Special Equipment:** Special equipment, such as scaffolding, would often be on the job as part of the abatement work. Other special equipment such as fans and enclosures are irrelevant to seismic work.

**Impact on Building Use:** Building use will be curtailed during any hazardous materials abatement work. The work cannot be done around occupants. It requires a vacant building or building wing.

#### ***C.2.10 Definitions of Seismic Performance Improvements***

The seismic performance improvements included in the matrices of integration opportunities in Sections C.2.1 through C.2.9 are all extracted from the generic list in the following tables. The table contains additional information (description and purpose) that should be useful to hospital and healthcare organization facility managers using this section.

## Nonstructural Seismic Performance Improvements

Hospital-Number*	Level of Seismicity			Definitions and Purpose		
	L	M	H	Seismic Performance Improvement	Description	Purpose
1	✓	✓	✓	Anchorage of Canopies at Exits	Canopies or roofs over exits.	Prevent collapse of canopies that would block exits and possibly cause injuries.
2		✓	✓	Anchorage and Detailing of Rooftop Equipment	Equipment should be properly attached, and restrained if isolation-mounted.	Prevent equipment from sliding or falling off platforms due to connection failure or non function.
3		✓	✓	Bracing and Detailing of Sprinkler and Piping	Sprinkler pipes should be braced in each direction.	Prevent sprinkler lines from breaking and flooding the building.
4		✓	✓	Suspension and Bracing of Lights	Lights may swing or otherwise fall in an earthquake.	Prevent lights from falling and injuring occupants. Lights should not be supported by a suspended ceiling in a high or moderate seismic zone. Pendent lights should have their sway limited.
5		✓	✓	Fastening and Bracing of Ceilings	Diagonal bracing of ceiling.	Suspended ceilings should be braced against sidesway to reduce the chance of elements falling.
6	✓	✓	✓	Anchorage and Bracing of Emergency Lighting	Positive attachment of emergency lights.	Prevent heavy battery packs from falling.
7		✓	✓	Attachment and Bracing of Cabinets and Furnishings	Anchorage to structural walls or other elements.	Prevent cabinets and other furnishings from toppling or moving and causing damage. Fallen file cabinets may block exit doors.
8		✓	✓	Fastening and Bracing of Equipment (Mechanical and Electrical)	Equipment above ceilings.	Prevent fans and other equipment from swaying and falling on occupants; connections could fail resulting in equipment no longer functioning.
9		✓	✓	Support and Detailing of Elevators	Elevator guides have become dislodged in earthquakes. Applies to cable lift elevators.	Keep elevators functioning.
10	✓	✓	✓	Bracing or Reinforcing Masonry Walls at Interior Stairs	Interior exit stairs may have unreinforced masonry enclosure walls that could collapse.	Prevent collapse of walls blocking stairways.
11		✓	✓	Attachment and Bracing of Large Ductwork	Large ducts.	Prevent ducts from falling on occupants.
12	✓	✓	✓	Bracing of Parapets, Gables, Ornamentation, and Appendages	Construct parapet bracing on the roof side of the parapet. Gables are braced in the attic space. Other elements are anchored in a positive manner.	Prevent parapets, gables, and ornamentation from falling outward.
13		✓	✓	Restraint of Hazardous Materials Containers	Chemical labs, shops, etc. may have materials that could, when combined, create a fire or chemical hazard.	Reduce danger of breakage and mixing of chemicals.
14		✓	✓	Bracing of Interior Partitions (Masonry and Wood)	Bracing may be vertical or diagonal braces.	Interior partitions must be braced to prevent falling/collapse.
15		✓	✓	Shut-Off Valves	Installation of a shut-off device.	Gas and water lines could break and should have a means of turning them off.
16	✓	✓	✓	Glazing Selection and Detailing	Glass above a walking surface.	Prevent exterior or interior glass from falling onto the walking surface and causing injuries.
17		✓	✓	Underfloor Bracing of Computer Access Floor	Raised floors for cabling.	Prevent floors from collapsing and damaging equipment.
18	✓	✓	✓	Cladding Anchorage	Heavy cladding (concrete) must be connected to the structure.	Prevent cladding from falling. Careful design is required so the cladding does not limit the structure's lateral movement.
19		✓	✓	Anchorage of Masonry Veneer	Veneer over exterior wood or masonry walls or over other materials in steel or concrete structure. Materials may be brick, terra cotta, stone, or similar materials.	Prevent inadequately anchored veneer from falling outward on pedestrians.
20		✓	✓	Anchorage of Steel Stud Backup	Steel studs behind veneer or other cladding.	Prevent steel studs, used as a backup to support veneer or other cladding, from becoming detached or falling.
21		✓	✓	Anchorage of Exterior Wythe in Cavity Walls	A masonry wall separated from the veneer by a hollow space.	Prevent veneer from falling outward. Existing anchorage should be checked for rust damage and loss of strength.
22		✓	✓	Bracing or Removal of Chimneys	Chimneys should be braced to the structure.	Prevent chimneys from toppling into yards or through roofs.

\* Items numbered for ease of reference.



## Structural Seismic Performance Improvements

Level of Seismicity			Building Element	Structural Sub-System	Definitions and Purpose		
L	M	H			Seismic Performance Improvement	Description	Purpose
	✓	✓	Foundation		Anchor Bolts	Connection between the foundation and the building.	Improve load path. Prevent building from sliding off foundation.
	✓	✓	Foundation		Anchorage	Connection between the foundation and the building for larger buildings.	Improve load path. Provide adequate connection between building and foundation.
	✓	✓	Foundation		Cripple Stud Bracing	Short wood studs between the foundation and the first floor.	Cripple studs are usually not braced. Prevent them from toppling and causing the building to fall off the foundation.
	✓	✓	Foundation		New Foundations	New foundations to convey loads.	Additional foundations may be the preferred solution in some cases.
	✓	✓	Foundation		Pile Cap Lateral Load	Piles supporting buildings may try to move laterally from building loads during earthquakes.	Brace piles at their top to eliminate the chance of lateral movement and reduce chance of foundation failure.
	✓	✓	Foundation		Uplift	Under overturning type loads, foundations may be pulled upward.	Reduce the uplift chance by improving foundation system; engineer should evaluate the effects of uplift.
Definition			Horizontal Elements			Floors, mezzanines, and roofs.	
Definition			Horizontal Elements	Diaphragms		Floors and roofs connecting walls and lateral force-resisting elements.	Diaphragms are the roof and floors of a building. They must be of adequate strength to transfer the earthquake loads to the walls and other elements. The connection from the diaphragm to the wall or other lateral force-resisting element is part of the load path.
	✓	✓	Horizontal Elements	Diaphragms	Attachment and Strengthening at Boundaries	Improving the connection of the diaphragm to the edge/boundary elements with nails, bolts, or welding.	This is part of the load path and conveys the diaphragm forces into the walls or other lateral force-resisting elements.
	✓	✓	Horizontal Elements	Diaphragms	Mezzanine Anchorage and Bracing	Anchor the mezzanine to the wall. Where there is an open side of the mezzanine bracing may be necessary.	Make sure the mezzanine is attached to the building to provide for a load path for the mezzanine diaphragm and to reduce any pounding of the mezzanine against the building's walls or columns. A large mezzanine may require bracing on the open sides.
	✓	✓	Horizontal Elements	Diaphragms	Strength/Stiffness	Strengthen the diaphragm to limit its lateral deflection.	Control the movement of the diaphragm to reduce the damage due to drift and to control the out-of-plane loads on vertical elements.
	✓	✓	Horizontal Elements	Diaphragms	Strengthening at Openings	Strapping around diaphragm openings.	Openings may create a weak point in the diaphragm. Straps will provide additional strength to wood diaphragms.
	✓	✓	Horizontal Elements	Diaphragms	Strengthening at Re-entrant Corners	"L" and "U" shaped buildings have stress concentrations at the interior corners.	Reduce damage from cracking and failures caused by stress concentration.
	✓	✓	Horizontal Elements	Diaphragms	Topping Slab for Precast Concrete	Concrete slab over precast concrete roof to create a continuous diaphragm. Connect to the vertical elements as part of a load path.	Strengthen the roof to act as a lateral force element. Controls drift of the roof or floor.
Definition			Vertical Elements	Braced Frames		Steel or concrete beams and columns with diagonal bracing.	Braced frames act as a lateral force-resisting element. They are often used as the lateral force-resisting element on open sides of buildings. They must be connected to the horizontal element as part of the load path.
	✓	✓	Vertical Elements	Braced Frames	Capacity/Stiffness	Frame capacity improvements for adequate load resistance.	Capacity and stiffness assure the adequacy of the frame elements to resist loads.
	✓	✓	Vertical Elements	Braced Frames	Continuity	Braced frames should be continuous from the foundation to the roof.	Discontinuities of lateral force-resisting elements create load transfer demands. Design standards may impose higher loads for this condition.
	✓	✓	Vertical Elements	Braced Frames	Connections	The details of the connections, bolts, or welds must be adequate. Improvements to strength will not have a negative effect on the phased construction.	Braced frame connections assure the adequacy of the frame elements to resist loads. Improvements may be made by the addition of steel plates with bolting or welding.
✓	✓	✓	Vertical Elements	Load Path	Lateral Resisting System to Diaphragm Connection	Connections between roof/floor and wall or other element.	Permit earthquake loads to be conveyed to the foundation—develop a load path. This is the key element in seismic safety.

