ATC 71

NEHRP Workshop on Meeting the Challenges of Existing Buildings

Part 3: Action Plan for the FEMA Existing Buildings Program

Applied Technology Council

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Applied Technology Council

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Cover illustration: Non-ductile concrete frame structure with wood diaphragms retrofitted with reinforced concrete shear walls.

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Part 3: Action Plan for the FEMA Existing Buildings Program

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Preface

In September 2006 the Federal Emergency Management Agency (FEMA) awarded the Applied Technology Council (ATC) a multi-year project, under Task Order Contract HSFEHQ-04-D-0641, to carry out the Program Definition and Guidance Development Phase of a longer term effort intended to "Update Seismic Rehabilitation Guidance". Designated the ATC-71 Project, its purpose was to develop and produce a comprehensive seismic rehabilitation guidance package for FEMA, including necessary implementation strategies for the creation, update, and maintenance of seismic evaluation and seismic rehabilitation documents for existing buildings.

Guidance developed under the ATC-71 Project will explore new and creative ways to promote more widespread evaluation and rehabilitation of vulnerable existing buildings by addressing the technical and practical needs of engineering practitioners, and the policy, implementation, and regulatory needs of building officials, government agencies, and other stakeholders with jurisdiction over existing buildings.

The initial major activity was the *NEHRP Workshop on Meeting the Challenges of Existing Building,* which was held in San Francisco on September 19-20, 2007. The Workshop was co-organized by ATC and the Earthquake Engineering Research Institute, and funded by all four agencies of the National Earthquake Hazards Reduction Program (NEHRP): FEMA, the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the U.S. Geological Survey (USGS).

This report is Part 3 of a series of reports to be produced under the ATC-71 Project, and provides guidance for the FEMA Existing Buildings Program in the form of an action plan. It is also one in a collection of reports arising from the NEHRP Workshop that includes the ATC-71 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 1: Workshop Proceedings* (ATC, 2008); ATC-71 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings* (ATC, 2009); and the ATC-73 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings* (ATC, 2007).

This action plan is intended to chart a path for FEMA's Existing Buildings Program that both reflects its core NEHRP mission to serve as the interface between government and existing buildings stakeholder communities, and to leverage its resources in conjunction with the interests of its strategic partners.

ATC is indebted to the ATC-71 Project Management Committee, including Andy Merovich (Lead Technical Consultant), David Bonowitz, Larry Brugger, Craig Comartin, Ed Dean, and Jim Harris for their efforts in collecting the necessary information and preparing this report. Review and guidance was provided by a Project Review Panel consisting of Richard Bernknopf, Nick Delli Quadri, Melvyn Green, Nathan Gould, Chris Poland, and Thomas Tyson. Thomas R. McLane served as ATC Project Manager for this work. The affiliations of these individuals are included in the list of Project Participants.

ATC also gratefully acknowledges Cathleen Carlisle (FEMA Project Monitor) and Dan Shapiro (FEMA Subject Matter Expert) for their input and guidance in the preparation of this report, and Peter Mork for ATC report production services.

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Executive Summary

In 1977, Congress first authorized the National Earthquake Hazards Reduction Program (NEHRP) to reduce the risks of life and property from future earthquakes in the United States. The program was formulated to include the integrated efforts of four agencies: the National Institute of Standards and Technology (NIST), which serves as the lead agency, the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF) and the U.S. Geologic Survey (USGS). Through a sequence of recurring reauthorizations, the NEHRP agencies work to achieve the vision, mission, goals and objectives of a strategic plan to address this Congressional mandate in a cooperative sharing of responsibilities that are generally aligned with the missions of each agency.

In broad terms, the NEHRP agencies support program objectives by providing: (1) basic research; (2) applied research; and (3) dissemination and implementation activities. As lead NEHRP agency, NIST provides overall direction, coordination and support of joint activities. In addition, NIST generally provides support in the applied research and development area. FEMA generally provides dissemination and implementation support, NSF generally supports activities that are in the basic research area, and the USGS provides some support for basic research and some for applied research and development. A strategic priority of the current NEHRP strategic plan (2009-2013) calls for focused activity to "improve techniques for evaluating and rehabilitating existing buildings."

Since 1984, FEMA has sponsored efforts to address the problems of seismically hazardous existing buildings. FEMA's support has led to an extensive collection of publications that provide technical and public policy guidance regarding the identification of seismic risk and mitigation through building rehabilitation. The development of these products has been substantially accomplished through FEMA's Existing Building's Program. With the release of the American Society of Civil Engineers (ASCE) reference standards ASCE 31, *Seismic Evaluation of Existing Buildings*, and ASCE 41, *Seismic Rehabilitation of Existing Buildings*, which are based on the FEMA 310 *Handbook for the Seismic Evaluation of Buildings: A Prestandard*, and the FEMA 356 *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, respectively, FEMA has achieved a major accomplishment in supporting the development of a set of nationally

applicable, consensus-based, engineering guidance documents on the seismic evaluation and rehabilitation of existing buildings.

The ATC-71 Project was initiated with the objective of developing a prioritized list of tasks that best serve the overarching goal of increasing the number of identified "at risk" buildings and reducing their risk to an acceptable level by rehabilitation. This included the development of recommendations for promoting and updating the ASCE 31 and ASCE 41 standards to reflect the latest research and other technical developments that facilitate their broader application.

Arriving at this prioritized list involved the identification of current challenges associated with existing buildings and the collection of information describing the current status of seismic evaluation and rehabilitation practice in the United States. This information was developed through a process that involved research, interviews, and a 2-day workshop (*NEHRP Workshop on Meeting the Challenges of Existing Buildings*, September 2007) that included the active participation of over 90 individuals representing the viewpoints of engineering practitioners, researchers, regulators, building owners, and public policy experts. Documentation of this process and information used as a basis for identifying and setting priorities are provided in the companion ATC-71 Reports, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 1: Workshop Proceedings,* and *Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings*.

Resulting priority needs were divided into five thematic areas that facilitated the generation of activities to address them. These are:

1. Facilitate Framework to Update Existing Building Standards
2. Develop and Improve Actionable Understanding of Earthquake Risk
3. Develop Simplified Evaluation and Rehabilitation Procedures
4. Improve Education and Training of Engineering Professionals
5. Develop New Products

Activities were then developed to address needs in each of these thematic areas in alignment with NEHRP Strategic Objectives and Strategic Priorities.

A total of 28 activities were defined for consideration within FEMA's Existing Buildings Program. These activities were prioritized to reflect their urgency for supporting the ongoing programs of other strategic partners as well as the anticipated duration of the activity. The prioritization process

resulted in 11 activities for initiation in the near-term, 8 activities for initiation in the mid-term, and 7 activities for initiation in the long-term. The plan is anticipated to encompass a 10-year time frame. A summary outline of recommended activities by thematic area and priority (near-term, mid-term, and long-term) is as follows:

1. **Facilitate Framework to Update Existing Building Standards**

    - Activity A5: Support Development of Standards Update Framework (near-term)
    - Activity A7: Develop Consensus Code Change Proposals to Align the Provisions of the IBC, IEBC, and IRC (near-term)
    - Activity A11: Framework for Convening Issue Teams to Move Research into Practice (near-term)
    - Activity A13: Develop Recommendations for Treatment of Earthquake Hazard Issues for Existing Buildings (mid-term)
    - Activity A16: Define Test Beds and Case Studies (mid-term)
    - Activity A18: NEHRP Existing Building Workshop Support (mid-term)
    - Activity A19: Coordinate Recommendations for Evaluation & Rehabilitation of Nonstructural Components (mid-term)

2. **Develop & Improve Actionable Understanding of Earthquake Risk**

    - Activity A3: Monitor Use of ASCE 31 and ASCE 41 for Projects Triggered by Codes (near-term)
    - Activity A4: Develop Community Building Inventories (near-term)
    - Activity A6: Enhance LEED Ratings for Resilience (near-term)
    - Activity A10: Develop & Promote Earthquake Risk Communication Tool (near-term)
    - Activity A17: Develop and Disseminate Policies and Guidance for Various Mitigation Approaches (mid-term)
    - Activity A21: Benchmark Model Building Expected Performance (long-term)

- Activity A25: Prepare White Paper on Seismic Rehabilitation and Social Vulnerability (long-term)
- Activity A26: Develop Methodology for Tracking the Progress of Earthquake Risk Reduction (long-term)

3. **Develop Simplified Evaluation and Rehabilitation Procedures**
   - Activity A8: Develop Simplified Evaluation and Rehabilitation Guidance (Regional Module) (near-term)
   - Activity A24: Develop Simplified Rehabilitation Guidance (General Module) (long-term)
4. **Improve the Education & Training of Engineering Professionals**
   - Activity A9: Develop Seismic Evaluation & Rehabilitation Example Applications (near-term)
   - Activity A12: Promote Incremental Seismic Rehabilitation Guidance (mid-term)
   - Activity A14: Develop Nonlinear Analysis Modeling Guidelines (mid-term)
   - Activity A15: Promote Education and Training of Engineering Professionals (mid-term)
5. **Develop New Products**
   - Activity A1: Develop Earthquake Performance Rating System for Buildings (near-term)
   - Activity A2: Develop Rehabilitation Cost Guidance (Update FEMA 156 and FEMA 157) (near-term)
   - Activity A20: Develop Business Continuity Earthquake Planning Guidelines (long-term)
   - Activity A23: Develop Guidelines for Seismic Rehabilitation of Historic Structures (long-term)

Implementation of the activities recommended in this Action Plan is intended to achieve the following objectives:

- Facilitate technical improvements to existing building codes and standards for seismic evaluation and rehabilitation;
- Increase the number of seismically at risk buildings being identified and rehabilitated;

- Address the highest priority impediments to more widespread seismic evaluation and rehabilitation of existing buildings as identified by representatives of existing building stakeholder communities; and
- Support dissemination of NEHRP-sponsored basic and applied research to improve the climate for more widespread seismic evaluation and rehabilitation to reduce future earthquake losses.

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Chapter 1
Introduction

1.1 Background

In 1977, Congress first authorized the National Earthquake Hazards Reduction Program (NEHRP) to reduce the risks of life and property from future earthquakes in the United States. The program was formulated to include the integrated efforts of four agencies: the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF) and the U.S. Geologic Survey (USGS). Through a sequence of recurring reauthorizations, the NEHRP agencies work to achieve the vision, mission, goals and objectives of a strategic plan to address this Congressional mandate in a cooperative sharing of responsibilities that are generally aligned with the missions of each agency.

In broad terms, the NEHRP agencies support program objectives by providing: (1) basic research; (2) applied research; and (3) dissemination and implementation activities. NIST presently serves as the lead agency for NEHRP, and provides overall direction, coordination and support of joint activities. In addition, NIST generally provides support in the applied research and development area. NSF generally supports activities that are in the basic research area, USGS provides some support for basic research and some for applied research and development, and FEMA generally provides dissemination and implementation support. A brief summary of the current NEHRP strategic plan (2009-2013) is provided in Appendix A. A strategic priority of the current plan calls for focused activity to "improve techniques for evaluating and rehabilitating existing buildings."

Since 1984, FEMA has sponsored efforts to address the problems of seismically hazardous existing buildings. FEMA's support has led to an extensive collection of publications that provide technical and public policy guidance regarding the identification of seismic risk and mitigation through building rehabilitation. The development of these products has been substantially accomplished through FEMA's Existing Buildings Program.

To guide the process of selecting projects that will be the most effective in promoting seismic evaluation and rehabilitation of potentially vulnerable buildings, the Existing Buildings Program has relied on the development of the FEMA 90 Report, *An Action Plan for Reducing Earthquake Hazards of*

Existing Buildings, and the FEMA 315 Report, *Seismic Rehabilitation of Buildings: Strategic Plan 2005*. Each of these plans has identified specific tasks that were intended to accomplish important objectives in support of achieving the overall goal of reducing future earthquake losses.

In *Strategic Plan 2005*, important Existing Buildings Program objectives included the development of new seismic rehabilitation tools and the identification of new program directions. With the release of the American Society of Civil Engineers (ASCE) reference standards ASCE 31, *Seismic Evaluation of Existing Buildings*, and ASCE 41, *Seismic Rehabilitation of Existing Buildings*, which are based on the FEMA 310 *Handbook for the Seismic Evaluation of Buildings: A Prestandard*, and the FEMA 356 *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, respectively, FEMA has achieved a major accomplishment in supporting the development of a set of nationally applicable, consensus-based, engineering guidance documents on the seismic evaluation and rehabilitation of existing buildings. Even so, there are other tasks that have not yet been undertaken to advance these objectives.

1.2 Scope and Objectives

The ATC-71 Project was initiated with the objective of developing a prioritized list of tasks that best serve the overarching goal of increasing the number of identified "at risk" buildings and reducing their risk to an acceptable level through rehabilitation. This included the development of recommendations for promoting and updating the ASCE 31 and ASCE 41 standards to reflect the latest research and other technical developments and facilitate their broader application. It also included the development of recommendations to:

- Facilitate technical improvements to existing building codes and standards for seismic evaluation and rehabilitation;
- Increase the number of seismically at risk buildings being identified and rehabilitated;
- Address the highest priority impediments to more widespread seismic evaluation and rehabilitation of existing buildings, as identified by representatives of existing building stakeholder communities; and
- Support dissemination of NEHRP-sponsored basic and applied research to improve the climate for more widespread seismic evaluation and rehabilitation to reduce future earthquake losses.

1.3 Approach

Arriving at a prioritized list of activities involved the identification of current challenges associated with existing buildings and the collection of information describing the current status of seismic evaluation and rehabilitation practice in the United States. This information was developed through a process that involved research, interviews, and a 2-day workshop (*NEHRP Workshop on Meeting the Challenges of Existing Buildings*, September 2007) that included the active participation of over 90 individuals representing the viewpoints of engineering practitioners, researchers, regulators, building owners, and public policy experts. Documentation of this process and information used as a basis for identifying and setting priorities are provided in the companion ATC-71 Reports, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 1: Workshop Proceedings,* and *Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings*.

Based on information obtained in workshop deliberations and in the development of the status report, a prioritized list of needs was generated. This list was subsequently screened to eliminate needs being addressed by other ongoing efforts within FEMA and its strategic partners (NIST, NSF, and USGS). Remaining priority needs were divided into five thematic areas that facilitated the development of activities to address them. These are:

1. Facilitate Framework to Update Existing Building Standards
2. Develop and Improve Actionable Understanding of Earthquake Risk
3. Develop Simplified Evaluation and Rehabilitation Procedures
4. Improve Education and Training of Engineering Professionals
5. Develop New Products

Within these thematic areas, recommended activities were developed for possible action within FEMA's Existing Buildings Program. They were defined to include the participation of strategic partner organizations, where appropriate, and were prioritized into recommended activities for the near-term (1-3 years), mid-term (4-6 years), and long-term (7-10 years).

1.4 Report Organization and Content

This action plan is Part 3 in a series of reports to be produced on the ATC-71 Project. It describes a prioritized list of activities for FEMA's Existing Buildings Program that is based on the needs identified by a diverse group of existing building stakeholder groups.

Chapter 1 provides background information on the National Earthquake Hazards Reduction Program, and the scope, objectives, and project approach. Chapter 2 summarizes existing building stakeholder needs based on the findings from the workshop and status report phases of investigation. Chapter 3 discusses the alignment of needs with potential existing building strategic partners. Chapter 4 presents a recommended action plan for the FEMA Existing Buildings Program prioritized into near-term, mid-term, and long-term activities.

Appendix A provides a brief summary of the goals and objectives of the current NEHRP Strategic Plan (2009-2013). Appendix B provides a detailed description of each of the activities recommended for implementation in the action plan, and Appendix C provides a discussion of the rationale used in prioritizing activities. Acronyms and references used throughout the document are provided after the appendices.

This report is one in a collection of reports arising from the *NEHRP Workshop on Meeting the Challenges of Existing Buildings*. Other reports in this collection include:

- *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 1: Workshop Proceedings*, ATC-71 Report (ATC, 2008)
- *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings*, ATC-71 Report (ATC, 2009)
- *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings*, ATC-73 Report (ATC, 2007)

Chapter 2
Summary of Existing Building Stakeholder Needs and Priorities

Conduct of the 2007 *NEHRP Workshop on Meeting the Challenges of Existing Buildings*, and investigation into the status of seismic evaluation and rehabilitation practice in the United States, involved the participation of multiple existing building stakeholder groups including engineering practitioners, researchers, regulators, building owners, and public policy experts. This process led to a consensus perspective on significant impediments to more widespread seismic evaluation and rehabilitation of existing buildings. More than 80 existing building issues, along with consensus-based identification of significant impediments, are documented in the companion report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 1: Workshop Proceedings*, (ATC, 2008).

The workshop also identified a list of existing building research needs for the National Science Foundation George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). These needs are recorded in the ATC-73 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings* (ATC, 2007), and are not considered further here.

The status of seismic evaluation and rehabilitation practice in the United States, along with initial recommendations for the FEMA Existing Buildings Program, are documented in the companion report *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings* (ATC, 2009).

Interpretation of impediments to seismic evaluation and rehabilitation, coupled with the constraints and opportunities identified in the status of seismic evaluation and rehabilitation practice in the United States, led to the development of existing building stakeholder needs and priorities.

2.1 Summary of Findings

Workshop participants identified the following general observations with regard to the challenges posed by existing buildings:

- The biggest impediment to seismic rehabilitation was identified as the lack of market forces aligned to support such activities.
- Public policy and regulatory issues are critical to the implementation of seismic rehabilitation, including whether or not rehabilitation is mandatory or voluntary; the presence (or lack) of financial incentives; and differing perceptions of risk and acceptable levels of risk.
- The language of practitioners does not adequately convey seismic risks to owners and the public. As a consequence, the community largely ignores the potential consequences of earthquake loss.
- Risk of potential loss in business revenue was identified as a persuasive justification for performing seismic rehabilitation, particularly in regions of moderate seismicity.
- Currently available seismic evaluation and rehabilitation tools need to be technically improved through a program of focused research and technology transfer.
- In regions where there is a perceived seismic risk, the cost of seismic rehabilitation work can impede rehabilitation activities, even where there is a legislative mandate to perform such work.
- There was strong consensus for the development of prescriptive procedures for selected model building types and for simplification of currently available evaluation and rehabilitation procedures, as a means to reduce costs and improve implementation of rehabilitation efforts.
- There was strong indication of the need for additional education and training materials including the development of more example applications of actual projects illustrating seismic rehabilitation methodologies and standards.

2.1.1 Stakeholder Needs

From interviews, focused workshop breakout discussions, and polling of workshop participants, the following points reflect what is needed to promote more widespread mitigation of future earthquake losses through seismic rehabilitation:

- Available financial data for seismic vulnerability and rehabilitation assessments, which can engage market forces in a voluntary decision making process.
- An understanding of the seismic vulnerability in today's building stock among the public, politicians, and building owners.
- An increase in political will to support seismic mitigation measures.

- Technical improvements to the ASCE 31 and ASCE 41 standards are needed and are important.
- The language used to communicate seismic performance by engineers does not facilitate an actionable understanding among existing building stakeholders.
- Expanded education among engineers and regulators in less seismically active areas of the country is urgently needed to enhance familiarity with available technical resources, and to facilitate more widespread acceptance and integration into practice.
- For practitioners in areas of low to moderate seismicity who infrequently address seismic issues, the complexity of ASCE 41 is daunting. Greater simplification through prescriptive models for common building types or load-path requirements would significantly enhance potential use in these areas of the country.
- A program of focused research is needed to develop a better understanding of the extreme limits of performance of structural components, and the relationship between component fragility and global building performance.
- With the release of ASCE 31 and ASCE 41, the ASCE standards update process should permit introduction of incremental changes to the documents to more rapidly improve the application and understanding of technical provisions.

2.1.2 Common Themes Across Multiple Stakeholder Needs

Each stakeholder group focused on a subset of needs judged to be the most pressing in their area of concern (i.e., engineering practice, regulation, policy, and research). Highest priority needs in each group were consolidated into combined issue statements covering common needs, areas of emphasis, or similar themes. While the names of consolidated issue statements generated by each stakeholder group were somewhat different, certain themes arose that were common across multiple groups. Common themes are identified in *Part 1: Workshop Proceedings*, and summarized in Table 2-1.

Table 2-1 Most Commonly Identified Stakeholder Needs, 2007 NEHRP Workshop

Issue	Stakeholder Needs
Recommended by three or more stakeholder groups	
Improved Communication Between Stakeholder Groups – communication between engineers and owners, plan reviewers, and the public on seismic risk, business continuity planning, and cost/benefit decisions	Technical Resources; Engineering Practice Guidance; Regulatory/Public Policy; Research Needs
Update and Revision of Guidelines and Standards for Existing Buildings – for both structural and nonstructural components; includes transition of research into practice, improvement of acceptance criteria with new data, and calibration of procedures with engineering judgment or actual loss data	Technical Resources; Engineering Practice Guidance; Research Needs
Recommended by at least two stakeholder groups	
Education and Training in Seismic Rehabilitation – education of engineers and plan reviewers on the technical aspects of seismic rehabilitation; education of owners and the public on seismic risk and mitigation of risk; education of legislators on implementation of effective seismic policy	Engineering Practice Guidance; Regulatory/Public Policy
Development of Simplified Procedures – further simplification of currently available simplified procedures; development of prescriptive provisions for selected systems; and guidance on how to address non-engineered structures	Engineering Practice Guidance; Regulatory/Public Policy
Consistency in Enforcement – consistency in application of mandated seismic requirements; consistency in how requirements are enforced on individual projects; and development of guidance on peer review	Engineering Practice Guidance; Regulatory/Public Policy

2.1.3 Constraints and Opportunities

Factors that shape current seismic evaluation and rehabilitation practice serve to constrain and influence activities that are designed to address existing building needs. Such factors include:

- **Activity Initiation.** There are three ways in which seismic evaluation and rehabilitation activities can be initiated. Work can be mandated, triggered, or voluntarily undertaken. Mandated work is generally established by state or jurisdictional authority. A larger portion of current seismic evaluation and rehabilitation work (according to practitioners) is initiated as a consequence of being triggered by the scope or nature of other work on a building. A third means by which existing buildings are seismically evaluated or rehabilitated is initiated by voluntary action on the part of a building owner.

