NISTIR 6762

PB2002-102211

# Standards of Seismic Safety for Existing Federally Owned and Leased Buildings

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January 2002


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## ACKNOWLEDGMENTS

The Interagency Committee on Seismic Safety in Construction (ICSSC) developed the Standards as part of the continuing effort toward seismic safety for existing Federal buildings. The report was drafted by the National Institute of Standards and Technology (NIST) on behalf of ICSSC Subcommittee 1 and reviewed with the members of Subcommittee 1, who provided valuable input from their agency's perspective. Degenkolb Engineers made a critical review of the draft document. The following persons contributed to this project:

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## PREFACE

In response to Public Law 101-614, the *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary (RP 4)* was issued by the Interagency Committee on Seismic Safety in Construction (ICSSC) in 1994. Pursuant to Executive Order 12941, *the Standards* are periodically updated to incorporate advanced knowledge in earthquake engineering gained from research and from observed performance of structures in recent earthquakes. This document, *Standards of Seismic Safety for Federally Owned and Leased Buildings (RP 6)*, is the revision to *the Standards of Seismic Safety for Owned or Leased Buildings and Commentary (RP 4).*

The intent of the Standards is to identify common minimum evaluation and mitigation measures for all Federal departments and agencies, and to ensure that all federal entities have a balanced, agency-conceived and controlled seismic safety program for their existing owned or leased buildings.

Since the issuance of *RP 4*, the Federal Emergency Management Agency (FEMA) has published a number of documents related to evaluation and rehabilitation of existing buildings. The *Handbook for the Seismic Evaluation of Buildings – A Prestandard (FEMA 310),* supersedes *the NEHRP Handbook for the Seismic Evaluation of Existing Buildings (FEMA 178).* The *Prestandard and Commentary for the Seismic Rehabilitation of Buildings (FEMA 356)* now provides guidance for seismic rehabilitation of buildings. Under the auspices of FEMA, standards for seismic evaluation and rehabilitation are being developed by the American Society of Civil Engineers (ASCE) based on FEMA 310 and FEMA 356. These documents are referenced and cited throughout the standards (RP 6) and as they become available, they will be incorporated into RP 6.

## ABSTRACT

The seismic safety evaluation and mitigation standards, *Standards of Seismic Safety for Existing Federally Owned and Leased Buildings,* were developed for use by the Federal Government by the Interagency Committee on Seismic Safety in Construction (ICSSC) in conjunction with the National Institute of Standards and Technology (NIST) and with the funding support of several ICSSC member agencies. The intent of this document is to provide Federal agencies with minimum (Life-Safety) and extended (Immediate Occupancy) standards for the evaluation and mitigation of seismic risks in their building inventories. This document responds to Executive Order 12941 Sec. 4, which directs the ICSSC to "...update the Standards at least every 5 years," and to "...update the Standards within 2 years of the publication of the First Edition of FEMA's *Guidelines for Seismic Rehabilitation of Buildings and Commentary"* (FEMA 273).

Life-Safety is the minimum acceptable performance objective for Federal buildings. This document further provides for an extended level of performance, Immediate Occupancy, where required to meet agency mission. FEMA 310, *Handbook for the Seismic Evaluation of Buildings – A Prestandard,* and FEMA 356, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, provide the basis for defining these performance objectives, evaluation, and if necessary, mitigation criteria.

The Standards and Commentary include: an identification of situations that trigger application of the Standards, preliminary and detailed evaluation procedures, and mitigation requirements for the two performance levels, Life-Safety and Immediate Occupancy.

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# STANDARDS

## 1.0 INTRODUCTION

The intent of the *Standards of Seismic Safety for Federally Owned and Leased Buildings* (hereinafter referred to as the *Standards*) is to provide Federal agencies with common minimum and higher standards for the evaluation and mitigation of seismic risks in their owned or leased buildings, and privately owned buildings on Federal land to ensure that all agencies have a balanced, agency-conceived and controlled seismic safety program. The *Standards* allow for two levels of seismic performance: a minimum Life-Safety level intended to provide a low risk of earthquake induced life safety endangerment and a higher Immediate Occupancy level, intended to minimize the risk of earthquake-induced impairment of mission, recommended for critical facilities. The *Standards* build upon previous efforts by the Interagency Committee on Seismic Safety in Construction (ICSSC) in support of the National Earthquake Hazards Reduction Program (NEHRP). This document supersedes the Interagency Committee on Seismic Safety in Construction's *Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary* (RP 4).

The *Standards* consist of this Introduction and three additional sections as follows:

The **Application of the *Standards*** section identifies situations that trigger the application of the *Standards*, defines compliance with the *Standards*, and identifies additional measures that must be included in each agency's seismic safety responsibilities for existing buildings.

The **Evaluation Requirements** of the *Standards* identifies building data required before conducting a building evaluation and provides guidance on the application of FEMA 310 and FEMA 356 based on building type and other factors.

The **Mitigation Requirements** section of the *Standards* includes the requirements for mitigation of seismic risks; standards for rehabilitation of structural, non-structural, foundation/geologic/site, and adjacency hazards; guidance on incremental or partial rehabilitation; alternative mitigation methods; and rehabilitation of historic buildings based on FEMA 356.