## Structural Seismic Performance Improvements (continued)

Level of Seismicity			Building Element	Structural Sub-System	Definitions and Purpose of Structural Performance Improvements		
L	M	H			Seismic Performance Improvement	Description	Purpose
Definition			Vertical Elements	Moment Frames		A steel or concrete system of beams and columns.	Moment frames act as a lateral force-resisting element and brace the structure. They are often used as the lateral force-resisting element on open sides of buildings. They must be connected to the horizontal element as part of the load path.
	✓	✓	Vertical Elements	Moment Frames	Beam Column Capacity/Stiffness	Frame capacity improvements for adequate load resistance.	Capacity and stiffness assure the adequacy of the frame elements to resist loads.
	✓	✓	Vertical Elements	Moment Frames	Beam Column Connection	Steel or concrete with improved connections to increase strength. Improvements will not have a negative effect on the phased construction.	Beam column connections assure the adequacy of the frame elements to resist loads. Improvements may be made by the addition of steel plates with bolting or welding.
Definition			Vertical Elements	Shear Walls		Walls that brace the building against earthquakes.	Shear walls brace the structure. Building walls can act as lateral load-resisting elements. They must be connected to the horizontal elements as part of the load path.
	✓	✓	Vertical Elements	Shear Walls	Capacity	Capacity equals strength.	Capacity assures the adequacy of walls to resist loads.
	✓	✓	Vertical Elements	Shear Walls	Continuity	Shear walls should be continuous from the foundation to the roof.	Discontinuities of lateral force-resisting elements create load transfer demands. Design standards may impose higher loads for this condition. This is one of the most cost-effective improvements in buildings.
	✓	✓	Vertical Elements	Shear Walls	Extension of Wood Interior Walls to Roof	Extending interior wood walls to diaphragms in unreinforced masonry and other buildings.	Permit walls that were not constructed full height to be used as shear walls in buildings with wood interior walls.
	✓	✓	Vertical Elements	Shear Walls	Lateral Stability	Tall walls may buckle and need bracing.	Prevent buckling and possible wall collapse. Walls must be anchored at the top or may have other bracing elements such as diagonal or vertical braces.
✓	✓	✓	Vertical Elements		Out-of-Plane Anchorage of Concrete or Masonry Wall	Connections from the walls to the floors and roof.	Prevent walls from falling outward due to inadequate connections between the wall and the diaphragms. A cost-effective mitigation measure for bearing wall buildings.
✓	✓	✓	All Elements		Load Path and Collectors	Distribute loads from diaphragms into lateral force-resisting elements.	These are straps of steel or wood that "collect" load and distribute it into the vertical lateral force-resisting elements. Connections may be with bolts, nails, or welding depending the material and location.



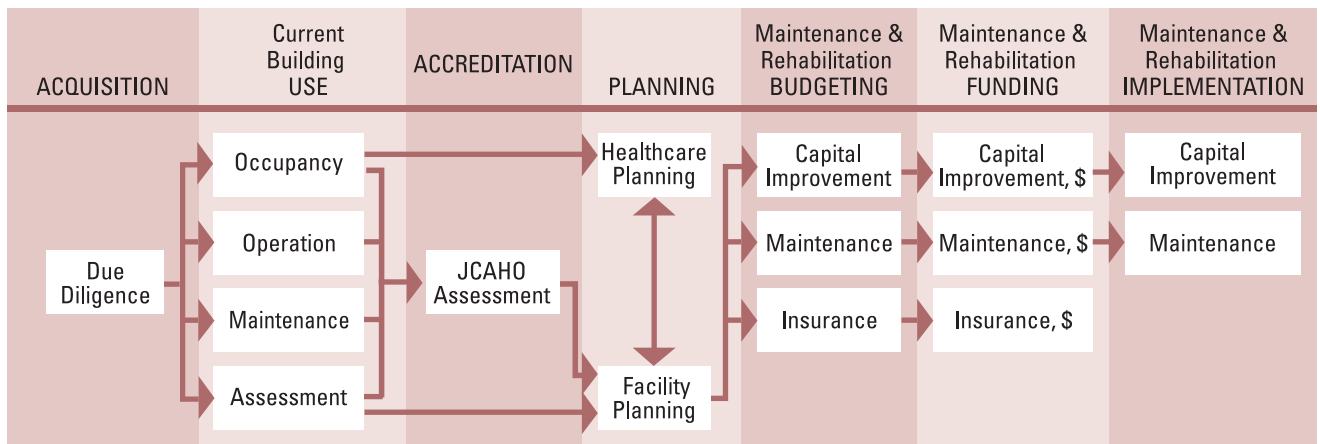
# Appendix. Additional Information on Hospital Facility Management

## Introduction: Typical Facility Management for Hospitals

The typical facility management process for existing hospital buildings consists of seven phases of activities: Acquisition, Current Building Use, Accreditation, Planning, Maintenance & Rehabilitation Budgeting, Maintenance & Rehabilitation Funding, Maintenance & Rehabilitation Implementation, as diagrammed in Figure 1. This process is sequential, progressing from left to right in any given building. A healthcare organization that has a large inventory of buildings is likely to have ongoing activities in all of these phases.

This process is generic and, while local variations may occur, it is generally followed by healthcare organizations, either explicitly or implicitly.

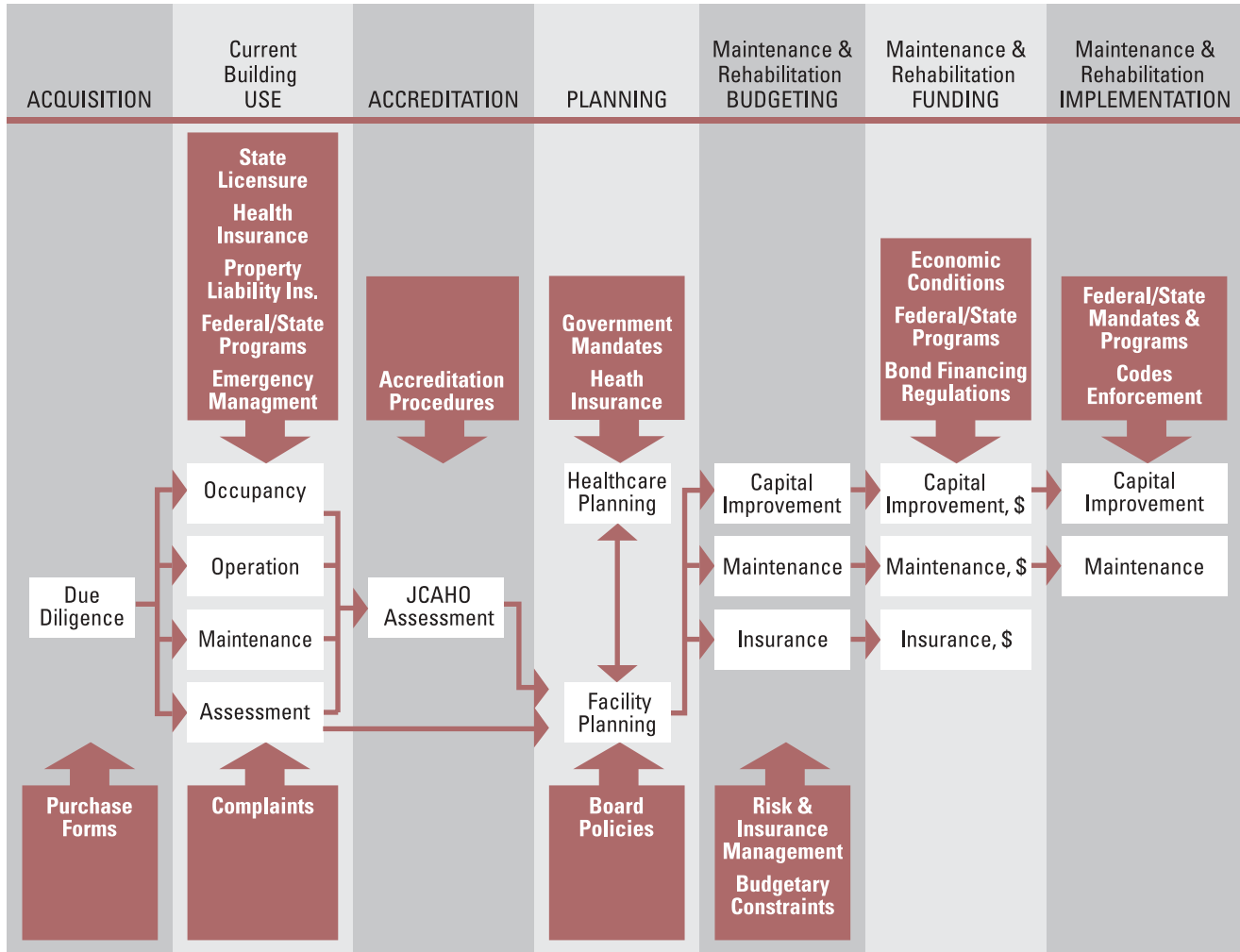
**Figure 1: Typical Management Process**



