ATC 71

NEHRP Workshop on Meeting the Challenges of Existing Buildings

Part 1: Workshop Proceedings

Applied Technology Council

Funded by
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Applied Technology Council

The Applied Technology Council (ATC) is a nonprofit, tax-exempt corporation established in 1973 through the efforts of the Structural Engineers Association of California. ATC's mission is to develop 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 also identifies and encourages needed research and develops consensus opinions on structural engineering issues in a non-proprietary format. ATC thereby fulfills a unique role in funded information transfer.

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

ATC-71

NEHRP Workshop on Meeting the Challenges of Existing Buildings

Part 1: Workshop Proceedings

Prepared by

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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 is 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 (EERI), 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). Planning for the workshop incorporated the work of two other synergistic efforts: (1) an initiative of EERI to conduct a similar workshop utilizing separate FEMA funding; and (2) another ATC project, "Workshop to Identify and Establish Priorities for NEES Research on Existing Buildings: Practitioners' Point of View" (ATC-73 Project) to provide community-based strategic guidance on priorities for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) research on existing buildings, funded by the National Science Foundation (NSF).

This workshop included the participation of practicing engineers, building officials, policy makers, researchers, owner/developers, industry product suppliers, and service providers involved with seismic evaluation and rehabilitation of existing buildings. A major undertaking in the workshop planning effort involved these multi-disciplinary stakeholder groups in the development of an initial list of existing building issues in advance of the workshop. This list was used to set the workshop structure, seed workshop discussion, and target workshop content to address the most pressing issues in existing building rehabilitation practice, regulation, policy, and research.

This report is Part 1 of a series of reports to be produced on the ATC-71 Project, and describes workshop planning efforts and records workshop findings. It is also the first 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 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings* (ATC, 2009a), 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). Guidance for FEMA's future activities related to the creation, update, and maintenance of seismic evaluation and rehabilitation documents for existing buildings will be based on this information, and provided in the ATC-71 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 3: Action Plan for the FEMA Existing Buildings Program* (ATC, 2009b).

ATC is indebted to the ATC-71 Project Management Committee, including Thomas R. McLane (Project Manager), Andrew Merovich (Lead Technical Consultant), David Bonowitz, Lawrence Brugger, Craig Comartin, Edwin Dean, and James Harris for their efforts in planning and conducting this workshop. ATC also acknowledges the cooperation of the EERI Planning Committee including Daniel Alesch, Susan Dowty, Marjorie Greene, Jack Hayes, Ugo Morelli, Farzad Naeim, Lawrence Reaveley, and Susan Tubbesing, as well as the ATC-73 Working Group consisting of Gregory Deierlein, Robert Hanson, John Hooper, James Jirsa, and Maryann Phipps. The affiliations of these individuals are included in the list of Project Participants provided in Appendix B.

ATC also gratefully acknowledges Cathleen Carlisle (FEMA Project Monitor) and Daniel Shapiro (FEMA Subject Matter Expert) for their input and guidance, and Peter Mork for report production services.

Jon A. Heintz — ATC Director of Projects

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Chapter 1

Introduction

The earthquake engineering community stands at an important juncture in the development and implementation of standards and guidelines for the seismic rehabilitation of existing buildings. The efforts of many dedicated earthquake engineers, researchers, building officials, social scientists, policy advocates, and others have resulted in the achievement of several major milestones during the past two decades. For example:

- The FEMA 356 *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* has become a national standard.
- The national earthquake engineering research centers have recently produced important new understandings that could greatly benefit engineering practice and guidelines development.
- The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) is poised to produce significant data on actual building performance with funding from the National Science Foundation (NSF).
- The United States Geological Survey (USGS) has produced and updated high quality national seismic hazard maps, improving the characterization of seismic hazard across the country.
- The National Earthquake Hazards Reduction Program (NEHRP) was reauthorized in 2004, and Congress has asked National Institute for Standards and Technology (NIST) to lead the program in a new era in which the potential costs associated with large earthquakes in densely populated urban areas have grown substantially.

Despite this significant progress, complex technical, practical, regulatory, and public policy issues surrounding the seismic rehabilitation of existing buildings are far from resolved.

In a coordinated effort, the four agencies comprising NEHRP sponsored a national workshop to identify and discuss multi-disciplinary challenges associated with seismic evaluation and rehabilitation of existing buildings. With funding from FEMA, NSF, NIST, and USGS, the Applied Technology Council (ATC) and the Earthquake Engineering Research Institute (EERI) conducted the *NEHRP Workshop on Meeting the Challenges of Existing Buildings* in San Francisco, California on September 19-20, 2007. Representatives drawn from different geographic regions (eastern, central and western United States) and different stakeholder groups (practitioners, regulators, public policy interests, owners/managers, researchers, and industry representatives) were assembled to identify and prioritize issues related to seismic evaluation and rehabilitation of existing buildings, and to recommend future earthquake engineering research and practice needs.

The workshop was designed to address the following questions:

- What are the biggest barriers to the implementation of seismic rehabilitation, including technical, practical, and regulatory challenges?
- Are there gaps in research related to seismic rehabilitation that, if filled, would help address some of these barriers?
- How should research efforts be prioritized to support development of more effective and economical existing building evaluation and rehabilitation techniques?
- Who are possible strategic partners, and how can these partnerships be used to find common objectives and foster greater progress toward earthquake risk reduction in existing buildings?
- What is the future of seismic rehabilitation research and practice?
- What type of guidance and tools would best help achieve this vision?

The answers to these questions will be used to develop a strategy for the next phase of FEMA's Existing Buildings Program, and to help establish earthquake engineering research priorities for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), in order to meet current and future challenges associated with existing buildings.

1.1 Report Organization and Content

This report is Part 1 in a series of reports to be produced on the ATC-71 Project. It describes workshop planning efforts and records workshop findings.

Chapter 1 provides background on recent accomplishments and future needs related to seismic evaluation and rehabilitation of existing buildings. Chapter 2 describes workshop planning efforts and the workshop program. Chapters 3 through 5 provide a record of workshop plenary presentations and discussions. Chapter 6 documents the results of detailed discussions on existing building issues in the Technical, Practical, Regulatory and Public

Policy, and Research Needs breakout tracks. Chapter 7 provides a summary of workshop findings and conclusions. Appendices A and B provide the names and affiliations of project and workshop participants, respectively. Appendix C provides a record of existing building issues identified in advance of the workshop, in their pre-workshop format, and Appendix D presents the results of plenary balloting on pre-workshop issues.

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 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings*, ATC-71 Report (ATC, 2009a)
- *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 3: Action Plan for the FEMA Existing Buildings Program*, ATC-71 Report (ATC, 2009b)
- *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

Workshop Preparations and Program

Preparation for the workshop commenced in February 2007. Planning was conducted by members of the ATC-71 Project Management Committee, the EERI Workshop Planning Committee, and selected members of the ATC-73 Project Working Group. Members of these groups are included in the list of project participants provided in Appendix A. Planning activities included the development of a preliminary list of issues related to the seismic rehabilitation of existing buildings, identification of potential workshop participants, collection of input from a broad-based multi-disciplinary group of existing building stakeholders, and development of the workshop program.

2.1 Identification and Invitation of Workshop Participants

The planning group was divided into small teams organized around the following stakeholder groups: practitioners, regulators, public policy interests, owners/managers, researchers, and industry representatives. These teams identified leading experts involved in existing building rehabilitation design, permitting, ownership, management, regulation, and research. Targeted participants included practicing engineers, building officials, policy makers, researchers, owner/developers, and industry product suppliers and service providers. Workshop participation was by invitation only, and the distribution of invitations was structured to be multi-disciplinary across these groups.

Proposed workshop participants were reviewed by Cathleen Carlisle at FEMA, Joy Pauschke at NSF, and Jack Hayes at NIST. Letters of invitation were sent requesting interest and availability for attending the workshop. Invitees who could not attend were replaced with a participant of the same discipline in order to maintain the targeted balance across all stakeholder groups.

In all, more than 90 individuals participated in the workshop, including members of the ATC-71 Project Team, EERI Workshop Planning

Committee, and ATC-73 Project Team. A list of workshop participants is provided in Appendix B.

2.2 Collection of Pre-Workshop Existing Building Issues

Workshop invitees and other representatives from targeted stakeholder groups were invited to provide input prior to the workshop. Individuals who responded favorably to this solicitation were asked to review preliminary workshop materials, offer comments on a growing list of existing building issues, and make suggestions for modifying or adding to the list. More than 80 existing building issues were identified in advance of the workshop.

These issues were used to set the workshop structure, seed workshop discussion, and target workshop content to address the most pressing issues in existing building rehabilitation practice, regulation, policy, and research. They formed the basis of workshop plenary balloting, and served as the starting point for focused breakout discussions. A summary of these issues is provided in Appendix C. The subset of these issues that was identified as having the highest priority in each breakout is reported in Chapter 6.

2.2.1 Engineering Practitioner Stakeholder Group

A total of 22 engineering practitioners participated in a series of pre-workshop conference call discussions on the current state of seismic rehabilitation practice. Collectively, this group represented 16 different states and each geographic region within the United States that is considered to be seismically active.

This group had seismic rehabilitation experience with single- and multi-story buildings covering a wide range of uses, occupancies, structural systems, and structural materials including steel, masonry, wood, and concrete. Professional experience ranged from 15 to 38 years, with an average experience of over 25 years. Clients of this group included public agencies (e.g., federal, state, and local governments, schools, and port authorities); public and private institutions (e.g., universities and hospitals); and private owners and their representatives (e.g., developers, architects, insurance companies, high-tech manufacturers, and individual homeowners).

This group provided broad-based practitioner input on types of rehabilitation projects, approaches to design, technical resources used in design, and future improvements needed in engineering technologies. Issues identified through interviews with this stakeholder group are included in the list of issues provided in Appendix C.

2.2.2 Regulatory/Public Policy Stakeholder Groups

Selected building officials and plan reviewers in large jurisdictions (e.g., Seattle, Los Angeles, St. Louis, New York), medium-size jurisdictions (e.g., Portland, Oregon and Clark County, Nevada) and small jurisdictions (e.g., Roseville, California) were contacted for input on building code, enforcement, criteria, and plan review issues. Public policy experts including public officials, academics, and private consultants from across the country were contacted for input on policy and program issues. Issues identified through interviews with these stakeholder groups are included in the list of issues provided in Appendix C.

2.2.3 Building Owner/Manager Stakeholder Group

Selected building owners and facility managers with extensive experience in the seismic evaluation and rehabilitation were contacted for input on challenges related to upgrading and maintaining their existing building stock. This group included individuals from high-tech industrial facilities, urban mixed-use developments, major university campuses, and state agencies. Comments and concerns from this group were incorporated into the list of issues provided in Appendix C.

2.2.4 Research Stakeholder Group

The ATC-73 Working Group sought input from a variety of different groups with an interest in research activities related to seismic rehabilitation of existing buildings. These groups included leading structural design and geotechnical engineering practitioners from various regions of the country, and representatives of the three NSF-funded earthquake engineering research centers: the Mid-America Earthquake (MAE) Center, the Multidisciplinary Center for Earthquake Engineering Research (MCEER), and the Pacific Earthquake Engineering Research (PEER) Center. This input was used to identify an initial list of potential topics for research needs including: (1) performance and anchorage of nonstructural components; (2) soil-structure interaction; (3) foundation design; (4) advanced structural analysis programs; (5) simplified procedures; (6) innovative solutions and new materials; (7) learning from earthquakes; and (8) risk analysis. These topics were used to seed brainstorming discussions in the Research Needs breakout track.

2.3 Workshop Format and Agenda

The two-day workshop format was structured around plenary introductory presentations, overall group discussions, and multi-disciplinary interaction on

Day 1, and a series of focused breakout discussions and plenary reporting on Day 2. The workshop agenda is shown in Figures 2-1 through 2-3.