### C1 INTRODUCTION:

RP 4, published in 1994, was based upon FEMA 178, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings,* which established the criteria for evaluating buildings to a performance level of Substantial Life-Safety. Since the publication of RP 4, several new documents have been published that have made RP 4 obsolete. The *1997 NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures Parts 1 and 2* (FEMA 302 and 303) introduced new seismic hazard maps that better defined the risk of damaging ground shaking across the United States. These design maps were based on probabilistic seismic hazard maps produced by the U.S. Geological Survey. The maps provide median values of 5 % damped spectral accelerations at two periods (0.2 sec and 1.0 sec) for Site

Class B (FEMA 302), with a 2 % exceedance probability in 50 years (return period of about 2500 years). Prior to the 1997 NEHRP Recommended Provisions, ground shaking intensity was characterized by effective peak response acceleration, $A_a$, and effective peak velocity-related response acceleration, $A_v$. These values were derived from maps developed by Algermissen and Perkins for shaking with a 10 % exceedance probability in 50 years (return period of about 500 years) on rock sites.

In 1997, FEMA 273, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* and FEMA 274, *NEHRP Commentary on the Guidelines for the Seismic Rehabilitation of Buildings* were published. A prestandard based upon these documents was issued in November 2000 as *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (FEMA 356) and is accompanied by a resource document entitled, *Global Topics Report on the Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (FEMA 357). FEMA 310, *Handbook for the Seismic Evaluation of Buildings, A Prestandard,* was published in 1998. (It will soon be published by the American Society of Civil Engineers as the ASCE 31 standard.) While FEMA 178 dealt only with the life-safety risk, FEMA 310 and FEMA 356 include procedures for evaluation and rehabilitation of buildings for Life-Safety and Immediate Occupancy performance levels.

## 1.1 Objectives

The primary objective of the *Standards* is to reduce the life-safety risk to occupants of Federal buildings and to the public. Life-Safety is the minimum performance level appropriate for Federal buildings. In addition, the *Standards* provide for a higher level of performance, commonly referred to as Immediate Occupancy, when needed to meet agency mission requirements. Both levels of performance are defined in Section 1.1.1 below.

### C1.1 Objectives:

RP 4 established Substantial Life-Safety as the minimum performance level for Federally owned and leased buildings. Executive Order 12941 directed Federal agencies to adopt RP 4 for use in assessing the seismic safety of their owned and leased buildings and in mitigating seismic risks in those buildings. Recent earthquakes have clearly identified the importance of immediate use of critical facilities after an earthquake. Recognizing this need, FEMA 310 provides for evaluation to a higher level of performance, Immediate Occupancy, in addition to Life-Safety.

The *Standards* are not intended for use in judging the adequacy of past good-faith agency efforts at evaluation and mitigation; they are intended to establish appropriate minimums for actions taken after the *Standards* are formally adopted by the ICSSC.

### 1.1.1 Seismic Rehabilitation Objectives

FEMA 310 defines the Life-Safety and Immediate Occupancy Performance Levels as follows:

**Life-Safety Level:** Building performance that includes significant damage to both structural and nonstructural components during the design earthquake, though at least some margin against

either partial or total structural collapse remains. Injuries may occur, but the level of risk for life-threatening injury and entrapment is low. People will likely be unable to reoccupy the building for continuous use until structural repairs are completed.

**Immediate Occupancy Level:** Building performance that includes very limited damage to both structural and nonstructural components during the design earthquake. The basic vertical and lateral-force-resisting systems retain nearly all of their pre-earthquake strength and stiffness. The level of risk for life-threatening injury as a result of damage is very low. Although some minor repairs may be necessary, the building can be fully occupied after a design earthquake, and the needed repairs may be completed while the building is occupied.

In addition to these performance levels, FEMA 356 defines the Damage Control Structural Performance Range as the continuous range of damage states between the Life Safety Structural Performance Level and the Immediate Occupancy Structural Performance Level. Design for performance within the Damage Control Structural Performance Range may be desirable to minimize repair time and operation interruption, to protect valuable equipment or contents, or to preserve important historic features when the cost of design for Immediate Occupancy is excessive.

### 1.1.2 Additional Objectives

Federal agencies may pursue more stringent standards than Life-Safety for those buildings where a higher performance level is necessary to control damage or maintain post-earthquake operation for mission readiness. The *Standards* provide for evaluation and mitigation of seismic risks in Federal buildings to a performance level of Immediate Occupancy where this higher level of performance is needed. Buildings that must remain fully functional during an earthquake and afterwards (Operational Level) are beyond the scope of the *Standards* and must be evaluated using appropriate, agency specific criteria.