- **Regional Variations.** Significant regional variations exist in the treatment of existing buildings. In areas of the country that have experienced significant damaging earthquakes within the last 50 to 100 years (West Coast and Inter-Mountain West), mandatory, triggered, and voluntary rehabilitation work is actively underway. Knowledge of available technical resources is high and communities have developed legislative mandates to address a limited number of vulnerable building types. In other regions of the country, there is considerably less seismic evaluation and rehabilitation work being undertaken, in either mandated, triggered, or voluntary programs.
- **Building Regulations and Enforcement.** Building regulations are generally established by state authorities with local (municipal and county) responsibility for enforcement. Local jurisdictions exhibit considerable variation in their degree of enforcement of building regulations. Larger jurisdictions generally provide more active review, while smaller jurisdictions provide less.
- **Green Building Movement.** Currently, the most active area of building regulation change is the attempt to create more sustainable, energy-efficient construction. As a consequence of many factors including the remarkably successful voluntary Leadership in Energy and Environmental Design (LEED) rating system, federal, state and local jurisdictions have mandated numerous regulations to improve the energy consumption in the building process and the buildings themselves. Extending the useful life of the existing building stock presents a significant opportunity to align seismic evaluation and rehabilitation with an actively advocated process of building sustainability concepts.

2.2 Summary and Grouping of Needs Relevant to the Existing Buildings Program

Based on workshop and status report investigations, a total of 28 priority needs have been identified for FEMA's Existing Buildings Program consideration and are listed in Table 2-2. To facilitate the planning of activities to address these needs, they have been grouped into five broad categories based on the common themes identified in Table 2-1.

Table 2-2 Priority Stakeholder Needs Relevant to the Existing Buildings Program

No.	Priority Need	
1.0	**Facilitate Framework to Update Existing Buildings Standards**	
	1.1	Update of ASCE 31 and ASCE 41
	1.2	Coordination with Other Efforts
	1.3	Evaluation and Rehabilitation Case Studies
	1.4	Transfer of Research into Practice
	1.5	Elimination/Reduction of Over Conservatism of ASCE 31, ASCE 41
	1.6	Improved Methods for Ground Motion (Hazard) Selection for Existing Buildings
	1.7	Consistency in the Evaluation and Rehabilitation of Nonstructural Components
	1.8	Allowing Some Engineering Judgment in Seismic Rehabilitation Standards
2.0	**Develop and Improve Actionable Understanding of Earthquake Risk**	
	2.1	Guidance for Improved Engineers' Communication with Owners and Stakeholders about Seismic Rehabilitation
	2.2	Encouraging Retrofit by Raising Vulnerability Awareness
	2.3	More Incentives for Seismic Rehabilitation
	2.4	Guidance on Voluntary versus Mandatory Programs
	2.5	Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards
	2.6	Education of Public on Seismic Risk and Reduction/Elimination of Misconceptions
	2.7	More Information on Social Impacts of Seismic Rehabilitation on Vulnerable Populations
3.0	**Develop Simplified Evaluation and Rehabilitation Procedures**	
	3.1	Simplified and/or Prescriptive Procedures
4.0	**Improve Education and Training of Engineering Professionals**	
	4.1	Consistency in Code Enforcement
	4.2	Consistency in Seismic Evaluation Results
	4.3	Nonlinear Analysis Modeling Guidelines
	4.4	Education and Training in Seismic Rehabilitation
5.0	**Develop New Products**	
	5.1	Business Continuity Planning Guidelines
	5.2	Acceptance of Incremental Mitigation Strategies for Seismic Rehabilitation
	5.3	Special Policies and Guidelines for Seismic Rehabilitation of Historic Structures
	5.4	A Uniformly Acceptable Standard Building Performance Rating System
	5.5	Coordination with Response and Recovery Planning
	5.6	Reduction in the High Cost of Rehabilitation

Chapter 3
Existing Building Partnership Opportunities

A large number of professional and trade organizations are actively engaged in the improvement of model building codes and standards, and have used their influence in the code development process to improve seismic safety. Additionally, there are other organizations that have actively worked to improve the understanding of seismic risk among policy makers, and to affect public policy discussions at the local and regional levels where enforcement occurs. Finally, organizations that include building owners, managers, lenders, realtors, insurers, and historical preservation groups can be influential stakeholders in the existing building community.

3.1 Partnership Opportunities

This section describes potential strategic partners who may be positioned to take a lead or supportive role in addressing the many needs identified by the existing building community. Descriptions have been taken from information produced by the organizations themselves, on their websites, or in their publications.

3.1.1 NEHRP Agencies

Charged with the task of reducing the risk of life and property from future earthquakes by Congress, the primary strategic partners in addressing the challenges of existing buildings are the NEHRP agencies. These organizations coordinate their activities through the framework of the NEHRP Strategic Plan. The defined roles, objectives, and goals of each agency are:

- The **National Institute of Standards and Technology (NIST)** is the lead NEHRP agency. As lead agency, NIST provides the overall direction, coordination and support of NEHRP joint activities; conducts applied research and development in earthquake engineering to improve building codes and standards for new and existing buildings and infrastructure lifelines; advances seismic resistant construction practices; develops measurement and prediction tools supporting performance-based standards; and evaluates advanced technologies. Consistent with its broader research mission, NIST research focuses on removing

technical barriers and enabling innovation and competitiveness in the U.S. design and construction industry.

- The **Federal Emergency Management Agency (FEMA)** translates research and lessons learned from earthquakes into guidance, training, and support. FEMA works with national model codes and standards groups; promotes better building code practices; assists states in developing mitigation, preparedness and response plans; and supports comprehensive earthquake education and awareness. FEMA also develops and disseminates earthquake-resistant design guidance for new and existing buildings and lifelines and aids in the development of performance-based design guidelines and methods. FEMA applies earthquake risk reduction measures to other hazards where appropriate; provides preparedness, response and mitigation recommendations to communities; and establishes demonstration projects on earthquake risk mitigation to link earthquake research and mitigation with emergency management programs.
- The **National Science Foundation (NSF)** supports basic research in geosciences, engineering, social, behavioral, and economic sciences relevant to the understanding of the causes and effects of earthquakes. NSF supports research into the causes of earthquakes, plate tectonics, crustal deformation and the seismic response of structural, geotechnical, nonstructural and infrastructure systems. NSF also supports research on risk perception, mitigation decision making, incentive systems related to risk and mitigation, and factors that can promote community resiliency. NSF supports the education of new scientists and engineers, the integration of research and education and outreach to professionals and the public.
- The **U.S. Geological Survey (USGS)** conducts and supports targeted geosciences research on earthquake causes and effects, produces national and regional hazard maps and assessments, monitors and reports on earthquake occurrences and their shaking intensities in the United States and worldwide, works to improve public understanding of earthquake hazards and coordinates post-earthquake reconnaissance carried out by NEHRP agencies and others.

3.1.2 Professional and Trade Organizations

In addition to the NEHRP agencies, numerous organizations composed of building professionals, regulators, and trade representatives are actively engaged in addressing the challenges of existing buildings. These organizations are funded through various sources including government

agencies, membership dues, and publication sales. A sampling of these groups, in alphabetical order, include:

- The **American Concrete Institute (ACI**), a nonprofit technical and educational society founded to advance the development of concrete knowledge worldwide through technical programs, publications, education, and certification programs.
- The **American Institute of Steel Construction (AISC),** a not-for-profit technical institute and trade association that serves the structural steel design community and construction industry in the United States. AISC's mission is to make structural steel the material of choice by being the leader in structural-steel-related technical and market-building activities, including specification and code development, research, education, technical assistance, quality certification, standardization, and market development.
- The **American Plywood Association (APA),** a nonprofit trade association that works in partnership with its members to develop and maintain markets through excellence in APA trademarked product promotion, quality assurance and technical and educational support.
- The **American Society of Civil Engineers (ASCE),** an American National Standards Institute (ANSI)-accredited standards development organization that produces consensus standards under the direction of its Codes and Standards Committee. ASCE draws upon its membership to maintain and update its standards and upon its committee structures to develop new standards.
- The **American Society of Civil Engineers/ Structural Engineering Institute (ASCE/SEI)**, founded to stimulate coordination and understanding between structural engineering academia and practicing engineers, thereby driving the practical application of cutting edge research. The organization also provides a forum for research, education, design, testing, manufacturing, construction and operations in the structural engineering profession. Technical activities include the development and updating of the ASCE 7 standard, *Minimum Design Loads for Buildings and Other Structures*.
- The **Applied Technology Council (ATC)**, a non-profit corporation founded to develop and promote state-of-the-art, user-friendly engineering resources and applications for use in mitigating the effects of natural and other hazards on the built environment. ATC fulfills a unique role in funded information transfer by developing nonproprietary consensus opinions on structural engineering issues. ATC also identifies and encourages needed research and disseminates its technological

developments through guidelines and manuals, seminars, workshops, forums, and electronic media.

- The **Building Seismic Safety Council (BSSC)**, one of several councils of the National Institute of Building Sciences. BSSC promotes the development of seismic safety provisions suitable for use throughout the United States; recommends, encourages, and promotes the adoption of appropriate seismic safety provisions in voluntary standards and model codes; assesses progress in the implementation of such provisions by federal, state, and local regulatory and construction agencies; identifies opportunities for improving seismic safety regulations and practices and encourages public and private organizations to effect such improvements; promotes the development of training and educational courses and materials for use by design professionals, builders, building regulatory officials, elected officials, industry representatives, other members of the building community, and the public; advises government bodies on their programs of research, development, and implementation; and periodically reviews and evaluates research findings, practices, and experience and makes recommendations for incorporation into seismic design practices.
- The **Earthquake Engineering Research Institute (EERI)**, a non-profit association that works to reduce earthquake risk by (1) advancing the science and practice of earthquake engineering, (2) improving understanding of the impact of earthquakes on the physical, social, economic, political, and cultural environment, and (3) advocating comprehensive and realistic measures for reducing the harmful effects of earthquakes. EERI fosters a sense of shared commitment among the diverse communities dedicated to earthquake risk management, promotes research and facilitates the exchange of information among members and others to forge a consensus and common voice for presentation at public forums and legislative bodies on behalf of the diverse risk management community.
- The **International Code Council (ICC)**, a U.S.-based non-governmental organization that allows U.S. jurisdictions (cities, counties, states) around the world and other stakeholders to collaborate to create model building codes and other building safety standards. The International Codes, or I-Codes, published by the International Code Council, provide minimum safeguards for people at home, at school and in the workplace. The I-Codes are a complete set of comprehensive, coordinated building safety and fire prevention codes.
- The **Masonry Standards Joint Committee (MSJC)**, an organization composed of volunteers who through background, use, and education

have acquired experience in the manufacture of masonry, or in the design and construction of masonry structures. Working under its three sponsoring societies—The Masonry Society (TMS), the American Concrete Institute (ACI), and the Structural Engineering Institute of the American Society of Civil Engineers—the Committee is charged with developing and maintaining safe, practical and efficient design provisions for masonry using ANSI consensus procedures.

- The **National Council of Structural Engineers Associations (NCSEA),** which was formed to advance the practice of structural engineering and, as the national voice for practicing structural engineers, protect the public's right to safe, sustainable and cost effective buildings, bridges and other structures.
- The **National Institute of Building Sciences (NIBS),** a non-profit, non-governmental organization bringing together representatives of government, the professions, industry, labor and consumer interests to focus on the identification and resolution of problems that hamper the construction of safe, affordable structures for housing, commerce and industry throughout the United States. NIBS provides an authoritative source of advice for both the private and public sector of the economy with respect to the use of building science and technology. NIBS operates a number of councils that advise key aspects of many of the Institute's technical programs.

3.1.3 Others

A large number of organizations are actively working in various capacities to effect existing buildings in the United States. These organizations influence many aspects of existing buildings and have historically had somewhat limited involvement with the seismic treatment of existing buildings. They include, in alphabetical order:

- The **American Institute of Architects (AIA),** the leading professional membership for licensed architects, emerging professional and allied partners since 1857. AIA serves as the voice for the architecture profession and the resource for members in service to society. AIA provides many resources for its members including sponsoring continuing education experiences for Architects to maintain licensure, settings the industry standard with standard form and contracts, producing online publications, and provides web-based resources for emerging architecture professionals.
- The **Associated General Contractors of America (AGC),** the largest and oldest national construction trade association in the United States. Operating in partnership with its nationwide network of Chapters, AGC

provides a full range of services satisfying the needs and concerns of its members, thereby improving the quality of construction and protecting the public interest.

- The **Building Owners and Managers Association (BOMA),** founded to serve the commercial real estate industry by fostering a future vision, forward thinking research, innovative thought, and global best practices. BOMA is dedicated to sponsoring and encouraging innovative research and educational activities that advance the commercial real estate industry and profession. In addition, its Foundation initiates programs that seek to enhance the public appreciation of real estate and its significance in society. Programs and projects are developed to assist real estate professionals, researchers and others concerned with building performance and its impact on society.
- The **Chartered Property Casualty Underwriters (CPCU) Society,** a community of credentialed property and casualty insurance professionals who promote excellence through ethical behavior and continuing education by offering seminars, workshops, and symposia, leadership training, public speaking opportunities and courses from the CPCU Society Center for Leadership.
- The **Institute for Business and Home Safety (IBHS),** founded to reduce the social and economic effects of natural disasters and other property losses by conducting research and advocating improved construction, maintenance and preparation practices. IBHS works to promote resiliency from natural disasters and other property losses by developing an infrastructure that is damage-resistant and through personal and corporate action that helps minimize disruption to normal life and work patterns.
- The **National Association of Home Builders (NAHB),** an association that represents tradesmen in the housing industry. Chief among NAHB's goals is providing and expanding opportunities for all consumers to have safe, decent and affordable housing. NAHB's various groups analyze policy issues, take the industry's story to the public through the media and other outlets, monitor and work toward improving the housing finance system, and analyze and forecast economic and consumer trends. They also provide a wide range of services to members and Home Builder Associations. The association also represents the industry's interests on Capitol Hill and strives to ensure that housing remains a national priority when laws are made and policies are established. NAHB also works with federal agencies on regulations affecting the housing industry in areas such as mortgage finance, codes, energy and the environment.

- The **National Association of Realtors (NAR),** founded to work for America's property owners. The National Association provides a facility for professional development, research and exchange of information among its members and to the public and government for the purpose of preserving the free enterprise system and the right to own real property.
- The **Real Estate Lenders Association (RELA),** which brings real estate finance professionals together with leaders in the industry to discuss focused topics, in a format that is conducive to sharing knowledge and to fostering networking opportunities.
- The **U.S. Green Building Council (USGBC),** a non-profit organization that certifies sustainable businesses, homes, hospitals, schools, and neighborhoods. USGBC is dedicated to expanding green building practices and education, and promoting its LEED (Leadership in Energy and Environmental Design) Green Building Rating System. USGBC works to transform the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life.

3.2 Alignment of Needs and Strategic Partnerships

It is important that the Existing Buildings Program undertake activities addressing priority needs that no other organization is likely to consider. It is equally important to undertake activities that will facilitate actions by other organizations or build on the results of their work.

Due to direct interaction with many existing building stakeholder groups, the Existing Buildings Program is well suited to understand the gaps and overlapping areas of interest and activity. FEMA's Existing Buildings Program should seek out strategic partnerships to leverage available funding and utilize emerging technologies as they are developed. Conversely, other organizations should seek to contribute to the activities of FEMA's Existing Buildings Program where interests are aligned with the objectives identified in this plan.

Chapter 4
Action Plan

A total of 28 activities are recommended for consideration within FEMA's Existing Buildings Program. In developing this action plan, consideration has been given to FEMA's defined role within the NEHRP agencies, limitations in available funding, and the need to leverage the efforts of other organizations that share objectives with the Existing Buildings Program. The plan has been constructed to acknowledge potential strategic partners, and to define activities that could be used to seed further actions by these partners in order to expand the effectiveness of the work undertaken by the Existing Buildings Program.

For each existing building stakeholder need, an activity has been developed that focuses on the execution of tasks designed to reduce the gap in knowledge, understanding, perception, or technology, in some measure.

The plan is anticipated to encompass a 10-year time frame. Activities have been prioritized into recommendations for the near-term (1-3 years), mid-term (4-6 years), and long-term (7-10 years). Factors such as the number of needs addressed by the activity, activities addressing the highest priority needs identified by multiple stakeholder groups, and activities that need to be coordinated with the timing of other strategic partner activities were assigned the highest priority rankings.

The prioritization process resulted in 11 activities for initiation in the near-term, 8 activities for initiation in the mid-term, and 7 activities for initiation in the long-term. A summary of recommended activities by time frame (near-term, mid-term, and long-term) is provided in the following sections. Detailed descriptions of the activities are provided in Appendix B, including additional information on implementation of tasks, management of activities, and monitoring of program effectiveness. The rationale for prioritization of recommended activities is provided in Appendix C.

4.1 Near-Term Activities

Near-term activities are listed in Table 4-1. A brief narrative description of each activity is provided below. Stakeholder needs that are addressed by each activity, and potential strategic partners, are also identified.

Table 4-1 Near-Term Activities

Activity No.	Activity Name	Stakeholder Need*	Strategic Partners
A1	Develop Earthquake Performance Rating System for Buildings	A Uniformly Standard Building Performance Rating System (Need 5.4)* Encouraging Retrofit by Raising Vulnerability Awareness (Need 2.2)*	ATC, BSSC, BOMA, NCSEA, insurers, lenders, realtors
A2	Develop Rehabilitation Cost Guidance (Update FEMA 156 and FEMA 157)	Reduction in the High Cost of Rehabilitation (Need 5.6)*	FEMA, NIST
A3	Monitor Use of ASCE 31 and ASCE 41 for Projects Triggered by Codes	Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards (Need 2.5)*	ICC (and regional organizations like CALBO), NCSEA
A4	Develop Community Building Inventories	Coordination with Response and Recovery Planning (Need 5.5)*	FEMA; professional engineer associations, planners, and building owners; emergency planners and building officials
A5	Support Development of Standards Update Framework	Update of ASCE 31 and ASCE 41 (Need 1.1)*	NIST, NSF, USGS, ACI (Committee 369), AISC ASCE/SEI, BSSC, ICC, NCSEA
A6	Enhance LEED Ratings for Resilience	Encouraging Retrofit by Raising Vulnerability Awareness (Need 2.2)* More Incentives for Seismic Rehabilitation (Need 2.3)*	AIA, ASCE/SEI, NCSEA, USGBC
A7	Develop Consensus Code Change Proposals to Align the Provisions of the IBC, IEBC, and IRC	Coordination with Other Efforts (Need 1.2)*	FEMA, ASCE/SEI, CRSC of BSSC, ICC, NCSEA
A8	Develop Simplified Evaluation and Rehabilitation Guidance (Regional Module)	Simplified and/or Prescriptive Procedures (Need 3.1)*	ATC, BSSC, Local Professional Organizations, Building Officials
A9	Develop Seismic Evaluation and Rehabilitation Example Applications	Consistency in Code Enforcement (Need 4.1)* Consistency in Seismic Evaluation Results (Need 4.2)* Education and Training in Seismic Rehabilitation (Need 4.4)*	ASCE/SEI, ICC, NCSEA
A10	Develop and Promote Earthquake Risk Communication Tool	Guidelines for Improved Engineers' Communication with Owners and Stakeholders about Seismic Rehabilitation (Need 2.1)*	ASCE/SEI, ATC, BSSC, EERI, NCSEA
A11	Develop Framework for Convening Issue Teams to Move Research into Practice	Transfer of Research into Practice (Need 1.4)* Elimination of Over Conservatism of ASCE 31 and ASCE 41 (Need 1.5)*	NIST, NSF, ASCE/SEI, ATC, BSSC, CUREE, ICC, NCSEA, standards writing organizations

*See Table 2-2 for complete list of Priority Stakeholder Needs Relevant to the Existing Buildings Program.

Activity A1: Develop Earthquake Performance Rating System for Buildings

Activity A1 calls for the development and dissemination of an Earthquake Performance Rating System for Buildings for use in a pilot market to serve selectively identified stakeholders and interest groups. The rating system should be built from existing assessment tools; however, to the extent that consensus tools are not yet available to support quantification of end user's parameters of interest (e.g., recovery time, repair cost), development of a pilot rating system would be useful in identifying where existing standards require supplementation and where additional research is needed.

Activity A2: Develop Rehabilitation Cost Guidance (Update FEMA 156 and FEMA 157)

Currently, the best non-proprietary tool for rapid estimation of seismic rehabilitation costs is the Seismic Rehabilitation Cost Estimator, which is based on the companion documents FEMA 156, 157, *Typical Costs for Seismic Rehabilitation of Existing Buildings, 2nd Edition*, Volumes 1 and 2 (published in 1994). The cost database for this tool, however, does not include nonstructural costs and is now more than 15 years old. An update should expand the web-based interactive delivery of the Seismic Rehabilitation Cost Estimator and provide expanded options that include updated material, including nonstructural costs.