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09/18/07

NEHRP Workshop
Meeting the Challenges of Existing Buildings

September 19 & 20, 2007
Hotel Miyako, San Francisco, CA

AGENDA

Wednesday September 19, 8:00am – 5:00pm

8:00am	I.	Opening Remarks – Day 1 Workshop Purpose, Structure, Background, Goals	Jon Heintz - ATC Susan Tubbesing - EERI
8:15am	II.	NEHRP Perspective	NEHRP Representatives
8:30am	III.	Historical Context – FEMA 315: Seismic Rehabilitation of Buildings: Strategic Plan 2005	Ugo Morelli
8:45am	IV.	Existing Buildings: Issues Framework	
		• Overview	Andrew Merovich
9:00am		• Summary of Issues	Craig Comartin
		Technical Issues	David Bonowitz
		Practical Issues	Ed Dean
		Regulatory/Policy Issues	Susan Dowty
9:45am	V.	Current Research Approaches, Capabilities, Programs, and Utilization	
		• Current Research Approaches	Jim Jirsa
		• Summary Overview of NEES Research Capabilities	Steve McCabe
		• The NEESR Research Program	Joy Pauschke
		• Research Utilization by the NEHRP Agencies	Robert Hanson
10:45am	Break		

Figure 2-1 Agenda Day 1 – NEHRP Workshop on Meeting the Challenges of Existing Buildings

11:00am	VI. Open Forum Topics to seed discussion: • Need for transparency in communicating performance • An owner's perspective • Standardization of ASCE 41 • How legislation works with reference documents • Seismic rehabilitation issues in Mid-America • Research needs from a West Coast practitioner's perspective • Research needs from an East Coast practitioner's perspective	
12:30pm	Lunch	
2:00pm	VII. Issue Identification, Development, and Discussion • Vision for the Future National Standards and Model Codes Web Based Resources for Regional Application Other? • Initial Prioritization of Issues for Breakout Discussions	Andrew Merovich John Whitmer David Bonowitz Ed Dean Susan Dowty
3:15pm	Break	
3:30pm	VII. Issue Identification, Development, and Discussion (continued)	
5:00pm	Adjourn – Day 1	

Figure 2-2 Agenda Day 1 (cont'd) – NEHRP Workshop on Meeting the Challenges of Existing Buildings

Thursday September 20, 8:30am – 5:00pm

8:30am	VIII. Opening Remarks – Day 2 Agenda Review, Objectives for Day 2 Breakout Instructions	Jon Heintz - ATC Susan Tubbesing - EERI
8:45am	IX. Breakout Sessions: Issue Discussion and Clarification (Round 1 – groups assigned)	Moderators:
	• Technical Impediments	David Bonowitz/Tony Court
	• Practical Impediments	Ed Dean/Jim Harris
	• Regulatory/ Public Policy Issues	SusanDowty/Susan Tubbesing
	• Research Needs Session	John Hooper/Maryann Phipps
	– PEER Research	Jack Moehle
	– MCEER Research	Andre Filiatrault
	– MAE Research	Mary Beth Hueste
10:45am	Break	
11:00am	X. Breakout Sessions: Issue Discussion and Prioritization (Round 2 – groups not assigned)	Moderators:
	• Technical Impediments	David Bonowitz/Tony Court
	• Practical Impediments	Ed Dean/Jim Harris
	• Regulatory/ Public Policy Issues	Susan Dowty/Susan Tubbesing
	• Research Needs Session	John Hooper/Maryann Phipps
12:30pm	Lunch	
2:00pm	XI. Breakout Sessions: Issue Discussion and Resolution (Round 3 – groups not assigned)	Moderators:
	• Technical Impediments	David Bonowitz/Tony Court
	• Practical Impediments	Ed Dean/Jim Harris
	• Regulatory/ Public Policy Issues	Susan Dowty/Susan Tubbesing
	• Research Needs Session	John Hooper/Maryann Phipps
3:00pm	Break	
3:30pm	XII. Summary of Findings: Breakout Session Reporting • Technical Impediments • Practical Impediments • Regulatory/Public Policy Issues • Research Needs Session	Designated Group Presenters
4:55pm	XIII. Concluding Remarks Expected Outcomes and Next steps	Jon Heintz - ATC Susan Tubbesing - EERI
5:00pm	Adjourn – Day 2	

Figure 2-3 Agenda Day 2 – NEHRP Workshop on Meeting the Challenges of Existing Buildings

2.4 Workshop Description

Day 1 introductory presentations in the initial plenary session included: an overview of the workshop purpose, structure, background, and goals; a discussion of the NEHRP Perspective on the workshop from each of the four lead agencies (NIST, FEMA, NSF, and USGS); and historical context for the strategies and direction of the FEMA Existing Buildings Program. Workshop participants were then provided with an overview of workshop preparations, a brief summary of existing buildings issues identified in advance of the workshop, and a series of presentations outlining current research approaches, capabilities, and programs.

In an open forum on Day 1, participants were given an opportunity to interact in a seeded, multi-disciplinary discussion on a number of important, and possibly controversial, challenges related to existing buildings. In the final plenary session on Day 1, participants were exposed to the detailed list of pre-workshop issues. In this session, participants were invited to help establish preliminary priorities for the issues by casting an electronic ballot on polling questions that were generated by workshop organizers based on pre-workshop input.

Day 2 breakouts consisted of three rounds of increasingly focused discussion, encouraging input and ideas from as many participants as possible. Breakout discussions were centered on four topical areas, or tracks: (1) *Technical Impediments*, related to technical problems with currently available resource documents; (2) *Practical Impediments*, related to problems in the application of currently available resource documents or the absence of a resource serving a specific need; (3) *Regulatory/Public Policy Issues*, related to problems in implementation of seismic rehabilitation in the building code/permit approval process or in setting effective public policy; and (4) *Research Needs*, as identified from a practitioner's point of view.

These topical areas (*Technical Impediments*, *Practical Impediments*, *Regulatory/Public Policy Issues*, and *Research Needs*) served as focal points for the breakout discussions, with one area assigned to each breakout track. To ensure multi-disciplinary discussion among the practitioner, owner/manager, regulator, public policy, and researcher stakeholder groups in attendance at the workshop, participants were assigned to each breakout track for the first round of breakout discussions. During the second and third rounds, participants were permitted to move between breakout tracks.

Breakout discussions were moderated by members of the EERI Planning Committee, participants in the ATC-71 Project, and participants in the ATC-73 Project. Moderators were instructed to discuss pre-workshop issues and review Day 1 plenary balloting with breakout participants, discuss and clarify the issues to promote a common understanding, and identify the most important issues in each topical area for reporting back to the overall group. In the final plenary session at the end of Day 2, each breakout group reported the subset of pre-workshop issues that were identified as the most important needs in each topical area.

Chapter 3

Plenary Presentations and Discussions

3.1 NEHRP Perspective

Speakers: Jack Hayes (NIST), Cathleen Carlisle (FEMA), Joy Pauschke (NSF), Richard Bernknopf (USGS), and Nicolas Luco (USGS).

Representatives from each of the four NEHRP agencies (NIST, FEMA, NSF, and USGS) provided their perspectives on the challenges posed by existing buildings, and the goals of their respective organizations with regard to the workshop. Under the direction of NIST, the future of the National Earthquake Hazards Reduction Program includes interagency collaboration and coordination on engineering product development objectives and research agendas. This joint workshop provides a unique opportunity to discuss cross-cutting issues and obtain recommendations from multi-disciplinary stakeholder groups on a national scale.

3.2 Historical Context

Speaker: Ugo Morelli

A description of the evolution of the FEMA Existing Buildings Program was provided as context for workshop discussions. The FEMA program on seismic safety of existing buildings was presented in three phases. With this workshop, FEMA is poised to embark on a fourth phase.

First Phase. The first phase extends from the beginning of the existing buildings effort to the creation of the first action plan in 1984. During this phase, with no established program, activities on existing buildings were confined mostly to fundamental research carried out by a few individual investigators supported by the National Science Foundation.

At this time, the Tentative Provisions for the Development of Seismic Regulations for Buildings (ATC-3-06) included a summary treatment of existing buildings. Also begun during this period was Evaluating the Seismic Resistance of Existing Buildings (ATC-14), which laid out the original methodology for evaluating the seismic resistance of existing buildings.

Second Phase. The second phase began with a workshop convened at the University of Arizona, Tempe, Arizona, in 1984. From this workshop came the first plan for existing buildings, FEMA 90, *An Action Plan for Reducing Earthquake Hazards for Existing Buildings* (FEMA, 1985). This plan identified and described 23 tasks to be completed over a five-year period, at an estimated cost of about $40 million.

Based on this plan, FEMA took deliberate steps to establish the first cohesive, internally consistent, and nationally applicable program on the seismic safety of existing buildings, including a set of common concepts, technical approaches, and basic definitions (e.g., building types) that were to remain constant throughout the program. Resources produced in this phase included the FEMA 154 *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook* (FEMA, 1988a), the FEMA 156 *Typical Costs for Rehabilitation of Existing Buildings* (FEMA, 1988b), cost/benefit and incentive documents, various training material packages geared to different audiences, and some guidance for non-technical decision makers on how to implement seismic rehabilitation of existing buildings.

Third Phase. By early 1997, resources produced in the second phase were being used extensively and routinely, and some had appeared in revised and updated editions. In this phase, two very significant milestones were reached: the completion of the FEMA 310 *Handbook for the Seismic Evaluation of Buildings - A Prestandard* (FEMA, 1998a), and the FEMA 356 *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (FEMA, 2000), forming a consistent set of guidelines on seismic evaluation and rehabilitation that was ready for conversion into national consensus standards.

Another workshop was convened in August of 1997 in Reno, Nevada. This workshop produced a second plan for existing buildings, FEMA 315 *Seismic Rehabilitation of Buildings: Strategic Plan 2005* (FEMA, 1998b), which is essentially still in effect today. This plan outlined 25 tasks across four objectives, with an estimated cost of about $45.5 million. Objectives of FEMA 315 included: (1) promotion and encouragement of the use of existing resource documents; (2) continual updating of resource documents; (3) development of new tools; and (4) the exploration and setting of new directions. In addition to the new plan, the report included a critique of the implementation of the previous plan, pointing out a lack of any truly novel undertaking in this area, and an over-concentration on continuing along the same path.

Fourth Phase. Given the criticism included in FEMA 315, an appropriate starting point for the deliberations of this workshop is the identification of new tools and new approaches for the update of existing tools, as well as the exploration of possible new directions for progress in this area. The capabilities offered by technological advances in different fields should be harnessed to help address these needs, and initiate the fourth phase of FEMA's Existing Buildings Program.

3.3 Existing Buildings: Issues Framework

Speakers: Andrew Merovich, Craig Comartin, David Bonowitz, Edwin Dean, Susan Dowty, Susan Tubbesing

3.3.1 Overview

An overview of the organizational framework used in the collection of pre-workshop existing building issues was provided. Intersections between four broad areas of activity and knowledge were used to define effective implementation of earthquake hazard reduction. The intersecting areas of activity and knowledge included: Technical, Practical, Regulatory/Public Policy, and Research.

Technical. The Technical area includes structural engineering standards, guidelines, analytical algorithms, procedures, and engineering resource documents that form the technical basis for building evaluation and rehabilitation. This area has been a major thrust in past FEMA efforts to develop nationally applicable engineering resources for earthquake hazard reduction.

Practical. The Practical area covers the application of technical resources to building project efforts including building restoration, adaptive reuse, maintenance, tenant improvements, damage repair, and seismic rehabilitation.

Regulatory/Public Policy. The Regulatory/Public policy area encompasses building code, financial, and legislative policies that promote and regulate building use and construction, and in particular, seismic rehabilitation.

Research. The Research area includes system and material testing, analytical simulation, experimental investigation, and new knowledge development activities undertaken to explain the fundamental aspects of the seismic behavior of buildings, components, and ground motion.

3.3.2 Summary of Pre-Workshop Issues

These four areas were used as an organizational framework to collect and analyze existing building issues related to the state of seismic rehabilitation practice, regulation, and policy prior to the workshop. In the research area, identification of specific research needs was planned to occur during the workshop. Pre-workshop activities in the research area identified broad categories of potential research needs to seed workshop discussion.

Brief summaries of the key issues and themes that arose during pre-workshop activities in the technical, practical, and regulatory/public policy areas were provided. These themes were discussed in more detail during plenary balloting.

3.4 Current Research Approaches, Capabilities, Programs, and Utilization

Speakers: Jim Jirsa, Steve McCabe, Joy Pauschke, Robert Hanson

Workshop participants were provided with a summary of research approaches, capabilities, programs, and utilization. Presentations expressed both the potential capabilities and availability of the facilities and resources within the research community, as well as some of the concerns regarding the current state of operations.

Researchers expressed concern over the preponderance of funding they receive from government sources and the lack of industry sponsored research. Research/Industry partnerships are much more common in fields other than structural engineering, and as a consequence, innovation in structural engineering is constrained to a level that is much lower than it could be. Researchers generally seek to do research that interests them, but use their research to help train the next generation of engineers as well as to advance the knowledge base of the discipline.