C1.1.2 Additional Objectives

Some Federal agencies own or lease buildings that house facilities that are considered essential or mission critical and should be evaluated to the Immediate Occupancy performance level. The definition of what is "essential" or "mission critical" needs to be determined by each individual agency. As a guide, Section 1.3.1 of *the 2000 Edition, NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA 368) defines the following buildings as essential facilities:

- Fire or rescue and police stations,
- Hospitals,
- Designated medical facilities having emergency treatment facilities,
- Designated emergency preparedness centers
- Designated emergency operation centers
- Designated emergency shelters
- Power generating stations or other utilities required as emergency back-up facilities for Seismic Use Group III (essential facilities)

- Emergency vehicle garages and emergency aircraft hangars
- Designated communication centers
- Aviation control towers and air traffic control centers
- Structures containing sufficient quantities of toxic or explosive substances deemed to be hazardous to the public
- Water treatment facilities required to maintain water pressure for fire suppression

The *Standards* provide tools for evaluating buildings to the Immediate Occupancy performance level. Agencies may, at their discretion, designate buildings other than those listed above to have a performance level of Immediate Occupancy. Levels of performance higher than Immediate Occupancy require consideration of all critical building systems and the availability of utilities. Such consideration is beyond the scope of the *Standards*.

## 1.2 Scope – Compliance Categories

The *Standards* address the potential vulnerability of Federal buildings to all significant seismic risks, which are grouped into four compliance categories:

- Structural,
- Nonstructural,
- Foundation,
- Geologic Site, and
- Adjacency.

The basis for evaluation of buildings within the United States (the fifty states and territories) shall be the Maximum Considered Earthquake (MCE) shaking values obtained from the seismic hazard maps, modified to account for Site *Class* effects and reduced by a factor of 2/3 as found in FEMA 310. The MCE maps show values of 5 % damped, spectral response accelerations with a 2% chance of exceedance in 50 years, except at some sites in highly active seismic regions, where MCE shaking contours are based on maximum magnitude earthquakes on the known faults in the region. As an alternative to using mapped values of MCE shaking demands, site-specific MCE seismic hazards defined using the site-specific procedure described in the *2000 NEHRP Provisions,* incorporating detailed information about a particular site's geology and seismicity, may also be used.

### C1.2 Scope – Compliance Categories

The compliance categories identified – structural, nonstructural, foundation, geologic site, and adjacency – are convenient groupings of sources of potential life-safety risks. Elements of all are included within the scope of FEMA 310. The adjacency category often will directly involve property not owned by the government and may therefore require legal or administrative intervention, rather than engineering solutions.

The seismic maps accompanying the *2000 NEHRP Recommended Provisions* and referenced in the *Standards* represent the varying levels of seismic hazard for all areas in the United States.

These maps should be used by agencies along with site-specific studies (where appropriate) to establish the seismicity of a site.

### 1.2.1 Items Not Included in the *Standards*

The *Standards* do not include means to evaluate or mitigate the effects of:

- flooding,
- fire,
- wind,
- blast, or
- volcanic activity.

The *Standards* also do not address criteria for:

- repair of damaged or deteriorated buildings, including damage caused by previous earthquakes,
- preparation of post-earthquake preparedness plans, or
- seismic instrumentation of Federal buildings.

C1.2.1 Items Not Included in the *Standards*

Although there are obvious interactions between seismic hazards and other natural or manmade threats to buildings, a multi-hazard approach is beyond the scope of this document. However, before mitigation measures are taken for seismic deficiencies, it is strongly suggested that other potential hazards, particularly wind and blast, be considered. It is beyond the scope of these *Standards* to address evaluation and mitigation criteria for damaged or deteriorated buildings, including those buildings damaged by earthquakes. However, any agency conducting an evaluation of a building damaged by any cause must investigate the condition of both the vertical and lateral-force-resisting elements to ensure that these elements can perform dependably during an earthquake.

Seismic instrumentation of Federal buildings is not addressed by the Standards. Agencies should be encouraged to instrument a sample number of Federal buildings to record their responses during seismic events in order to validate and/or improve their expected performance.

## 1.3 Scope – Buildings

Except for buildings that require a seismic performance level beyond Life-Safety or Immediate Occupancy because of agency mission requirements, the following buildings are exempt from the *Standards*:

a. all buildings located in regions of low seismicity where $S_{DS}$<0.167 g, and $S_{D1}$<0.067 g (unless designated by agency as a critical facility),
b. detached one- and two-family dwellings located where $S_{DS}$<0.4 g,

c. detached one- and two-family wood frame dwellings located where $S_{DS} \geq 0.4$ g that satisfy the light-frame construction requirements of the 2000 *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures,*
d. agricultural and storage structures that are intended only for incidental human occupancy or that are occupied by persons for a total of less than 2 hours a day,
e. one story buildings of steel light frame or wood construction with areas less than 280 $m^2$ (3000 $ft^2$),
f. special structures including, but not limited to: bridges, transmission towers, industrial towers and equipment, piers and wharves, and hydraulic structures,
g. fully rehabilitated buildings that comply with these Standards, to the satisfaction of the owning agency, in all compliance categories (structural, nonstructural, foundation, geologic site hazards, and adjacency),
h. post-benchmark buildings as defined in Table 1-1 which also comply with the structural, nonstructural, foundation, geologic site hazards, and adjacency compliance categories and are being evaluated to the Life-Safety Performance Level,
i. pre-benchmark buildings which have been shown by evaluation to the satisfaction of the owning agency to be life-safe in all four compliance categories,
j. buildings constructed for the Federal Government whose detailed design was done after the date of adoption of Executive Order 12699 (January 5, 1990) and that were designed and constructed in accordance with the ICSSC *Guidelines and Procedures for Implementation of the Executive Order on Seismic Safety of New Building Construction,* RP 2.1-A,
k. buildings scheduled for demolition; temporary short-term leases; and foreclosure buildings,
l. the remaining useful life of the building or the agency's requirement for the building has been identified as being less than five years,
m. rehabilitated buildings that substantially comply with RP 4, or other agency specific standards and criteria to the satisfaction of the owning agency, in all four compliance categories (structural, nonstructural, foundation, geologic site hazards, and adjacency).