Activity A3: Monitor Use of ASCE 31 and ASCE 41 for Projects Triggered By Codes

The 2009 *International Building Code* (IBC) specifically allows, for the first time, the use of standards ASCE 31, *Seismic Evaluation of Existing Buildings*, and ASCE 41, *Seismic Rehabilitation of Existing Buildings,* when seismic evaluation and retrofit are triggered by Chapter 34: Existing Structures. This provides an opportunity to study and improve the application of these standards in triggered projects. Liaisons with certain key building departments can be established and funding provided for collection of information on existing building projects that do and do not lead to seismic work. The information collected can clarify why the standards are or are not used and how they might be improved to engender more consistent and broader application.

Activity A4: Develop Community Building Inventories

Current codes, standards, and mitigation programs address some essential occupancies (independent of structure type) and some collapse hazards (independent of occupancy) but exclude many buildings and are divorced from response and recovery goals. To implement rational resilience plans,

communities need to assemble inventories of building stock by occupancy *and* by structure type. The Existing Buildings Program should support development of rough guidelines for producing such inventories (often from existing demographic and historic data) and work with pilot communities to assist in their developing inventories for use in resilience planning.

Activity A5: Support Development of Standards Update Framework

ASCE 31 and ASCE 41 were developed with the intent to be periodically updated to reflect both new information and to rectify problems in application discovered through use. Stakeholders have identified numerous immediate concerns with the documents. The FEMA Existing Buildings Program should take the lead in working with NIST, ASCE/SEI, ICC, and NCSEA officials and other organizations (see Table 4-1) to build a coordinated framework for the periodic update of these important reference standards. The Existing Buildings Program should organize a discussion among its strategic partners to determine resources, timelines and a process by which this important task can be executed.

Activity A6: Enhance LEED Ratings for Resiliency

The U.S. Green Building Council (USGBC) developed and currently maintains the Leadership in Energy and Environmental Design (LEED) rating system, a voluntary, consensus-based, national standard for developing high-performance sustainable buildings. The system currently does not recognize anticipated building performance for extreme hazards as a consideration of sustainability. The Existing Buildings Program can help to improve the LEED rating system by a concerted effort to introduce the concepts of building performance and resilience as scoring components and thus promote more widespread rehabilitation.

Activity A7: Develop Consensus Code Change Proposals to Align the Provisions of the IBC, IEBC, and IRC

The 2009 *International Building Code* (IBC) allows, for the first time, the use of ASCE 31 and ASCE 41. However, ICC publishes three model codes that deal with existing buildings: Chapter 34 of the *International Building Code* (IBC), the *International Existing Building Code* (IEBC), which has long referenced the ASCE standards, and the *International Residential Code* (IRC), which addresses existing structures only in an appendix. The Existing Buildings Program should support development of code change proposals that align the terminology and philosophy of the model codes with respect to earthquake effects and lateral system upgrade provisions, ultimately working toward replacement of obsolete methods with standards-based provisions.

Activity A8: Develop Simplified Evaluation and Rehabilitation Guidance (Regional Modules)

This activity calls for the development of simplified evaluation and rehabilitation guidance for one or more subsets of at-risk buildings in selected geographic regions. Examples might include soft-story commercial and multi-family residential facilities in zones of high, frequent seismicity; and wood and/or unreinforced masonry (URM) residential construction in the Central United States. The activity should include a project formulation process for prioritizing buildings types and regions to be addressed.

Activity A9: Develop Seismic Evaluation and Rehabilitation Example Applications

Activity A9 calls for the development of a series of publications that cover the FEMA model building types and provide detailed example applications of the provisions for evaluation (ASCE 31) and rehabilitation (ASCE 41). The material can serve as the basis for development of Activity A15 and should provide links to currently available example applications (e.g., FEMA 343, *Case Studies: An Assessment of the NEHRP* (FEMA 273) *Guidelines for the Seismic Rehabilitation of Buildings*).

Activity A10: Develop and Promote Earthquake Risk Communication Tool

Practicing engineers have expressed a need to improve their ability to communicate issues of earthquake risk to owners, architects and non-engineering decision makers. Some of the issues raised that could be addressed include: providing a glossary of terms, characterizing low probability/high consequence events, articulating the variability of anticipated seismic performance of existing buildings when subjected to strong ground motion, providing clarification that code conformance is not a guarantee of future performance nor does it preclude an unusable post earthquake building. These topics and others can be addressed in a brief primer to help engineers express their understanding of seismic risk to others not as familiar with the subject.

Activity A11: Develop Framework for Convening Issue Teams to Move Research into Practice

The Existing Buildings Program should facilitate the transition of new research findings into practical engineering criteria by developing a framework for "Issue Teams" to be charged to review existing and new research results and develop appropriate provisions for codes and standards similar to the process used for ASCE 41, Supplement 1, as developed by ASCE/SEI. The framework should address questions such as Issue Team

membership, leadership, cost sharing, identification and prioritization of issues of interest, tracking progress, criteria for judging applicability and completeness of research results and coordination with parallel efforts undertaken by others.

4.2 Mid-Term Activities

Mid-term activities are listed in Table 4-2. A brief narrative description of each activity is provided below. Stakeholder needs that are addressed by each activity, and potential strategic partners, are also identified.

Table 4-2 Mid-Term Activities

Activity No.	Activity Name	Stakeholder Need*	Strategic Partners
A12	Promote Incremental Seismic Rehabilitation Guidance	Acceptance of Incremental Mitigation Strategies for Seismic Rehabilitation (Need 5.2)*	FEMA, ASCE/SEI, ICC, NCSEA
A13	Develop Recommendations for Treatment of Earthquake Hazard Issues for Existing Buildings	Improved Methods for Ground Motion Hazard Selection for Existing Buildings (Need 1.6)*	FEMA, NIST, USGS, ASCE/SEI, ATC, BSSC, NCSEA, PEER
A14	Develop Nonlinear Analysis Modeling Guidelines	Non Linear Analysis Modeling (Need 4.3)*	NIST, ASCE/SEI, ATC, BSSC, ICC, NCSEA
A15	Promote Education and Training of Engineering Professionals	Education and Training in Seismic Rehabilitation (Need 4.4)*	ASCE/SEI, BSSC, ICC, NCSEA
A16	Define Test Beds and Case Studies	Evaluation and Rehabilitation Case Studies (Need 1.3)*	NIST, NSF, USGS, professional and industry groups
A17	Develop and Disseminate Policies and Guidance for Various Mitigation Program Approaches	Guidance on Voluntary vs. Mandatory Programs (Need 2.4)* Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards (Need 2.5)*	FEMA, associations of public and private risk managers.
A18	Provide NEHRP Existing Buildings Workshop Support	Coordination with Other Efforts (Need 1.2)* Transfer of Research into Practice (Need 1.4)*	FEMA, NIST, NSF, USGS, ASCE/SEI, ATC, BOMA, CUREE, EERI, NCSEA, NEES
A19	Coordinate Recommendations for Evaluation and Rehabilitation of Nonstructural Components	Consistency in the Evaluation and Rehabilitation of Nonstructural Components (Need 1.7)*	NIST, ASCE/SEI, NCSEA

*See Table 2-2 for complete list of Priority Stakeholder Needs Relevant to the Existing Buildings Program

Activity A12: Promote Incremental Seismic Rehabilitation Guidance

Programs of partial and incremental seismic rehabilitation can be an effective long-term risk reduction strategy, and FEMA has produced a series of publications that provide useful guidance to a broad range of existing building stakeholders on the advantages of incremental seismic rehabilitation efforts. A seminar series to disseminate, explain and demonstrate the concepts and materials needs to be developed and executed. From the feedback gained from a national seminar program, it may be possible to develop a set of recommendations for providing updates to ASCE 31 and ASCE 41 that incorporate incremental rehabilitation concepts.

Activity A13: Develop Recommendations for Treatment of Earthquake Hazard Issues for Existing Buildings

The ASCE 31 and ASCE 41 standards need to be amended to incorporate the definitions for earthquake shaking demands in the ASCE-7 standard, *Minimum Design Loads for Buildings and Other Structures*, with modifications appropriate to the performance objectives for existing buildings. Significant differences exist between the seismic performance characteristics of existing buildings, rehabilitated buildings and new buildings. These differences require consideration in the development and characterization of ground shaking representation based on uniform seismic risk versus seismic hazard. Presently, the ASCE-7 standard for defining earthquake shaking demands anticipates application to new buildings with current code compliant details of construction and the resultant collapse probabilities. As a consequence of the unique variations not permitted in new construction, broader questions exist for existing buildings on the selection of appropriate ground motion characterizations when uniform risk is the goal. Recommendations for the treatment of these issues are needed to fill an important gap in the consistent application of the ASCE 31 and ASCE 41 standards.

Activity A14: Develop Nonlinear Analysis Modeling Guidelines

Interpretive guidance on nonlinear analysis modeling is needed for practicing engineers and to assist regulatory officials responsible for interpreting submitted work to assess code conformance. A resource document should be developed to provide this information through application examples. The document should provide commentary and discussion on a range of topics regarding nonlinear modeling and analysis. The document should be permitted to accrue new modules over a period of time, rather than being held out of circulation until a large assembly of examples have been completed and vetted.

Activity A15: Promote Education and Training of Engineering Professionals

The Existing Buildings Program should develop a seminar series providing instruction on ASCE 31 and ASCE 41 that feature example applications for a national audience of engineers. The seminar program should be offered and promoted by regional engineering and building official organizations with professional education credits made available. The material developed by Activity A9 can be used for this program.

Activity A16: Define Test Beds and Case Studies

The FEMA Existing Buildings Program, with the support and involvement of NIST and NSF, should define several robust seismic evaluation and rehabilitation case studies (test beds representing common existing buildings) and encourage researchers in a variety of fields to use them for both basic and applied research. The test beds should not be limited to simplified model buildings but should include the full range of issues that existing buildings present, including occupancy continuity, nonstructural components and contents, historic preservation, other code-triggered work, and other issues. Of immediate interest are controlled studies comparing traditional code-based evaluation and retrofit approaches with simplified prescriptive methods, performance-based standards, and alternative techniques.

Activity A17: Develop and Disseminate Policies and Guidance for Various Mitigation Program Approaches

Mitigation programs can include voluntary, mandated, or triggered retrofits as well as other strategies such as risk transfer, redundancy planning, incremental rehabilitation, or expedited occupancy resumption. As jurisdictions weigh the costs and benefits of implementing one or more programs, they would benefit from Existing Buildings Program guidance on the relative merits and applicability of different strategies, model ordinances, appropriate incentives, and best practices to develop effective policies.

Activity A18: Provide NEHRP Existing Buildings Workshop Support

In September of 2007, the NEHRP agencies sponsored a two-day workshop to solicit input from a broad spectrum of existing buildings stakeholders. The workshop generated the identification and prioritization of the most important actions the NEHRP agencies could undertake to facilitate the reduction of loss of life and property in future earthquakes. A periodic survey by the NEHRP agencies of the existing buildings community provides both feedback on past and ongoing activities and the opportunity to change directions and adjust to changing technological and sociological

developments. FEMA's Existing Buildings Program should play a significant role in convening future similar NEHRP workshops on a periodic basis (i.e., every four to six years) to serve both its own strategic initiatives and those of its NEHRP partners.

Activity A19: Coordinate Recommendations for Evaluation and Rehabilitation of Nonstructural Components

Treatment of nonstructural components should be coordinated in a rational fashion among the provisions of ASCE 7, ASCE 31 and ASCE 41. This activity envisions formation of an "Issue Team" (See Activity A11) to establish recommendations to fulfill this need.

4.3 Long-Term Activities

Long-term activities are listed in Table 4-3. A brief narrative description of each activity is provided below. Stakeholder needs that are addressed by each activity, and potential strategic partners, are also identified.

Activity A20: Develop Business Continuity Earthquake Planning Guidelines

The Existing Buildings Program should develop business continuity earthquake planning guidelines. Potential building occupancies where significant economic interest exists in maintaining operations should be identified. Variations in approach that recognize the unique characteristics of regional hazards should be considered. Efforts should be coordinated with the FEMA-funded ATC-68 QuakeSmart earthquake awareness project series and web-based electronic version of FEMA 74, *Reducing Risks of Nonstructural Earthquake Damage – A Practical Guide*. Guidelines could be formatted to provide baseline downtime estimates and tools for benefit/cost studies of mitigation efforts.

Activity A21: Benchmark Model Building Expected Performance

ASCE 31 provides a methodology for determining building compliance for a Life Safety or Immediate Occupancy performance objective. The methodology is a mix of prescriptive and quantitative assessment steps that are executable by practicing engineers. Building evaluations are also widely done in the commercial real estate industry using probabilistic risk assessment techniques (often with proprietary software) to estimate losses in financial terms. Comparative studies are needed to establish benchmark correlations between ASCE 31 determinations and estimates of dollar and/or downtime losses as well as among the different loss estimation methods. This alignment would facilitate a more coherent approach to risk management and remove a portion of the ambiguity that exists regarding the anticipated seismic performance of ASCE 31 conforming and non-conforming buildings.

Products being developed by the FEMA-funded ATC-58 project, Development of Next Generation Performance-Based Guidelines for the Seismic Design of New and the Seismic Rehabilitation of Existing Buildings, may support this activity.

Table 4-3 Long-Term Activities

Activity No.	Activity Name	Stakeholder Need*	Strategic Partners
A20	Develop Business Continuity Earthquake Planning Guidelines	Business Continuity Planning Guidelines (Need 5.1)*	ASCE/SEI, EERI, NCSEA, community organizations, industry
A21	Benchmark Model Building Expected Performance	Encourage Retrofit by Raising Vulnerability Awareness (Need 2.2)* More Incentives for Seismic Rehabilitation (Need 2.3)* Uniformly Acceptable Building Performance Rating System (Need 5.4)*	NIST, ASCE/SEI, NCSEA
A22	Develop Rational Resilience Criteria Customizable by Jurisdiction	Coordination with Response and Recovery Planning (Need 5.5)*	FEMA, NSF, professional organizations of planners and emergency managers
A23	Develop Guidelines for Seismic Rehabilitation of Historic Structures	Special Policies and Guidelines for Seismic Evaluation and Rehabilitation of Historic Structures (Need 5.3)*	AIA, ASCE/SEI, NCSEA, National Trust for Historic Preservation, National Park Service, other preservation organizations
A24	Develop Simplified Rehabilitation Guidance (General Module)	Simplified and/or Prescriptive Evaluation and Rehabilitation Procedures (Need 3.1)*	ASCE/SEI, ATC, BSSC, ICC (and its sections), NCSEA (and its member associations)
A25	Prepare White Paper on Seismic Rehabilitation and Social Vulnerability	More Information on Social Impacts of Seismic Rehabilitation on Vulnerable Populations (Need 2.7)*	NIST, NSF, professional and industry groups, social policy advocacy groups
A26	Develop Methodology for Tracking the Progress of Earthquake Risk Reduction	Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards (Need 2.5)*	BOMA (and other building owner organizations), ICC, local planning and building departments,
A27	Prepare Continuity Guidelines That Address Initial Seismic Evaluation Through Seismic Rehabilitation	Prepare Continuity Guidelines That Address Initial Seismic Evaluation Through Seismic Rehabilitation (Need 5.5)*	FEMA, local building officials
A28	Review and Compare Current Conventional Simplified Evaluation and Rehabilitation Practices	Simplified and/or Prescriptive Evaluation and Rehabilitation Procedures (Need 3.1)*	ASCE/SEI, BSSC, ICC, NCSEA

*See Table 2-2 for complete list of Priority Stakeholder Needs Relevant to the Existing Buildings Program

Activity A22: Develop Rational Resilience Criteria Customizable by Jurisdiction

Rational community mitigation plans should be linked to response and recovery plans, which should be premised on a model of resilience. Every community should have its response and recovery goals stated in terms of when certain critical functions (e.g., housing, transportation, schools, hospitals, emergency response facilities) must recover. The Existing Buildings Program should support development of a pilot set of community resilience goals. This effort should support continuity of operations planning.

Activity A23: Develop Guidelines for Seismic Rehabilitation of Historic Structures

Historic structures pose unique challenges that are not presently addressed by ASCE 31 and ASCE 41 standards. A document is needed that provides guidance on rehabilitation approaches to provide property protection commensurate to the value placed on the cultural resource being protected. Plaster ceilings, wall frescoes and many other historic features require a careful assessment of their fragility to establish target demand parameters of structural response that will achieve the desired level of damage protection. Guidelines are needed to provide a broader range of analytical tools to the practitioner community for the protection of important historic and cultural assets. This activity envisions development of a series of chapters addressing common historic building features using advanced analytical techniques and approaches.

Activity A24: Develop Simplified Rehabilitation Guidance (General Module)

ASCE 41 includes Simplified Rehabilitation provisions keyed to model building types (limited by seismicity and building height) and to typical deficiencies identified by an ASCE 31 evaluation. The current approach eliminates known deficiencies but does not involve a comprehensive structural analysis. Nor is it considered to achieve ASCE 41's two-part Basic Safety Objective.

The ASCE 41 Simplified Rehabilitation approach should be updated as appropriate, and supplemented with worked examples, a companion "how-to" handbook, or other tools to encourage its use. In general, the Activity would address concerns about the general complexity of ASCE 41 and whether abridged or simplified versions could be deemed to meet the Basic Safety Objective.

Activity A25: Prepare White Paper on Seismic Rehabilitation and Social Vulnerability

Seismic risk reduction as public or institutional policy includes considerations of social costs and benefits. Efforts to encourage or require risk reduction are most effective when they account for competing interests related to sustainable design, historic preservation, disabled access, and building valuation. This activity is intended to address how issues of social vulnerability should be accounted for in benefit-cost models, and how they should inform public policy options. Related questions include: Should vulnerable groups (and organizations serving them) be exempted from certain risk reduction programs? Should their costs be subsidized by the larger community?

The Existing Buildings Program should convene experts to produce a White Paper framing these issues, summarizing the current state or knowledge, and identifying open questions critical to Existing Buildings Program success that could serve as a starting point for investigation by strategic partners (NIST, NSF, social policy awareness groups).

Activity A26: Develop Methodology for Tracking the Progress of Earthquake Risk Reduction

As seismic risk becomes better understood and modeled, as tools for risk reduction become more available, and as FEMA is successful at encouraging rehabilitation programs, it might become feasible to study in a rigorous way how much risk is actually being abated.

The Existing Buildings Program should develop an appropriate methodology for baselining the current seismic risk and quantitatively tracking how it changes through retrofit projects (or by building stock attrition). Any number of valid methods for collecting, sampling, estimating, and extrapolating data might be valuable here. This Activity should engage experts to study potential methods and recommend a program to implement one or more of them. Actual implementation, with selected jurisdictions and possibly involving the development of new online tools, would be a separate task, though a pilot study might be attempted as "proof of concept."

Activity A27: Prepare Continuity Guidelines That Address Initial Seismic Evaluation Through Seismic Rehabilitation

The FEMA 154 Rapid Visual Screening procedure, as described in the first and second editions of FEMA 154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook,* has been used to conduct numerous surveys of communities and facilities. Presently, there is little specific guidance in FEMA 154, nor have tools been developed, to carry the initial

survey results to the next level of engineering evaluation (i.e., as prescribed in ASCE 31). The Existing Buildings Program should develop coordinated guidance on the entire process, from initial survey to seismic rehabilitation, with specific emphasis on the steps to address the findings from a FEMA 154 survey.

This activity supports coordination with response and recovery planning.

Activity A28: Review and Compare Current Conventional Simplified Evaluation and Rehabilitation Practices

Several recommended activities deal with the need for simplified evaluation and rehabilitation methodologies. In fact, several such methodologies already exist. Chief among them is the obsolete but conventional practice of applying selected building code provisions intended for new construction to existing conditions. This remains the default approach still taken by *International Building Code* Chapter 34 at this time. In addition, alternative (usually prescriptive or simplified) approaches exist for specific building types.

The Existing Buildings Program should support an activity that reviews a suite of comprehensive studies of model building types already addressed by alternative or simplified provisions. For a given study, if the alternative provisions yield the same practical results as ASCE 31 and ASCE 41, that will justify the use and further development of simplified methodologies. If the alternative provisions reach significantly different conclusions, that will be an important finding that should lead to further review and reconciliation of our codes and standards.

Appendix A

NEHRP Strategic Plan (2009-2013)

This Appendix briefly explains the organization of the National Earthquake Hazards Reduction Program (NEHRP), and provides a summary of the objectives and strategic priorities of the most recent strategic plan.

The National Earthquake Hazards Reduction Program (NEHRP) was formulated to include the integrated efforts of four agencies: the National Institute of Standards and Technology (NIST), the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF) and the U.S. Geologic Survey (USGS).

In broad terms, the NEHRP agencies support program objectives by providing: (1) basic research; (2) applied research; and (3) dissemination and implementation activities. NIST presently serves as the lead agency for NEHRP, and provides overall direction, coordination and support of joint activities. In addition, NIST generally provides support in the applied research and development area. NSF generally supports activities that are in the basic research area, USGS provides some support for basic research and some for applied research and development, and FEMA generally provides dissemination and implementation support.

NEHRP Mission: To develop, disseminate, and promote knowledge, tools, and practices for earthquake risk reduction—through coordinated, multi-disciplinary interagency partnerships among the NEHRP agencies and their stakeholders—that improve the nation's earthquake-resilience in public safety, economic strength, and national security.

NEHRP goals, objectives, and strategic priorities are summarized in Table A-1.