**Figure 2:  
Management  
Process  
Influences**

Both internal and external factors typically influence the hospital facility management process in its various phases. Internal factors (represented by up arrows in Figure 2) are generated within the healthcare organization and its administration. External factors (down arrows) are imposed on healthcare organizations by outside entities.

This Appendix describes the activities and influences within each phase.



### 1. The ACQUISITION Phase of Hospital Facility Management

#### Typical Process

Hospital acquisitions are a frequent feature of the healthcare delivery system in the United States. Hospital buildings and their professional staffs will be acquired as part of a single transaction. The due diligence process that precedes an acquisition is intended to identify, and quantify if possible, all the liabilities or potential liabilities related to the asset being acquired.

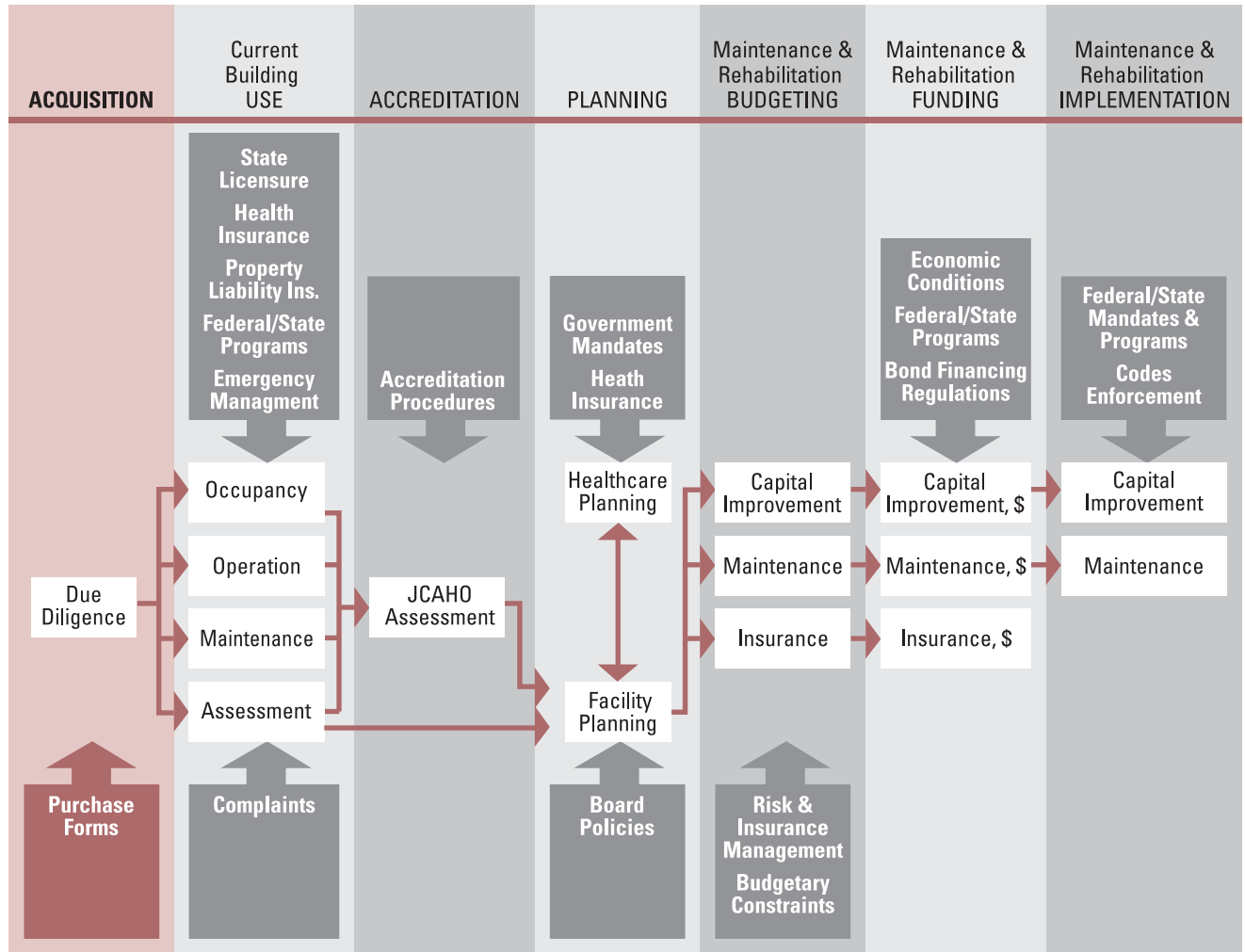
A multi-discipline team that includes legal, risk management, and engineering carries out the due diligence. Because of the potential professional liabilities, legal questions are often the driving force in the process. The due diligence process also involves a walk-through of the building. Environmen-

tal risks, such as the presence of asbestos, are identified in the due diligence process.

**Influences and Related Seismic Considerations**

As indicated in Figure 3, one internal factor (up arrow) influences acquisition phase decision making.

**Figure 3:  
Acquisition**



Purchase Forms: Some healthcare organizations use internally generated hospital purchase forms to guide their purchase decisions and related due diligence. These forms are eclectic and developed over time. The forms may focus on the facility age, equipment, and risk management history over a 5- to 10-year period.