C1.3 Scope - Buildings

Buildings that require higher performance than Life-Safety should be identified as such prior to their elimination as exempted buildings to assure that they are given adequate consideration. Also, performance expectations for recently constructed buildings should be compared with their required objectives. Benchmark years, suggested in Table 1-1 of the *Standards* (Section 1.3.1), may not be applicable to the higher performance objectives.

The list of buildings that need not meet the *Standards* – either because they are unlikely to present a significant life-safety risk or because they do not fit within the boundaries commonly placed on *building* standards and technology – was developed considering the extent of application of FEMA 310, and previous exemptions listed in *the Standards of Seismic Safety for Existing Federally Owned or Leased Buildings and Commentary*, RP 4, that are still valid.

Item a. is based upon the recommendation by the ICSSC to exempt Federal buildings in regions of low seismicity. Agencies may, at their discretion, choose to apply higher performance levels to buildings located in areas where $S_{DS}$<0.167 g and $S_{D1}$<0.067 g to meet mission requirements. Item b, c, and d are based directly on the extent of application of FEMA 310. FEMA 310 does not automatically exempt any class of buildings, however, based on the exemptions contained in codes for new buildings, agencies may elect to exempt these classes of construction. Items e, g, h, and i have been retained from RP 4.

### 1.3.1 Benchmark Buildings

A benchmark building is one that was designed and built in accordance with adequate seismic provisions, which are considered to provide acceptable life-safety protection. The determination of benchmark years is complex and varies with building location, age, structural system, and governing building code. A table of benchmark years is provided in Table 1-1. Note that if the seismicity of a region has changed since the benchmark dates listed in Table 1-1, a building must have been designed and constructed or evaluated in accordance with the current seismicity of the region to be compliant with the *Standards*. Only buildings designed and constructed in accordance with the documents listed in Table 1-1 and being evaluated to the Life-Safety Performance Level may be considered Benchmark Buildings.

**Table 1-1: Benchmark Buildings**

| | **Model Building Seismic Design Provisions** | | | |
|---|---|---|---|---|
| **Building Type**[1,2] | BOCA | SBCCI | UBC | NEHRP |
| Wood Frame, Wood Shear Panels (Type W1 & W2) | 1993 | 1994 | 1976 | 1985 |
| Wood Frame, Wood Shear Panels (Type W1A) | 1993 | 1994 | 1976 | 1985 |
| Steel Moment Resisting Frame (Type S1 & S1A) | * | * | 1994[4] | ** |
| Steel Braced Frame (Type S2 & S2A) | 1993 | 1994 | 1988[5] | 1991 |
| Light Metal Frame (Type S3) | * | * | * | * |
| Steel Frame w/ Concrete Shear Walls (Type S4) | 1993 | 1994 | 1976 | 1985 |
| Reinforced Concrete Moment Resisting Frame (Type C1)[3] | 1993 | 1994 | 1976 | 1985 |
| Reinforced Concrete Shear Walls (Type C2 & C2A) | 1993 | 1994 | 1976 | 1985 |
| Steel Frame with URM Infill (Type S5, S5A) | * | * | * | * |
| Concrete Frame with URM Infill (Type C3 & C3A) | * | * | * | * |
| Tilt-up Concrete (Type PC1 & PC1A) | * | * | * | * |
| Precast Concrete Frame (Type PC2 & PC2A) | * | * | * | * |
| Reinforced Masonry (Type RM 1) | * | * | 1997 | * |
| Reinforced Masonry (Type RM 2) | 1993 | 1994 | 1976 | 1985 |
| Unreinforced Masonry (Type URM)[6] | * | * | 1991[7] | * |
| Unreinforced Masonry (Type URMA) | * | * | * | * |

[1]Building Type refers to one of the Common Building Types defined in FEMA 310, Table 2-2 (p. 2-6 through 2-10).
[2]Buildings on hillside sites shall not be considered Benchmark Buildings.
[3]Flat Slab Moment Resisting Frame Buildings shall not be considered Benchmark Buildings.
[4]Steel Moment-Resisting Frame Connections shall comply with the 1994 UBC Emergency Provisions, the 1997 UBC, the 1997 AISC Seismic Provisions, the 2000 IBC or FEMA 350; or the analytical evaluation provisions of FEMA 351.

[5]Buildings with thin-walled steel tubes in braced frames shall not be considered Benchmark Buildings.
[6]URM buildings evaluated using the ABK Methodology (ABK, 1984) may be considered benchmark buildings.
[7]Refers to the UCBC.

*No benchmark year; buildings shall be evaluated using the Standards.
**Local provisions shall be compared with the UBC.