Table A-1 NEHRP Strategic Plan 2009-2013

Goal A: Improve understanding of earthquake processes and impacts.	
Objective 1:	Advance understanding of earthquake phenomena and generation processes.
Objective 2:	Advance understanding of earthquake effects on the built environment.
Objective 3:	Advance understanding of the social, psychological and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors.
Objective 4:	Improve post-earthquake information management.
Goal B: Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and the society at large.	
Objective 5:	Assess earthquake hazards for research and practical application.
Objective 6:	Develop advanced loss estimation and risk assessments tools.
Objective 7:	Develop tools to improve the seismic performance of buildings and other structures.
Objective 8:	Develop tools to improve the seismic performance of critical infrastructure.
Goal C: Improve the earthquake resilience of communities nationwide.	
Objective 9:	Improve the accuracy, timeliness, and content of earthquake information products.
Objective 10:	Develop comprehensive earthquake risk scenarios and risk assessments.
Objective 11:	Support development of seismic standards and building codes and advocate their adoption and enforcement.
Objective 12:	Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies.
Objective 13:	Increase public awareness of earthquake hazards and risks.
Objective 14:	Develop the nation's human resource base in earthquake safety fields.
Strategic Priorities:	
• Fully implement the Advanced National Seismic System • Improve techniques for evaluating and rehabilitating existing buildings. • Further develop performance-based seismic design. • Increase consideration of socio-economic issues related to hazard mitigation implementation. • Develop a national post-earthquake information management system. • Develop advanced earthquake risk mitigation technologies and practices. • Develop earthquake-resilient lifeline components and systems. • Develop and conduct earthquake scenarios for effective earthquake risk reduction. • Facilitate improved earthquake mitigation at state and local levels.	

Appendix B
Detailed Activity Descriptions

This Appendix provides a detailed description of activities recommended for FEMA's Existing Buildings Program.

B.1 Activity Description Format

Activity descriptions include information in the following categories: Task Description, Stakeholder Needs, Potential Strategic Partners, Time Frames, Suggested Performance Measures, and NEHRP Strategic Goals/Objectives Addressed by Activity. This information is intended to supplement the information provided in Chapter 4 by providing additional guidance on implementation of tasks, management of activities, and monitoring of program effectiveness.

Task Description

This section includes a description of the tasks to be performed and the work products to be developed. It also includes a discussion of the expected improvements to be gained by executing the activity. In some instances, the tasks are more broadly defined to facilitate innovations in execution, while other tasks are more narrowly defined to target a specified need.

Stakeholder Needs

This section identifies the stakeholder needs that are addressed by the recommended activity. In most instances, the activity cannot be expected to completely eliminate the need, but should be expected to provide measurable progress toward reducing the need.

Potential Strategic Partners

Many activities will require participation, and even leadership, from other organizations. This section identifies potential strategic partners to assist in the execution of the activity and promotion/use of the results.

Time Frames

This section provides estimates for the period of time expected to execute the activity. In most instances, some time to monitor the effectiveness of the

activity has been provided. These estimates are intended to provide targets for program management, and were used in the prioritization process.

Suggested Performance Measures

This section provides suggested performance measures that might be used to demonstrate and report on the effectiveness of the program. Sometimes a preliminary baseline activity is suggested and a post-activity monitoring effort is suggested. Post-activity monitoring efforts can be extended beyond the estimated duration to continue demonstrating activity effectiveness.

NEHRP Strategic Goals and Objectives Addressed by Activity

Recommended activities support the goals and objectives of the NEHRP Strategic Plan. This section identifies the specific goals and objectives that are being addressed by each activity.

B.2 Detailed Activity Descriptions

Detailed descriptions for each recommended activity are provided in the sections that follow.

Activity A1: Develop Earthquake Performance Rating System for Buildings

Task Description

Develop and disseminate an Earthquake Performance Rating System for Buildings to serve selectively identified stakeholders and interest groups. Work by the Structural Engineers Association of Northern California (SEAONC) has concluded that a given rating system, consisting of a set of methods, criteria, and terminology, is likely to be appropriate for some rating programs but not for others. The Existing Buildings Program should support an effort to define one or more contexts for a rating system (starting, perhaps, with the one developed by SEAONC) and convene the selected stakeholders and interest groups to establish critical objectives and industry-specific parameters for one or more pilot markets. The engineering framework for the rating system should be built from existing assessment tools to support the end users' needs. Even pilot rating systems will likely need to assess building performance considerations such as repair cost and recovery time, as opposed to just occupant safety. To the extent that consensus engineering tools to make those assessments are not yet available, development of pilot rating systems will also be useful in identifying where existing standards require improvements and where additional research is needed. It is likely that ongoing FEMA efforts in developing next-generation performance-based seismic design guidelines for new and existing buildings (ATC-58 Project) will provide valuable tools to support the rating methodology.

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

- Need 2.2 Encouraging Retrofit by Raising Vulnerability Awareness

Theme 5: Develop New Products

- Need 5.4 A Uniformly Acceptable Standard Building Performance Rating System

Potential Strategic Partners

ATC, BSSC, Building Owners (BOMA), NCSEA (and member associations like SEAOC), insurers, lenders, realtors

Time Frames

- Year 1: Project formulation, selection of rating program context and model building types for development of pilot system; outline of pilot rating system.
- Year 2: Consensus-building workshops with interest groups associated with the pilot context; development of straw-man pilot system.
- Year 3: Test applications; identification of technical and implementation issues for resolution; draft report with examples for industry review.
- Year 4: Release pilot system with user notes; formulate model implementation plan for users.
- Year 5: Consensus-building and marketing of system and implementation of plan.

Suggested Performance Measures

- Years 5-10: Monitor number of rated buildings in pilot market. A reporting system will be required with opportunity to gather feedback.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 12: Promote the implementation of earthquake resilient measures in professional practice and in private and public policies

Objective 13: Increase public awareness of earthquake hazards and risks

Activity A2: Develop Rehabilitation Cost Guidance (Update FEMA 156 and FEMA 157)

Task Description

Owners and public policy advisors frequently cite the high cost of seismic rehabilitation as a significant barrier to more widespread rehabilitation to reduce future losses. Estimating these costs with the ability to identify the "high cost" components could permit scope modifications to better align with economic realities. FEMA's best tool for estimation of seismic rehabilitation costs is the Seismic Rehabilitation Cost Estimator, which is based upon the companion documents FEMA 156 and 157, *Typical Costs for Seismic Rehabilitation of Existing Buildings, 2nd Edition*, Volumes 1 and 2 (published in 1994). The data in these documents is now more than 15 years old and in serious need of updating for them to be a useful resource. Within the next five years, it can be expected that the ATC-58 project will provide a building specific structural and non-structural performance assessment methodology that enables estimation of expected losses in terms of property damage, casualties and time out of service. Enhancing the existing FEMA Seismic Rehabilitation Cost Estimator database to include non-structural considerations and updated structural costs would permit the assembly of a cost/benefit tool as well as providing a methodology that permits identification of the most significant cost components of a rehabilitation. The interactive web-based format of the Cost Estimator offers users greater flexibility in building estimates and could be improved to better reflect unique project features. Given the significant range in unit costs (due to project complexity, variations in seismicity, and other considerations), alternative approaches to improve the usefulness of the methodology should be considered.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.6 Reduction in the High Cost of Rehabilitation

Potential Strategic Partners

FEMA, NIST

Time Frames

- Year 1: Project formulation.
- Year 2: Update databases.
- Year 3: Software development.

- Year 4: Promotion/applications/website.

Suggested Performance Measures

- Years 5-10: Monitor hits at website and promote user feedback.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 3: Advance understanding of the social, psychological and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness and content of earthquake information products

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Activity A3: Monitor Use of ASCE 31 and ASCE 41 for Projects Triggered by Codes

Task Description

The 2009 *International Building Code* (IBC) specifically allows, for the first time, the use of standards ASCE 31 and ASCE 41 when seismic evaluation and retrofit are triggered by Chapter 34: Existing Structures. The IBC does this by reference to the *International Existing Building Code* (IEBC) as a deemed-to-comply alternative. This provides an opportunity to study the application of these standards in triggered projects. The Existing Buildings Program should support an effort to establish liaisons with a selection of key building departments and fund them to track existing building projects that do and do not lead to seismic work. This information will be invaluable for learning why the standards are or are not used and how they might be improved to engender more consistent application.

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

Need 2.5 Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards

Potential Strategic Partners

ICC (and local organizations like CALBO), NCSEA (and member associations like SEAOC)

Time Frames

- Year 1: Identify project consultants to select key building departments and to serve as liaisons (some already familiar with ASCE 41 and others not); establish standards for collecting information and training building officials on program goals.
- Year 2: Provide training to building officials and practitioners in selected jurisdictions and promote knowledge and use of ASCE 31 and ASCE 41 (Participating building departments should coordinate tracking and record-keeping procedures with liaisons).
- Years 3-4: Data collection by liaisons from participating building departments, and data analysis by consultants and FEMA.
- Year 5: Review of initial data and strategizing for improvement of the standards and their implementation, potentially leading to recommendations for improvement.

Suggested Performance Measures

- Year 2: Record number of jurisdictions interested in voluntary participation and number of training sessions provided.
- Years 3-4: Identify number of buildings with and without rehabilitation.
- Year 5: Summarize results and promote recommendations to improve triggered rehabilitation.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A4: Develop Community Building Inventories

Task Description

Current codes, standards, and mitigation programs address some essential occupancies (independent of structure type) and some collapse hazards (independent of occupancy) but exclude many buildings and are divorced from response and recovery goals. To implement rational resilience plans, communities need inventories of their building stock by occupancy and structure type. The Existing Buildings Program should support a program to establish rough guidelines for producing such inventories (often from existing demographic and historic data) and should work with pilot communities to assist in their development of such inventories for use in resilience planning. Creation and maintenance of these inventories will support response planning, mitigation planning, and even post-earthquake information acquisition. The Existing Buildings Program should undertake a program to promote the creation of integrated inventories for post-earthquake planning.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.5 Coordination with Response and Recovery Planning

Potential Strategic Partners

FEMA (organizational units not involved in the Existing Buildings Program); professional associations of engineers, planners, and building owners; jurisdiction emergency planners and building officials

Time Frames

- Year 1: Establish liaisons with key jurisdictions and strategic partners for varying earthquake hazard and building stock; establish guidelines for participation in a FEMA-funded inventory program.
- Year 2-4: Produce inventory guidelines and support efforts by participating jurisdictions to produce inventories in accordance with agreed guidelines.
- Year 5: Review and analysis of integrated inventories produced with eye toward promoting their use in expanded mitigation and resilience planning.

Suggested Performance Measures

- Year 2: Identify number of jurisdictions interested in voluntary participation.
- Year 5: Identify number of integrated inventories produced and activities undertaken as a consequence in a summary report promoting the effort to a broader audience of communities.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 3: Advance understanding of the social, behavioral, and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Objective 4: Improve post-earthquake information acquisition and management

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 6: Develop advanced loss estimation and risk assessment tools

Goal C. Improve the earthquake resilience of communities nationwide

Objective 10: Develop comprehensive earthquake risk scenarios and risk assessments

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 13: Increase public awareness of earthquake hazards and risks

Activity A5: Support Development of Standards Update Framework

Task Description

ASCE 31 and ASCE 41 were developed with the intent to be periodically updated to reflect both new information and to rectify problems in application discovered through use. Stakeholders have identified numerous immediate concerns with the documents. Given its formative involvement in development of the standards, the Existing Buildings Program should take the lead in working with NIST, ASCE/SEI, ICC, and NCSEA officials to build a coordinated framework for the periodic update of these important reference standards. It should organize a discussion among its strategic partners to determine resources, timelines and process by which this important task can be executed. The 2007 *NEHRP Workshop on Meeting the Challenges of Existing Buildings* identified numerous areas of suggested improvements to the standards that should be fed, by the Existing Buildings Program, into a process for consideration and updating to the standards. NEHRP cannot achieve its strategic Goal C without making a commitment to update the basic engineering tools of seismic assessment and rehabilitation.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Building Standards

Need 1.1 Update of ASCE 31 and ASCE 41

Potential Strategic Partners

NIST, NSF, USGS, ACI (Committee 369), AISC, ASCE/SEI, BSSC, ICC, NCSEA (and member associations)

Time Frames

- Year 1: Strategic meetings among partners to define objectives and schedules.
- Year 2: Ratify agreements; establish framework.
- Year 3: Coordinate implementation and maintain scheduled activities for initial update cycle.

Suggested Performance Measures

- Year 2: Agreements in place.
- Year 3: Initiate support activities and monitor progress of partners.
- Years 4-5: Monitor progress of partners.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness and content of earthquakes information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Activity A6: Enhance LEED Ratings for Resilience

Task Description

The U.S. Green Building Council (USGBC) developed and currently maintains the Leadership in Energy and Environmental Design (LEED) rating system, which is a voluntary, consensus-based, national standard for developing high-performance sustainable buildings. The system has been extremely successful in its adoption and incorporation in both public and private sector construction projects. The system currently does not recognize anticipated building performance for extreme hazard as a consideration of sustainability in determining the rating categories of Certified, Silver, Gold and Platinum

The Existing Buildings Program can improve the LEED rating system by a concerted effort to introduce the concepts of building performance and resilience as scoring components. The Existing Buildings Program effort should include strategic partnerships with ASCE/SEI and NCSEA and other organizations to work with the USGBC LEED update process, and work to develop a strategy to support development of a set of recommendations for submission to USGBC. If properly weighted, improvements in structural resilience through rehabilitation could receive significantly broader consideration due to the remarkable success of the LEED system.

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

- Need 2.2 Encouraging Retrofit by Raising Vulnerability Awareness
- Need 2.3 More Incentives for Seismic Rehabilitation

Potential Strategic Partners

AIA, ASCE/SEI, NCSEA, USGBC

Time Frames

- Year 1: Build coalition; collect material; and formulate position.
- Year 2: Submit for USGBC consideration.
- Year 3: Support USGBC process to obtain ratification and incorporation.

Suggested Performance Measures

- Year 3: Monitor progress of submittal and advocate as required.

- Year 4-10: Survey LEED usage among engineering organizations and prepare report of findings documenting importance of the change in promoting rehabilitation.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools to improve performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 13: Increase public awareness of earthquake hazards and risks

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A7: Develop Consensus Code Change Proposals to Align the Provisions of the IBC, IEBC, and IRC

Task Description

The 2009 *International Building Code* (IBC) allows, for the first time, the use of ASCE 31 and ASCE 41. However, ICC publishes three model codes that deal with existing buildings: the IBC (in Chapter 34); the *International Existing Building Code* (IEBC), which has long referenced the ASCE standards, and the *International Residential Code* (IRC), which addresses existing structures only in an appendix. The Existing Buildings Program should support an effort to develop code change proposals that align the terminology and philosophy of each of the model codes with respect to earthquake effects and lateral system upgrade provisions, ultimately working toward replacement of obsolete methods with standards-based provisions.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Building Standards

Need 1.2 Coordination with Other Efforts

Potential Strategic Partners

FEMA, ASCE/SEI, the Code Resources Support Committee (CRSC) of BSSC, ICC and its local associations (such as CALBO), NCSEA (and its member associations)

Time Frames

This activity must align with the ICC's code development schedule. The next opportunity to make substantive changes to the model codes will come in early 2012; approved proposals will be published in the 2015 model codes.

- Year 1: Develop consensus for an overarching philosophy of code triggers (2009 IBC Chapter 34 or the 2009 IEBC Work Area Method may be used as a straw man).
- Year 2: Draft code change proposals for the three model codes based on the consensus philosophy, and develop a coalition of engineers, building officials, and others in advance of the hearings in late 2012.
- Year 3: Submit code change proposals (2012) through NCSEA or the CRSC; provide testimony and support at code development hearings.
- Year 4: Support approved code changes at ICC final action hearings; distribute copies of expected code changes, with commentary, to

building departments and engineers to prepare them for the 2015 codes.

Suggested Performance Measures

- Year 1: Completion of the overarching philosophy and track number of organizations expressing buy-in.
- Year 2-4: Track number of code change proposals developed with consensus, submitted, and approved.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Activity A8: Develop Simplified Evaluation and Rehabilitation Guidance (Regional Module)

Task Description

The purpose of this task is to develop simplified evaluation and rehabilitation guidance for one or more subsets of at-risk buildings in selected geographic regions. Examples might include soft story commercial and multi-family residential facilities in zones of high, frequent seismicity; and wood and/or unreinforced masonry (URM) residential construction in the Central United States (Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, Tennessee) in areas likely to suffer a significant number of complete building losses in the event of significant earthquake events within the New Madrid Seismic Zone, Wabash Valley Seismic Zone or East Tennessee Seismic Zone. A recently released study by the Mid-America Earthquake Center, *Impact of Earthquakes on the Central USA,* (September, 2008), suggests complete and extensive losses of 5 to 10% of residential construction of this type in these regions for credible earthquake scenarios. The activity should include a project formulation process for prioritizing building types and regions to be addressed.

Stakeholder Needs

Theme 3: Develop Simplified Evaluation & Rehabilitation Procedures

Need 3.1 Simplified and/or Prescriptive Procedures

Potential Strategic Partners

ATC, BSSC, local professional organizations (NSCEA member associations), building officials

Time Frames

- Year 1: Identify potential pilot regions; solicit regional engineers and building officials, select prototype buildings and region.
- Year 2: Assemble regional task team; formulate simplified methodology.
- Year 3: Vet methodology; develop outreach program to community and support development of Voluntary, Triggered, and/or Mandatory evaluation and rehabilitation programs with new technology.

Suggested Performance Measures

- Year 2: Establish regional estimate of potential losses to prototype buildings without rehabilitation and potential savings with rehabilitation.
- Years 4-10: Record number of permits issued for rehabilitation of prototype buildings and estimate savings; monitor change in permits for prototype and estimate yearly and total savings.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools to improve the seismic performance of buildings and other structures

Activity A9: Develop Seismic Evaluation & Rehabilitation Example Applications

Task Description

The Existing Buildings Program should develop a series of publications covering the FEMA model building types that provide detailed example applications of the provisions for evaluation (in ASCE 31) and rehabilitation (in ASCE 41). The material should be developed by experienced, practicing engineers and should include commentary discussing judgments made in applying the provisions. ASCE/SEI and NCSEA should be approached for providing example application materials and ICC should be consulted for potential publishing and distribution. Execution of this task may be facilitated by the significant participation of strategic partners and result in a non FEMA publication series. The material can serve as the basis for development of Activity A15 and should provide links to currently available documents containing example applications (e.g., FEMA 343, *Case Studies: An Assessment of the NEHRP (FEMA 273) Guidelines for the Seismic Rehabilitation of Buildings*).

Stakeholder Needs

Theme 4: Improved Education & Training of Engineering Professionals

- Need 4.1 Consistency in Code Enforcement
- Need 4.2 Consistency in Seismic Evaluation Results
- Need 4.4 Education and Training in Seismic Rehabilitation

Potential Strategic Partners

ASCE/SEI, ICC, NCSEA

Time Frames

- Year 1: Develop scope/budget, framework, and identify participating organizations.
- Year 2-8: Produce examples and vet work.

Suggested Performance Measures

- Years 2-8: Monitor examples completed and vetted.
- Years 4-8: Monitor copies sold, ordered and distributed.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timelines and content of earthquake information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A10: Develop and Promote Earthquake Risk Communication Tool

Task Description

Practicing engineers have expressed a need to improve their ability to communicate issues of earthquake risk to owners, architects and non-engineering decision makers. Several problems have been identified that could be addressed for an audience of engineers to improve their effectiveness in communication of earthquake risk concepts. Examples of the issues that could be addressed include: providing a glossary of terms, characterizing low probability/high consequence events, articulating the variability of anticipated seismic performance of existing buildings when subjected to strong ground motion and providing clarification that code conformance is not a guarantee of future performance nor does it preclude an unusable post-earthquake building.

These topics and others could be addressed in a brief primer prepared and disseminated with the support of the Existing Buildings Program that engineers could reference to help them express their understanding of seismic risk to others not as familiar with the subject.

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

Need 2.1 Guidance for Improved Engineers' Communication with Owners and Stakeholders about Seismic Rehabilitation

Potential Strategic Partners

ASCE/SEI, ATC, BSSC, EERI, NCSEA

Time Frames

- Year 1: Convene project team and broader focus group to establish framework and topics of document; draft document.
- Year 2: Obtain document reviews; revise and publish document.

Suggested Performance Measures

- Years 3-10: Monitor usage through copies sold, ordered and/or distributed.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 13 Increase public awareness of earthquake hazards and risks

Objective 14 Develop the nation's human resource base in earthquake safety fields

Activity A11: Develop Framework for Convening Issue Teams to Move Research into Practice

Task Description:

The Existing Buildings Program should facilitate the transition of new research findings into practical engineering criteria. A recent successful example involved the development of ASCE 41 Supplement 1, which incorporated new data on concrete frame elements into ASCE 41 through an *ad hoc* committee that teamed practicing engineers and researchers.

The Existing Buildings Program should develop a framework by which similar committees, or "Issue Teams" are convened and charged to review new and existing research results and develop appropriate provisions for codes and standards. The framework would address questions of Issue Team membership, leadership, cost sharing, identification and prioritization of issues of interest, tracking progress, criteria for judging applicability and completeness of research results and coordination with parallel efforts undertaken by others.

Issue team formation and charges should be coordinated with code and standard update cycles and structured to support Activity A5.

Stakeholder Need

Theme 1: Facilitate Framework to Update Existing Buildings Standards

Need 1.4 Transfer of Research into Practice

Need 1.5 Elimination/Reduction of Over Conservatism of ASCE 31 and ASCE 41

Potential Strategic Partners

NIST, NSF, ASCE/SEI, ATC, BSSC, CUREE, ICC, NCSEA, standards writing organizations

Time Frames

- Year 1: Planning with strategic partners; assembly of a working group; initial drafting of framework guidelines and initial issue identification.
- Year 2: Final recommendations of the working group as a framework for convening issue teams to move research into practice and listing of priority issues to be addressed.