**Seismic Consideration**

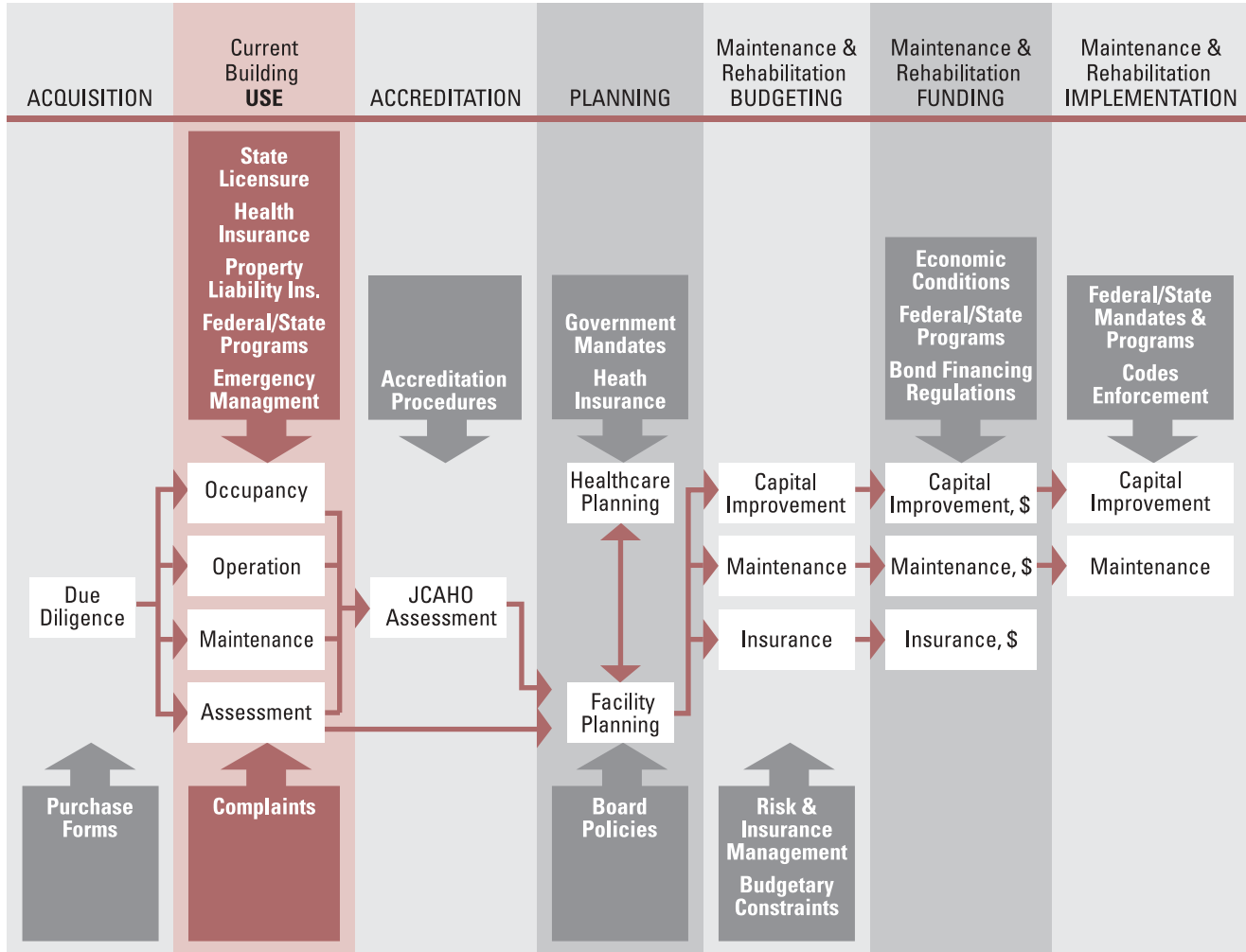
A 5- to 10-year risk management history is unlikely to cover earthquake risks outside of California. In California, healthcare systems are subject to Senate Bill (SB) 1953 that requires all California hospitals to upgrade their facilities to allow their functioning after a large earthquake. The cost of compliance with SB1953 is likely to be the most important factor in the purchase of existing hospital buildings and the related due diligence.

## 2. The Current Building USE Phase of Hospital Facility Management

### Typical Process

The current building use phase of the typical hospital facility management process consists of four categories of activities and is influenced by significant internal and external pressures, as depicted in Figure 4.

**Figure 4:**  
**Use**



**Occupancy:** This category of activity consists of all the functions that the hospital is intended to shelter and to support. These include healthcare delivery, support, and ancillary functions. The healthcare delivery functions are determined by demographic, sociological, anthropological, and other factors. Support functions are administrative, and ancillary functions may be educational and community support.

These functions are carried out in each facility under the authority of the hospital director by the hospital staff. Each of these functions is subject to seismic risk and can be disrupted by seismic damage.

Hospitals are often characterized by the level of care provided therein. Tertiary care is considered the highest level of care, and includes the full range of technological and specialty care (such as open heart surgery and cancer) in

addition to a Level 1 Trauma Center with a list of medical disciplines on site 24 hours per day. Secondary care is provided by a facility such as a 20-bed rural hospital. Primary care is healthcare that can be provided by “your primary care physician,” involving the lowest level of technology (for example, a long-term care facility). A regional hospital system will often include one tertiary care facility and several hospitals providing secondary and primary care.

**Operation:** Facility operation consists of all the activities and functions that the facility and its components must perform in order to support the occupancy. Examples are the mechanical functions (heating, cooling, ventilation, and medical support functions), electrical functions (lighting, communications, alarm, and medical support functions), and plumbing functions.

Operation functions may be carried out by custodial staff of the healthcare organization or the individual facilities and/or by contractors. Each of these functions is subject to seismic risk and can be disrupted by seismic damage.

**Maintenance:** Maintenance includes all the activities required to enable the occupancy and operation of the building to be carried out continuously over time. They can be broken down into custodial maintenance, routine maintenance, and repair.

Maintenance functions may be carried out by custodial staff of the individual facilities, by healthcare organization staff, and/or by contractors.

**Facility Assessment:** Facility assessment consists of the survey or inspection of the hospital facilities on a scheduled basis. It may also include a review of documents, such as archival building plans, for retrieving specific information. The purpose of the surveys or inspections is to determine facility conditions in relation to one or more of the following categories:

- user complaints
- maintenance needs
- preventive maintenance needs
- specific environmental hazards
  - asbestos
  - lead paint
  - lead
  - radon
- structural hazards
- fire/life safety
- environmental quality
- energy use/conservation
- accessibility
- other

These surveys are carried out by the individual hospital facility staff, with possible participation by central healthcare organization staff. In some cases surveys are carried out by a state or local fire marshal, an insurance company, or other outside entity. The surveys may or may not be coordinated as to schedule, content, personnel, etc. Healthcare organizations may or may not use prepared inspection forms or checklists. Finally, healthcare organizations may vary as to the extent and specific nature of their record keeping and reporting.

### ***Influences and Related Seismic Considerations***

As indicated in Figure 4, five external factors (down arrow) and one internal factor (up arrow) influence current building use phase decision making.

**State Licensure:** External state licensure regulations establish requirements affecting the building use phase, which have implications for facilities. The Rules and Regulations for Licensure of Hospitals in Virginia, for example, require a licensure survey of hospital buildings every 18 to 24 months.



### **Seismic Consideration**

Currently there are no seismic rehabilitation mandates or implications in any state programs related to hospitals outside of California. In California, healthcare systems are subject to SB1953 that has established three interim milestone dates (January 1, 2002; January 1, 2008; and January 1, 2030) for progressively bringing all hospital buildings into full compliance with the seismic requirements of California Building Codes by January 1, 2030.

Health Insurance: External private health insurance programs establish requirements for healthcare delivery. These requirements may have facility management implications.

### **Seismic Consideration**

Private health insurance requirements are unlikely to impose any seismic considerations on hospitals.

Property and Liability Insurance: External private property and liability insurance companies often require surveys or inspections of hospital facilities on an annual or other scheduled basis.

### **Seismic Consideration**

Property insurers are unlikely to recommend extensive seismic improvements outside of California. In Utah, for example, they have recommended seismic bracing of sprinklers as part of the life safety systems, but no other improvements.

Federal and State Programs: Various external programs may establish requirements affecting use of a healthcare organization's facilities (e.g., Americans with Disabilities Act [ADA] and Occupational Safety and Health Administration [OSHA] requirements). Additionally, governmental funding programs may impose facility requirements (e.g., Medicare reimbursements and energy conservation).

### **Seismic Consideration**

Currently, there are no seismic rehabilitation mandates or implications in any federal or state programs related to hospitals, with the exception of California.

Specific surveys or inspections may be mandated by external federal, state, or local laws/programs. In Virginia, for example, fire marshal surveys of hospitals are carried out annually. These surveys/inspections may be carried out by a variety of entities:

- Federal personnel (e.g., from OSHA, Environmental Protection Agency [EPA])
- State/city/county personnel (e.g., fire marshal, code enforcement, environmental, health)
- Healthcare organization personnel (e.g., custodial or facility managers)
- Hospital building contracted personnel (e.g., asbestos inspectors)
- Consultants

### **Seismic Consideration**

Currently, there are no seismic survey or inspection mandates or implications in any federal or state programs related to hospitals, with the exception of California.

Emergency Management: External state or local emergency management agencies may assign specific roles that hospitals must perform in case of natural disasters, including earthquakes. This may affect the occupancy phase by requiring periodic exercises involving building occupants.

**Seismic Consideration**

Local emergency management plans related to the role of hospitals in a disaster may be general and broad, or detailed and specific. In some cases, specific hospitals are assigned a specific function they are to perform in the post-disaster environment. In such cases a legitimate question is “In what condition will the building in question be following an earthquake?” Answering this question requires some form of seismic inspection, evaluation, and possible mitigation.