In recent years, the development of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) affiliated sites has dramatically changed the research world in terms of opportunities for collaboration. With over $82 million in equipment, $200 million in operations and maintenance support over 10 years, and $100 million (projected) in research support over 10 years, the network offers unparalleled opportunities to address significant structural issues. The network includes 16 equipment sites linked with an IT system capable of creating a shared infrastructure for the earthquake engineering community including a national data archive. Equipment permits testing of near or full scale structures including the soil structure interface.

NEES Research (NEESR) emphasizes transformative and innovative research that includes significant utilization of NEES equipment sites, industry/practitioner collaboration, and technology transfer. Research grants are awarded in the categories of Grand Challenge, Small Group, Individual Investigator, Simulation Development, and Payloads. NEESR is looking for recommendations on structural, nonstructural, geotechnical, and public policy issues needing research, with an emphasis on considering new disciplines and expertise, new materials, controls, sensors and other NSF funding opportunities.

Successful implementation of research requires the active participation and cooperation of practicing engineers, researchers, industry representatives, building officials and funding agencies. Examples of past successes in implementation of research into practice include: (1) development of performance based seismic assessment procedures; (2) preparation of guidelines for evaluation and rehabilitation of existing buildings; (3) development of acceptable seismic design factors; (4) generation of design ground motions and risk-based maps; (5) update of steel moment frame evaluation, design and construction techniques; and (6) development of earthquake damage evaluation and repair techniques for concrete and masonry wall buildings.

Chapter 4

Open Forum Discussion

4.1 Description

Moderator: David Bonowitz
Invited Contributors: Chris Poland, Ross Asselstine, Ron Hamburger, Jonathan Siu, Fred Turner, Richard Howe, Ramon Gilsanz, William Holmes

An open forum session gave participants the opportunity to interact in a seeded, multi-disciplinary discussion on a number of important, and possibly controversial, challenges related to existing buildings. As a moderated discussion, it was designed to bring out the diverse perspectives of the participants and illustrate the interdisciplinary nature of the issues. It was intended to provoke thought and create interest in the breakout sessions on Day 2. Eight individuals were pre-selected to seed the discussion with ideas they had previously expressed to workshop planners. These individuals, and others providing input to the discussion, were then prompted with follow-up questions to further explore the issues. The session addressed the following pre-selected topics:

- Describing performance to non-expert stakeholders
- Metrics that influence owners, tenants, and financial stakeholders
- Regulation and design creativity: the effects of standardized technical criteria
- Voluntary vs. mandatory work: the role of legislation and code requirements
- Regional variations in practice, regulation, and research needs (Mid-America, East Coast, West Coast/California)

4.2 Key Discussion Points

The following discussion points were among those offered by workshop participants:

- The engineer's vocabulary of "performance objectives" does not adequately help owners understand what they can reasonably expect in terms of building performance. It is the responsibility of the engineering profession to change this by providing a description of anticipated performance in the evaluation/rehabilitation documents and communicating with simpler labels, scores, or ratings. Our current language is both too complex and too variable between the various codes and guidelines.

- The biggest impediment design professionals (and other risk reduction advocates) face is that they do not know whom owners listen to when making rehabilitation decisions. Are the "change levers" lenders, insurers, re-insurers? If we speak the language of the "change lever," we can communicate much more effectively.
- Decisions regarding capital spending are frequently made at the highest level of an organization and, unfortunately, information regarding anticipated seismic performance provided to lower level intermediaries does not percolate upward.
- As the expression of risk moves up the chain of authority, it is softened.
- Real estate decisions are market or code driven. Owners and lenders consider probable maximum losses (PMLs) to the extent that the cost or availability of insurance depends on such an analysis. Tenants do not seem to have seismic performance on their radar. They are interested in safety and do not question performance or criteria as long as the structure meets minimum legal requirements.
- Owners and tenants think that an existing building is safe to occupy unless the local building department tells them it is unsafe. The building departments do not have a mandate to evaluate and notify owners and tenants that they are occupying a seismically vulnerable building. If communities provided a mandate to evaluate and post the safety status of existing buildings, the building departments, owners and tenants would better understand their vulnerability and perhaps make informed decisions regarding rehabilitation.
- Although the ASCE 31 *Seismic Evaluation of Existing Buildings* (ASCE, 2003) and ASCE 41 *Seismic Rehabilitation of Existing Buildings* (ASCE, 2006b) technical resource documents are standards, and are therefore written in mandatory language, their provisions are routinely modified to reflect the unique conditions associated with individual project applications. Some provisions are adjusted while others are not applied. This is certainly the case for voluntary work, but is also true in the case of mandatory or triggered work. In general, design professionals are obligated to follow the standard of care.

- Building officials understand that existing buildings call for flexible approaches, both by the engineers and the regulators. Without a standard, engineers sometimes feel they are at the mercy of the interpretation of the building official. Similarly, building officials sometimes feel that they are at the mercy of highly regarded engineering experts. The goal of achieving uniform and consistent application of criteria is often in conflict with allowing flexibility in the approach to seismic rehabilitation.
- The acceptability criteria in ASCE 31 and ASCE 41 have always been considered subject to revision. It has been expected that they would be updated over time as new research provides more data. The value of having standards for use by the profession is to provide seismic evaluation and rehabilitation methodologies for the majority of practicing engineers.
- The ASCE 31 and ASCE 41 documents could well serve as loading standards with the material sections and acceptability criteria removed in a manner similar to what is done with ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2006a). Material-specific provisions would then be developed and supported by such groups as the American Concrete Institute (ACI) and the American Institute of Steel Construction (AISC), as is done for new construction.
- Prior to the development of ASCE 31, the FEMA 178 *NEHRP Handbook for the Seismic Evaluation of Existing Buildings* (FEMA, 1992) was used to establish the number of California hospitals considered to be at risk of collapse. Application of FEMA 178 predicted that 82% of all buildings evaluated were in danger of collapse. This was an unanticipated result, and was also considered to be unrealistic. If available standards produce too many false positives (buildings deemed hazardous that really are not), it can be as serious a problem as too many false negatives (hazardous buildings that are deemed to be safe).
- In the case of hospitals, there is no sufficient funding source to pay for seismic rehabilitation, despite the existence of a legislative mandate to upgrade such facilities. When linkages are made to other code requirements, such as the Americans with Disabilities Act (ADA), costs escalate beyond the ability of a facility to fund the work.
- There is no current consensus as to who should pay for the rehabilitation of at-risk hospital facilities in California. Legislators are prepared to support consensus based, simple solutions to well-defined and understood problems. Legislators will also support actions in the

immediate aftermath of a disaster when the perception of expected action on their part is high. In these cases they will support actions with or without clearly defined standards, problems or funding.

- The Midwest has different problems. Most decision-makers seem to believe there is no seismic risk. Engineers are ready to do seismic evaluations and rehabilitation (though many do not practice routinely in this area) but there is no incentive for building owners to engage them for this purpose. Some business owners have shown interest in business continuity planning but many are not convinced there is a real problem. Those owners interested in taking action are doing more to address nonstructural hazards than structural deficiencies because they believe it is more cost effective.

- In the New York area, the experience of past earthquake damage is missing, so the potential for losses due to earthquake risk is not an effective motivator. Most seismic improvements are being made by owners who are required to do so in order to enlarge their buildings. As a result, most owners are interested in understanding what the triggers for seismic rehabilitation are, and how much space can be added without triggering seismic rehabilitation work.

- There are large engineering companies located in the Midwest that are involved in power, highway, and bridge projects in the western United States. These engineers want and need access to the latest developments in seismic design. More training needs to be made available in these geographic areas.

- Research is needed in several areas in order to advance rehabilitation as a mitigation tool. We need to be able to push components to their limits of performance, which requires the collection of fragility data for the great many components found in existing buildings. We also need to test existing building systems to develop system fragilities and to better understand how component fragilities correlate to system fragilities. We need to better understand how and why buildings collapse. We need to update the ASCE 31 and ASCE 41 acceptability criteria accordingly. From these data we need to develop prescriptive regulations that define a national inventory of the "worst of the worst" buildings facing collapse, especially for building types like non-ductile concrete frames, for which there are no straightforward rules for identifying deficiencies (as there are for unreinforced masonry, tilt-ups, and soft story apartments). We need to identify where passive triggers can be effective in promoting acceptable levels of rehabilitation, and where mandates are needed.

4.3 Observations

The open forum discussion provided participants with exposure to a wide range of concerns from many different perspectives. Despite the preponderance of design professionals (engineers and architects totaled 42% of participants) the majority of discussion time was spent on communication issues rather than technical issues.

Engineers and others expressed concern that the language used by practitioners does not adequately convey seismic risk to owners and the public. As a consequence, the community largely ignores the potential consequences of earthquake losses. In regions where there is a perceived seismic risk, the costs of seismic rehabilitation and associated work can impede rehabilitation activities, even where there is a legislative mandate to perform such work. Since the magnitude and nature of the losses are not clearly conveyed, the costs of building rehabilitation cannot be put into a context that supports a rationale for how to distribute costs among the benefiting parties.

Participants also expressed concern that current seismic evaluation and rehabilitation tools need to be technically improved through a program of focused research. Limitations in our understanding of the extreme limits of performance of structural components and building systems serve to impede rehabilitation activities. It is anticipated that improved technical criteria will permit a significant extension beyond what is considered acceptable by today's standards. This will facilitate identification of buildings that are most at risk along with those that are not, minimize potential seismic rehabilitation program costs, and help promote the development of consensus-based community action plans that address seismic risk.

In areas of the country that have not experienced significant, damaging earthquakes in the last 100 years, there is a lack of societal concern over potential earthquake consequences. There is a concern, however, among some in the business community that the potential of a loss in business revenue is worthy of investigation and limited mitigation. This suggests that consideration of business interruption is a potential framework for enhancing the more widespread evaluation of seismic risk and rehabilitation to reduce future losses.

Chapter 5

Plenary Balloting of Pre-Workshop Issues

5.1 Description

Moderators: Andrew Merovich, John Whitmer, David Bonowitz, Edwin Dean, Susan Dowty, Susan Tubbesing

Selected technical, practical, and regulatory/public policy issues identified in pre-workshop activities were reformatted into questions and balloted in a plenary session at the end of Day 1. Pre-workshop issues related to research needs that were developed within the context of the other focus areas were included in the ballot. Balloting was conducted with electronic voting devices that permitted instantaneous posting of results. Moderators presented questions and led discussions to clarify the issues. Results were displayed immediately following the close of voting on each issue.

An initial block of questions was asked to familiarize the participants with the process, and to confirm the demographics of the respondents. Balloting then commenced through the technical, practical, regulatory and public policy focus areas.

Ballot questions were intended to engage workshop participants and familiarize them with the issues in a thought-provoking way. Balloting of pre-workshop issues was not intended to be a scientific survey. It was also not intended to end discussion by taking a vote, but rather to start discussion by taking a snapshot poll based on the current characterization of each issue. Many of the ballot questions presumed a certain level of knowledge or expertise in order to answer. For the multi-disciplinary group in attendance, it was understood that some questions might not be meaningful to every participant, so a "no opinion" option was presented for each question.

Some participants objected to a few questions for which a full range of responses was not offered, and to a few questions that suggested a premise with which they did not agree. The "no opinion" option was also available to any participant who objected to the phrasing or premise of a particular question. Participants were informed that breakout discussions would provide an opportunity to help revise the characterization of the issues and their eventual prioritization.

5.2 Summary of Ballot Results

A summary of trends and observations from the balloting in each focus area is provided in this section. The complete set of ballot questions and results of the balloting are provided in Appendix D.

An initial round of questions was used to confirm the demographics of workshop participants, familiarity with key resource documents, and initial opinions regarding the most important challenges with respect to seismic rehabilitation of existing buildings. These results are shown in Figures 5-1 through 5-6.