Suggested Performance Measures

- Year 1: Number of partners committing to participate and devote resources; completion of issues identification report.
- Year 2: Completion of framework agreements and endorsement by strategic partners of prioritized list of issues.
- Year 3: Implementation of the framework on the highest priority issues with results timed to coincide with target code/standard update cycle.
- Year 4-10: Identify and report code/standard successful changes.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools that improve the seismic performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

.

Activity A12: Promote Incremental Seismic Rehabilitation Guidance

Task Description

Programs of partial and incremental seismic rehabilitation can be an effective long-term risk reduction strategy. FEMA has produced a series of publications that provide useful guidance to a broad range of existing building stakeholders on the advantages of incremental seismic rehabilitation efforts. The information, however, does not seem to have gained significant buy-in by the practicing engineering or code regulatory community. This material needs to be more widely understood by these stakeholders. A seminar series to disseminate, explain and demonstrate the concepts and materials needs to be developed and executed. From the feedback gained from a concerted national seminar program, it may be possible to develop a set of recommendations for providing updates to ASCE 31 and ASCE 41 that incorporate the incremental rehabilitation concepts into code changes that address more serious building vulnerabilities without complete building compliance [triggered code upgrades]. These approaches may also be used to provide guidelines for regulatory review of voluntary rehabilitation efforts undertaken by owners to reduce future earthquake losses.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.2 Acceptance of Incremental Mitigation Strategies for Seismic Rehabilitation

Potential Strategic Partners

ASCE/SEI, ICC, NCSEA (and member associations)

Time Frames

- Year 1: Formulate and prepare seminar materials.
- Year 2: Provide regional seminar series in partnership with ASCE/SEI, ICC, and NCSEA (and member associations). Solicit attendees on needs for improved acceptance.
- Year 3: Prepare report of findings and recommendations for efforts to increase acceptance.
- Year 4-10 Pursue recommendations to promote greater acceptance possibly supporting pilot programs.

Suggested Performance Measures

- Year 2: Monitor turnout at seminars.
- Year 3: Assess seminar success and determine potential for wider acceptance.
- Year 4-10: Monitor communities implementing methodology to reduce risk.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve earthquake resilience of communities nationwide.

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

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Activity A13: Develop Recommendations for Treatment of Earthquake Hazard Issues for Existing Buildings

Task Description:

The recently completed Next Generation Attenuation of Ground Motions project led by PEER has led to an overhaul of the ASCE-7 standard for defining earthquake demands. The ASCE 31 and ASCE 41 standards need to be amended to incorporate this information. Broader questions exist, however, regarding the selection of appropriate ground motion characterizations based on uniform risk versus uniform hazard. These questions arise as a consequence of the variations in construction that are unique to existing buildings and are not permitted in new construction. Additionally, the incremental construction costs in designing new construction for higher confidence levels in ground motion parameters is relatively small while using the same confidence levels for existing buildings may significantly increase rehabilitation requirements or result in characterization as a hazardous building. Recommendations for the treatment of these issues would fill an important gap in the application of the ASCE 31 and 41 standards. The Existing Buildings Program should initiate formation of an "Issue Team" to identify relevant issues for consideration in updating the ASCE 31 and ASCE 41 standards regarding ground shaking hazards and developing a set of recommendations for consideration in the update process.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Buildings Standards

Need 1.6 Improved Methods for Ground Motion (Hazard) Selection for Existing Buildings

Potential Strategic Partners

FEMA, NIST, USGS, ASCE/SEI, ATC, BSSC, NCSEA, PEER

Time Frames

- Year 1: Assemble issues group; identify scope of issues, schedule, and leadership.
- Year 2: Develop recommendation on selected issues; publish recommendations for code/standard consideration.
- Year 3: Advocate as required for adoption.

Suggested Performance Measures

Year 3: Monitor code/standard process and record success/failure.

NEHRP Strategic Goals and Objectives

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools that improve the seismic performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

.

Activity A14: Develop Nonlinear Analysis Modeling Guidelines

Task Description

Since the publication of ASCE 41 (and FEMA 356), considerable information has become available regarding nonlinear analysis techniques (static and dynamic) including FEMA 440, *Improvement of Nonlinear Static Seismic Analysis Procedures*, and 440A, *Effects of Strength and Stiffness Degradation on Seismic Response*. As practicing engineers have gained exposure to these methodologies, interpretive guidance has been found lacking. To fill these needs and to assist regulatory officials responsible for interpreting submitted work to assess code conformance, a resource document should be developed that provides information through applications. The Existing Buildings Program should support an effort to produce a document that provides commentary and discussion on nonlinear static and dynamic analyses that illustrates the application of ASCE 41. It should provide example applications that highlight stiffness and strength modeling decisions for commonly encountered forms of building construction. Additionally, the document should provide guidance on ground motion selection and scaling to address the unique problems of existing buildings. Other areas that should be presented include hysteretic models and stiffness and strength degradation modeling for dynamic systems. The resource document should be permitted to accrue new modules over a period of time rather than being held out of circulation until a large assembly of examples have been completed and vetted.

Stakeholder Needs

Theme 4: Improve Education and Training of Engineering Professionals

Need 4.3 Nonlinear Analysis Modeling Guidelines

Potential Strategic Partners

NIST , ASCE/SEI, ATC, BSSC, ICC, NCSEA

Time Frames

- Year 1: Formulate plan budgets; engage strategic partners; devise schedule.
- Year 2: Develop initial modules (initially 2-3 examples/issues).
- Year 3: Vet initial modules; develop additional modules (2 to 3).
- Year 4: Release initial modules; vet second set of modules (2 to 3); develop new modules (2 to 3).

- Year 5: Continue to vet and release modules as time and budget permits.

Suggested Performance Measures

- Year 4: If published, measure distribution, orders, sales or if web based, measure hits.
- Years 5-10: Monitor distribution/hits.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness and content of earthquakes information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A15: Promote Education and Training of Engineering Professionals

Task Description

The Existing Buildings Program should support development of a seminar series providing instruction on ASCE 31 and ASCE 41 for a national audience of engineers. The seminar program should be offered and promoted by regional engineering and building official organizations with professional education credits made available. Example applications should be the primary emphasis with multiple sessions covering basic building types and seismic zones. The material generated in Activity A9 can be used for this program.

Stakeholder Needs

Theme 4: Improve Education and Training of Engineering Professionals

Need 4.4 Education and Training in Seismic Rehabilitation

Potential Strategic Partners

ASCE/SEI, BSSC, ICC, NCSEA

Time Frames

- Year 1: Assemble curricula, contact partners and schedule programs.
- Year 2,3,4: Conduct seminars.

Suggested Performance Measures

- Year 2,3,4: Collect seminar feedback; report number of attendees and reassess interest.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 12: Promote the implementation of earthquake resilience measures in professional practice and in private and public policies

Objective 13: Increase public awareness of earthquake hazards and risks

Activity A16: Define Test Beds and Case Studies

Task Description

The FEMA Existing Buildings Program, with the support and involvement of NIST and NSF, should define several robust seismic evaluation and rehabilitation case studies (test beds representing common existing buildings) and encourage researchers in a variety of fields to use them for both basic and applied research. The test beds should not be limited to simplified model buildings but should include the full range of issues that existing buildings present, including occupancy continuity, non-structural components and contents, historic preservation, other code-triggered work, and other issues. Of immediate interest are controlled studies comparing traditional code-based evaluation and retrofit approaches with simplified prescriptive methods, performance-based standards, and alternative techniques.

The first set of test beds would likely be certain model building types due for risk reduction programs, such as non-ductile concrete frames. For example, two different building sizes from two different eras would yield a suite of four model buildings. These would be supplemented by further definition of occupancies, geotechnical conditions (assuming these were unknown or ignored at the time of typical design), market conditions, other related regulations (for access and greening, for example), and other relevant issues to make each model building "robust" in terms of its definition. The well-defined test beds would then provide a range of pre-defined conditions in which techniques for evaluation, retrofit, loss estimation, and return on investment analysis could be studied consistently.

In Part 2 of the 2007 workshop report (ATC, 2009) the test beds described here were referred to as "focused case studies." Since "case studies" suggests reports on past projects, as opposed to the forward-looking studies contemplated here, "test bed" is a more appropriate term.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Buildings Standards

Need 1.3 Evaluation and Rehabilitation Case Studies

Potential Strategic Partners

NIST, NSF, USGS, professional and industry groups

Time Frames

- Year 1: Planning with strategic partners to identify framework; budget and schedule project to organize a workshop with researchers.
- Year 2: Drafting of template and/or pilot test bed; solicitation of researcher feedback.
- Year 3: Development and dissemination of first set of test beds, with request for research proposals to study the test bed data.
- Year 4: Development and dissemination of second set of test beds, with request for research proposals to study the test bed data.
- Year 5: Status review and planning for next sets of test beds.

Suggested Performance Measures

- Years 1-2: Letters of interest and approval from research community.
- Years 3-4: Number of test beds defined and disseminated; number of research proposals submitted.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

- Objective 2: Advance understanding of earthquake effects on the built environment
- Objective 3: Advance understanding of the social, behavioral, and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

- Objective 6: Develop advanced loss estimation and risk assessment tools
- Objective 7: Develop tools that improve the seismic performance of buildings and other structures
- Objective 8: Develop tools that improve the seismic performance of critical infrastructure

Goal C. Improve the earthquake resilience of communities nationwide

- Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Activity A17: Develop and Disseminate Policies and Guidance for Various Mitigation Program Approaches

Task Description

Mitigation programs can include voluntary, mandated, or triggered retrofits as well as other strategies such as risk transfer, redundancy planning, incremental rehabilitation, or expedited occupancy resumption. As jurisdictions weigh the costs and benefits of implementing one or more programs, they would benefit from Existing Buildings Program guidance on the relative merits and applicability of different strategies, model ordinances, appropriate incentives, and best practices. The best policies might vary from community to community depending on the local hazard, the building stock, local tax policy and other regulations, and other conditions. Further, to the extent that pre- or post-disaster FEMA grants are tied to mitigation policies, jurisdictions deserve to know in advance which policies and enforcement terms FEMA requires.

Stakeholder Needs

Theme 2: Develop & Improve Actionable Understanding of Earthquake Risk

- Need 2.4 Guidance on Voluntary versus Mandatory Programs
- Need 2.5 Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards

Potential Strategic Partners

FEMA (organizational units not involved with the Existing Buildings Program), associations of public and private risk managers

Time Frames

- Year 1: Create and disseminate summary of Stafford Act and Disaster Mitigation Act requirements and associated regulations and policy interpretations that relate to the adequacy of various risk reduction measures; identify ways to clarify and align any out of synch regulations.
- Year 2: Modify inconsistent or incomplete regulations; update the Year 1 summary of existing regulations; compile examples of model risk reduction measures of different types to create a menu of best practices.

- Year 3: Produce a document that guides local jurisdictions to mitigation programs appropriate to their circumstances.
- Year 4: Disseminate and provide training in the Year 3 guidance document.
- Year 5: Support jurisdictions as they implement the Year 4 document.

Suggested Performance Measures

- Year 1: Number of summaries disseminated.
- Year 2: Number of examples and potential best practices compiled, and number of jurisdictions surveyed.
- Year 3: Completion of the guidance document.
- Year 4: Number of trained jurisdictions.
- Year 5: Number of tracked implementations.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Activity A18: Provide NEHRP Existing Buildings Workshop Support

Task Description

In September of 2007, the NEHRP agencies sponsored a two-day *NEHRP Workshop on Meeting the Challenges of Existing Buildings* to solicit input from a broad spectrum of existing buildings stakeholders. The workshop generated the identification and prioritization of the most important actions the NEHRP agencies could undertake to facilitate the reduction of loss of life and property in future earthquakes. A periodic survey by the NEHRP agencies of the existing buildings community provides both feedback on past and ongoing activities and the opportunity to change directions and adjust to changing technological and sociological developments. FEMA's Existing Buildings Program should play a significant role in convening similar NEHRP workshops every four-to-six years to serve both its own strategic initiatives and those of its NEHRP partners.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Building Standards

Need 1.2 Coordination with Other Efforts

Need 1.4 Transfer of Research into Practice

Potential Strategic Partners

FEMA, NIST, NSF, USGS, ASCE/SEI, ATC, BOMA, CUREE, EERI, NCSEA, NEES

Time Frames

- Year 1: Obtain NEHRP consensus on agenda; develop organizing framework; identify responsibilities and attendees; engage management team, facilitators and record keeping staff.
- Year 2: Invite potential attendees; coordinate logistics, conduct workshop; collect and distill findings; publish proceedings.

Suggested Performance Measures

- Year 2: Report on workshop and release findings.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 2: Advance understanding of earthquake effects on the built environment

Objective 3: Advance understanding of the social, psychological and economic factors linked to implementation risk reduction and mitigation strategies in the public and private sector

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness and content of earthquakes information products

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A19: Coordinate Recommendations for Evaluation & Rehabilitation of Non-Structural Components

Task Description:

Treatment of non-structural components should be coordinated in a rational fashion among ASCE 7, ASCE 31 and ASCE 41. This activity envisions Existing Buildings Program sponsored formation of an "Issue Team" to establish recommendations to achieve a consistent set of recommendations.

Stakeholder Needs

Theme 1: Facilitate Framework to Update Existing Buildings Standards

Need 1.7 Consistency in the Evaluation and Rehabilitation of Non-Structural Components

Potential Strategic Partners

NIST, ASCE/SEI, NCSEA (and member associations)

Time Frames

- Year 1: Assemble Issues Group; identify scope of issues to be addressed, strategic partners, schedule and budget.
- Year 2: Develop recommendation on selected issues; submit recommendations for code/standard consideration; and provide testimony and support at code/standard hearings.

Suggested Performance Measures

- Year 3: Track number of code change proposals developed, submitted and approved.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools that improve the seismic performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

.

Activity A20: Develop Business Continuity Earthquake Planning Guidelines

Task Description

The Existing Buildings Program should support an activity to develop business continuity earthquake planning guidelines. The activity should identify potential occupancies where interest in maintaining post-earthquake operation is high and consider variations in approaches that reflect regional hazards. Activities should be coordinated with the FEMA-funded ATC-68 QuakeSmart outreach and awareness efforts. The guidelines might offer baseline downtime estimates or reference material and assistance in constructing benefit/cost studies. The guidelines could provide a rational basis for decision-making. By focusing on a narrow slice of the earthquake loss prediction problem, the guidelines should promote mitigation efforts that could be undertaken to create a more manageable post-earthquake environment.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.1 Business Continuity Planning Guidelines

Potential Strategic Partners

ASCE/SEI, EERI, NCSEA, community and industry organizations

Time Frames

- Year 1: Frame problem for hazard, occupancy, product/users and overall scope.
- Year 2: Develop occupancy/hazard matrix.
- Year 3: Develop regional guidelines for selected hazards and building types.
- Year 4: Organize and conduct workshops to disseminate guidelines.

Suggested Performance Measures

- Years 4-5: Record number of seminar attendees and number of documents distributed, ordered and purchased.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts.

Objective 7: Develop tools to improve the seismic performance of buildings and other structures

Activity A21: Benchmark Model Buildings Expected Performance

Task Description

ASCE 31 provides a methodology for determining building compliance for a Life Safety or Immediate Occupancy performance objective. The methodology is a mix of prescriptive and quantitative assessment steps that are executable by practicing engineers. Building evaluations are also widely done in the commercial real estate industry using probabilistically based risk assessment (generally proprietary software) techniques to establish Probable Maximum Loss (PML) estimates. This process has led to the informal establishment of loss estimates of 20% as a trigger point for requiring seismic rehabilitation. The Existing Buildings Program should support an effort to perform comparative studies that establish benchmark correlations between ASCE 31 determinations and PML measures of performance (dollar and downtime losses). Such benchmark correlations would provide a direct path for engineers to follow to produce rehabilitation scope consistent with market need. This alignment would facilitate a more coherent approach to risk management and remove a portion of the ambiguity that currently exists regarding the anticipated seismic performance of ASCE 31 conforming and non-conforming buildings. It would also serve to make the ASCE 31 methodology more widely used. FEMA's HAZUS loss estimation software may be an excellent non-proprietary tool for launching such a study. The effort may also be supported by the ATC 58 *Guidelines for Seismic Performance Assessment of Buildings* document(s), which provide a methodology for detailed seismic performance assessment of existing buildings, including losses due to damage and down time and casualties.

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding Earthquake Risk

- Need 2.2 Encouraging Retrofit by Raising Vulnerability Awareness
- Need 2.3 More Incentives for Seismic Rehabilitation

Theme 5: Develop New Products

- Need 5.4 A Uniformly Acceptable Standard Building Performance Rating System

Potential Strategic Partners

NIST, ASCE/SEI, ATC, NCSEA (and member associations)

Time Frames

- Year 1: Formulate project (identify project team members, establish budget, schedule and scope); establish baseline buildings; initiate project.
- Year 2: Execute studies; perform variations on model buildings.
- Year 3: Draft findings; vet findings; produce report, conduct seminar.

Suggested Performance Measures

- Year 3: Release report, monitor seminar interest and record copies of reports distributed.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 2: Advance understanding of earthquake effects on the built environment

Objective 3: Advance understanding of the social, psychological and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 6: Develop advanced loss estimation and risk assessment tools

Objective 7: Develop tools to improve performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness and content of earthquakes information products

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Activity A22: Develop Rational Resilience Criteria Customizable by Jurisdiction

Task Description

Rational community mitigation plans should be linked to response and recovery plans, which should be premised on a model of resilience. Every community should have its response and recovery goals stated in terms of when certain critical functions (e.g., housing, transportation, schools) must recover. The question is, what recovery times are necessary to forestall community instability (or otherwise meet the nation's or FEMA's overarching resilience objectives)? For example, what portion of the housing stock must remain habitable, or by when must schools and businesses reopen? The answers will come from a combination of social science and engineering research and will vary by community. The Existing Buildings Program should support development of a straw man set of resilience goals. This activity would also support efforts related to stakeholder education, program adoption, rating systems, and performance-based tools.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.5 Coordination with Response and Recovery Planning

Potential Strategic Partners

FEMA (organizational units not involved in the Existing Buildings Program), NSF (social science research program), professional organizations of planners and emergency managers

Time Frames

- Year 1: Study and database explicit and implicit resilience objectives of selected jurisdictions of varying earthquake hazard, as reflected, for example, in the Disaster Mitigation Act of 2000 plans, past ordinances, and other resilience planning documents.
- Year 2: Develop straw man model resilience goals with ranges or variations suitable to communities of different sizes, hazards, or other key attributes.
- Year 3: Use the straw man to develop consensus model resilience plans; identify research needs to complete or substantiate the model plans; solicit research proposals.

- Year 4: Identify methods to incorporate model plans into FEMA and DHS policies, the Stafford Act, and local jurisdiction mitigation and recovery plans.
- Year 5 and beyond: Maintain, update, improve, and implement resilience criteria and model resilience plans.

Suggested Performance Measures

- Year 1: Number of jurisdictions and planning documents reviewed and organized (in a table).
- Year 2: Number and variety of straw-man resilience plans developed.
- Year 3: Number of jurisdictions and organizations expressing buy-in for consensus resilience criteria and model plans.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 3: Advance understanding of the social, behavioral, and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal C. Improve the earthquake resilience of communities nationwide

Objective 11: Support development of seismic standards and building codes and advocate their adoption and enforcement

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A23: Develop Guidelines for Seismic Rehabilitation of Historic Structures

Task Description

Historic structures pose unique challenges that are not presently addressed by the ASCE 31 and ASCE 41 standards. Historic buildings present a special opportunity for treatment since in many communities; strong political constituencies exist for their preservation. The Existing Buildings Program should support development of a document that provides guidance on rehabilitation approaches to provide property protection commensurate to the value placed on the cultural resource being protected. Plaster ceilings, wall frescoes and many other decorative features of construction require a careful assessment of their fragility to establish target demand parameters of structural response that will achieve the desired level of damage protection. Unreinforced stone and rubble wall construction may have sufficient resistance to safely resist significant ground shaking when accurately derived analytical models are used for analysis in conjunction with representative suites of ground motion histories of the selected hazard level. Guidelines are needed to provide a broader range of analytical tools to the practitioner community charged with protecting important historic and cultural building treasures. This activity envisions development of a series of chapters addressing many of the common historical building features using advanced analytical techniques and approaches.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.3 Special Policies and Guidelines for Seismic Evaluation and Rehabilitation of Historic Structures

Potential Strategic Partners

AIA, ASCE/SEI, NCSEA, National Trust for Historic Preservation, National Park Service, other preservation organizations

Time Frames

- Year 1: Formulate team (including historical architects, preservationists, engineers, building officials) and define items to be addressed.
- Year 2: Develop guidance on selected topics using both literature research and analytical development.
- Year 3: Apply guidance to example applications.

- Year 4: Develop consensus on guidelines.
- Year 5: Release and promote on guidelines.

Suggested Performance Measures

- Years 5-10: Monitor adoption into codes and standards and assess usage.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts.

Objective 2: Advance understanding of earthquake effects on the built environment

Goal B. Develop cost effective measures to reduce earthquake impacts on individuals, the built environment and society at large

Objective 7: Develop tools to improve performance of buildings and other structures

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timelines and content of earthquake information products

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A24: Develop Simplified Rehabilitation Guidance (General Module)

Task Description

ASCE 41 includes a chapter on Simplified Rehabilitation with provisions keyed to model building types (limited by seismicity and building height) and to typical deficiencies identified by an ASCE 31 evaluation. The current approach eliminates known deficiencies but does not involve a comprehensive structural analysis. Importantly, Simplified Rehabilitation is not considered adequate to achieve ASCE 41's two-part Basic Safety Objective.