Complaints by Occupants: Internal complaints by occupants (patients and staff) are a potentially significant pressure on the facility management process.

**Seismic Consideration**

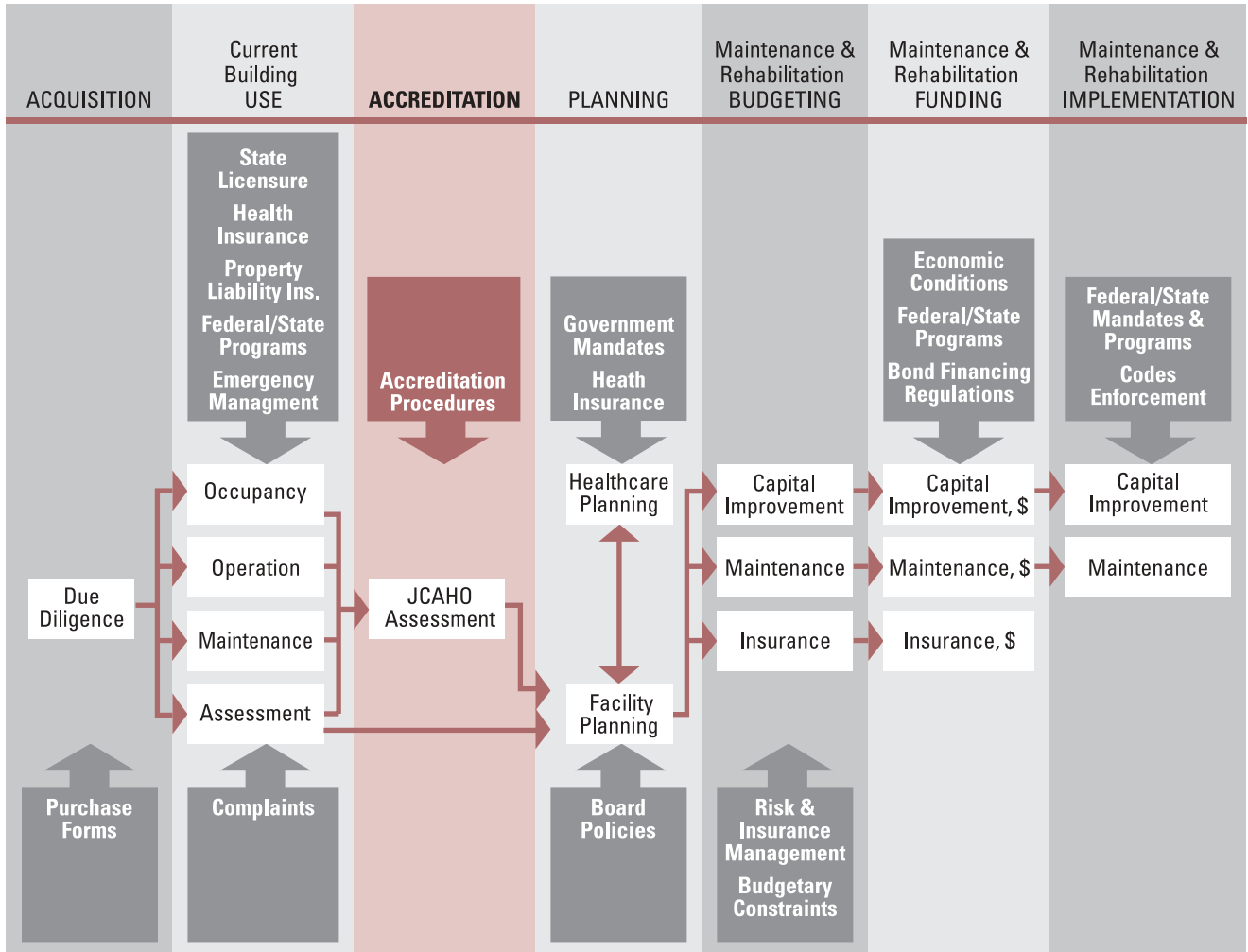
The extent of complaints about seismic vulnerability generated by hospital occupants is not known. Safety concerns of hospital staff in Utah have reportedly included seismic safety.

**3. The ACCREDITATION Phase of Hospital Facility Management**

**Typical Process**

The accreditation phase of the typical hospital facility management process consists of a variety of evaluation and inspection activities and is influenced by external pressures, as depicted in Figure 5.

**Figure 5: Accreditation**



### Typical Process

Joint Commission on Accreditation of Healthcare Organizations (JCAHO) Assessment: JCAHO provides voluntary accreditation to healthcare organizations including hospitals. The Commission has been accrediting hospitals for more than 40 years. Its accreditation is a nationwide seal of approval that indicates a hospital meets high performance standards.

Despite its voluntary nature, this accreditation is, de facto, mandatory in most states, because all federal payments and reimbursements, including Medicare and Medicaid payments, are made to only JCAHO-accredited organizations. Some states, including Utah, have alternative accreditation programs that are recognized by the federal government.

JCAHO accreditation is done on a 3-year cycle. Every 3 years a hospital is assessed for compliance with JCAHO accreditation standards.

### Influences and Related Seismic Considerations

As indicated in Figure 5, one external factor (down arrow) influences accreditation phase decision making.

Accreditation Procedures: JCAHO accreditation is a critical external factor that influences hospital operations, including facility management. The procedures of JCAHO accreditation of hospitals are covered in the *Comprehensive Accreditation Manual for Hospitals*, which includes EC3.2.1 – Designing the Environment of Care. EC3.2.1 contains many standards that address building performance, including compliance with NFPA 101, *Life Safety Code*®.

Environment of Care (EC) standards EC.1.4 and EC.2.4, amended and expanded in January 2001, require hospital, ambulatory care, behavioral health, home care, and long term care organizations to develop and implement a management plan that ensures effective response to emergencies affecting the delivery of healthcare. It requires the emergency management plans to address the following four phases of emergency management activities:

- Mitigation
- Preparedness
- Response
- Recovery

The JCAHO defines “emergency” as:

“a natural or manmade event that suddenly or significantly:

- disrupts the environment of care (for example, damage to the organization’s buildings and grounds due to severe windstorms, tornadoes, hurricanes, or earthquakes);
- disrupts care and treatment (for example, loss of utilities due to floods, civil disturbances, accidents, or emergencies within the organization or in its community); or
- changes or increases demands for the organization’s services (for example, bioterrorist attack, building collapse, or airplane crash in the organization’s community).”

The official JCAHO newsletter, *Perspectives*, dated December 2001, includes the following discussion of mitigation:

“Mitigation activities lessen the severity and impact of a potential emergency. Mitigation begins by identifying potential emergencies (hazards) that may affect the organization’s operations or the demand for its services, followed by implementing a strategy that supports the perceived areas of vulnerability within the organization.”

Standard EC.2.9.1 requires organizations to execute the emergency management plan by conducting emergency management drills.

The American Society for Healthcare Engineering (ASHE) has developed a tool, entitled *Hazard Vulnerability Analysis*,<sup>1</sup> to help organizations develop an emergency management plan. It is a simple matrix that lists a variety of hazards, including earthquake, and requires the rating of each in terms of its probability (on a 4-point scale from “none” to “high”), risk (on a 5-point scale from “low disruption” to “life threat”), and preparedness (on a 3-point scale from “poor” to “good”). The values on each scale are multiplied to arrive at a total value for each hazard. The tool instructs: “Determine a value below which no action is necessary. Acceptance of risk is at the discretion of the organization.”

#### Seismic Consideration

Earthquake damage to hospitals is specifically noted in both the JCAHO standard and in the ASHE tool as a potential hazard to be addressed in the management plan. This document, *Incremental Seismic Rehabilitation of Hospital Buildings*, can be used in developing the management plan.