Figure 5-1 Ballot Results – Workshop demographics

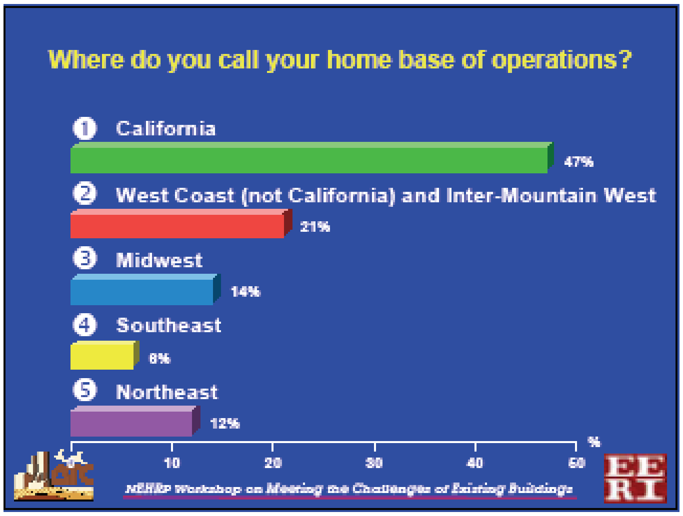

Figure 5-2 Ballot Results – Geographic distribution of workshop participants

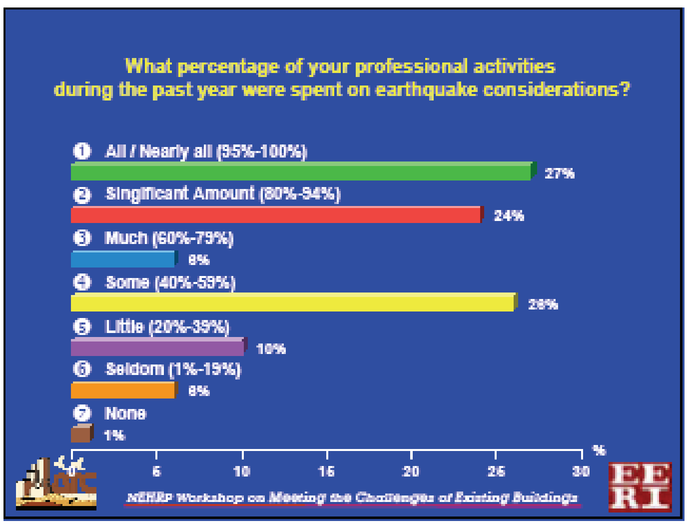

Figure 5-3 Ballot Results – Time spent on earthquake-related professional activities

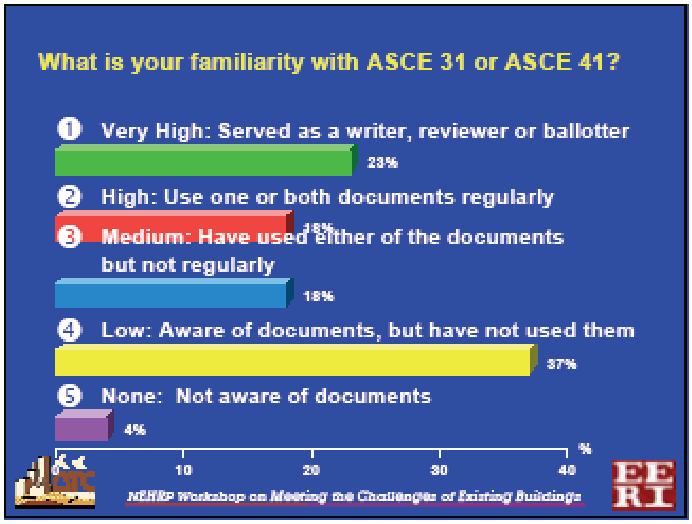

Figure 5-4 Ballot Results – Familiarity with ASCE 31 or ASCE 41

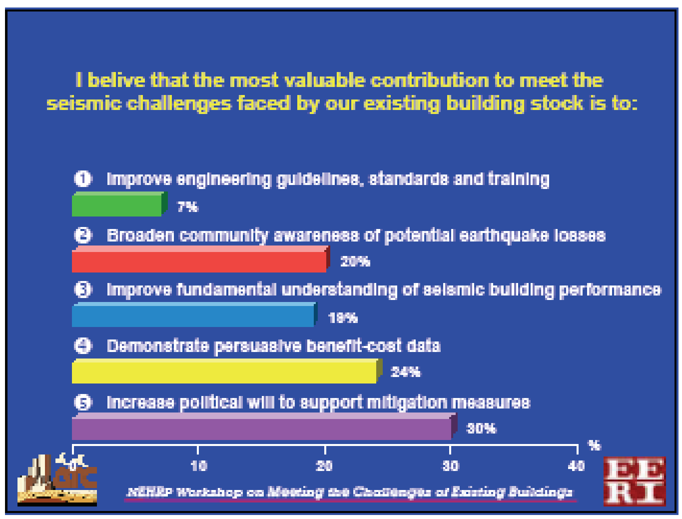

Figure 5-5 Ballot Results – Opinion on most valuable contribution toward meeting the challenges faced by existing buildings

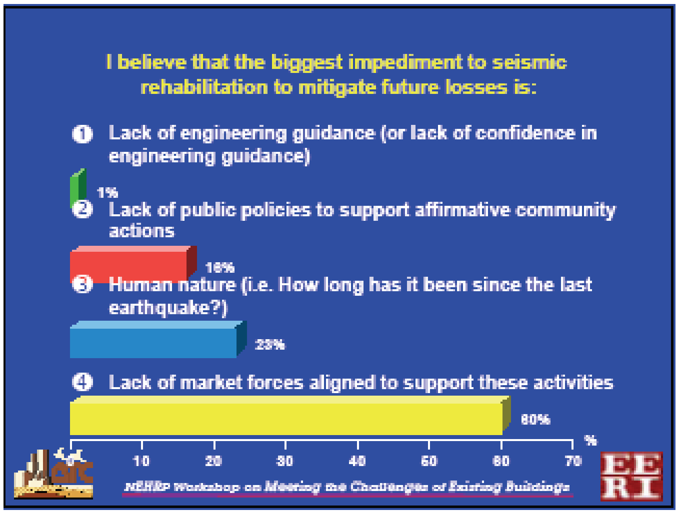

Figure 5-6 Ballot Results – Opinion on biggest impediment to seismic rehabilitation of existing buildings

Answers to general questions in Figures 5-4 through 5-6 suggest that the current status of existing engineering resource documents is not the most significant impediment to seismic rehabilitation, and that improvement of existing engineering resource documents is not necessarily the highest priority effort that could be undertaken to meet the seismic challenges of existing buildings.

- 37% of the workshop attendees had not actually used the ASCE 31 *Seismic Evaluation of Existing Buildings* (ASCE, 2003) and ASCE 41 *Seismic Rehabilitation of Existing Buildings* (ASCE, 2006b) technical resource documents, and another 4% were not familiar with them at all. Thus more than 40% of participants found the largest obstacles were unrelated to these documents.
- Only 7% of participants felt that improving the standards would be the most valuable next step to take.
- Only 1% felt that the greatest obstacle to earthquake risk reduction is the lack of adequate engineering guidance.

5.2.1 Ballot Results – Technical Issues

The ballot included 39 questions on technical issues, lumped into 11 general areas of inquiry. Considering questions for which a consensus emerged among those in attendance, the following observations can be made:

- Participants strongly believe more effort should be put into the collection of damage and loss data to support further development of ASCE 31 and ASCE 41.

- Additional case studies of both original and rehabilitated buildings are strongly supported to validate ASCE 31 and ASCE 41 provisions.
- A significant majority of participants (65%) expressed support for clarifying whether ASCE 31 and ASCE 41 acceptance criteria are based on relevant test data or expert opinion.
- Participants strongly support actions to define and inform rehabilitation by cost/benefit analysis tools.
- Participants expressed strong support for the development of a seismic rating system for buildings that extends ASCE 31 and ASCE 41 findings into consistent, reliable terms understandable by tenants, owners, and other stakeholders.

5.2.2 Ballot Results – Practical Issues

The ballot included 11 questions on practical issues for which the following observations can be made:

- Participants favored peer review over example problem review or sensitivity studies to help resolve unease with regard to the lack of consistency between the results of new analytical methodologies and past experience. The margin of consensus was more than 2 to 1.
- Participants expressed strong support (67%) for the development of seismic rehabilitation peer review guidelines.
- A majority of participants (60%) expressed support for the idea of developing prescriptive procedures for a select number of model building types as a means to "simplify" the seismic rehabilitation design process.
- Participants expressed strong support (85%) for the development of more example applications of actual projects illustrating seismic rehabilitation methodologies and standards.
- Participants expressed strong support (70%) for the development of additional guidelines for nonlinear analysis.

5.2.3 Ballot Results – Regulatory Issues

The ballot included 12 questions on regulatory issues for which the following observations can be made:

- A majority of participants (65%) felt it was important for jurisdictions to adopt the same (or similar) seismic rehabilitation provisions.
- Over 80% of the participants supported development of a building seismic rating system that would enhance communication with

stakeholders on the advantages of adding more seismic resilience to the design of structures.

- 70% of the participants expressed the opinion that plan reviewers do not have sufficient access to the training needed to review seismic rehabilitation projects.
- 93% of the participants agreed that there are situations for which peer review of a seismic rehabilitation project should be mandated.
- A majority of participants (64%) agreed that prescriptive rehabilitation provisions need to be developed for non-engineered buildings.

5.2.4 Ballot Results - Public Policy Issues

The ballot included 10 questions on public policy issues for which the following observations can be made:

- 82% of the participants agreed that materials to help communities weigh seismic risk among the other competing needs should be developed and refined.
- A majority of participants (68%) agreed that "Green Building Practices" should include earthquake safety considerations as an issue of sustainability.

Chapter 6

Breakout Discussions

Day 2 of the workshop included four breakout discussion tracks organized around the following focus areas: (1) *Technical Impediments*, related to technical problems with currently available resource documents; (2) *Practical Impediments*, related to problems in the application of currently available resource documents or the absence of a resource serving a specific need; (3) *Regulatory/Public Policy Issues*, related to problems in implementation of seismic rehabilitation in the building code/permit approval process or in setting effective public policy; and (4) *Research Needs*, as identified from a practitioner's point of view.

Each track featured three rounds of discussions with a consistent set of moderators leading each discussion, and a core group of participants. In the first round, attendance was assigned in each discussion track in order to ensure multi-disciplinary discussion of the issues. In subsequent rounds, participants (other than the moderators and core group) were free to move between discussion tracks.

The first round was intended for discussion and clarification of the pre-workshop issues listed in Appendix C. Participants were instructed to review the collection of assigned issues, discuss and clarify as necessary, and to add new issues, if needed. The second round was intended for prioritization of the issues. Participants were instructed to establish a consensus-based comparative ranking of each issue in terms of its importance either as an impediment to seismic rehabilitation or its ability to promote rehabilitation, if addressed. The third round was intended for completion of the prioritization process and discussion of potential solutions for the highest priority issues.

Pre-workshop issues assigned to each discussion track are identified in Appendix C. Many issues were identified as having a multi-disciplinary focus and were assigned to multiple discussion tracks. This overlap was intentional, and was intended to promote the investigation of the issues from the multiple perspectives of the different focus areas. Discussions in each of the breakout tracks are summarized in the sections that follow.

6.1 Breakout Discussion Track 1: Technical Impediments

Moderators: David Bonowitz, Anthony Court

6.1.1 General

Workshop attendees who participated in one or more of the three Technical Impediments breakout discussions are listed in Appendix B.

Technical Impediments breakout discussions considered issues related to the technical provisions of engineering resource documents including ASCE 31 *Seismic Evaluation of Existing Buildings* (ASCE, 2003) and ASCE 41 *Seismic Rehabilitation of Existing Buildings* (ASCE, 2006b). Pre-workshop activities identified about 45 issues that were assigned to the Technical Impediments breakout track. Issues were reorganized to remove duplication and grouped into the following categories for discussion: (1) calibrating the procedures; (2) standardization; (3) getting the right answer; (4) incorporating new information; (5) dealing with uncertainty; (6) special building types; (7) guidance on complicated tasks; and (8) specific technical provisions. Six additional issues were developed and considered during breakout discussions.

A number of highly specific technical issues related to detailed provisions contained in ASCE 31 and ASCE 41 were included in the list of assigned issues. Participants agreed that the current ASCE standards update process provides a mechanism for "fixing" technical issues that are covered within the framework of existing standards. While it was considered important that these issues be addressed in future editions of the standards, breakout participants did not feel they were general enough to warrant further discussion within the context of the workshop. Important technical issues deferred to the ASCE standards update process are identified in Table 6-1.

The remaining issues were then discussed in groups. Participants examined each issue statement before accepting its premise, and several issue statements were rewritten as a result.