A separate Activity (the Regional Module) is recommended to develop more specific, perhaps prescriptive, guidance consistent with the current ASCE 41 approach, with an emphasis on prevalent conditions within a geographic region. This Activity is more general; it involves revisiting the ASCE 41 approach to Simplified Rehabilitation overall, updating it where appropriate, and recommending supplementary materials to make the standard more valuable as an alternative to obsolete code-based methods. The supplementary materials could include proposed revisions to the standard, worked examples, a companion "how-to" handbook, or other tools. In general, the Activity would address concerns about the general complexity of ASCE 41 and whether abridged or simplified versions could be deemed to meet the BSO.

Stakeholder Needs

Theme 3: Develop Simplified Evaluation and Rehabilitation Procedures

Need 3.1 Simplified and/or Prescriptive Procedures

Potential Strategic Partners

ASCE/SEI , ATC, BSSC, ICC (and its sections), NCSEA (and its member associations)

Time Frames

- Year 1: Review existing ASCE 41 Simplified Rehabilitation provisions; identify implementation obstacles.
- Year 2: Develop and prioritize a menu of supplementary materials.
- Year 3: Produce supplementary materials and supporting analyses as prioritized.

Suggested Performance Measures

- Year 1: Completion of the review.
- Year 2: Industry consensus on prioritized options for supplementary materials.
- Years 3 and forward: Production and dissemination of supplementary materials as prioritized.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost effective measures to reduce earthquake impacts on individuals, the built environment and society at large

Objective 7: Develop tools that improve the seismic performance of buildings and other structures

Activity A25: Prepare White Paper on Seismic Rehabilitation and Social Vulnerability

Task Description

Seismic rehabilitation as a technical task is complex but relatively circumscribed. Seismic risk reduction as public or institutional policy, however, is bound up with essential considerations of social costs and benefits. Efforts to encourage or require risk reduction have the best chance of succeeding when they account for competing interests related to sustainable design, historic preservation, disabled access, building valuation, and other related issues.

Of particular interest are issues related to potential impacts on socially vulnerable populations. On one hand, these are the people who would be least able to recover from earthquake losses. On the other hand, they are also the ones least likely to undertake voluntary risk reduction and least able to manage the unintended consequences of triggered or mandated retrofit. Should vulnerable groups (and organizations serving them) be exempted from certain risk reduction programs? Should their costs be subsidized by the larger community? How should issues of social vulnerability be accounted for in benefit-cost models, and how should they inform public policy options?

These questions call for continued and new social science research generally beyond the scope of FEMA's Existing Buildings Program (the research agenda [ATC, 2007] developed as part of the 2007 *NEHRP Workshop on Meeting the Challenges of Existing Buildings* did not include social science projects). Yet the Existing Buildings Program's success relies on an understanding of these issues. Therefore, it is clearly in FEMA's interest to convene experts to produce a White Paper framing the issues, summarizing the current state or knowledge, and identifying open questions critical to Existing Buildings Program success that could serve as a starting point for investigation by strategic partners (NIST, NSF, social policy awareness groups).

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

- Need 2.7 More Information on Social Impacts of Seismic Rehabilitation on Vulnerable Populations

Potential Strategic Partners

NIST, NSF, professional and industry groups, social policy advocacy groups

Time Frames

- Year 1: Planning with strategic partners and core consultant team; initial research and issue identification.
- Year 2: Workshop with selected stakeholder groups, researchers, and other experts.
- Year 3: Development of White Paper summarizing the Existing Buildings Program perspective, research needs, and interim positions.

Suggested Performance Measures

- Year 1: Number of partners committing to participate and devote resources.
- Year 2: Participants in Workshop.
- Year 3: Completion of White Paper; citations and research proposals based on White Paper.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 3: Advance understanding of the social, behavioral, and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 6: Develop advanced loss estimation and risk assessment tools

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Objective 12: Promote the implementation of earthquake-resilient measures in professional practice and in private and public policies

Objective 14: Develop the nation's human resource base in earthquake safety fields

Activity A26: Develop Methodology for Tracking the Progress of Earthquake Risk Reduction

Task Description

As seismic risk becomes better understood and modeled, as tools for risk reduction become more available, and as FEMA is successful at encouraging rehabilitation programs, it might finally become feasible to study in a rigorous way how much risk is actually being abated. We can already track (approximately) where different policies, codes, and best practices are in place. If we can chart as well the critical socioeconomic factors (e.g., nature of the building stock, community affluence) and estimate the actual projects that use the various tools, we will greatly improve our understanding of what works and what needs to be done differently. The last part—counting the actual retrofits—has always been the most elusive piece.

FEMA should develop an appropriate methodology for baselining the current seismic risk and quantitatively tracking how it changes through retrofit projects (or by building stock attrition). Any number of valid methods for collecting, sampling, estimating, and extrapolating data might be valuable here. This Activity would engage experts to study potential methods and recommend a program to implement one or more of them. Actual implementation, likely through the cooperation of selected jurisdictions and possibly involving the development of new online tools, would be a separate task, though a pilot study might be attempted as "proof of concept."

Stakeholder Needs

Theme 2: Develop and Improve Actionable Understanding of Earthquake Risk

Need 2.5 Guidance on Adoption and Enforcement of Rehabilitation Codes and Standards

Potential Strategic Partners

BOMA (and other building owner organizations), ICC, local planning and building departments

Time Frames

- Year 1: Establish objectives for tracking; identify ancillary variables and controls; develop a menu of potential methodologies; select one or more methodologies for development.
- Year 2: Develop selected methodologies in logistical terms; convene stakeholders and strategic partners to generate consensus.

- Year 3: Proof of concept study; revision of draft methodologies; write-up of recommended methodology.

Suggested Performance Measures

- Year 1: Number of potential methodologies identified.
- Year 2: Number of participants in consensus-generating efforts.
- Year 3: Completion of study and report; number of jurisdictions and organizations expressing interest in participating.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal A. Improve understanding of earthquake processes and impacts

Objective 3: Advance understanding of the social, behavioral, and economic factors linked to implementing risk reduction and mitigation strategies in the public and private sectors

Goal C. Improve the earthquake resilience of communities nationwide

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Objective 13: Increase public awareness of earthquake hazards and risks

Activity A27: Prepare Continuity Guidelines That Address Initial Seismic Evaluation Through Seismic Rehabilitation

Task Description:

The FEMA 154 Rapid Visual Screening procedure for identifying potential seismic hazards in existing buildings has been presented to numerous groups and potential users. A number of surveys of communities and facilities have been completed using this procedure. Presently there is no guidance in FEMA 154, nor have tools been developed, to carry the initial survey results to the next level of engineering evaluation of potentially hazardous buildings.

The Existing Buildings Program should develop a methodology on the entire process, from initial survey to seismic rehabilitation, with specific emphasis on the steps to implement the findings of a FEMA 154 survey. Such a methodology could support community response and recovery planning.

Stakeholder Needs

Theme 5: Develop New Products

Need 5.5 Coordination with Response and Recovery Planning

Potential Strategic Partners

FEMA (organizational units not involved in the Existing Buildings Program), local building officials

Time Frames

- Year 1: Frame problem; develop scope of effort.
- Year 2: Draft guidelines; vet guidelines.
- Year 3: Provide seminar on guidelines.

Suggested Performance Measures

- Year 3: Record number of attendees at seminar and number of guidance documents distributed.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal C. Improve the earthquake resilience of communities nationwide.

Objective 9: Improve the accuracy, timeliness, and content of earthquake information products

Activity A28: Review and Compare Current Conventional Simplified Evaluation and Rehabilitation Practices

Task Description:

Several recommended activities deal with the need for simplified evaluation and rehabilitation methodologies. In fact, several such methodologies already exist. Chief among them is the obsolete but conventional practice of applying selected building code provisions intended for new construction to existing conditions. This remains the default approach still taken by the *International Building Code* Chapter 34 at this time. In addition, alternative (usually prescriptive or simplified) approaches exist for specific building types. These include the five IEBC Appendix A Chapters and FEMA 351, *Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings*, which was developed in response to the poor performance of numerous steel moment frame buildings during the 1994 Northridge, California, earthquake. The question is whether these approaches reliably reach the same (or appropriately conservative) results as the standards ASCE 31 and ASCE 41. And if not, why not? Which is more reliably correct, and are the more sophisticated provisions of the standards justified?

The Existing Buildings Program should support an activity that reviews a suite of comprehensive studies of model building types already addressed by alternative or simplified provisions. For a given study, if the alternative provisions yield the same practical results as ASCE 31 and ASCE 41, that will justify the use and further development of simplified methodologies. If the alternative provisions reach significantly different conclusions that will be an important finding that should lead to further review and an attempt at reconciliation of our codes and standards.

In some ways, this activity is a logical update and extension of the FEMA 356 studies described in FEMA 343, but with emphasis on simplified approaches.

Stakeholder Needs

Theme 3: Develop Simplified Evaluation and Rehabilitation Procedures

Need 3.1 Simplified and/or Prescriptive Procedures

Potential Strategic Partners

ASCE/SEI, BSSC, ICC, NCSEA (and its member associations)

Time Frames

- Year 1: Identify alternative methodologies of interest and define prototype buildings; develop project management to assure consistency and quality from multiple studies.
- Years 2-5: Perform studies, comparing results of ASCE 31 and ASCE 41 standards to alternative and simplified methods (duration will depend on the number of studies and building prototypes selected).
- Year 3-6: Compile study results and summarize findings so as to facilitate standards updates and building code change proposals.

Suggested Performance Measures

- Years 3-6: Development of summary papers and code change proposals.

NEHRP Strategic Goals and Objectives Addressed by Activity

Goal B. Develop cost-effective measures to reduce earthquake impacts on individuals, the built environment, and society-at-large

Objective 7: Develop tools that improve the seismic performance of buildings and other structures

Appendix C

Activity Prioritization and Rationale

This Appendix provides a discussion of the rationale that was used in determining the relative prioritization of recommended Existing Building Program activities. For each time frame (near-term, mid-term, and long-term), a collection of activities have been defined that address the most pressing needs identified by existing building stakeholders. Activities have been grouped based on their relative priority given such factors as the number of needs addressed by the activity, activities that address the highest priority needs identified by multiple stakeholder groups, and activities that need to be coordinated with the timing of other strategic partner activities. This discussion includes background information on how the activities would be expected to address certain needs, and why they have been recommended to occur within a given time frame.

C.1 Rationale for Near-Term Activities

Activities recommended in the near-term include selections that address all five thematic areas of need:

1. **Facilitate Framework to Update Existing Building Standards**
    - Activity A5: Support Development of Standards Update Framework
    - Activity A7: Develop Consensus Code Change Proposals to Align the Provisions of the IBC, IEBC, and IRC.
    - Activity A11: Develop Framework for Convening Issue Teams to Move Research into Practice

    It is critical to the ongoing use of ASCE 31 and ASCE 41 that references to their applicability in the dominant model codes (IBC, IEBC, IRC) are consolidated and unified. Additionally, practitioners have voiced concerns about the use and outcomes obtained from application of the documents and have urged improvements to make results align more closely with expectations. The development of ASCE 41, Supplement 1 has been uniformly praised as an effective way to make focused updates to the standards and serves as an excellent strategy for feeding updates into a consensus update process. Unfortunately, such a process is not

presently in effect. Taken as a group, the activities recommended in the near-term to address these concerns should create a plan among strategic partners to provide a consensus update process and schedule that is fed technical issue upgrades by Existing Buildings Program formulated "Issue Teams". Uniform treatment of ASCE 31 and ASCE 41 by the ICC codes (IBC, IEBC, IRC) should consolidate the use of these standards in triggered seismic rehabilitation work across the county.

2. Develop & Improve Actionable Understanding of Earthquake Risk

- Activity A3: Monitor Use of ASCE 31 and ASCE 41 for Projects Triggered by Codes
- Activity A4: Develop Community Building Inventories
- Activity A6: Enhance LEED Ratings for Resiliency
- Activity A10: Develop and Promote Earthquake Risk Communication Tool

Workshop participants overwhelmingly expressed the view that the primary reasons seismic rehabilitations are not undertaken have more to do with the understanding of seismic risk among community decision makers and building users than lack of technical resources or their quality. To address these concerns by broadening the understanding of the seismic risk existing buildings pose, 5 activities have been defined for the near-term. Highest ranked among this group is the recommendation to develop an Earthquake Performance Rating System for Buildings.

The promise for this activity (A1) is that it could support a fundamental shift in the awareness of the public and other existing building stakeholders to better appreciate the value of rehabilitation to reduce earthquake consequences. Such a shift could produce actionable financial incentives for rehabilitation as market forces align to reflect an appreciation of added value and that could lead to an increase of voluntary efforts to improve existing building earthquake performance. This activity was the most highly ranked undertaking for the Existing Buildings Program and addresses a concern expressed by all workshop focus groups.

Other activities to improve and expand the "at large" understanding of earthquake risk include an activity (A3) to identify and track the circumstances under which seismic rehabilitation work is triggered and when it is not. This effort is intended to document how seismic rehabilitation triggers are actually used in the regulatory environment

and how they might be improved to provide more uniform application and consideration by building officials. Also included is a task (A4) to support efforts to assist building authorities in constructing a building inventory system for their jurisdiction that includes occupancy and structural system, thereby permitting subsequent analyses to assess and understand community vulnerability in the context of resilience. This task can lead to development of public policies that reflect a more rational treatment of the seismic risks communities face and that promote voluntary, triggered and mandated mitigation programs.

Also highly ranked among near-term activities is an effort to enhance the LEED rating system to include earthquake performance. Activity A6 is intended to provide "green" incentives to design and rehabilitate structures to survive the effects of significant ground shaking, thereby raising awareness of the issue of earthquake risk in sustainable design. Such a shift in awareness may provide stronger incentives for voluntary mitigation. Lastly, in the near-term, it is recommended that the Existing Buildings Program fund development of a primer on earthquake risk for use by practicing engineers to facilitate better communication with building owners, fellow building design professionals and the public (A10). Improving the ability of engineers to express the concepts of earthquake risk will bolster the effectiveness of the subject's foremost advocates. This support may be most valuable in those areas of the country where communities have not experienced damaging earthquakes in the last 50 years.

3. Develop Simplified Evaluation and Rehabilitation Procedures

- Activity A8: Develop Simplified Evaluation and Rehabilitation Guidance (Regional Module)

All focus groups of the 2007 NEHRP workshop concluded the development of simplified methods for evaluation and rehabilitation of existing buildings could substantially reduce the risk of vulnerable buildings. Activity (A8) is recommended as a near-term task to develop simplified treatment of a limited class of high-risk buildings. The development of such an approach would support voluntary, triggered or mandated rehabilitation programs in appropriate jurisdictions to address a significant vulnerability.

4. Improve the Education & Training of Engineering Professionals

- Activity A9: Develop Seismic Evaluation & Rehabilitation Example Applications

Practicing engineers and building officials were clear in their call for improved education and training of engineering professionals. Activity A9 envisions Existing Buildings Program support to produce a publication that provides example applications of the ASCE 31 and ASCE 41 standards using FEMA model building types. This resource document is expected to take 8 years to fully populate but will be an invaluable tool in assisting engineers in the uniform application of the standards. Initial modules can be published much earlier than 8 years from initiation (2 to 3 years), but building a critical mass of application examples will take at least a few years, and consequently, this activity has been recommended for initiation in the near-term.

5. Develop New Products

- Activity A1: Develop Earthquake Performance Rating System for Buildings
- Activity A2: Develop Rehabilitation Cost Guidance (Update FEMA 156 and FEMA 157)

A primary objective of Strategic Plan 2005 was the development of new products. In the near-term, Activities A1 and A2 are the 2 most highly ranked tasks to be undertaken to address thematic need category 5. Activity 1 was previously discussed. Activity 2 envisions an update to the FEMA 156, 157 rehabilitation cost series. The update is urged to address the difficulty in determining the cost of rehabilitation. It is suggested that the web based approach of FEMA's seismic rehabilitation Cost Estimator be updated with more recent data and expanded to include non-structural costs. Modifications to permit interactive features that allow the user to build an estimate by adding or subtracting items may facilitate the process of identifying the most significant cost items and reduce the dispersion of uniform square foot tables of costs for model building types.

C.2 Rationale for Mid-Term Activities

The mid-term includes the initiation of eight additional activities in four out of the five thematic areas of need.

1. Facilitate Framework to Update Existing Building Standards

- Activity A13: Develop Recommendations for Treatment of Earthquake Hazard Issues for Existing Buildings
- Activity A16: Define Test Beds and Case Studies
- Activity A18: Provide NEHRP Existing Buildings Workshop Support

- Activity A19: Coordinate Recommendations for Evaluation & Rehabilitation of Nonstructural Components

The mid-term activities identified to facilitate the framework for updating the ASCE 31 and ASCE 41 standards address more specific concerns raised by existing building stakeholders than those of the near-term. In particular, building on the platforms to put an update cycle in place for the standards and to establish protocols for using "Issue Teams" to develop technical improvement proposals, Activities 13 and 19 envision charging Issue Teams to develop recommendations for the treatment of nonstructural items and ground motion characterizations for existing buildings.

Additionally, a highly recommended task of the workshop technical focus group was Activity A16. This activity envisions the Existing Buildings Program working in conjunction with NIST, NSF and others to define a series of case study efforts designed to encompass a broad range of issues (e.g., technical, regulatory, financial, historical, architectural) that are raised by the seismic evaluation and rehabilitation of existing buildings. In defining the case study considerations and protocols, researchers in technical and the social sciences will be encouraged to document problems encountered, solutions generated and alternatives both investigated and uninvestigated to provide a broad database of considerations that may provide new directions and insights into reducing the potential future losses of at risk existing buildings.

Lastly, the mid-term includes Activity A18, which calls for the Existing Buildings Program to facilitate a NEHRP Workshop on Existing Buildings to help define progress, establish new directions and promote rehabilitation as a risk mitigation choice.

2. Develop & Improve Actionable Understanding of Earthquake Risk

- Activity A17: Develop and Disseminate Policies and Guidance for Various Mitigation Program Approaches

With at least 3 ongoing activities in this thematic area of needs from the near-term, only 1 initiative is proposed for the mid-term. Activity A17 envisions Existing Buildings Program support for development of a guidance document to assist communities in the process of formulating policies promoting mitigation. Existing Buildings Program guidance would address post-disaster FEMA support issues (Coordinating Response & Recovery) and sorting through the advantages of voluntary, triggered, mandatory or other risk reduction strategies communities may pursue.

4. **Improve the Education and Training of Engineering Professionals**

   - Activity A12: Promote Incremental Rehabilitation Guidance
   - Activity A14: Develop Nonlinear Analysis Modeling Guidelines
   - Activity A15: Promote Education and Training of Engineering Professionals

Three new activities (A12, A14, A15) are recommended for initiation in the mid-term that address this important need identified as a high priority by both practicing engineers and building officials. The activities envision a national seminar series on the "Opportunities and Challenges of Incremental Rehabilitation" and "Example Applications of ASCE 31 and 41." The seminars are expected to support both regulatory and practicing engineers in their understanding of seismic rehabilitation tools. Additionally, Activity A14 recommends the Existing Buildings Program support an effort to develop a "hands on" application reference for Nonlinear Analysis Modeling. The emphasis of the document is to be on illustrative descriptions of modeling options and consequences.

5. **Develop New Products**

   - Activity A12: Promote Incremental Seismic Rehabilitation Guidance

The only mid-term activity proposed is the previously described seminar series promoting Incremental Rehabilitation.

C.3 Rationale for Long-Term Activities

The long-term includes the initiation of seven additional activities in three out of the five thematic areas of need.

2. **Develop & Improve Actionable Understanding of Earthquake Risk**

   - Activity A21: Benchmark Model Building Expected Performance
   - Activity A25: Prepare White Paper on Seismic Rehabilitation and Social Vulnerability
   - Activity A26: Develop Methodology for Tracking the Progress of Earthquake Risk Reduction

Activities recommended to improve an actionable understanding of earthquake risk in the long-term include an Existing Buildings Program task to benchmark model building expected performance to descriptors other than Pass/Fail. This task may support or supplement the near-term

Activity A1. Additionally, Activity A25 calls on the Existing Buildings Program to convene a panel of experts to frame the issues associated with the impacts of seismic rehabilitation on those judged to be socially most vulnerable to earthquake losses. Lastly, Activity A26 envisions development of a plan to monitor and measure progress made in reducing the vulnerability of existing building stock. These activities taken as a group offer the potential for new insights into potential activities to increase mitigation and may serve to set the table for the next Existing Buildings Program Action Plan.

3. Develop Simplified Evaluation and Rehabilitation Procedures

- Activity A24: Simplified Rehabilitation Guidance (General Module)

This activity envisions examination of approaches that could lead to simplification of the ASCE 31 and ASCE 41 provisions for classes of buildings or conditions. Unlike Activity A8, which focuses on the development of simplified approaches for specific building genres found in specific geographic locales, this task investigates more general simplifications that may be appropriate for certain classes of buildings and a broader range of seismicity.