## 4. The PLANNING Phase of Hospital Facility Management

### Typical Process

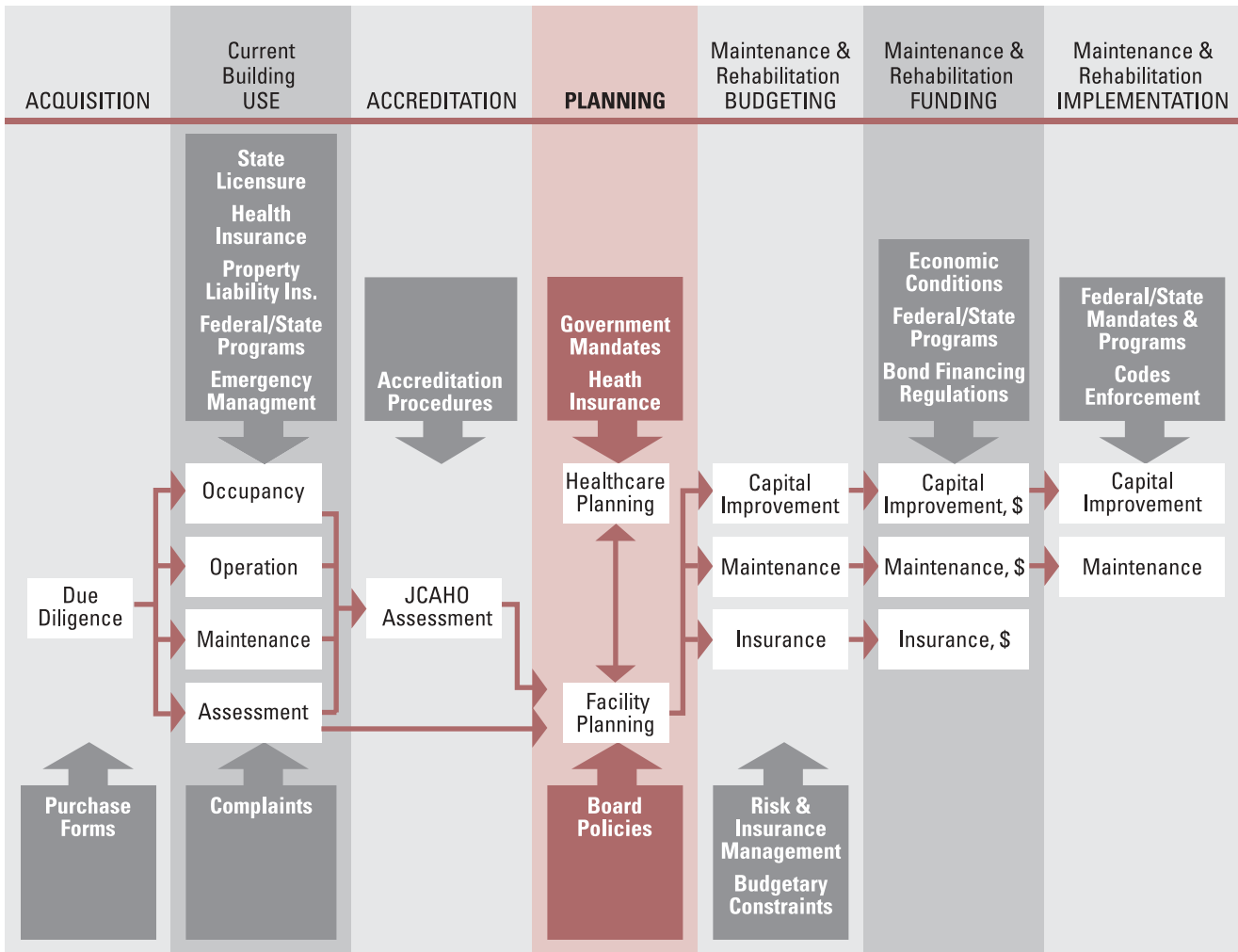
The planning phase consists of projecting and forecasting future needs. It can be carried out periodically or continuously, and it may vary as to the time period covered by the projections and forecasts. Planning functions may be carried out by the hospital administration as well as central healthcare organization staff, with or without the assistance of consultants. Planning consists of two separate but related activities—healthcare planning and facility planning—and is affected by both external government and health insurance requirements and internal board policies, as depicted in Figure 6.

Healthcare Planning: Healthcare planning attempts to formulate future healthcare delivery programs and their support needs by analyzing and forecasting several factors, such as:

- demographics (population growth or decline, neighborhood shifts, etc.)
- healthcare philosophy
- medical technology
- cultural and socioeconomic factors
- federal and state mandates
- equity and civil rights

<sup>1</sup> Healthcare Facilities Management Series, Management Monograph #055920, Susan B. McLaughlin, February 2001, ASHE of the American Hospital Association.

**Figure 6:  
Planning**



A national trend in healthcare planning is the movement toward outpatient care, driven by health insurance and best-practice medical care.

Healthcare planning is generally carried out by the central healthcare organization's staff. However, specific medical service improvements are generated by hospital department heads who suggest reorganization within their respective departments.

**Facility Planning:** Facility planning consists of preparing long-range facility plans, strategic facility plans, or a similar document. It combines the products of three distinct activities—the healthcare plan, the facility assessment, and the JCAHO accreditation (see Figure 6)—into a detailed projection of facility requirements. Thus, it is a product of the combined efforts of individual hospital staff and central healthcare administration staff. The projection may cover a defined time frame, such as 5 years.

Different organizations may use different classifications of projects in their facility plans, reflecting a variety of legal, administrative, jurisdictional, and other factors. However they may be classified, a comprehensive facility plan should include the following elements:

- New construction
- Additions to existing buildings
- Renovations of existing buildings
- Building systems replacements
- Building systems repairs
- Scheduled maintenance
- Preventive maintenance
- Building disposition (change of use, sale, demolition)

The plan will identify the time frames in which each project is to be accomplished, and it may include cost estimates. Some experts have conceptualized the facility plan as consisting of four general categories, which may provide guidance for budgeting:

- Physical plant renewal
- Physical plant adaptation
- Catch-up maintenance
- New construction

If effective, the facility plan will be used as a budgeting tool and will provide direct inputs into the budget process. It should be revised and updated on a routine basis to reflect:

- Changes in the healthcare delivery plan
- Revised facility assessments
- Budgeting and funding realities

### ***Influences and Related Seismic Considerations***

As indicated in Figure 6, two external factors (down arrow) and one internal factor (up arrow) influence current planning phase decision making.

**Board Policies:** In terms of internal influences, healthcare organization boards may occasionally adopt written policies on issues of political and social significance that can affect both healthcare and facility planning. These policies guide the actions of the healthcare organization.

#### **Seismic Consideration**

**Boards may adopt policies addressing seismic issues, including seismic performance objectives and rehabilitation of hospital buildings, either as a one-time task or a recurring incremental program.**

**Government Mandates:** Federal, state, and local government agencies have historically established external requirements affecting the planning phase as regards both healthcare delivery planning and facility planning. These requirements may have facility rehabilitation implications. Some of these requirements may be accompanied by funding, perhaps providing an opportunity to integrate disparate objectives into coordinated actions.

#### **Seismic Consideration**

**Currently, federal or state programs do not include seismic rehabilitation mandates or implications applicable to non-federal hospitals, with the exception of California.**

**Health Insurance:** Health insurance programs, both federal (Medicare and Medicaid) and private, establish external requirements affecting the planning

phase with regard to healthcare delivery planning, and possibly facility planning as well. Medicare depreciation schedules are one example of the latter.