Table 6-1 Technical Issues Deferred to the ASCE Standards Update Process

Issue No.	Issue
G020	Improvement of Foundation Design
G028	FEMA 356 / ASCE 41 – Improve Target Displacement Determination
G029	FEMA 356 / ASCE 41 – Clarify Force Delivery Reduction Factor "J"
G030	FEMA 356 / ASCE 41 – Simplify m-factor Determination for New Construction
G031	FEMA 356 / ASCE 41 – Reduce Conservatism in Overturning Factor R_{OT}
G032	FEMA 356 / ASCE 41 – Simplify Classification of Primary vs. Secondary Components
G033	FEMA 356 / ASCE 41 – Simplify Classification of Force- vs. Deformation-Controlled Elements
G043	FEMA 356 / ASCE 41 Foundation Requirements
G044	FEMA 356 / ASCE 41 Diaphragm Requirements
G056	Explicit Consideration of Building Adjacencies

6.1.2 Prioritization of Technical Issues

Time did not allow a full discussion of every issue, or an absolute ranking of each issue into an overall list of priorities. Discussion was focused on the most relevant issues through a triage process, and issues were prioritized on a relative scale, identified by the group as being either "high" or "low" priority. Technical Impediments breakout participants were instructed to emphasize issues that appeared to be keeping seismic risk reduction from happening, and to identify efforts capable of removing real or perceived obstacles to implementation of seismic rehabilitation.

Although not necessarily conclusive on any one topic, ballot results from Day 1 were used to initiate conversation and to identify any issues that might be prioritized without much additional discussion. Highest priority issues from the Technical Impediments breakout discussion track are summarized in Table 6-2.

Table 6-2 Highest Priority Technical Issues

Issue No.	Issue
Calibrating the Procedures	
G041	Improved Global Damage Prediction
G064	Case Studies to Correlate Seismic Design with Actual Damage
G065	Comprehensive and Systematic Collection of Damage and Loss Data
Getting the Right Answer	
G024	Conservative Bias of ASCE 41
G046	FEMA 356 / ASCE 41 – Consideration of Global Ductility
G077	Improvement of Seismic Assessments of Existing Buildings
G078	"Over-Conservatism" of ASCE 41
G078(b)	"Over-Conservatism" of ASCE 31
Incorporating New Information	
G002	Role of Industry Organizations
G003	Transferring Research into Practice
G011	Role of Technical Journals
G074	Evaluation and Rating Process for New Technical Information
Dealing with Uncertainty	
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System
G071	Integration of Risk Analysis Methods
G080	Development of a Realistic and Valid Methodology for Cost/Benefit Analysis
Special Building Types	
G015	Development of Simplified Procedures
G034	FEMA 356 / ASCE 41 – Simplify the “Simplified Procedure”
G067	Development of Rehabilitation. Guidelines for Non-Engineered Buildings
Guidance on Complicated Tasks	
G026	Development of Nonlinear Analysis Modeling Guidelines
G075	Improvement of Advanced Structural Analysis Procedures

6.1.3 Clarification of Technical Issues

Technical Impediments breakout discussions resulted in clarifications, revised issue statements, and expanded issue descriptions for the following highest priority technical issues. This information supersedes pre-workshop issue descriptions contained in Appendix C.

Role of Industry Organizations (G002). Because seismic rehabilitation often takes advantage of new technologies (including new information about material or component behavior), a rehabilitation standard such as ASCE 41 must be able to accommodate alternate design criteria. Yet the standard provides no mechanism for incorporating new information except through the discretion of the code official, a process that is often cost-prohibitive. Further, industry organizations that typically develop design data for new construction have not made the same commitment to existing building applications.

Transferring Research into Practice (G003). While new research on existing buildings and seismic rehabilitation continues, new and past research findings are not generally presented or compiled in formats that facilitate incorporation into ASCE 31 and ASCE 41. The successful collection of recent testing on reinforced concrete components and translation into revised acceptance criteria in ASCE 41 Supplement 1 is a notable exception.

Development of Simplified Procedures (G015). The same attributes that make ASCE 41 a comprehensive standard suitable for any structure also make it unnecessarily complex for simpler structures that comprise a sizable portion of the existing building stock nationwide. This increases the cost of evaluation and design, discouraging rehabilitation, and might even result in errors. Any of the following three sets of modified criteria would encourage and facilitate application of the standard: (1) subsets of the general criteria tailored to specific model building types such as those considered in ASCE 31; (2) simplified criteria appropriate to buildings that meet specific eligibility requirements or have a limited set of deficiencies per ASCE 31; or (3) prescriptive rehabilitation measures requiring no quantitative analysis or design, perhaps tied to specific deficiencies identified by ASCE 31. Each of these approaches is represented by other rehabilitation codes or guidelines, such as Appendix A of the *International Existing Building Code* (ICC, 2006b), but a reconciliation of these approaches with ASCE 41 has not yet been produced.

Development of Nonlinear Analysis Modeling Guidelines (G026). ASCE 31 and ASCE 41 allow (and often require) nonlinear procedures but provide little guidance as to why or how to implement them. Reluctance to use the nonlinear procedures, or incorrect application, can lead to unreliable findings or ineffective or wasteful recommendations.

Improved Global Damage Prediction (G041). ASCE 31 and ASCE 41 offer acceptance criteria for different structural component types. The criteria, based largely on laboratory testing, are de facto damage predictors. Yet the correlation between the implied damage and actual damage observed after earthquakes is not well established. Actual buildings seem to have a toughness that is not captured by the acceptance criteria. This may be because the criteria are too conservative, because the deterministic criteria do not represent full fragility curves, or because of other reasons. Better documentation of the correlation between actual damage patterns and the standards' criteria will improve practitioner confidence in the standards.

FEMA 356 / ASCE 41 – Consideration of Global Performance (G046). The earthquake performance of a structure is generally a function of more than any single component. Yet ASCE 41 measures acceptability only at the component level and does not explicitly consider the response of the structural system as a whole. Classification of certain elements as "secondary" does allow for relaxed acceptability criteria in some cases, but does not account for global behavior in a fully rational way.

Case Studies to Correlate Seismic Design with Actual Damage (G064). Validation of the ASCE 31 and ASCE 41 technical criteria is essential to the ongoing development of the standards. Yet the earthquake engineering community still lacks a full complement of realistic case study analyses and rehabilitation designs, consistently performed and documented. Also lacking are case study analyses of realistic buildings comparing performance before and after rehabilitation.

Comprehensive and Systematic Collection of Damage and Loss Data (G065). Actual damage and loss data is essential to the development of technical standards like ASCE 31 and ASCE 41, as well as standards and guidelines for loss estimation, cost-benefit analysis, risk management, and public policy development. Yet the earthquake engineering community still lacks consistent documentation of past damage and protocols for the systematic collection of future damage.

Development of a Uniformly Acceptable Standard Building Performance Rating System (G066). ASCE 31 and ASCE 41 will be more widely used if their implied performance predictions are presented in a format that allows relatively simple comparison of the risks posed by different buildings or by the same building before and after rehabilitation. Many in the earthquake engineering community feel that this would be achieved if a uniform rating system based on ASCE 31 and ASCE 41 were to be developed.

Evaluation and Rating Process for New Technical Information (G074). Because seismic rehabilitation often takes advantage of new technologies (including new information about material or component behavior), a rehabilitation standard such as ASCE 41 must be able to accommodate alternate design criteria. While Section 1.2 of ASCE 41 does allow for alternate criteria at the discretion of the code official, neither guidance nor incentive for discretionary approval is provided. Application thus differs between jurisdictions.

Consistency in Seismic Evaluation Results (G077). Widespread acceptance of ASCE 31 requires confidence that it will yield not only correct findings, but also reproducible findings. Yet the experience of engineers is that two evaluators frequently do not reach the same conclusions on some issues critical to building performance. This could be due to technical complexity, a lack of procedural clarity, differences in the skill or judgment of evaluators, uncertainty inherent in the evaluation process, or other causes.

"Over-Conservatism" of ASCE 41 (G078). Many engineers feel that strict application of ASCE 41 too often leads to expensive and unnecessary rehabilitation measures. If true, such over-conservatism could lead to rejection of the standard or to decisions to avoid rehabilitation. Development of ASCE 41 Supplement 1 showed that some conservatism was largely due to the lack of relevant data in support of acceptance criteria. Over-conservatism could also be due to a focus on individual components (as opposed to system behavior), to rigid “bright line” acceptance criteria, to an accumulation of nominally conservative provisions and procedures, or to other factors.

"Over-Conservatism" of ASCE 31 (G078b). Many engineers feel that strict application of ASCE 31 finds too many buildings to be deficient, especially when only Tier 1 or Tier 2 procedures are applied. If true, such over-conservatism could lead to rejection of the standard or to mis-application of rehabilitation funds. Some conservatism in an evaluation standard is necessary to avoid an unacceptable number of false negatives. Over-conservatism could be due to a lack of data to support acceptability criteria, to the use of high-confidence (as opposed to mean) test data, to conservative judgment applied by the evaluator, or to other factors.

Development of a Realistic and Valid Methodology for Cost/Benefit Analysis (G080). ASCE 31 and ASCE 41 will be more widely used and understood when non-engineers have tools with which to assess the benefits and costs of seismic rehabilitation. Currently, however, these standards do not directly support and do not interface with other guidelines for performing cost/benefit studies, most of which require an estimate of damage, repair cost, functional loss, and/or repair duration.

6.1.4 Consolidation of Technical Issues

Technical Impediments breakout discussions resulted in a strong consensus that broad efforts addressing multiple key issues would be more effective, and of greater long-term value, than focused studies resolving only one issue at a time. Highest priority technical issues were consolidated into four broad areas of emphasis, as follows:

Development of Focused Case Studies. A suite of case studies of real (or realistic) existing buildings would: (1) identify shortcomings in the current standards; (2) provide a basis for comparing alternative or simplified analytical procedures; (3) provide a basis for comparing or demonstrating rehabilitation technologies; (4) generate consistent information for the ASCE standards committees; and (5) generate consistent information for non-engineering studies, including policy development.

While case study results will be valuable, simply defining and documenting a set of case study buildings will be an important contribution. Because existing buildings present such a range of technical, economic, and regulatory constraints (much more so than new construction), case studies of past projects in the literature do not provide a useful basis for evaluating new analysis techniques or rehabilitation technologies. What is needed is a set of well-defined buildings usable by multiple parties over time.

In addition to defining the structure, architecture, and nonstructural components, it is also important to define a study matrix of the non-technical attributes that often affect rehabilitation, such as historic status, occupancy, valuation, access compliance, fire safety, quality of materials and construction. This will facilitate studies of costs and regulatory policies vital to earthquake risk management.

Development of focused case studies would help to resolve the technical issues listed in Table 6-3.

Table 6-3 Technical Issues Addressed by Development of Focused Case Studies

Issue No.	Issue
G002	Role of Industry Organizations
G003	Transferring Research Into Practice
G011	Role of Technical Journals
G015	Development of Simplified Procedures
G026	Development of Nonlinear Analysis Modeling Guidelines
G034	FEMA 356 / ASCE 41 – Simplify the "Simplified Procedure"
G041	Improved Global Damage Prediction
G064	Case Studies to Correlate Seismic Design With Actual Damage
G065	Comprehensive and Systematic Collection of Damage and Loss Data
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System
G067	Development of Rehabilitation. Guidelines for Non-Engineered Buildings
G071	Integration of Risk Analysis Methods
G074	Evaluation and Rating Process for New Technical Information
G075	Improvement of Advanced Structural Analysis Procedures
G078	"Over-Conservatism" of ASCE 41
G078(b)	"Over-Conservatism" of ASCE 31
G080	Development of a Realistic and Valid Methodology for Cost/Benefit Analysis

Transition of Research into Practice. New and continuing research is important. Equally important is the compilation, interpretation, and translation of existing research results into practical tools that fit within the context of available ASCE standards.

A model for this work is offered by the recent process used to produce Supplement 1 to ASCE 41, in which a joint committee of researchers and practitioners updated acceptability criteria for concrete elements based on several recent research programs.

Transition of research into practice would help to resolve the technical issues listed in Table 6-4.