5. Develop New Products

- Activity A20: Develop Business Continuity Earthquake Planning Guidelines
- Activity A21: Benchmark Model Building Expected Performance
- Activity A23: Develop Guidelines for Seismic Rehabilitation of Historic Structures

In the long-term, new products are proposed for the Existing Buildings Program that include development of business continuity engineering guidelines and treatment of features found in historic structures. Engineers in some parts of the country have reported that owners prepared to undertake seismic rehabilitation are driven by business continuity concerns and little else. Activity A20 attempts to arm engineers with more tools to address this issue. Treatment of historic structures has long been part of Existing Buildings Program strategic initiatives, and Activity A23 has been developed to address these concerns. Lastly, Activity A21 (Benchmark Performance) has been previously discussed under theme 2, but in the long-term, this activity will also include development of a new tool to correlate the ASCE 31 and ASCE 41 methodologies to non-engineering descriptions of structural performance.

C.4 Rationale for Activities Omitted from Existing Buildings Program Consideration

Needs that appear to be addressed solely by the ongoing (and planned) activities of existing building strategic partners have not been assigned new activities in the plan. Table C-1 lists priority needs that have been identified by existing stakeholder groups in the workshop and status report phases of investigation, but have been omitted from consideration by the Existing Buildings Program.

Table C-1 Priority Needs Omitted from Existing Buildings Program Consideration

Priority Need	2007 NEHRP Workshop Global Issue	Strategic Partners	Rationale
Lack of Building Specific Loss Estimation Procedures	Consideration of Uncertainty (G019); Improved Global Damage Prediction (G041); Development of a Uniformly Acceptable Standard Building Performance Rating System (G066)	FEMA, ATC	FEMA is presently funding the multi-year ATC-58 project (Next-Generation Performance-Based Seismic Design Guidelines), which is expected to produce a Seismic Performance Assessment methodology that predicts the earthquake performance of individual buildings, including both component and global behavioral considerations.
Improved Global Damage Prediction	Improved Global Damage Prediction (G041)	FEMA, NSF, ATC	FEMA is presently funding the ATC-63 project (Quantification of Building Seismic Performance Factors), which is focused on improving the understanding of global building seismic performance. Also, understanding the extreme limits of component response, and calibrating to global building performance is a topic of basic research for NSF.
Consideration of Global Performance	FEMA 356 / ASCE 41 – Consideration of Global Ductility (G046)	FEMA, NIST,NSF, ASCE/SEI, ATC, BSSC	Information from the ATC-58 project should be used to update and improve the ASCE 31 and ASCE 41 standards with regard to global performance measures. The process for developing these updates should include significant participation from numerous organizations including FEMA, NIST, ASCE/SEI, and BSSC. Also, understanding the extreme limits of component response, and calibrating to global building performance is a topic of basic research for NSF.
Comprehensive and Systematic Collection of Damage and Loss Data	(Comprehensive and Systematic Collection of Damage and Loss Data (G065)	NIST, NSF, USGS	The Post-Earthquake Information Management System (PIMS) is to be developed by NEHRP to serve as an internet accessible electronic data repository for multi-hazard post event data collections.
Evaluation and Rating Process for New Technical Information	Role of Industry Organizations (G002); Role of Technical Journals (G011); Evaluation and Rating Process for New Technical Information G074)	NIST, ASCE/SEI	NIST is well positioned to lead the process of evaluating and rating new technical information.
Treatment of Vacant Buildings	Vacant Buildings (G069)	NSF, EERI	Policies that address the problems of vacant buildings can be researched through NSF support, and strategies for effective policy recommendations can be developed and disseminated through organizations such as EERI.

Acronyms

ABE Joint Venture	A partnership of ATC, BSSC, and EERI
ACI	American Concrete Institute
AIA	American Institute of Architects
AISC	American Institute for Steel Construction
ASCE	American Society of Civil Engineers
ATC	Applied Technology Council
BSSC	Building Seismic Safety Council
CALBO	California Building Officials
CBC	*California Building Code*
CRSC	Code Resource Support Committee of BSSC
CUREE	Consortium of Universities for Research in Earthquake Engineering
EERI	Earthquake Engineering Research Institute
FEMA	Federal Emergency Management Agency
GSREB	*Guidelines for the Seismic Retrofit of Existing Buildings* (Appendix A of *IEBC*)
HAZUS	FEMA's U.S. Hazards loss-estimation software
IBC	*International Building Code*
IBHS	Institute for Business and Home Safety
ICBO	International Conference of Building Officials
ICC	International Code Council
IEBC	*International Existing Building Code*
LEED	Leadership in Energy and Environmental Design, a rating system
NCSEA	National Council of Structural Engineers Associations
NEHRP	National Earthquake Hazards Reduction Program
NIST	National Institute of Standards and Technology
NFPA	National Fire Protection Association
NSF	National Science Foundation
PEER	Pacific Earthquake Engineering Research Center

PIMS	NEHRP's Postearthquake Information Management System
PML	probable maximum loss
SEAOC	Structural Engineers Association of California
SEI	Structural Engineering Institute of ASCE
UCBC	*Uniform Code for Building Conservation*
USBBC	U.S. Green Building Council
USGS	U.S. Geological Survey

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Applied Technology Council Projects and Report Information

One of the primary purposes of the Applied Technology Council is to develop engineering applications and resources that translate and summarize useful information for practicing building and bridge design professionals. This includes the development of guidelines and manuals, as well as the development of research recommendations for specific areas determined by the profession. ATC is not a code development organization, although ATC project reports often serve as resource documents for the development of codes, standards and specifications.

Applied Technology Council conducts projects that meet the following criteria:

1. The primary audience or benefactor is the design practitioner in structural engineering.
2. A cross section or consensus of engineering opinion is required to be obtained and presented by a neutral source.
3. The project fosters the advancement of structural engineering practice.

Funding for projects is obtained from government agencies and tax-deductible contributions from the private sector. Brief descriptions of completed ATC projects and reports are provided below.

ATC-1: This project resulted in five papers published as part of *Building Practices for Disaster Mitigation, Building Science Series 46*, proceedings of a workshop sponsored by the National Science Foundation (NSF) and the National Bureau of Standards (NBS). Available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22151, as NTIS report No. COM-73-50188.

ATC-2: The report, *An Evaluation of a Response Spectrum Approach to Seismic Design of Buildings*, was funded by NSF and NBS and was conducted as part of the Cooperative Federal Program in Building Practices for Disaster Mitigation. Available through ATC. (Published 1974, 270 Pages)

ATC-3: The report, *Tentative Provisions for the Development of Seismic Regulations for Buildings* (ATC-3-06), was funded by NSF and NBS. The tentative provisions in this report served as the basis for the seismic provisions of the 1988 and subsequent issues of the *Uniform Building Code* and the *NEHRP Recommended Provisions for the Development of Seismic Regulation for New Building and Other Structures*. The second printing contains proposed amendments prepared by a joint committee of the Building Seismic Safety Council (BSSC) and the NBS. Available through ATC. (Published 1978, amended 1982, 505 pages plus proposed amendments)

ATC-3-2: The project, "Comparative Test Designs of Buildings Using ATC-3-06 Tentative Provisions", was funded by NSF. It consisted of a study to develop and plan a program for making comparative test designs of the ATC-3-06 Tentative Provisions. The project report was intended for use by the Building Seismic Safety Council in its refinement of the ATC-3-06 Tentative Provisions.

ATC-3-4: The report, *Redesign of Three Multistory Buildings: A Comparison Using ATC-3-06 and 1982 Uniform Building Code Design Provisions*, was published under a grant from NSF. Available through ATC. (Published 1984, 112 pages)

ATC-3-5: The project, "Assistance for First Phase of ATC-3-06 Trial Design Program Being Conducted by the Building Seismic Safety Council," was funded by the Building Seismic Safety Council to obtain assistance in conducting the first phase of its program to develop trial designs for buildings in Los Angeles, Seattle, Phoenix, and Memphis.

ATC-3-6: The project, "Assistance for Second Phase of ATC-3-06 Trial Design Program Being

Conducted by the Building Seismic Safety Council," was funded by the Building Seismic Safety Council to obtain assistance in conducting the second phase of its program to develop trial designs for buildings in New York, Chicago, St. Louis, Charleston, and Fort Worth.

ATC-4: The report, *A Methodology for Seismic Design and Construction of Single-Family Dwelling*s, was published under a contract with the Department of Housing and Urban Development (HUD). Available through ATC. (Published 1976, 576 pages)

ATC-4-1: The report, *The Home Builders Guide for Earthquake Design*, was published under a contract with HUD. Available through ATC. (Published 1980, 57 pages)

ATC-5: The report, *Guidelines for Seismic Design and Construction of Single-Story Masonry Dwellings in Seismic Zone 2*, was developed under a contract with HUD. Available through ATC. (Published 1986, 38 pages)

ATC-6: The report, *Seismic Design Guidelines for Highway Bridges*, was published under a contract with the Federal Highway Administration (FHWA). Available through ATC. (Published 1981, 210 pages)

ATC-6-1: The report, *Proceedings of a Workshop on Earthquake Resistance of Highway Bridges*, was published under a grant from NSF. Available through ATC. (Published 1979, 625 pages)

ATC-6-2: The report, *Seismic Retrofitting Guidelines for Highway Bridges*, was published under a contract with FHWA. Available through ATC. (Published 1983, 220 pages)

ATC-7: The report, *Guidelines for the Design of Horizontal Wood Diaphragms*, was published under a grant from NSF. Available through ATC. (Published 1981, 190 pages)

ATC-7-1: The report, *Proceedings of a Workshop on Design of Horizontal Wood Diaphragms*, was published under a grant from NSF. Available through ATC. (Published 1980, 302 pages)

ATC-8: The report, *Proceedings of a Workshop on the Design of Prefabricated Concrete Buildings for Earthquake Loads*, was funded by NSF. Available through ATC. (Published 1981, 400 pages)

ATC-9: The report, *An Evaluation of the Imperial County Services Building Earthquake Response and Associated Damage*, was published under a grant from NSF. Available through ATC. (Published 1984, 231 pages)

ATC-10: The report, *An Investigation of the Correlation Between Earthquake Ground Motion and Building Performance*, was funded by the U.S. Geological Survey (USGS). Available through ATC. (Published 1982, 114 pages)

ATC-10-1: The report, *Critical Aspects of Earthquake Ground Motion and Building Damage Potential*, was co-funded by the USGS and the NSF. Available through ATC. (Published 1984, 259 pages)

ATC-11: The report, *Seismic Resistance of Reinforced Concrete Shear Walls and Frame Joints: Implications of Recent Research for Design Engineers*, was published under a grant from NSF. Available through ATC. (Published 1983, 184 pages)

ATC-12: The report, *Comparison of United States and New Zealand Seismic Design Practices for Highway Bridges*, was published under a grant from NSF. Available through ATC. (Published 1982, 270 pages)

ATC-12-1: The report, *Proceedings of Second Joint U.S.-New Zealand Workshop on Seismic Resistance of Highway Bridges*, was published under a grant from NSF. Available through ATC. (Published 1986, 272 pages)

ATC-13: The report, *Earthquake Damage Evaluation Data for California*, was developed under a contract with the Federal Emergency Management Agency (FEMA). It presents expert-opinion earthquake damage and loss estimates for industrial, commercial, residential, utility and transportation facilities in California. Included are damage probability matrices for 78 classes of structures and estimates of time required to restore damaged facilities to pre-earthquake usability. Available through ATC. (Published 1985, 492 pages)

ATC-13-1: The report, *Commentary on the Use of ATC-13 Earthquake Damage Evaluation Data for Probable Maximum Loss Studies of California Buildings*, was developed with funding from the ATC Endowment Fund. It provides guidance for using ATC-13 expert-opinion data for probable maximum loss (PML) studies of California buildings. Included are discussions of the limitations on the use of the ATC-13 expert-opinion data, and appendices containing information not included in the original ATC-13 report, such as model building type descriptions,

beta damage distribution parameters for ATC-13 model building types, and PML values for ATC-13 model building types. Available through ATC. (Published 2002, 66 pages)

ATC-14: The report, *Evaluating the Seismic Resistance of Existing Buildings*, was developed under a grant from the NSF. It describes a methodology for performing preliminary and detailed seismic evaluations of buildings. A precursor to the eventual ASCE 31 Standard, *Seismic Evaluation of Existing Buildings*, it contains useful background information including a state-of-practice review; seismic loading criteria; data collection procedures; a detailed description of the building classification system; preliminary and detailed analysis procedures; and example case studies, including nonstructural considerations. Available through ATC. (Published 1987, 370 pages)

ATC-15: The report, *Comparison of Seismic Design Practices in the United States and Japan*, was published under a grant from NSF. Available through ATC. (Published 1984, 317 pages)

ATC-15-1: The report, *Proceedings of Second U.S.-Japan Workshop on Improvement of Building Seismic Design and Construction Practices*, was published under a grant from NSF. It includes state-of-the-practice papers and case studies of actual building designs and information on regulatory, contractual, and licensing issues. Available through ATC. (Published 1987, 412 pages)

ATC-15-2: The report, *Proceedings of Third U.S.-Japan Workshop on Improvement of Building Structural Design and Construction Practices*, was published jointly by ATC and the Japan Structural Consultants Association. It includes state-of-the-practice papers on steel braced frame and reinforced concrete buildings, base isolation and passive energy dissipation devices, and comparisons between U.S. and Japanese design practice. Available through ATC. (Published 1989, 358 pages)

ATC-15-3: The report, *Proceedings of Fourth U.S.-Japan Workshop on Improvement of Building Structural Design and Construction Practices*, was published jointly by ATC and the Japan Structural Consultants Association. It includes papers on postearthquake building damage assessment; acceptable earthquake damage; repair and retrofit of earthquake-damaged buildings; base-isolated buildings, Architectural Institute of Japan recommendations for design; active damping systems; and wind-resistant design. Available through ATC. (Published 1992, 484 pages)

ATC-15-4: The report, *Proceedings of Fifth U.S.-Japan Workshop on Improvement of Building Structural Design and Construction Practices*, was published jointly by ATC and the Japan Structural Consultants Association. It includes papers on performance goals and acceptable damage; seismic design procedures and case studies; seismic evaluation, repair and upgrade; construction influences on design; isolation and passive energy dissipation; design of irregular structures; and quality control for design and construction. Available through ATC. (Published 1994, 360 pages)

ATC-16: The FEMA 90 report, *An Action Plan for Reducing Earthquake Hazards of Existing Buildings*, was funded by FEMA and was conducted by a joint venture of ATC, the Building Seismic Safety Council and the Earthquake Engineering Research Institute. Available through FEMA. (Published 1985, 75 pages)

ATC-17: The report, *Proceedings of a Seminar and Workshop on Base Isolation and Passive Energy Dissipation*, was published under a grant from NSF. It includes papers describing case studies in the United States, applications and developments worldwide, recent innovations in technology development, and structural and ground motion issues in base-isolation and passive energy-dissipation. Also included is a proposed 5-year research agenda. Available through ATC. (Published 1986, 478 pages)

ATC-17-1: The report, *Proceedings of a Seminar on Seismic Isolation, Passive Energy Dissipation and Active Control,* was published under a grant from NCEER and NSF. Available through ATC. (Published 1993, 841 pages in two volumes)

ATC-18: The report, *Seismic Design Criteria for Bridges and Other Highway Structures: Current and Future***,** was developed under a grant from NCEER and FHWA. Available through ATC. (Published, 1997, 151 pages)

ATC-18-1: The report, *Impact Assessment of Selected MCEER Highway Project Research on the Seismic Design of Highway Structures***,** was developed under a contract with the Multidisciplinary Center for Earthquake Engineering Research (MCEER, formerly NCEER) and FHWA. Available through ATC. (Published, 1999, 136 pages)

ATC-19: The report, *Structural Response Modification Factors* was funded by NSF and NCEER. Available through ATC. (Published 1995, 70 pages)

ATC-20: The report, *Procedures for Postearthquake Safety Evaluation of Buildings*, was developed under a contract with the California Office of Emergency Services (OES), California Office of Statewide Health Planning and Development (OSHPD) and FEMA. It provides procedures and guidelines for inspecting buildings that have been damaged in an earthquake, and making decisions regarding their continued use and occupancy. Written for volunteer structural engineers and building inspectors, it includes rapid and detailed evaluation procedures for posting buildings as "inspected" (apparently safe, green placard), "limited entry" (yellow) or "unsafe" (red). Available through ATC (Published 1989, 152 pages)

ATC-20-1: The report, *Field Manual: Postearthquake Safety Evaluation of Buildings*, *Second Edition*, was funded by Applied Technology Council. A companion to the ATC-20 report, the Field Manual summarizes postearthquake safety evaluation procedures in a concise format designed for ease of use in the field. Available through ATC. (Published 2004, 143 pages)

ATC-20-2: The report, *Addendum to the ATC-20 Postearthquake Building Safety Procedures* was published under a grant from the NSF and funded by the USGS. It provides updated assessment forms, placards, and evaluation procedures based on application and use in five earthquake events that occurred after the initial release of the ATC-20 report. Available through ATC. (Published 1995, 94 pages)

ATC-20-3: The report, *Case Studies in Rapid Postearthquake Safety Evaluation of Buildings,* was funded by ATC and R.P. Gallagher Associates. Containing over 50 case studies using the ATC-20 Rapid Evaluation procedure, the report is intended for use as a training and reference manual. It describes how buildings are inspected and evaluated, and is illustrated with photos and completed safety assessment forms and placards. Available through ATC. (Published 1996, 295 pages)

ATC-20-T: The *Postearthquake Safety Evaluation of Buildings Training CD* was developed in cooperation with FEMA. The 4½-hour training seminar includes photographs, schematic drawings, and textual information. Available through ATC. (Published 2002, 230 PowerPoint slides with Speakers Notes)

ATC-21: The FEMA 154 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, *Second Edition*, was developed under a contract with FEMA. It describes a rapid visual screening procedure for identifying buildings that might pose serious risk of loss of life and injury in the event of a damaging earthquake. The screening procedure utilizes an approach that involves identification of the primary structural load-resisting system and materials of construction, and assignment of a structural hazard score based on observed building characteristics. It identifies those buildings that are potentially hazardous and should be analyzed in more detail by an experienced professional engineer. Available through ATC and FEMA. (Published 2002, 161 pages)

ATC-21-1: The FEMA 155 report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: Supporting Documentation*, *Second Edition*, was developed under a contract with FEMA. It provides the technical basis for the updated rapid visual screening procedure. Available through ATC and FEMA. (Published 2002, 117 pages)

ATC-21-2: The report, *Earthquake Damaged Buildings: An Overview of Heavy Debris and Victim Extrication*, was developed under a contract with FEMA. (Published 1988, 95 pages)

ATC-21-T: The report, *Rapid Visual Screening of Buildings for Potential Seismic Hazards Training Manual, Second Edition,* was developed under a contract with FEMA. Training materials include120 slides in PowerPoint format and companion narrative coordinated with the presentation. Available through ATC. (Published 2004, 148 pages and PowerPoint presentation on companion CD)

ATC-22: The report, *A Handbook for Seismic Evaluation of Existing Buildings (Preliminary)*, was developed under a contract with FEMA in 1989. Based on the information originally developed in ATC-14, this report was revised by BSSC and published as the FEMA 178 report, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings* in 1992, revised by ASCE and published as the FEMA 310 report, *Handbook for the Seismic Evaluation of Buildings – a Prestandard* in 1998. Currently available through the American Society of Civil Engineers as the

ASCE 31 Standard, *Seismic Evaluation of Existing Buildings*.