**Seismic Consideration**

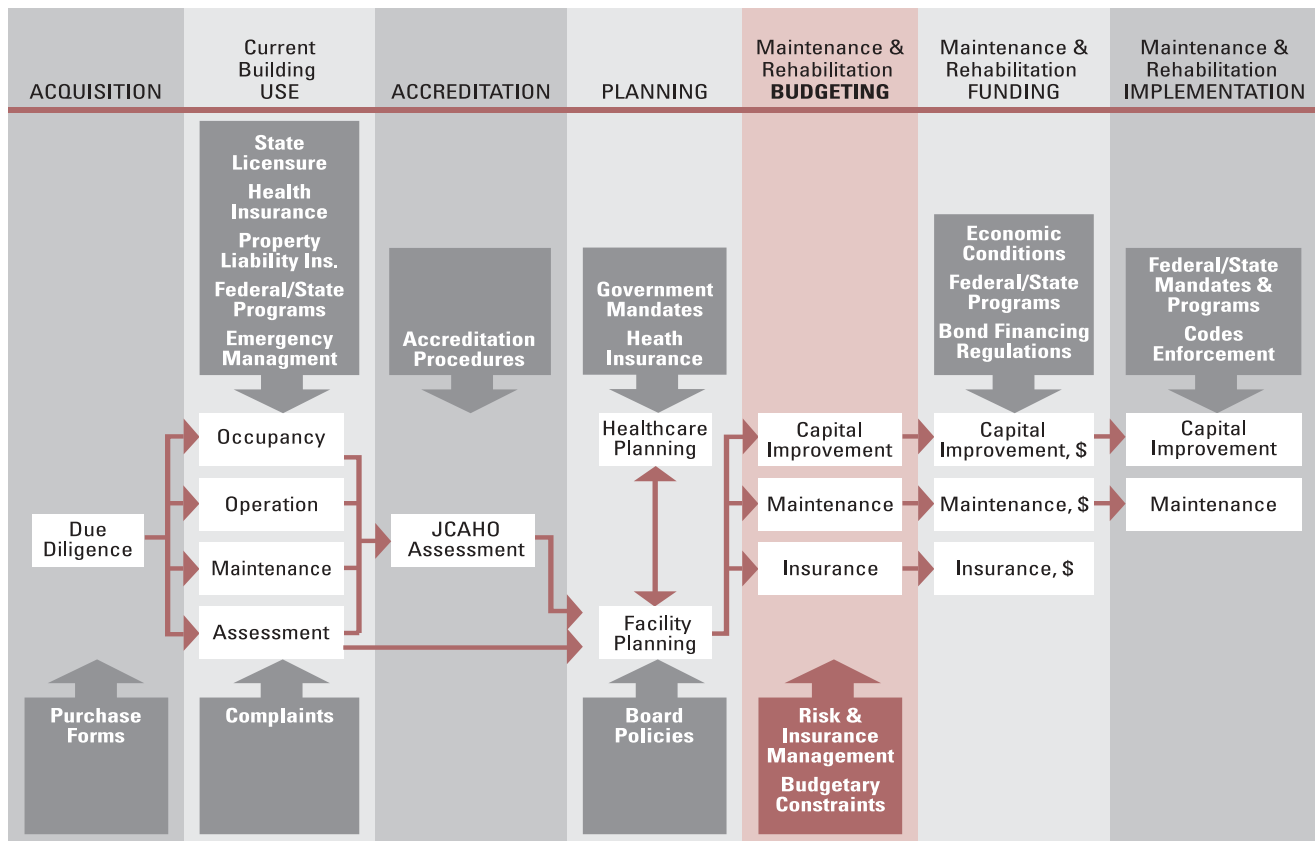
Currently, no seismic rehabilitation mandates or implications exist in any health insurance programs.

**5. The Maintenance and Rehabilitation BUDGETING Phase of Hospital Facility Management**

**Typical Process**

The budgeting phase consists of the projection of future financial resources required to meet future needs. It is carried out annually (covering a period of one or more years). Each hospital director initiates the budgeting phase with input from the respective hospital engineering department and safety officer. Organization-wide, the vice president for facilities services oversees the budget development. The facility budget is a process that can be thought of as percolating up through the organization. It is affected by externally influenced risk management policies and internal budget constraints, as depicted in Figure 7.

**Figure 7: Budgeting**



Three elements of the budget are relevant to the discussion of facility management:

- Capital
- Maintenance
- Insurance

**Capital Budgets:** Capital budgets generally relate to the acquisition of buildings and major systems and to major additions to existing buildings, the occurrence of which is not annual or repetitive and which can therefore be amortized. The distinction between capital and maintenance budgets may vary among different healthcare organizations. At one extreme is a total separation, mandated by law, labor jurisdiction, or other factors. At the other extreme is a rather unclear separation between the two funding mechanisms.

**Maintenance Budgets:** Maintenance budgets generally relate to recurring annual expenditures and address existing inventories of buildings and systems without adding to the inventories. Maintenance activities are often part of operations budgets or general fund budgets.

**Insurance Budgets:** Financial resources earmarked for insurance may be used in different ways, including the purchase of third-party insurance, the contribution to a regional or statewide risk and insurance pool, and/or the funding a self-insurance reserve. Property and general liability insurance are relevant to facility management considerations.

### ***Influences and Related Seismic Considerations***

As indicated in Figure 7, two internal factors (up arrow) influence budgeting phase decision making.

**Budgetary Constraints:** Internally, political and economic conditions may place limits on hospital budgets. The problem is often exacerbated by unfunded mandates imposed on healthcare organizations by federal and state agencies.

#### **Seismic Consideration**

**The strategy of integrating incremental seismic rehabilitation with other work, which is an integral part of this facility and financial management model, can provide a method for addressing seismic risk reduction within budget constraints. See full discussion of this opportunity in Section B.2.2.6, Seismic Rehabilitation Planning for Specific Buildings.**

**Risk and Insurance Management:** The healthcare organization's risk and insurance management requirements, developed in response to external insurance influences, may have a direct or indirect role in the budget phase of the process regarding the decisions related to insurance. Medicare, for example, sets limits on capital and operating budgets and establishes detailed depreciation schedules, which influence levels of reimbursement.

#### **Seismic Consideration**

**In areas of seismic hazard, the risks of building loss or damage, occupant death or injury, and healthcare organization liability must all be assessed. It must be decided whether to seek earthquake property and casualty insurance coverage and general liability coverage. Insurance companies that offer such coverage do not usually offer incentives to customers to undertake loss reduction measures in the form of seismic rehabilitation. However, this situation might change, and the question may be subject to negotiation.**

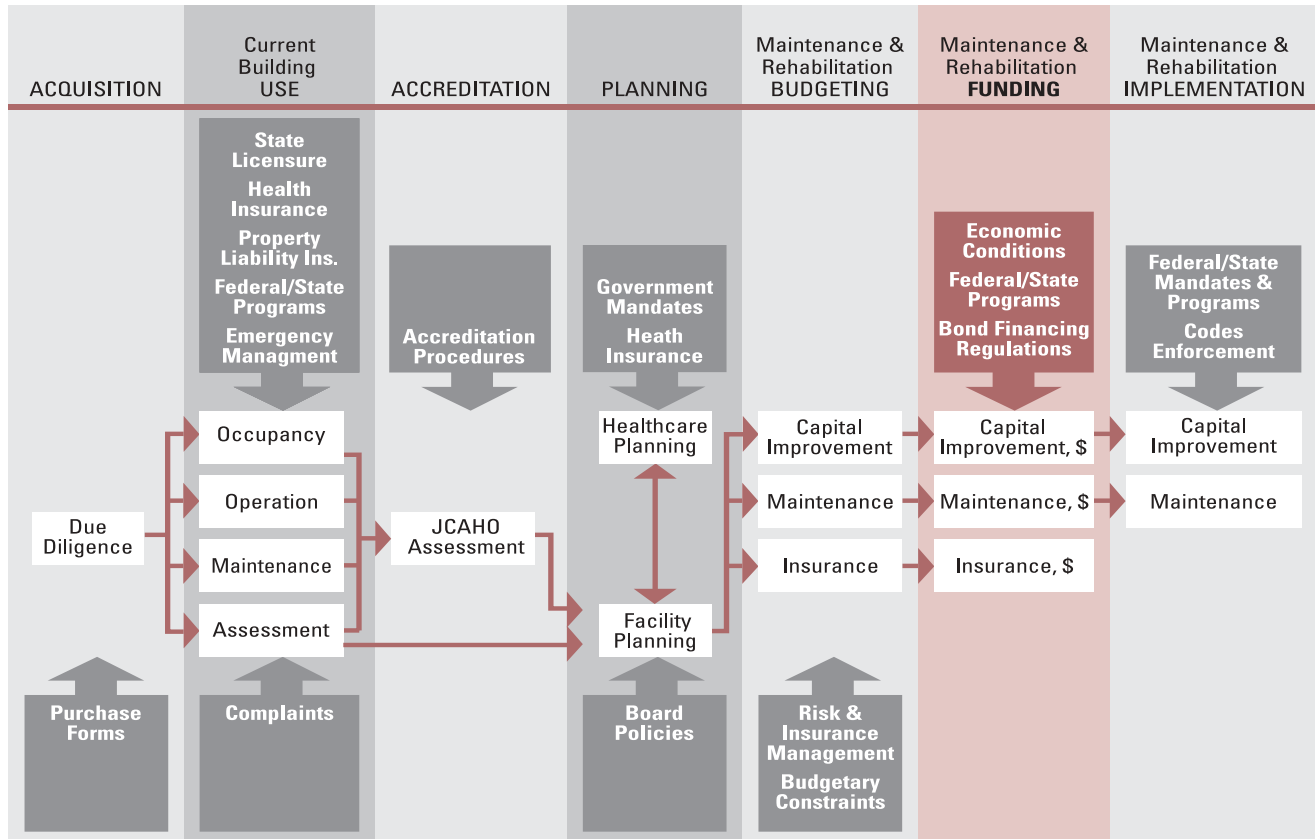


## 6. The Maintenance and Rehabilitation FUNDING Phase of Hospital Facility Management

### Typical Process

The funding phase consists of obtaining the financial resources to meet hospital needs. The funding of hospital budgets in general, and of the three budget elements of capital, maintenance, and insurance, varies from one healthcare organization to another. Funding is influenced externally by regional and local economic conditions, federal and state programs, and bond financing regulations, as depicted in Figure 8.