BOCA – Building Officials and Code Administrators, *National Building Code.*
SBCCI – Southern Building Code Congress International, *Standard Building Code.*
UBC – International Conference of Building Code Officials, *Uniform Building Code.*
NEHRP – Federal Emergency Management Agency, *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings and Other Structures.*
UCBC – Uniform Code for Building Conservation

Note: Table adapted from fourth ballot version of ASCE Draft Standard for Seismic Evaluation of Existing Buildings.

C1.3.1 Benchmark Buildings

The establishment of benchmark years that will automatically qualify buildings as being structurally adequate is complex. The designation of benchmark years changes to reflect new knowledge gained from studying the performance of buildings in seismic events, from new research results, and other relevant information. Table 1-1 reflects the benchmark years adopted by the ICSSC for Federal Buildings. Benchmark years for any previously used seismic provisions can be established by comparing resulting designs by building types with the acceptance standards. Care must be taken in such comparisons to consider all possible variations of the building type studied.

### 1.3.2 Leased Buildings

The *Standards* shall apply to all or portions of non-Federally owned buildings leased by the Federal Government, unless exempt under the provisions of Section 1.3

The following provisions shall also apply:

a. No new leases or lease renewals/extensions shall be made in buildings that do not comply with the *Standards*.

Exception: If no seismically conforming space is available, otherwise acceptable space with the best seismic resistance shall be pursued.

b. The building owner shall obtain certification by a registered professional engineer that the building conforms to the *Standards*.

C1.3.2 Leased Buildings

Non-federally owned buildings in which the Federal Government leases space are subject to the *Standards*, unless exempt per Section 1.3. RP 4 provided an exception that allowed agencies to continue leasing space in non-conforming buildings if no other conforming space was available.

1.3.3 Privately-Owned Buildings on Federal Land

The *Standards* shall be applied to all privately owned buildings located on Federal land. Application of the *Standards* to evaluation and rehabilitation of seismic risks shall be the responsibility of the building owner.

C1.3.3 Privately-Owned Buildings on Federal Land

Privately-owned buildings on Federal land, such as concessionaire buildings in National Parks, schools on military bases, and buildings constructed and owned by private contractors with long-term exclusive relationships with Federal agencies, were exempted by RP 4. However, the ICSSC has recommended that these buildings be evaluated and that unacceptable seismic risks be mitigated. As a result, the *Standards* shall apply to all privately owned buildings located on Federal land.

## 2.0 APPLICATION OF THE STANDARDS

This section defines those situations that trigger a seismic evaluation and rehabilitation of a Federal building.

### 2.1 Situations Requiring Evaluation and Mitigation

At a minimum, a building shall be evaluated and unacceptable risks mitigated when any of the following occur:

a. a change in the building's function which results in a significant increase in the building's level of use, importance, or occupancy, as determined by the agency,
b. a project is planned which significantly extends the building's useful life through alterations or repairs which total more than *30 %* of the replacement value of the facility.
c. the building or part of the building has been damaged by fire, wind, earthquake, or other cause to the extent that, in the judgement of the agency, significant structural degradation of the building's vertical or lateral load carrying systems has occurred,
d. the building is deemed by the agency to be an exceptionally high risk to occupants or the public at large, or
e. the building is added to the Federal inventory through purchase or donation after adoption of the *Standards*.

### C2.1 Situations Requiring Evaluation and Mitigation

Seismic risk mitigation programs consist of both "active" and "passive" components. "Active" components of a seismic risk mitigation program specifically require some action to be taken, such as inventory, evaluation, planning for rehabilitation, and rehabilitation of buildings.

The focus of the "passive" components or "triggers" is on changes to the building which increase its life or value or will increase the risk level of the building, such as a change in occupancy. The philosophy of the use of triggers is to achieve safety similar to a new building when renovating an old building. Such triggers also serve to gradually reduce the overall seismic risk presented by the existing building stock. Since such triggered improvements will be done concurrently with significant non-seismic work, the cost and disruption attributable to the seismic rehabilitation is minimized.

In the private sector, strict enforcement of such triggers has also served to effectively limit improvements to the existing building stock and at times has encouraged careful planning to avoid the triggers.

The basic triggers listed in this section encourage consistent application of the "renovation" philosophy discussed above. Because of the efficiency of combining seismic rehabilitation with other work, additional triggers may be advantageous for each agency considering characteristics of its own program.

The definition of the term "exceptionally high risk" varies from agency to agency but is based upon consideration of one or more of the following factors: (1) seismicity of the building site,

(2) structural system, (3) number of occupants, (4) date of construction, (5) number of stories, (6) occupancy type, (7) size (area), (8) structural irregularities, (9) unusual building geometry or characteristics, and (10) importance of building to agency mission.

A building presenting an "exceptionally high risk" may be discovered at any time, either in a systematic evaluation process, or by review of the building for other purposes. A plan to reduce such high risks should be developed immediately. One or more of the mitigation measures listed in Section 4.1 should be considered.

Item e. is intended to prevent unsafe buildings from being permanently added to the Federal inventory, by triggering a seismic evaluation and if necessary, mitigation, when they are acquired. It is not intended to apply to buildings temporarily under Federal ownership, such as those in the assets of failed banks placed under Federal guardianship. Newly leased buildings are covered in Section 1.3.2.