ATC-22-1: The report, *Seismic Evaluation of Existing Buildings: Supporting Documentation*, was developed under a contract with FEMA. (Published 1989, 160 pages)

ATC-23A: The report, *General Acute Care Hospital Earthquake Survivability Inventory for California, Part A: Survey Description, Summary of Results, Data Analysis and Interpretation*, was developed under a contract with the Office of Statewide Health Planning and Development (OSHPD), State of California. Available through ATC. (Published 1991, 58 pages)

ATC-23B: The report, *General Acute Care Hospital Earthquake Survivability Inventory for California, Part B: Raw Data*, was developed under a contract with the Office of Statewide Health Planning and Development (OSHPD), State of California. Available through ATC. (Published 1991, 377 pages)

ATC-24: The report, *Guidelines for Seismic Testing of Components of Steel Structures*, was jointly funded by the American Iron and Steel Institute (AISI), American Institute of Steel Construction (AISC), National Center for Earthquake Engineering Research (NCEER), and NSF. Available through ATC. (Published 1992, 57 pages)

ATC-25: The report, *Seismic Vulnerability and Impact of Disruption of Lifelines in the Conterminous United State*s, was developed under a contract with FEMA. Available through ATC. (Published 1991, 440 pages)

ATC-25-1: The report, *A Model Methodology for Assessment of Seismic Vulnerability and Impact of Disruption of Water Supply Systems*, was developed under a contract with FEMA. Available through ATC. (Published 1992, 147 pages)

ATC-26: This project, "U.S. Postal Service National Seismic Program," was funded under a contract with the U.S. Postal Service (USPS), and resulted in the following interim documents:

ATC-26 Report, *Cost Projections for the U. S. Postal Service Seismic Program* (Completed 1990)

ATC-26-1 Report, *United States Postal Service Procedures for Seismic Evaluation of Existing Buildings (Interim)* (Completed 1991)

ATC-26-2 Report, *Procedures for Post-disaster Safety Evaluation of Postal Service Facilities (Interim)*. Available through ATC. (Published 1991, 221 pages)

ATC-26-3 Report, *Field Manual: Post-earthquake Safety Evaluation of Postal Buildings (Interim)*. Available through ATC. (Published 1992, 133 pages)

ATC-26-3A Report, *Field Manual: Post Flood and Wind Storm Safety Evaluation of Postal Buildings (Interim)*. Available through ATC. (Published 1992, 114 pages)

ATC-26-4 Report, *United States Postal Service Procedures for Building Seismic Rehabilitation (Interim)* (Completed 1992)

ATC-26-5 Report, *United States Postal Service Guidelines for Building and Site Selection in Seismic Areas (Interim)* (Completed 1992)

ATC-28: The report, *Development of Recommended Guidelines for Seismic Strengthening of Existing Buildings, Phase I: Issues Identification and Resolution*, was developed under a contract with FEMA. Available through ATC. (Published 1992, 150 pages)

ATC-29: The report, *Proceedings of a Seminar and Workshop on Seismic Design and Performance of Equipment and Nonstructural Elements in Buildings and Industrial Structures*, was developed under a grant from NCEER and NSF. It includes papers describing current practice, codes and regulations; earthquake performance; analytical and experimental investigations; development of new seismic qualification methods; and research, practice, and code development needs for nonstructural elements and systems. Available through ATC. (Published 1992, 470 pages)

ATC-29-1: The report, *Proceedings of a Seminar on Seismic Design, Retrofit, and Performance of Nonstructural Components*, was developed under a grant from NCEER and NSF. It includes papers on observed performance in recent earthquakes; seismic design codes, standards, and procedures for commercial and institutional buildings; design issues relating to industrial and hazardous material facilities; and seismic evaluation and rehabilitation of components in conventional and essential facilities. Available through ATC. (Published 1998, 518 pages)

ATC-29-2: The report, *Proceedings of Seminar on Seismic Design, Performance, and Retrofit of Nonstructural Components in Critical Facilities*, was developed under a grant from MCEER (formerly NCEER) and NSF. It includes papers on seismic design, performance, and retrofit of nonstructural components in critical facilities including current practices and emerging codes; seismic design and retrofit; risk and performance evaluation; system qualification and testing; and advanced technologies. Available through ATC. (Published 2003, 574 pages)

ATC-30: The report, *Proceedings of Workshop for Utilization of Research on Engineering and Socioeconomic Aspects of 1985 Chile and Mexico Earthquakes*, was developed under a grant from the NSF. Available through ATC. (Published 1991, 113 pages)

ATC-31: The report, *Evaluation of the Performance of Seismically Retrofitted Buildings*, was developed under a contract with the National Institute of Standards and Technology (NIST, formerly NBS) and funded by the USGS. Available through ATC. (Published 1992, 75 pages)

ATC-32: The report, *Improved Seismic Design Criteria for California Bridges: Provisional Recommendations,* was funded by the California Department of Transportation (Caltrans). Available through ATC. (Published 1996, 215 pages)

ATC-32-1: The report, *Improved Seismic Design Criteria for California Bridges: Resource Document,* was funded by Caltrans. Available through ATC. (Published 1996, 365 pages; also available on CD-ROM)

ATC-33: The project, funded under a contract with the Building Seismic Safety Council, was initiated by FEMA to develop nationally applicable, state-of-the-art guidance for performance-based seismic rehabilitation of buildings. Work resulted in the publication of:

FEMA 273, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings* (Published 1997, 440 pages). Revised by ASCE and published as the FEMA 356 report, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* in 2000. Currently available through the American Society of Civil Engineers as the ASCE 41 Standard, *Seismic Rehabilitation of Existing Buildings*.

FEMA 274, *NEHRP Commentary on the Guidelines for the Seismic Rehabilitation of Buildings*. Available through ATC and FEMA. (Published 1997, 492 pages)

FEMA 276, *Example Applications of the NEHRP Guidelines for the Seismic Rehabilitation of Buildings*. Available through ATC and FEMA. (Published 1997, 295 pages)

ATC-34: The report, *A Critical Review of Current Approaches to Earthquake Resistant Design***,** was developed under a grant from NCEER and NSF. Available through ATC. (Published, 1995, 94 pages)

ATC-35: The report, *Enhancing the Transfer of U.S. Geological Survey Research Results into Engineering Practice* was developed under a cooperative agreement with the USGS. Available through ATC. (Published 1994, 120 pages)

ATC-35-1: The report, *Proceedings of Seminar on New Developments in Earthquake Ground Motion Estimation and Implications for Engineering Design Practice*, was developed under a cooperative agreement with USGS. It includes papers describing state-of-the-art information on regional earthquake risk; new techniques for estimating strong ground motions as a function of earthquake source, travel path, and site parameters; and new developments applicable to geotechnical engineering. Available through ATC. (Published 1994, 478 pages)

ATC-35-2: The report, *Proceedings: National Earthquake Ground Motion Mapping Workshop*, was developed under a cooperative agreement with USGS. It includes papers on ground motion parameters; reference site conditions; probabilistic versus deterministic basis; and the treatment of uncertainty in seismic source characterization and ground motion attenuation. Available through ATC. (Published 1997, 154 pages)

ATC-35-3: The report, *Proceedings: Workshop on Improved Characterization of Strong Ground Shaking for Seismic Design,* was developed under a cooperative agreement with USGS. It includes papers on identifying needs and developing improved representations of earthquake ground motion for use in seismic design practice and building codes. Available through ATC. (Published 1999, 75 pages)

ATC-37: The report, *Review of Seismic Research Results on Existing Buildings***,** was developed in conjunction with the Structural Engineers

Association of California (SEAOC) and California Universities for Research in Earthquake Engineering (CUREe) under a contract with the California Seismic Safety Commission (SSC). Available through the Seismic Safety Commission as Report SSC 94-03. (Published, 1994, 492 pages)

ATC-38: The report, *Database on the Performance of Structures near Strong-Motion Recordings: 1994 Northridge, California, Earthquake*, was developed with funding from the USGS, the Southern California Earthquake Center (SCEC), OES, and the Institute for Business and Home Safety (IBHS). Available through ATC. (Published 2000, 260 pages, with CD-ROM containing complete database).

ATC-40: The report, *Seismic Evaluation and Retrofit of Concrete Buildings***,** was developed under a contract with the California Seismic Safety Commission. It provides guidance on performance objectives, hazard characterization, identification of deficiencies, retrofit strategies, nonlinear static analysis procedures, modeling rules, foundation effects, and response limits for seismic evaluation and retrofit of concrete buildings. Available through ATC. (Published, 1996, 612 pages in two volumes)

ATC-41 (SAC Joint Venture, Phase 1): The project, "Program to Reduce the Earthquake Hazards of Steel Moment-Resisting Frame Structures, Phase 1," was funded by FEMA and OES and conducted by a Joint Venture partnership of SEAOC, ATC, and CUREe. Under Phase 1 the following documents were prepared:

SAC-94-01, *Proceedings of the Invitational Workshop on Steel Seismic Issues, Los Angeles, September 1994*. Available through ATC. (Published 1994, 155 pages)

SAC-95-01, *Steel Moment-Frame Connection Advisory No. 3*. Available through ATC. (Published 1995, 310 pages)

SAC-95-02, *Interim Guidelines: Evaluation, Repair, Modification and Design of Welded Steel Moment-Frame Structures* (FEMA 267 report) (Published 1995, 215 pages; superseded by FEMA 350 to 353)

SAC-95-03, *Characterization of Ground Motions During the Northridge Earthquake of January 17, 1994*. Available through ATC. (Published 1995, 179 pages)

SAC-95-04, *Analytical and Field Investigations of Buildings Affected by the Northridge Earthquake of January 17, 1994*. Available through ATC. (Published 1995, 900 pages in two volumes)

SAC-95-05, *Parametric Analytical Investigations of Ground Motion and Structural Response, Northridge Earthquake of January 17, 1994*. Available through ATC. (Published 1995, 274 pages)

SAC-95-06, *Surveys and Assessment of Damage to Buildings Affected by the Northridge Earthquake of January 17, 1994*. Available through ATC. (Published 1995, 315 pages)

SAC-95-07, *Case Studies of Steel Moment Frame Building Performance in the Northridge Earthquake of January 17, 1994* (Published 1995, 260 pages, Available through ATC)

SAC-95-08, *Experimental Investigations of Materials, Weldments and Nondestructive Examination Techniques*. Available through ATC. (Published 1995, 144 pages)

SAC-95-09, *Background Reports: Metallurgy, Fracture Mechanics, Welding, Moment Connections and Frame systems, Behavior* (FEMA 288 report). Available through ATC and FEMA. (Published 1995, 361 pages)

SAC-96-01, *Experimental Investigations of Beam-Column Subassemblages, Part 1 and 2*. Available through ATC. (Published 1996, 924 pages, in two volumes)

SAC-96-02, *Connection Test Summaries* (FEMA 289 report). Available through ATC and FEMA. (Published 1996, 144 pages)

ATC-41-1 (SAC Joint Venture, Phase 2): The project, "Program to Reduce the Earthquake Hazards of Steel Moment-Resisting Frame Structures, Phase 2," was funded by FEMA and conducted by a Joint Venture partnership of SEAOC, ATC, and CUREe. Under Phase 2 the following documents were prepared:

SAC-96-03, *Interim Guidelines Advisory No. 1 Supplement to FEMA 267 Interim Guidelines* (FEMA 267A report) (Published 1997, 100 pages; superseded by FEMA 350 to 353)

SAC-99-01, *Interim Guidelines Advisory No. 2 Supplement to FEMA 267 Interim Guidelines* (FEMA 267B report, superseding FEMA 267A). (Published 1999, 150 pages; superseded by FEMA 350 to 353)

FEMA 350, *Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings*. Available through ATC and FEMA. (Published 2000, 190 pages)

FEMA 351, *Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings*. Available through ATC and FEMA. (Published 2000, 210 pages)

FEMA 352, *Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings*. Available through ATC and FEMA. (Published 2000, 180 pages)

FEMA 353, *Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications*. Available through ATC and FEMA. (Published 2000, 180 pages)

FEMA 354, *A Policy Guide to Steel Moment-Frame Construction*. Available through ATC and FEMA. (Published 2000, 27 pages)

FEMA 355A, *State of the Art Report on Base Materials and Fracture*. Available through ATC and FEMA. (Published 2000, 107 pages; in print and on CD-ROM).

FEMA 355B, *State of the Art Report on Welding and Inspection*. Available through ATC and FEMA. (Published 2000, 185 pages; in print and on CD-ROM).

FEMA 355C, *State of the Art Report on Systems Performance of Steel Moment Frames Subject to Earthquake Ground Shaking*. Available through ATC and FEMA. (Published 2000, 322 pages; in print and on CD-ROM).

FEMA 355D, *State of the Art Report on Connection Performance*. Available through ATC and FEMA. (Published 2000, 292 pages; in print and on CD-ROM).

FEMA 355E, *State of the Art Report on Past Performance of Steel Moment-Frame Buildings in Earthquakes*. Available through ATC and FEMA. (Published 2000, 190 pages; in print and on CD-ROM).

FEMA 355F, *State of the Art Report on Performance Prediction and Evaluation of Steel Moment-Frame Structures*. Available through ATC and FEMA. (Published 2000, 347 pages; in print and on CD-ROM).

ATC-43: The reports, *Evaluation of Earthquake-Damaged Concrete and Masonry Wall Buildings, Basic Procedures Manual* (FEMA 306)*, Evaluation of Earthquake-Damaged Concrete and Masonry Wall Buildings, Technical Resources* (FEMA 307)*,* and *The Repair of Earthquake Damaged Concrete and Masonry Wall Buildings* (FEMA 308)**,** were developed for FEMA under a contract with the Partnership for Response and Recovery, a Joint Venture of Dewberry & Davis and Woodward-Clyde. Available through ATC and FEMA. (Published, 1998 in print and on CD-ROM; *Basic Procedures Manual*, 270 pages; *Technical Resources*, 271 pages; *Repair Manual*, 81 pages)

ATC-44: The report, *Hurricane Fran, North Carolina, September 5, 1996: Reconnaissance Report***,** was funded by the Applied Technology Council. Available through ATC. (Published 1997, 36 pages)

ATC-45: The report, *Field Manual*, *Safety Evaluation of Buildings After Wind Storms and Floods*, was developed with funding from the ATC Endowment Fund and the Institute for Business and Home Safety (IBHS). It provides rapid and detailed evaluation procedures for inspecting buildings that have been damaged in wind storms and floods, and making decisions regarding their continued use and occupancy. Presented in a concise format designed for ease of use in the field, it is intended for use by volunteer structural engineers and building inspectors in posting buildings as "inspected" (apparently safe, green placard), "restricted use" (yellow) or "unsafe" (red). Available through ATC. (Published 2004, 132 pages)

ATC-48 (ATC/SEAOC Joint Venture Training Curriculum): The training curriculum, *Built to Resist Earthquakes, The Path to Quality Seismic Design and Construction for Architects, Engineers, and Inspectors*, was developed under a contract with the California Seismic Safety Commission and prepared by a Joint Venture partnership of ATC and SEAOC. Available through ATC. (Published 1999, 314 pages)

ATC-49: The 2-volume report, *Recommended LRFD Guidelines for the Seismic Design of Highway Bridges; Part I: Specifications* and *Part*

II: Commentary and Appendices, were developed under the ATC/MCEER Joint Venture partnership with funding from the Federal Highway Administration. Available through ATC. (Published 2003, *Part I*, 164 pages and *Part II*, 294 pages)

ATC-49-1: The document, *Liquefaction Study Report, Recommended LRFD Guidelines for the Seismic Design of Highway Bridges,* was developed under the ATC/MCEER Joint Venture partnership with funding from the Federal Highway Administration. Available through ATC. (Published 2003, 208 pages)

ATC-49-2: The report, *Design Examples, Recommended LRFD Guidelines for the Seismic Design of Highway Bridges*, was developed under the ATC/MCEER Joint Venture partnership with funding from the Federal Highway Administration. Available through ATC. (Published 2003, 316 pages)

ATC-51: The report, *U.S.-Italy Collaborative Recommendations for Improved Seismic Safety of Hospitals in Italy*, was developed under a contract with Servizio Sismico Nazionale of Italy (Italian National Seismic Survey). Available through ATC. (Published 2000, 154 pages)

ATC-51-1: The report, *Recommended U.S.-Italy Collaborative Procedures for Earthquake Emergency Response Planning for Hospitals in Italy*, was developed under a contract with Servizio Sismico Nazionale of Italy (Italian National Seismic Survey, NSS). Available in English and Italian through ATC. (Published 2002, 120 pages)

ATC-51-2: The report, *Recommended U.S.-Italy Collaborative Guidelines for Bracing and Anchoring Nonstructural Components in Italian Hospitals*, was developed under a contract with the Department of Civil Protection, Italy. Available in English and Italian through ATC. (Published 2003, 164 pages)

ATC-52: The project, "Development of a Community Action Plan for Seismic Safety (CAPSS), City and County of San Francisco", was conducted under a contract with the San Francisco Department of Building Inspection. Under Phase I, completed in 2000, ATC defined the tasks to be conducted under Phase II, a multi-year ATC effort that commenced in 2001. The Phase II tasks include: (1) development of a reliable estimate of the size and nature of the impacts a large earthquake will have on San Francisco; (2) development of consensus-based guidelines for the evaluation and repair of San Francisco's most vulnerable building types; and (3) identification, definition, and ranking of other activities to reduce the seismic risks in the City and County of San Francisco.

ATC-53: The report, *Assessment of the NIST 12-Million-Pound (53 MN) Large-Scale Testing Facility*, was developed under a contract with NIST. Available through ATC. (Published 2000, 44 pages)

ATC-54: The report, *Guidelines for Using Strong-Motion Data and ShakeMaps in Postearthquake Response*, was developed under a contract with the California Geological Survey. Available through ATC. (Published 2005, 222 pages)

ATC-55: The FEMA 440 report, *Improvement of Nonlinear Static Seismic Analysis Procedures*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2005, 152 pages)

ATC-56: The report, FEMA 389, *Primer for Design Professionals: Communicating with Owners and Managers of New Buildings on Earthquake Risk*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2004, 194 pages)

ATC-56-1: The report, FEMA 427, *Primer for Design of Commercial Buildings to Mitigate Terrorist Attacks – Providing Protection to People and Buildings*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2003, 106 pages)

ATC-57: The report, *The Missing Piece: Improving Seismic Design and Construction Practices*, was developed under a contract with NIST. It provides a framework for eliminating the technology transfer gap that has emerged within the National Earthquake Hazards Reduction Program (NEHRP) that limits the adaptation of basic research knowledge into practice. Available through ATC. (Published 2003, 102 pages)

ATC-58: The project, "Development of Next-Generation Performance-Based Seismic Design Guidelines for New and Existing Buildings," is a multi-year, multi-phase effort funded by FEMA that has resulted in the publication of the following:

FEMA 445, *Next-Generation Performance-Based Seismic Design Guidelines, Program*

Plan for New and Existing Buildings. Available through ATC and FEMA. Published 2006, 131 pages).

FEMA 461, *Interim Testing Protocols for Determining the Seismic Performance Characteristics of Structural and Nonstructural Components*. Available through ATC and FEMA. (Published 2007, 113 pages).

ATC-60: The 2-volume report, *SEAW Commentary on Wind Code Provisions, Volume 1* and *Volume 2 - Example Problems,* was developed by the Structural Engineers Association of Washington (SEAW) in cooperation with ATC. Available through ATC. (Published 2004; *Volume 1*, 238 pages; *Volume 2*, 245 pages)

ATC-61: The 2-volume report, *Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities, Volume 1 – Findings, Conclusions, and Recommendations*, and *Volume 2 – Study Documentation,* was prepared for the Multihazard Mitigation Council (MMC) of the National Institute of Building Sciences, with funding provided by FEMA. Available through ATC and the MMC. (Published 2005; *Volume 1*, 11 pages; *Volume 2*, 366 pages)

ATC-62: The report, FEMA P-440A, *Effects of Strength and Stiffness Degradation on Seismic Response*, was developed under a contract with FEMA. Developed as a supplement to the FEMA 440 report, it provides additional guidance on modeling of nonlinear degrading response. Available through ATC and FEMA. (Published 2009, 310 pages)

ATC-63: The report, FEMA P-695, *Quantification of Building Seismic Performance Factors*, was developed under a contract with FEMA. It describes a methodology for establishing seismic performance factors (R , Ω_0, and C_d) that involves the development of detailed system design information and probabilistic assessment of collapse risk. It utilizes nonlinear analysis techniques, and explicitly considers uncertainties in ground motion, modeling, design, and test data. The technical approach is a combination of traditional code concepts, advanced nonlinear dynamic analyses, and risk-based assessment techniques. Available through ATC and FEMA. (Published 2009, 420 pages)

ATC-64: The reports, *Guidelines for Design of Structures for Vertical Evacuation from Tsunamis* (FEMA P-646), and *Vertical Evacuation from Tsunamis: A Guide for Community Officials* (FEMA P-646A), were developed under a contract with FEMA. Available through ATC and FEMA. (*Design Guidelines*, Published 2008, 174 pages; *Guide for Community Officials*, Published 2009, 62 pages)

ATC-65: The FEMA P-455 report, *Handbook for Rapid Visual Screening of Buildings to Evaluate Terrorism Risks*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2009, 174 pages)

ATC-66: The report, FEMA P-774, *Unreinforced Masonry Buildings and Earthquakes, Developing Successful Risk Reduction Programs*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2009, 194 pages)

ATC-68: The FEMA P-420 report, *Engineering Guideline for Incremental Seismic Rehabilitation*, was developed under a contract with FEMA. Available through ATC and FEMA. (Published 2009, 94 pages)

ATC-69: The report, *Reducing the Risks of Nonstructural Earthquake Damage, State-of-the-Art and Practice Report*, was developed under a contract with FEMA. Available through ATC. (Published 2008, 144 pages)

ATC-70: The report, NIST Technical Note 1476, *Performance of Physical Structures in Hurricane Katrina and Hurricane Rita: A Reconnaissance Report*, was developed under a contract with NIST. Available through NIST. (Published 2006, 222 pages)

ATC-72: The report, *Proceedings of Workshop on Tall Building Seismic Design and Analysis Issues,* was prepared for the Building Seismic Safety Council of the National Institute of Building Sciences, with funding provided by FEMA. Available through ATC. (Published 2007, 84 pages)

ATC-73: The report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings,* was developed under a grant from NSF. Available through ATC. (Published 2007, 22 pages)

ATC-74: The report, *Collaborative Recommended Requirements for Automatic Natural Gas Shutoff Valves in Italy,* was funded by the Department of Civil Protection, Italy.

Available through ATC. (Published 2007, 76 pages)

ATC-76: The project, "National Earthquake Hazards Reduction Program (NEHRP) Earthquake Structural and Engineering Research," was funded by NIST and conducted by a Joint Venture partnership between ATC, and CUREE. This task order project is a multi-year, multi-phase effort that has resulted in the publication of the following:

NEHRP Technical Brief No. 1, Seismic Design of Reinforced Concrete Special Moment Frames: A Guide for Practicing Engineers. Available through ATC, CUREE, and NIST as GCR 08-917-1. (Published 2008, 32 pages)

NEHRP Technical Brief No. 2, Seismic Design of Steel Special Moment Frames: A Guide for Practicing Engineers. Available through ATC, CUREE, and NIST as GCR 09-917-3. (Published 2009, 38 pages)

ATC-R-1: The report, *Cyclic Testing of Narrow Plywood Shear Walls,* was developed with funding from the ATC Endowment Fund. Available through ATC (Published 1995, 64 pages)

ATC Design Guide 1: The report, *Minimizing Floor Vibration***,** was developed with funding from the ATC Endowment Fund. Available through ATC. (Published, 1999, 64 pages)

ATC TechBrief 1: The ATC TechBrief 1, *Liquefaction Maps*, was developed under a contract with the United States Geological Survey. Available through ATC. (Published 1996, 12 pages)

ATC TechBrief 2: The ATC TechBrief 2, *Earthquake Aftershocks − Entering Damaged Buildings*, was developed under a contract with the United States Geological Survey. Available through ATC. (Published 1996, 12 pages)

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