Table 6-4 Technical Issues Addressed by Transition of Research into Practice

Issue No.	Issue
G003	Transferring Research Into Practice
G024	Conservative Bias of ASCE 41
G026	Development of Nonlinear Analysis Modeling Guidelines
G046	FEMA 356 / ASCE 41 – Consideration of Global Ductility
G075	Improvement of Advanced Structural Analysis Procedures
G078	"Over-Conservatism" of ASCE 41
G078(b)	"Over-Conservatism" of ASCE 31

Development of Application Examples. ASCE standards for seismic evaluation and rehabilitation are increasingly used and accepted, but they are still not familiar to much of the community of engineers and code officials. Example manuals would introduce concepts and terminology found in the standards but not in the building code for new construction. Brief examples, supplementing commentary in the current standards, might demonstrate and discuss more specifically: (1) ASCE 31 evaluation procedures and criteria; (2) ASCE 41 analysis procedures and design criteria; and (3) nonlinear modeling and analysis of new and existing elements.

Development of application examples would help resolve the technical issues listed in Table 6-5.

Establishing Relationships between Component Response and System Performance. Current standards measure acceptability on a component basis, and make no distinction between a building with 5% of its components failing the criteria and a building with 50% failing. Additional information is needed to help practitioners reconcile perceived inconsistencies between failure on the component level and acceptable performance on a system level.

Establishing relationships between component response and system performance would help resolve the technical issues listed in Table 6-6.

Table 6-5 Technical Issues Addressed by Development of Application Examples

Issue No.	Issue
G015	Development of Simplified Procedures
G024	Conservative Bias of ASCE 41
G026	Development of Nonlinear Analysis Modeling Guidelines
G034	FEMA 356 / ASCE 41 – Simplify the "Simplified Procedure"
G046	FEMA 356 / ASCE 41 – Consideration of Global Ductility
G064	Case Studies to Correlate Seismic Design With Actual Damage
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System
G067	Development of Rehabilitation Guidelines for Non-Engineered Buildings
G071	Integration of Risk Analysis Methods
G075	Improvement of Advanced Structural Analysis Procedures
G077	Improvement of Seismic Assessments of Existing Buildings
G078	"Over-Conservatism" of ASCE 41
G078(b)	"Over-Conservatism" of ASCE 31
G080	Development of a Realistic and Valid Methodology for Cost/Benefit Analysis

Table 6-6 Technical Issues Addressed by Establishing Relationships between Component Response and System Performance

Issue No.	Issue
G041	Improved Global Damage Prediction
G046	FEMA 356 / ASCE 41 – Consideration of Global Ductility

6.2 Breakout Discussion Track 2: Practical Impediments

Moderators: James Harris, Edwin Dean

6.2.1 General

Workshop attendees who participated in one or more of the three Practical Impediments breakout discussions are listed in Appendix B.

Practical Impediments breakout discussions considered issues related to the practical application of engineering standards thought to pose impediments to seismic rehabilitation of existing buildings. Pre-workshop activities identified 55 issues that were assigned to the Practical Impediments breakout track. Ten additional issues were developed during breakout discussions.

6.2.2 Prioritization of Practical Issues

Issues were prioritized by the Practical Impediments breakout group through a ballot process. Each participant was assigned five votes that could be used to identify the practical issues of highest importance. Priorities were established based on the number of votes received.

The highest priority issues from the Practical Impediments breakout discussion track are summarized in Table 6-7.

6.2.3 Clarification and Consolidation of Practical Issues

Practical Impediments breakout discussions were structured to identify salient points and different perspectives on the issues, which led to a consolidation of many related issues. Issues were consolidated where it was judged that multiple issues addressed a similar theme, or where more broadly defined issues encompassed the scope of issues that had a more narrow focus. The grouping of individual issues, and the resulting consolidated issue statements are shown in Table 6-7.

Clarifications, revised issue statements, and expanded issue descriptions for consolidated practical issues are provided below. This information supersedes pre-workshop issue descriptions contained in Appendix C.

Table 6-7 Highest Priority Practical Issues

Issue No.	Issue
Development of Building Specific Loss Estimation Procedures	
G019	Consideration of Uncertainty
G041	Improved Global Damage Prediction
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System
Education of Stakeholders about Seismic Rehabilitation	
G017	Example Applications
G039	Education of Building Owners and Users on Seismic Risk
Incorporation of Engineering Judgment into Seismic Rehabilitation Standards	
G001	Judgment vs. Analysis
G047	ASCE 31 and ASCE 41 Standardization Conundrum
Development of Business Continuity Planning Guidelines	
G036	Development of Business Continuity Planning Guidelines
Consistency in Code Enforcement	
G050	Improvement in Consistency of Code Enforcement
Education and Training in Seismic Rehabilitation	
G007	Education of Practitioners
G008	Education of Building Officials
G063	Seismic Rehabilitation Materials for College/University Instruction
Guidance on Incremental Mitigation Strategies for Seismic Rehabilitation	
G016	Incremental Seismic Rehabilitation
Improvement in Evaluation and Rehabilitation of Nonstructural Components	
G021	Nonstructural Components
G040	FEMA 356 / ASCE 41 – Further Development of Nonstructural Component Requirements
Simplified and/or Prescriptive Procedures	
G015	Development of Simplified Procedures
G034	FEMA 356 / ASCE 41 – Simplify the "Simplified Procedure"
G068	Development of Prescriptive Procedures
Special Policies and Guidelines for Historic Structures	
G006	Historic Structures

Development of Building Specific Loss Estimation Procedures (G019, G041, G066). Quantifiable earthquake loss estimation procedures are necessary for decision making. Owners need a rational means to evaluate procedures to use in a decision making process to make smart decisions about rehabilitation options. Procedures need to encompass cost/benefit ratios and be robust enough to compare alternative risks such as fire.

There is a need to extend building evaluation methods developed to date so that they include more factors, are useful to more stakeholders, portray relative risk, are better able to help set rehabilitation priorities and support decision making, and provide consistent results nationwide. This effort would combine engineering concepts of building performance with site conditions, occupancy, and other information to provide comparable results for understanding relative risk, deciding appropriate rehabilitation priorities and measures, establishing more accurate risk-based insurance rates, and assisting the financial community with making rehabilitation investment decisions.

Current standards tend to overestimate the amount of damage that will occur when compared to damage observed in inspections after recent earthquakes. There are many buildings that have a degree of toughness that current standards have trouble characterizing. We need to improve our ability to predict what will happen in a global sense. Additionally it is important to begin to link the financial aspects of damage and loss prediction to the cost/benefit analysis of retrofit.

Education of Stakeholders about Seismic Rehabilitation (G017, G039). Additional resources are needed to communicate seismic rehabilitation principles on various levels to different stakeholder groups, e.g., owners, architects, and builders. This information needs to be written in a vernacular and format tailored to the target audience. It can be used to introduce seismic rehabilitation strategies and bring into focus the economic risks in terms of financial and operational costs versus benefits. These resources need to incorporate illustrative examples of actual projects and decision processes.

Incorporation of Engineering Judgment into Seismic Rehabilitation Standards (G001, G047). Seismic rehabilitation techniques are project specific and require a significant amount of engineering judgment to implement. The process of "standardization" resulted in the introduction of mandatory language into what was once comprehensive engineering "guidance." The arguably premature standardization of FEMA 310 and FEMA 356 guidance documents has, in some cases, yielded unfavorable results. The use of mandatory language has also constrained the use and application of the documents as a result of specific requirements that are not applicable, have never (or rarely) been implemented, or are technically infeasible. A specific example of this is the extent of material testing required for buildings that have otherwise good documentation of the design.

Development of Business Continuity Planning Guidelines (G036). Business continuity planning that appropriately weighs the benefits and costs, with due consideration of risk, has been a proven rationale for implementing seismic rehabilitation strategies. Guidelines that foster a consistent rationale for business continuity planning would be a useful tool to decision-makers, but no such consensus-based resources are available to design professionals.

Consistency in Code Enforcement (G050). Uniformity and consistency in the application and enforcement of requirements for seismic rehabilitation in currently available codes and standards needs improvement. Compounded by the inherent complexity of ASCE 31 and ASCE 41, there are issues of inconsistency in how the various documents work together, including references to other standards. Improvement in this area is likely related to improvements in education and training.

Education and Training in Seismic Rehabilitation (G007, G008, G063). Proper application of seismic evaluation and rehabilitation techniques requires knowledge, experience, and training. Available resources, such as ASCE 41, are inherently complex, and application can be difficult for the inexperienced user. Training of design professionals and regulatory officials, along with the development of a broad spectrum of example applications, is necessary.

FEMA has generated numerous training seminars and workshops related to seismic evaluation and rehabilitation. There are also resource materials developed by other organizations (e.g., ATC, EERI) that could be applicable. Available resources need to be assembled, adapted, and maintained for future use. Additionally, the preparation of course curricula and training materials could promote development of expertise in emerging design professionals, and further seed the dissemination of seismic rehabilitation methods into practice.

Guidance on Incremental Mitigation Strategies for Seismic Rehabilitation (G016). Over time, small increments of rehabilitation can have a significant effect on reducing the overall vulnerability of a large population of highly vulnerable structures. Incremental approaches to addressing a population of vulnerable buildings are presently impeded by a lack of readily available technical guidance and lack of acceptance by building officials. Dissemination of available information on incremental rehabilitation into the community of practicing design professionals and building officials would help stimulate the process of reducing community vulnerability.

The incremental approach to seismic rehabilitation for various occupancies is described in currently available FEMA publications (FEMA 395 through FEMA 400). Existing performance-based seismic design (PBSD) approaches should be reviewed for applicability to incremental rehabilitation, and documentation should be prepared to facilitate their practical application for occupancies covered by the FEMA series. New PBSD approaches, if necessary, should be developed for specific application to incremental rehabilitation.

Improvement in Evaluation and Rehabilitation of Nonstructural Components (G021, G040). The majority of earthquake losses can be associated with nonstructural components, particularly when considered on a probabilistic basis. In low to moderate seismic regions, nonstructural rehabilitation may represent the best value solution in a partial or incremental strengthening approach. Improvements in the requirements for evaluation and rehabilitation of nonstructural components are needed. Current provisions need to be better aligned with nonstructural requirements for new construction. Particular attention is also needed on industrial components like shelving and piping.

Simplified and/or Prescriptive Procedures (G015, G034, G068). The ASCE 41 “Simplified Procedure” requires further simplification. In areas of low to moderate seismicity, the infrequent use of this standard is a challenge because of the steep learning curve associated with its implementation. Simplification through either prescriptive models, or emphasis on load-path alone (tying building elements together), is suggested.

Special Policies and Guidelines for Historic Structures (G006). Special policies and guidelines that address the unique challenges posed by historic structures are needed. Cultural resources deemed “historic” seem to warrant a higher level of property protection. However, improving the seismic performance of historic structures can compromise historical features. These somewhat diametrically opposed objectives create a unique situation for which seminal guidance is needed.

6.3 Breakout Discussion Track 3: Regulatory and Public Policy Issues

Moderators: Susan Dowty, Susan Tubbesing

6.3.1 General

Regulatory and public policy focus areas are closely related. Workshop attendees in these two stakeholder groups who participated in one or more of the three Regulatory/Public Policy breakout discussions are listed in Appendix B.

Pre-workshop activities identified 36 issues that were assigned to the Regulatory/Public Policy breakout track. Though closely related, regulatory and public policy issues were grouped and discussed separately by the breakout participants. In the first round of discussion, participants considered regulatory and public policy concerns that were not covered by the list of pre-workshop issues. Key discussion points expressed during the first round were distilled into eight new issues, for a combined total of 44 issues. Issues were consolidated where it was judged that more than one issue addressed a similar theme

In the second round of discussion, consolidated issues were prioritized. In the third round, participants reviewed the lists of regulatory and public policy issues identified as the most important, and clarified the issue statements.

6.3.2 Key Discussion Points

Throughout the workshop it was clear that public policy and regulatory issues are critical to the implementation of seismic rehabilitation. In Day 1 balloting, increased political will to support mitigation measures was identified as the most valuable contribution for meeting challenges faced by our existing building stock (30% of respondents). The biggest impediment to seismic rehabilitation was identified as the lack of market forces aligned to support such activities (60% of respondents).

Regulatory/Public Policy breakout participants were asked to express issues and concerns that they felt were not covered by the list of pre-workshop issues. Public policy officials at the federal, state and local levels, as well as policy researchers, identified three major issues in advancing the seismic rehabilitation of existing buildings: (1) power, (2) money, and (3) knowledge. Issues of power include whether or not rehabilitation is mandatory or voluntary, legal and liability issues that may be faced by an owner or jurisdiction, and competing objectives that may be faced by communities and individual building owners. Issues of money include the costs and benefits of rehabilitation, the role of mortgage lenders and insurers in encouraging or requiring rehabilitation, and financial incentives for owners (such as tax incentives and seed money for rehabilitation projects). Issues of knowledge include differing perceptions of risk and acceptable levels of risk, the question of building owner expectations with regard to building performance, the need for materials, guidelines, case studies and web-based tools for educating the public, and the need for strong channels of disseminating information.