## 2.2 Compliance

A building is considered to be in compliance with the *Standards* if the building is:

a. exempt from the *Standards* in accordance with Section 1.3,
b. determined by evaluation to be in compliance with the *Standards* in accordance with Section 3.0, or
c. unacceptable seismic risks have been mitigated in accordance with Section 4.0.

Compliance with the *Standards* should result in a minimum performance level of Life-Safety. The *Standards* also provide for the evaluation of buildings and mitigation of seismic risks to meet the higher performance level of Immediate Occupancy where this level of performance is required to meet the agency's mission.

## 2.3 Qualifications of Evaluators, Designers, and Reviewers

In general, all evaluation, development of mitigation approaches, and design of rehabilitation work shall be prepared by a registered professional engineer with experience in the type of work being considered. For independent peer reviews of alternative or innovative evaluation methods, analysis techniques or rehabilitation concepts required by the *Standards*, an individual highly qualified in the field of earthquake engineering or a panel of such individuals should be selected by the agency. Tier 2 and Tier 3 evaluations in accordance with FEMA 310 of potential foundation deficiencies, and geologic site hazards should be conducted by a geotechnical engineer or engineering geologist qualified to perform the work by registration and/or experience.

### C2.3 Qualifications of Evaluators, Designers, and Reviewers

Registered engineers should be used to evaluate seismic risks for each of the four compliance categories for a specific building and to plan rehabilitation schemes necessary for mitigation. The experience and qualifications of the individuals should match the scope and complexity of

the assignment. Registration as a Professional Engineer is intended to ensure that an individual possesses at least a familiarity with design and analysis of buildings for lateral loads. In addition, training and experience in seismic investigations should be required.

Those with a minimum amount of such background experience may be qualified for relatively small and simple buildings. Highly qualified individuals may be required for complex buildings or for peer review. Such persons will likely have academic credentials far beyond the bachelor level with courses in structural dynamics, inelastic analysis, and other topics in advanced earthquake engineering. They may have published technical articles on seismic issues of existing structures or be active in related professional organizations. Their project experience should relate specifically to seismic investigations of structures. They should be capable of providing personal references attesting to their successful completion of projects similar to that contemplated by the agency.

A specialist in geology or geotechnical engineering should be used for evaluation of foundation deficiencies and geologic site hazards.

## 2.4 Additional Requirements

As part of each agency's seismic safety responsibilities for existing buildings, the following measures shall be implemented as appropriate:

a. development of standards for seismic performance levels higher than Life-Safety and Immediate Occupancy if necessary to carry out agency mission,
b. development and dissemination of agency-specific policies consistent with all provisions of the *Standards*,
c. assurance that consistent measures of quality control are included in such policies and applied to all phases of evaluation, design, and construction, in a manner consistent with FEMA 310 and FEMA 356, and
d. assurance that agency-specific standards and procedures for evaluation and mitigation of hazards are substantially equivalent to or more stringent than FEMA 310 and FEMA 356 or successor documents adopted by the ICSSC.

## C2.4 Additional Requirements

Item c., quality control, cannot be overlooked in a seismic hazard mitigation project. All phases of a project, including evaluation, design, and construction, must be monitored and evaluated to be successful. Guidance from documents like the Standards, FEMA 310, and FEMA 356/357 is needed in order to consistently identify and improve seismically hazardous buildings. However, earthquake engineering is not an exact science. Codes are constantly developing in an attempt to incorporate new research results and to balance safety, building performance, and cost. Considerable engineering judgement is required to properly apply the provision of the *Standards* to existing buildings. Reviews of evaluations for consistency, of construction documents for adequacy, and of construction itself for compliance with drawings and construction standards are all essential to maximize effectiveness of the project.

Item d. is intended to serve as a generalized "grandfather" clause. It is not the intent of the *Standards* to rewrite agency procedures but to set common minimum standards for use by all Federal agencies. Once the Standards are formally adopted for Federal use, each agency should be able to demonstrate that its existing programs meet or exceed the *Standards*, which should be considered a minimum acceptable level of seismic safety for Federal buildings.

## 3.0 EVALUATION

The purpose of the evaluation described in this section is to determine whether buildings meet the Life-Safety or Immediate Occupancy performance levels as required to meet agency mission. FEMA 310 provides a seismic evaluation process for existing buildings in any region of seismicity to either the Life-Safety or Immediate Occupancy levels. The flowchart shown in Figure 3-1 provides an overview of the evaluation process, but does not include further evaluation steps that may be required based on irregularities or height limits for model building types. Note also that an agency may determine, through a risk assessment, that the level of risk is sufficiently low that mitigation is not required.