**Figure 8:  
Funding**



States vary widely in their contribution to local hospital budgets. Some states limit their contribution to capital budgets and others to a general fund.

Healthcare organizations can fund their budgets by various combinations of the following sources: revenue from operations, interest income, debt (bond financing), and taxation (in the case of public hospitals). The latter (debt and taxation) are in some cases controlled or limited by state constitutions or by periodic voter initiatives. Different hospital budgets may be subject to varying requirements of approval of taxation and/or debt by the electorate.

There are many local variations in funding where healthcare organizations, municipalities, and counties have overlapping jurisdictions.

### Influences and Related Seismic Considerations

As indicated in Figure 8, three external factors (down arrow) influence funding phase decision making.

Regional and Local Economic Conditions: Externally, the funding of hospital construction is subject to local and national socio-economic conditions well beyond the control of the healthcare organization. Construction funding depends on interest rates, the region's and organization's bond rating, and similar parameters.

#### **Seismic Consideration**

**Even though seismic rehabilitation is clearly a risk reduction activity, there is no evidence that any healthcare organization has improved its bond rating as the result of undertaking seismic mitigation activities of any kind.**

Federal and State Programs: The funding of hospital construction and rehabilitation may be subject to federal and state programs beyond the control of the healthcare organization.

#### **Seismic Consideration**

**While these programs are not likely to address seismic rehabilitation, they should be taken full advantage of for seismic rehabilitation purposes.**

Bond Financing Regulations: Local administrative procedures and structure in place to obtain bond financing will have a significant impact on the ability of a healthcare organization to achieve its objectives, regardless of whether they include seismic risk reduction or not. Certain types of expenditures out of the proceeds of a bond issue, such as operations or maintenance, may be prohibited by the conditions of the bond.

#### **Seismic Consideration**

**Some seismic rehabilitation increments may be classified as repair or maintenance work, and thereby be precluded from a capital improvement bond. As explained in Section B.2.2.9, Seattle Public Schools used two types of bonds (Capital Levy Bonds and Capital Improvement Bonds) to cover the funding of its incremental seismic rehabilitation program in response to Washington state law.**

## **7. The Maintenance and Rehabilitation IMPLEMENTATION Phase of Hospital Facility Management**

### **Typical Process**

The implementation phase includes design and construction and can be broken into four categories of projects, of which the latter three are relevant to existing buildings:

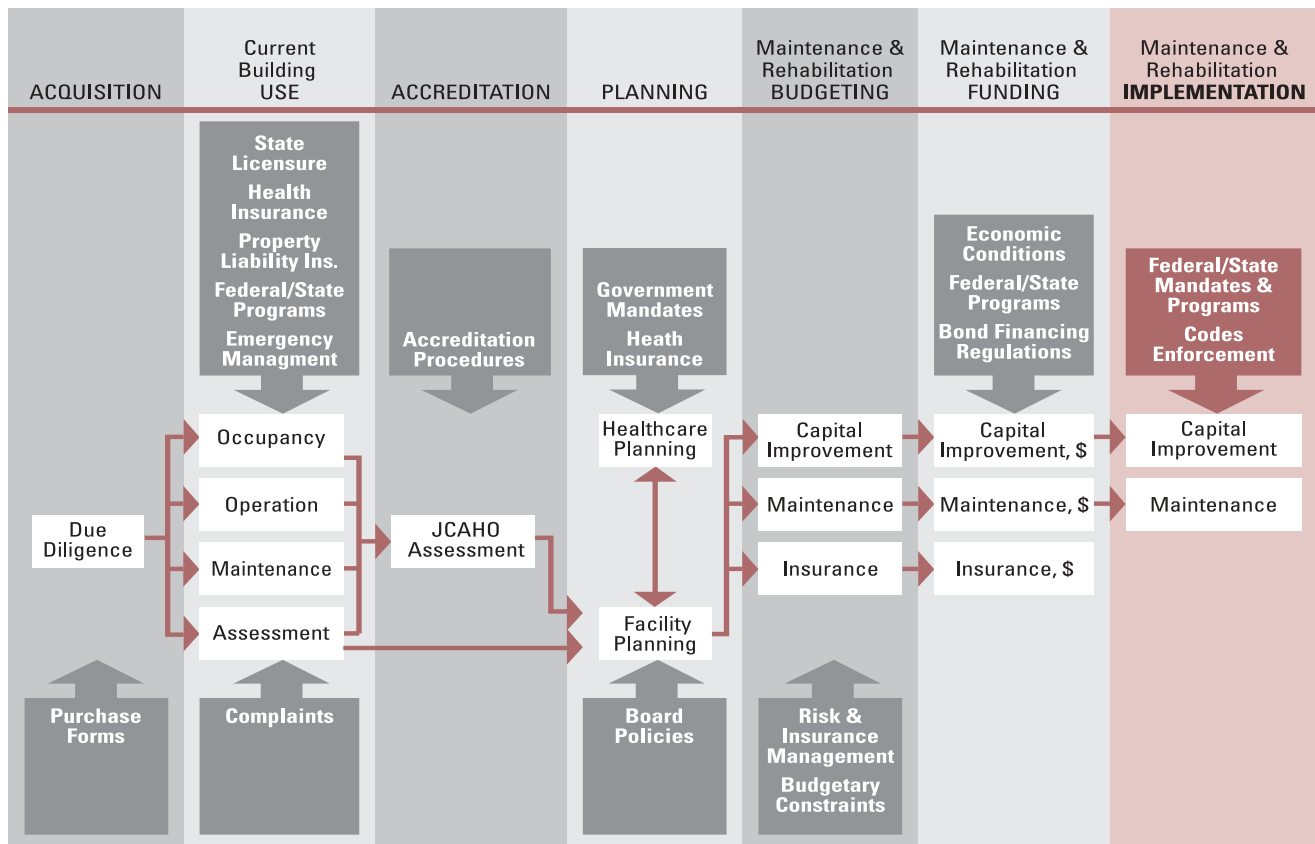
- New building construction projects
- Building acquisition projects
- Capital improvement projects
- Maintenance projects

The implementation phase is primarily affected by external federal and state programs and building code requirements, as depicted in Figure 9.

Acquisition of existing buildings is discussed above as the first phase of the facility management process.

Capital improvement and maintenance projects are managed by healthcare organization or individual hospital staffs, and carried out by these staffs and by contractors. The management of these two categories may be separated or combined, depending on issues of labor jurisdiction and legal authority.

**Figure 9:  
Implementation**



**Influences and Related Seismic Considerations**

As indicated in Figure 9, two external factors (down arrow) influence implementation phase decision making.

Federal and State Mandates and Programs: Externally, federal and state programs may establish requirements affecting the implementation phase (e.g., ADA and OSHA requirements). Additionally, governmental funding programs may mandate requirements for facilities in participating healthcare organizations (e.g., energy conservation).

**Seismic Consideration**

Currently there are no seismic rehabilitation mandates or implications in any federal programs related to existing non-federal hospitals.

Codes and Code Enforcement: Also externally, building codes, as well as the *Life Safety Code*®, impose requirements on the implementation phase, in cases of repair, alteration, or addition to existing buildings. These requirements may be enforced by a state or local agency, or there may be a requirement that hospital building staff be responsible for their enforcement. Such requirements can add costs to a project and jeopardize feasibility, unless done incrementally.

**Seismic Consideration**

Codes do not mandate seismic rehabilitation in repair and alteration projects, though additions must comply with building code seismic requirements. Incremental seismic rehabilitation is consistent with most building code requirements applicable to existing buildings.