The following is a summary of key discussion points raised by Regulatory/Public Policy breakout participants. Some of these points have been incorporated into the issues and recommendations identified in the sections that follow. Others are recorded for perspective on the unique insights and the complexity of the issues faced by regulatory, public policy, and owner stakeholder groups in attendance.

- One group that has not been identified as a stakeholder group includes building users, or the general public. Visitors, tenants, and customers go into buildings every day with the perception that they are safe. They may not realize potential seismic weaknesses in a building.
- Regulators identified a wide variety of standards and ordinances that are currently used to regulate seismic rehabilitation. On seismic retrofit projects there is often a unique negotiation process between designers and regulators that does not take place during the permit process for new buildings.
- Decision makers are the elected officials. Elected officials at the national level need to be leaders in advocating effective seismic policy.
- Many local officials find it easier to adopt and enforce regulations when the state or federal government mandates them.
- Buildings can become vacant because of restrictive seismic rehabilitation requirements. Sometimes buildings are ordered vacated if there is no compliance with a mandatory retrofit order, or an owner may decide it is cheaper to leave the building vacant than to fix it. Vacant buildings are a hazard to adjacent buildings and to fire fighters responding to fires in these structures. One unintended consequence of this is the deterioration of neighborhoods with several vacant buildings, as well as an increase in crime associated with such buildings. The question is, what is the bigger hazard, a vacant building or a seismically weak building.
- Politically, it is very hard to determine which buildings are hazardous. Owners don’t really want to know if their building has a weakness. If

they know the building is hazardous and people get hurt, owners are concerned that they will be held liable.

- When buildings are sold, lenders are typically not made aware of potential seismic vulnerabilities. If lenders are made aware, they may require some retrofitting before loaning money for the purchase. Lenders are willing to have seismically hazardous buildings within their portfolio, provided their inventory is spread out across the country.
- If an earthquake has a return period of 2500 years, and an owner wants to buy and hold a building for only 5 years, should the owner be worried about a rare event happening during the short time they own the building? Structural engineers need to be able to explain the hazard in terms that owners can understand.
- Rehabilitation often requires additional work beyond seismic strengthening, including asbestos abatement, sprinkler installations and disabled access upgrades. The cost to retrofit is passed on to the tenants. If the costs are too high, the tenants will move out to a more affordable building.
- Often the most vulnerable segments of society occupy the most seismically hazardous buildings. The poor often occupy old run-down buildings. Seismically retrofitting these buildings will require them to comply with additional upgrades. The piggybacking of requirements raises the cost to where it is not affordable. This is a social issue. How much does it cost and who pays?
- Engineers need to find more affordable ways to retrofit buildings. The problem must be addressed holistically. There are social impacts of mandating retrofit standards on the poor.
- The federal government, particularly FEMA, has built a reputation that after an earthquake they will come in and give money to rebuild. There is no federal incentive to do any retrofit. Is there a role for the federal government in rehabilitation? Possibly offering a federal tax credit for owners who retrofit their buildings would be a reasonable incentive.

6.3.3 Prioritization of Regulatory/Public Policy Issues

Issues were prioritized by the Regulatory/Public Policy breakout group through a ballot process. Participants reviewed and discussed the issues, and were asked to vote for the ones they felt were the most important. Each participant was assigned three votes that could be used to identify the highest priority issues. Priorities were established based on the number of votes received. Highest priority issues from the Regulatory/Public Policy breakout discussion track are summarized in Table 6-8 and Table 6-9

Table 6-8 Highest Priority Regulatory Issues

Issue No.	Issue
Encouraging Retrofit	
G057	Advocacy to Encourage More Seismic Retrofit
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System
Education and Training in Seismic Rehabilitation	
G008	Education of Building Officials
G063	Seismic Rehabilitation Materials for College/University Instruction
Simplified and/or Prescriptive Procedures	
G067	Development of Rehabilitation Guidelines for Non-Engineered Buildings
G068	Development of Prescriptive Procedures
Consistency in Plan Review	
G023	Mandate of Peer Review for Seismic Rehabilitation
G050	Improvement in Consistency of Code Enforcement
G070	Identification of Plan Review Requirements
Rehabilitation Codes and Standards	
G009	Standards Update Process
G047	ASCE 31 and ASCE 41 Standardization Conundrum
G058	Uniformity in Seismic Retrofit Requirements
Vacant Buildings	
G069	Vacant Buildings

Table 6-9 Highest Priority Public Policy Issues

Issue No. [1]	Issue
Incentives for Seismic Rehabilitation	
G059	Public Incentives for Seismic Rehabilitation (see also G079)
G060	Private Incentives ("change levers") for Seismic Rehabilitation (see also G079)
G079	Incentives for Seismic Rehabilitation (see also G059, G060)
Voluntary versus Mandatory Triggers	
G005	Voluntary vs. Mandatory Triggers
Costs for Seismic Rehabilitation	
G012	Typical Costs for Seismic Rehabilitation (see also G055)
Social Impacts of Seismic Rehabilitation on Vulnerable Populations	
XXX	Development of Program to Address the Social Impacts of Seismic Rehabilitation on Vulnerable Populations
G069	Vacant Buildings
Public Misconception and Education on Seismic Risk	
XXX	Public Misconception and Citizen Education
G039	Education of Building Owners and Users on Seismic Risk

1. "XXX" New issue added during breakout discussion

6.3.4 Clarification and Consolidation of Regulatory Issues

Discussions led to a consolidation of related issues. The grouping of individual regulatory issues, and the resulting consolidated issue statements are shown in Table 6-8.

Clarifications, revised issue statements, and expanded issue descriptions for consolidated regulatory issues are provided below. This information supersedes pre-workshop issue descriptions contained in Appendix C.

Encourage Retrofit (G057, G066). Jurisdictions should use a rating system that communicates the seismic resistance of older buildings. Such a rating system would inform the public about the condition of the buildings they live and work in, and would place seismic risk on front burner of elected officials to require seismic rehabilitation of hazardous buildings. Methods of publicizing stories of success and failure should be developed for the public and decision makers.

Education and Training in Seismic Rehabilitation (G008, G063). There should be college-level courses on seismic rehabilitation standards. Building officials and plan checkers should also be trained on the various code requirements for seismic rehabilitation of structures.

Simplified and/or Prescriptive Procedures (G067, G068). There should be seismic rehabilitation guidelines developed for non-engineered buildings. It is envisioned that these would be prescriptive procedures that a contractor could follow without the need of a design professional.

Consistency in Plan Review (G023, G050, G070). Peer review for certain complicated rehabilitation projects should be encouraged and in some cases, mandated. There needs to be improvement in the consistency of the application of rehabilitation criteria.

Rehabilitation Codes and Standards (G009, G047, G058). There should be guidelines for the adoption and enforcement of consistent rehabilitation criteria. Not only is it important to have uniformity in the codes that are adopted, but also in their enforcement.

Vacant Buildings (G069). Enforcement of mandatory seismic rehabilitation ordinances may cause jurisdictions to order buildings vacated for lack of compliance. Vacant buildings create blight on the surrounding neighborhoods, are potential fire hazards that are dangerous to fire fighter personnel, and in some cases house illegal activities.

6.3.5 Clarification and Consolidation of Public Policy Issues

Discussions led to a consolidation of related issues. The grouping of individual public policy issues and the resulting consolidated issue statements are shown in Table 6-9.

Clarifications, revised issue statements, and expanded issue descriptions for consolidated public policy issues are provided below. This information supersedes pre-workshop issue descriptions contained in Appendix C.

Incentives for Seismic Rehabilitation (G059, G060, G079). Public and private incentives need to be developed and used more widely. Public incentives may include tax breaks provided by the state and federal government for owners who seismically retrofit their buildings. Also grants from the government to offset a portion of the cost to retrofit buildings could be an important incentive. Other types of public incentives include encouraging retrofit through zoning incentives such as increases in the allowable floor area ratios.

Private incentives include insurance premium reductions for policy owners who retrofit their buildings or lending requirements that ask for some level of seismic evaluation or seismic rehabilitation as a condition of a loan.

Voluntary versus Mandatory Triggers (G005). Jurisdictions need to decide if voluntary or mandatory triggers will work better. Voluntary triggers include owners who want to add to or alter their buildings. During these voluntary construction projects, some jurisdictions require an analysis of the building to ensure that it is not seismically hazardous. Engineers use standards like ASCE 31 or ASCE 41 in their analysis. Mandatory triggers include ordinances that require seismic retrofitting, even if no other work is proposed. The Unreinforced Masonry Building (URM) program in the City of Los Angeles is such a program

Costs for Rehabilitation (G012). Costs to rehabilitate an existing building can be very high. The true cost of rehabilitation must include all associated costs, including other code requirements that are triggered as a result of the seismic work. This includes asbestos abatement, adding sprinklers, and making the building accessible for the disabled. In addition, some buildings may need to be vacated while being strengthened. The cost to move out, rent another facility, move back in, and perform any other necessary tenant improvements need to be included in the total costs. It is critical to understand these costs and look for ways to make rehabilitation more affordable.

Social Impacts of Seismic Rehabilitation on Vulnerable Populations (XXX, G069). Often the most vulnerable segments of society live in the most hazardous buildings. Requiring buildings to be retrofitted may cause them to be vacated. Vacant buildings can be big problems in a community. In addition, the majority of tenants in these buildings are part of a vulnerable population. This includes people on low and fixed incomes, the disabled, the elderly, and anyone who would be severely impacted by being forced to move out of a building that is ordered vacated or demolished. Understanding the societal impacts of rehabilitation on vulnerable populations is important. It is essential to develop rehabilitation programs that build these stakeholders into the process and account for these impacts.

Public Misconception and Education on Seismic Risk (XXX, G039). There is a misconception by the public that the buildings they work and live in are safe. They are not aware of the advances in structural design over the past several decades. Many do not think earthquakes are a real threat, as they occur infrequently. They have confidence in the engineers that designed older buildings. They feel that if nothing has happened so far, then the building will not need to be retrofitted. Geologists and engineers speak about return periods for earthquake faults of several hundred years. The public misunderstands this information and thinks that before the next earthquake, the building will have been replaced. Education programs need to be developed to change these misconceptions.

6.4 Breakout Discussion Track 4: Research Needs

Moderators: Maryann Phipps, John Hooper

6.4.1 General

Workshop attendees who participated in one or more of the three Research Needs breakout discussions are listed in Appendix B.

Pre-workshop activities identified general topics for research needs based on input from a variety of groups with an interest in research activities related to reducing the seismic hazards of existing buildings. These topics were used to seed a series of brainstorming discussions to identify the highest priority research needs from a practitioner's point of view.

During the Research Needs breakout discussions, more than 50 specific research needs were identified across the following 12 topics:

- Analysis
- Communication of Earthquake Risk
- Foundations
- Ground Motion
- Identifying Collapse
- Improvements to ASCE 31 and ASCE 41
- New Technologies
- Nonstructural Components and Systems
- Post-Earthquake Data Gathering and Documentation
- Public Policy
- Code Enforcement
- Miscellaneous

6.4.2 Prioritization of Research Needs

Issues were prioritized by the Research Needs breakout group through a ballot process. Participants were allowed ten votes to identify the most important research needs. Priorities were established based on the number of votes received. The highest priority research needs across all topics are listed in Table 6-10.

