For Facility Managers

Part C

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.

Category 1
Patient Care Improvements

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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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		■	■	■	■	■	■
Structural													
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.

Category 2
New Technology Accommodation

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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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		■	■	■	■	■	■
Structural													
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.

Category 3
Fire and Life Safety Improvements

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*®. 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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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		■	■	■	■	■	■
Structural													
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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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	■	■	■	■	■	■	■
Structural													
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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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		■	■	■	■	■	■
Structural													
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.

Category 6
Underfloor and Basement Maintenance and Repair

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 Seimicity L	M	H	Building Structural Element	Structural Sub-System	Seismic Performance Improvement	Vertical Load Carrying Structure: Wood	Masonry[1]: Unreinforced Masonry	Masonry[1]: Reinforced Masonry	Concrete: Wood Diaphragm	Concrete: Concrete Diaphragm	Steel: Wood Diaphragm	Steel: Concrete Diaphragm
Nonstructural													
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	■	■	■	■	■	■	■
Structural													
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.

Category 7
HVAC Improvements

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.

Category 8
Energy Conservation/ Weatherization/Air Conditioning

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

Category 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.

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 form 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.