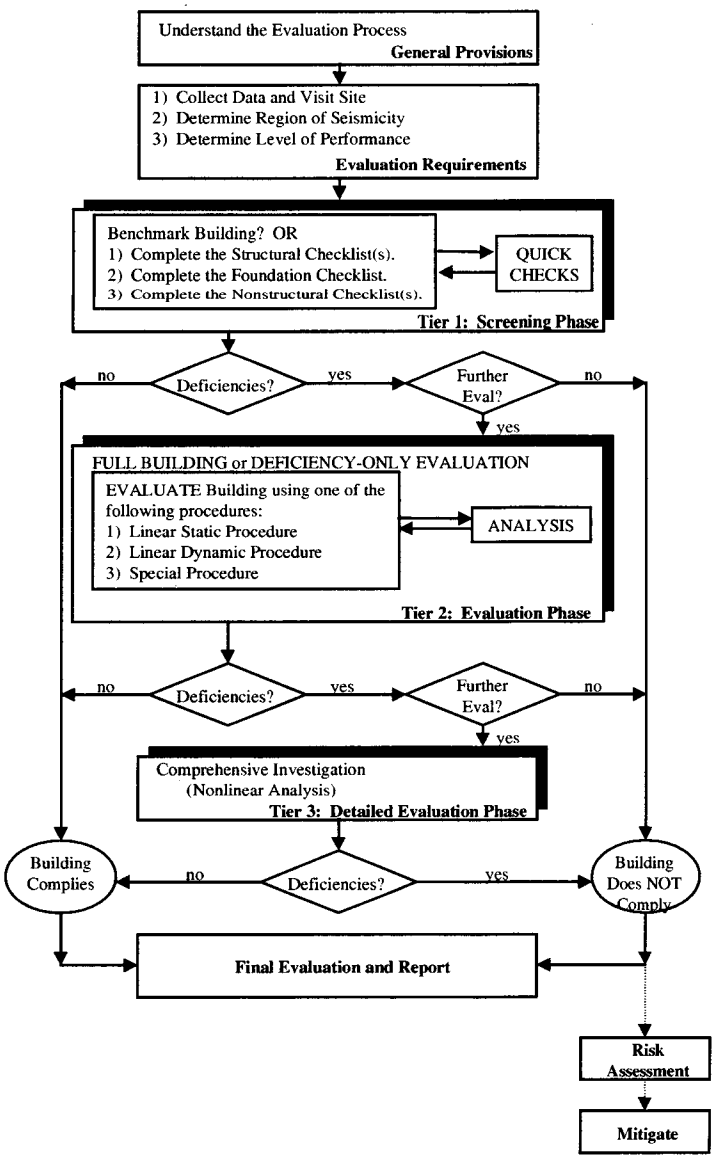


**Figure 3-1: Schematic of Evaluation Process.**

## 3.1 Evaluation Requirements

Seismic evaluation of a building for a specific performance level shall be carried out to satisfy the objectives of the *Standards* (Section 1.1). The level of performance shall be established by the agency having the jurisdiction over the building.

All buildings that do not meet the exemption criteria defined in Section 1.3 shall be evaluated using the procedures set forth in FEMA 310 or successor document. Buildings complying with the intent of all the requirements of FEMA 310 (or successor document) shall be deemed to meet the specified performance level, either Life-Safety or Immediate Occupancy.

Buildings may be evaluated for higher levels of performance than Life-Safety and Immediate Occupancy by other well-established procedures based on rational methods of analysis.

### C3.1 Evaluation Requirements

FEMA 310 provides a three-tier process for seismic evaluation of existing buildings. The procedures allow buildings to be evaluated to either the Life-Safety or Immediate Occupancy level. A Tier 1 evaluation shall be conducted for all non-exempt buildings in accordance with the requirements of Chapter 3 of FEMA 310. The Tier 2 evaluation is intended to be a detailed follow-up on the potential deficiencies that are identified by the Tier 1 evaluation. For relatively short, regularly configured buildings with a predictable earthquake performance record, the Tier 2 evaluation need only address the identified deficiencies as outlined in FEMA 310. A full building evaluation is not needed since it will likely not identify any other deficiencies that need attention. For all other buildings, a full building evaluation is needed along with the detailed consideration of the identified deficiencies to assure that the performance objective is properly addressed. Full building Tier 2 or Tier 3 evaluations are required for Immediate Occupancy performance level, taller buildings, and buildings that resist earthquakes in a complex manner. The evaluation process may be terminated and the building deemed to be compliant with the *Standards*, if the results of analysis demonstrate that the building or its elements satisfy performance requirements.

Special and historic buildings, because of their importance and value to the society, may be evaluated to an appropriate level of performance using rational methods of analysis based on principles of mechanics. The performance level may be better than or less than required for life-safety, depending on the building and whether the historic fabric is to be protected adequately. It is important to note that FEMA 310 is intended to serve as a guideline reference for evaluation of buildings, but strict adherence to the letter of the document may not be appropriate at all times. Engineering judgement must be applied in situations where FEMA 310 is silent or not applicable. What is important is that agencies meet the intent of FEMA 310, i.e. meet the performance goal desired, when evaluating their buildings.

## 4.0 MITIGATION

### 4.1 Requirements

Rehabilitation of buildings shall be performed in accordance with FEMA 356 or other methods that are consistent with and achieve a Performance Level that is equivalent to those prescribed in the *Standards*. Alternatives to rehabilitation include, but are not limited to the following:

a. removal of the building from an agency inventory by termination of lease agreement, sale with full disclosure, or demolition.

b. permanent evacuation of the building, or

c. change in occupancy of the building such that it becomes exempt in accordance with Section 1.3.

**C4.1 Requirements**

The *Standards* require reducing the risk to life loss in all federally owned and leased buildings and in private buildings on Federal land in the largest expected earthquake and acceptable performance of buildings requiring immediate occupancy as specified by each agency. Mitigation measures may or may not include rehabilitation of the building itself. In some cases, the nature or extent of necessary rehabilitation can be so extensive that abandonment and relocation is a cost effective alternative.

### 4.2 Minimum Standards and Scope for Rehabilitation

If shown by evaluation that the desired performance level is not satisfied, the rehabilitation of any building or site to attain the Life-Safety level and/or the Immediate Occupancy level shall satisfy substantially the requirements of FEMA 356.

**C4.2 Minimum Standards and Scope for Rehabilitation**

Since FEMA 310 is not a design standard, rehabilitation work must comply with FEMA 356 or agency standards if their requirements are more stringent than FEMA 356.

### 4.3 Incremental/Partial Rehabilitation

Risk-reduction by incremental or partial rehabilitation of a building is acceptable as an interim step in a complete seismic mitigation process. It shall be permitted only if the partial rehabilitation is designed and constructed in accordance with FEMA 356 and takes into account future completion of the rehabilitation objective. In addition, such partial rehabilitation shall comply with the following conditions:

a. The rehabilitation measures shall not result in a reduction in the performance level of the existing building;

b. The rehabilitation measures shall not create a new structural irregularity or make an existing structural irregularity more severe; and
c. All new or rehabilitated structural components and elements shall be detailed and connected to the existing structure in compliance with the requirements of FEMA 356.

C4.3 Incremental/Partial Rehabilitation

For a variety of reasons, it may be necessary to complete a rehabilitation project in several phases. This practice is acceptable as long as rehabilitation measures do not reduce the performance level of the existing structure at any time, except during actual rehabilitation construction. The requirement demands careful consideration of the performance of the structure after each increment of rehabilitation in accordance with FEMA 356.

## 4.4 Local Modification of Components

Local modification of deficient components shall be permitted as an applicable rehabilitation measure as long as the resultant rehabilitation conforms to FEMA 356.

C 4.4 Local Modification of Components

Some existing buildings have substantial strength and stiffness, but some of their components may not have adequate strength, toughness, or deformation capacity to satisfy the rehabilitation objectives. An appropriate rehabilitation measure for such structures may be to perform local modifications of components that are inadequate while retaining the basic configuration of the building's lateral-force resisting-system provided that the rehabilitation measures conform to FEMA 356.

## 4.5 Removal or Lessening of Existing Irregularities

Removal or lessening of existing irregularities shall be permitted as an applicable rehabilitation measure, provided the completed rehabilitation conforms to FEMA 356.

C4.5 Removal or Lessening of Existing Irregularities

Removal or lessening of existing irregularities may be an effective rehabilitation measure if a seismic evaluation shows that the irregularities result in the inability of the building to meet the performance objective but that their removal would achieve it.

## 4.6 Innovative Mitigation Methods

Innovative mitigation methods that are beyond the scope of the requirements of FEMA 356 shall be permitted, provided an analytical procedure acceptable to the agency shows that the required performance level is attained. When new and innovative rehabilitation techniques are proposed for a specific building, a peer review panel, acceptable to the agency, shall determine the adequacy of the mitigation techniques proposed by the engineer (see Section 2.3).

C4.6 Innovative Mitigation Methods

New materials and structural systems, or other non-complying techniques are generally allowed by building codes subject to some form of review and approval. Generally, the alternative methods must conform to the intent of the prevailing standard. This allowance is particularly important for the seismic rehabilitation of existing buildings due to large numbers of special conditions that inevitably arise. Many private and public institutions have established procedures for peer review. Some have standing panels; others hire reviewers specifically for projects when the need arises. Agencies should establish policies to ensure the independence and qualifications of the reviewers. The policy should also cover the general procedures to be followed by the engineer and the reviewers.

## 4.7 Historic Buildings

Historic buildings shall not be exempted from the *Standards*, and depending upon their use may be required to meet the same performance objectives as all other buildings in the Federal inventory. Many codes covering historic buildings allow some flexibility in required performance depending on the effect of rehabilitation on important historic features. In some cases, it may be appropriate to rehabilitate an historic building to the Damage Control Structural Performance Range per FEMA 356 to ensure that the architectural fabric survives certain earthquakes.

In preserving the historic fabric of these buildings, publications such as the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* and *Standards for the Treatment of Historic Properties* shall be used. Alternative methods of mitigation of seismic risks for historic buildings shall be permitted subject to the requirements of Section 4.6.

C4.7 Historic Buildings

The rehabilitation of historic buildings is a sensitive process. The design professionals must take care to protect the historical character and fabric of the building as much as possible. This reduces the flexibility and freedom to make alterations to the structure. In the development of mitigation strategies, consideration must be given to the architectural and historic value of the building. Many codes covering historic buildings allow some amount of flexibility in required performance, depending upon the effect of rehabilitation on important historic features. Modern building standards, including FEMA 356, do not specifically cover the use of all archaic materials and systems. The intent of the *Standards* is to provide essentially the same level of seismic performance objectives as for others without unreasonable impediment to the historic preservation process. Consequently, alternative mitigation methods (see Section 4.6) are allowed and encouraged when they can lessen the impact of the structural strengthening.

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