Table 6-10 Highest Priority Research Needs

Priority Ranking	Research Need	Topic
1	Fragility data for structural and nonstructural components and systems, and a consistent framework for developing and establishing such data	Analysis
2	Development of a nonproprietary building rating system	Communication of Earthquake Risk
3	Risk-based approaches to selection of ground motions for evaluation of buildings	Ground Motion
4	Full-scale shake table testing of complete building systems	Identifying Collapse
5	In-situ testing of the behavior of existing buildings	Identifying Collapse
6	Uniform method for development of acceptance criteria in guidelines and standards	Improvements to ASCE 31 and ASCE 41
7	Behavior and performance data on innovative structural materials and systems for use in seismic analysis and design	New Technologies
8	Improved analytical platforms for next-generation nonlinear analysis and quantification of risk	Analysis
9	Information on soil-foundation-structure interaction effects on input ground motion	Ground Motion
10	New tools for non-destructive investigation of building components (X-ray glasses)	New Technologies
11	Identification and inventory of buildings that are collapse risks, by type and region	Identifying Collapse
12	Soil-foundation-structure interaction (deformations, capacity, and behavior under extreme loading)	Analysis

6.4.3 Consolidation of Research Needs

The overarching recommendation from the Research Needs breakout group was to develop a coordinated research agenda for existing buildings that could be used to establish a program in which individual research projects serve a series of goals advancing the state of knowledge toward a common vision. Based on this recommendation, individual research needs were grouped into one or more goals that were deemed crucial to meeting the challenges of existing buildings. Research needs were grouped such that the successful accomplishment of any one of the needs within a goal would serve to advance the profession towards achieving that goal. In turn, successful accomplishment of any one goal would advance the profession towards meeting the challenges of existing buildings. Detailed research needs recommendations are contained in *Prioritized Research for Reducing the Seismic Hazards of Existing Buildings, NEHRP Workshop on Meeting the Challenges of Existing Buildings – Volume 2*, ATC-73 report (ATC, 2007).

Establishment of a Coordinated Research Program. There was general agreement that a coordinated research program related to existing buildings was needed as part of the NEES program. A wide range of issues that go beyond research supported by NSF was identified by the broad based user community represented at the workshop. Support from NSF, other federal agencies, from city and state agencies, and from the industrial community will be essential to success. In order to make progress on reducing the risks posed by existing buildings, a different mechanism for stimulating, selecting, and coordinating research in this area is needed.

Mitigation of Building Collapse Risks. Understanding what causes collapse is key to identifying buildings for which the risk of casualties is high and focusing mitigation efforts to most effectively protect life and property. Highest priority research needs in support of this goal include:

- Full- or large-scale shake table testing of complete building structural and/or nonstructural systems
- In-situ testing of the behavior of existing buildings
- Identification and inventory of buildings that are collapse risks, by type and region
- Improved ability to reliably simulate collapse

Advancement of Guidelines and Standards for Existing Buildings. Nationally applicable guidelines and standards form the engineering backbone that supports evaluation and mitigation of earthquake risk. Guidelines and standards are, by nature, evolutionary, requiring sustained attention to keep them current. Highest priority research needs in support of this goal include:

- Fragility data for structural and nonstructural components and systems, and a consistent framework for developing and establishing such data
- Risk-based approaches to selection of ground motions for evaluation of buildings
- Uniform method for development of acceptance criteria in guidelines and standards for seismic evaluation and rehabilitation of buildings
- Improved analytical platforms for next-generation nonlinear analysis and quantification of risk

- Information on soil-foundation-structure interaction effects on input ground motion

Communication of Earthquake Risks. Assessment, identification, and quantification of earthquake risks are pointless activities if the methods do not provide information in meaningful ways, or if the information is not usable or understandable by stakeholders and decision-makers. Effective means of communication, along with consistent and understandable messages, are needed to influence policy and initiate seismic rehabilitation activities. Highest priority research needs in support of this goal include:

- Development of a nonproprietary building rating system
- Information on most effective ways to communicate risk and mitigation alternatives
- Definition of acceptable (or tolerable) risk

Calibration of Engineering Tools with Realistic Data. Data from full- and large-scale tests are needed to support the development of engineering tools used for seismic evaluation and rehabilitation of existing buildings. Advanced procedures and techniques are promising, but require validation to enable their full potential to be realized. Both full- and large-scale simulations and post-earthquake data collection and analysis are needed to accomplish this. Highest priority research needs in support of this goal include:

- Full-/large-scale or in-situ testing of complete building systems
- Collection and archiving of detailed information on earthquake damage to nonstructural building components and systems
- Expansion of building instrumentation in the strong-motion instrumentation program, including instrumentation of potentially hazardous buildings

Development of New Materials and New Building Systems. Innovative materials and creative applications in existing building systems can lead to new, cost-effective, less-disruptive, and better-performing seismic rehabilitation solutions. Highest priority research needs in support of this goal include:

- Behavior and performance data on innovative structural materials and systems for use in seismic analysis and design
- Approaches for mitigating risk of non-engineered buildings
- Assessment of synergistic benefits of multi-hazard rehabilitation

Development of Building Investigative Technologies. One of the biggest challenges related to assessment of existing buildings is knowing, with some degree of certainty, the condition of the building, how it was constructed, and what materials were used in the construction. Development of new technologies and strategies for investigating the condition of existing buildings would significantly improve our ability to reliably assess seismic risk. Highest priority research needs in support of this goal include:

- New tools for non-destructive investigation of building components
- New building information and data collection and archiving systems when drawings are unavailable or building components are concealed

Chapter 7

Observations, Findings, and Conclusions

7.1 General Observations

Despite significant progress, and the achievement of several major milestones during the past two decades, complex technical, practical, regulatory, and public policy issues surrounding the seismic rehabilitation of existing buildings are far from resolved. There are technical, practical, and policy barriers to effective implementation and gaps in research related to seismic rehabilitation that remain a hindrance to earthquake risk reduction efforts in existing buildings.

Input from workshop participants during plenary balloting of pre-workshop issues, open forum discussions, and breakout discussion tracks included the following general observations with regard to the challenges posed by existing buildings:

- Public policy and regulatory issues are critical to the implementation of seismic rehabilitation. Increased political will to support mitigation measures was identified as the most valuable contribution for meeting challenges faced by our existing building stock. The biggest impediment to seismic rehabilitation was identified as the lack of market forces aligned to support such activities.
- Public policy officials and researchers identified three major issues in advancing seismic rehabilitation of existing buildings: (1) power, (2) money, and (3) knowledge. Issues of power include whether or not rehabilitation is mandatory or voluntary. Issues of money include the costs and benefits of rehabilitation, and the presence (or lack) of financial incentives. Issues of knowledge include differing perceptions of risk and acceptable levels of risk, building owner expectations with regard to building performance, the need for new tools to educate the public, and the need for strong channels of disseminating information.
- The language used by practitioners does not adequately convey seismic risk to owners and the public. As a consequence, the community largely ignores the potential consequences of earthquake losses. There was

strong support for the development of a seismic rating system for buildings that communicates risk in consistent, reliable terms understandable to tenants, owners, and other stakeholders.

- Risk of potential loss in business revenue was identified as a persuasive justification for performing seismic rehabilitation, particularly in regions of moderate seismicity. This suggests that consideration of business interruption is a potential framework for encouraging more widespread evaluation of seismic risk and rehabilitation to reduce future losses.
- Currently available seismic evaluation and rehabilitation tools need to be technically improved through a program of focused research. Limitations in our understanding of the extreme limits of performance of structural components and building systems serve to impede rehabilitation activities. It is anticipated that improved technical criteria will permit a significant extension beyond what is considered acceptable by today's standards. This will facilitate identification of buildings that are most at risk along with those that are not, minimize potential seismic rehabilitation program costs, and help promote the development of consensus-based community action plans that address seismic risk.
- In regions where there is a perceived seismic risk, the costs of seismic rehabilitation and associated 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.

7.2 Findings and Conclusions

7.2.1 Individual Issue Statements

Pre-workshop issues that were used to seed workshop plenary discussions and initiate focused breakout discussions are recorded in Appendix C. Issues that were identified as highest priority in the Technical, Practical, Regulatory/Public Policy, and Research Needs discussion tracks are recorded in Chapter 6. While the emphasis and priorities in each group were somewhat different, certain issues resonated with consensus in more than one group. Issues that were identified as high priority across multiple discussion tracks are summarized in Table 7-1.

Table 7-1 Issues Identified as High Priority in Multiple Discussion Tracks

Issue No.	Issue	Discussion Track
Three or more discussion tracks		
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System	Technical Practical Regulatory/Public Policy Research Needs
G015, G034, G067, G068	Development of Simplified and/or Prescriptive Procedures, and/or Procedures for Non-Engineered Buildings	Technical Practical Regulatory/Public Policy
At least two discussion tracks		
G008	Education of Building Officials	Practical Regulatory/Public Policy
G021, G040	FEMA 356 / ASCE 41 – Further Development of Nonstructural Component Requirements	Practical Research Needs
G024	Conservative Bias of ASCE 41	Technical Research Needs
G026	Development of Nonlinear Analysis Modeling Guidelines	Technical Research Needs
G039	Education of Building Owners and Users on Seismic Risk	Practical Regulatory/Public Policy
G041	Improved Global Damage Prediction	Technical Practical
G047	ASCE 31 and ASCE 41 Standardization Conundrum	Practical Regulatory/Public Policy
G050	Improvement in Consistency of Code Enforcement	Practical Regulatory/Public Policy
G063	Seismic Rehabilitation Materials for College/University Instruction	Practical Regulatory/Public Policy
G074	Evaluation and Rating Process for New Technical Information	Technical Research Needs
G075	Improvement of Advanced Structural Analysis Procedures	Technical Research Needs
G078	"Over-Conservatism" of ASCE 31 and ASCE 41	Technical Research Needs

7.2.2 Consolidated Needs

Each discussion track identified the subset of issues felt to be the most pressing in terms of existing building rehabilitation practice, regulation, policy, and research. In each track there was strong consensus that broad efforts addressing multiple key issues would be more effective and of greater long-term value, than focused studies resolving only one issue at a time.

Highest priority issues in each discussion track were consolidated into groups of combined issue statements covering common needs, areas of emphasis, or similar themes. The individual issues comprising each consolidated statement are identified in Chapter 6. Consolidated statements for the Technical, Practical, Regulatory/Public Policy, and Research Needs discussion tracks are summarized in Tables 7-2 through 7-6.

While the names of consolidated statements generated by each group were somewhat different, certain themes arose that were common across multiple discussion tracks. Common themes identified across multiple discussion tracks are summarized in Table 7-7.

Table 7-2 Summary of Consolidated Technical Needs

Issue No.	Consolidated Statement
G002, G003, G011, G015, G026, G034, G041, G064, G065, G066, G067, G071, G074, G075, G078, G080	Development of Focused Case Studies
G003, G024, G026, G046, G075, G078,	Transition of Research into Practice
G015, G024, G026, G034, G046, G064, G066, G067, G071, G075, G077, G078, G080	Development of Application Examples
G041, G046	Establishing Relationships between Component Response and System Performance

Table 7-3 **Summary of Consolidated Practical Needs**

Issue No.	Consolidated Statement
G019, G041, G066	Development of Building Specific Loss Estimation Procedures
G017, G039	Education of Stakeholders about Seismic Rehabilitation
G001, G047	Incorporation of Engineering Judgment into Seismic Rehabilitation Standards
G036	Development of Business Continuity Planning Guidelines
G050	Consistency in Code Enforcement
G007, G008, G063	Education and Training in Seismic Rehabilitation
G016	Guidance on Incremental Mitigation Strategies for Seismic Rehabilitation
G021, G040	Improvement in Evaluation and Rehabilitation of Nonstructural Components
G015, G034, G068	Simplified and/or Prescriptive Procedures
G006	Special Policies and Guidelines for Historic Structures

Table 7-4 **Summary of Consolidated Regulatory Needs**

Issue No.	Consolidated Statement
G057, G066	Encouraging Retrofit
G008, G063	Education and Training in Seismic Rehabilitation
G067, G068	Simplified and/or Prescriptive Procedures
G023, G050, G070	Consistency in Plan Review
G009, G047, G058	Rehabilitation Codes and Standards
G069	Vacant Buildings

Table 7-5 **Summary of Consolidated Public Policy Needs**

Issue No. [1]	Consolidated Statement
G059, G060, G079	Incentives for Seismic Rehabilitation
G005	Voluntary versus Mandatory Triggers
G012	Costs for Seismic Rehabilitation
XXX, G069	Social Impacts of Seismic Rehabilitation on Vulnerable Populations
XXX, G039	Public Misconception and Education on Seismic Risk

1. "XXX" New issue added during breakout discussion

Table 7-6 Summary of Consolidated Research Needs

Issue No. [1]	Consolidated Statement
n/a	Establishment of a Coordinated Research Program
n/a	Mitigation of Building Collapse Risks
n/a	Advancement of Guidelines and Standards for Existing Buildings
n/a	Communication of Earthquake Risks
n/a	Calibration of Engineering Tools with Realistic Data
n/a	Development of New Materials and New Building Systems
n/a	Development of Building Investigative Technologies

1. Research needs were generated during breakout discussion

Table 7-7 Common Themes Identified in Multiple Discussion Tracks

Theme	Discussion Track
Three or more discussion tracks	
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 Practical Regulatory/Public Policy Research Needs
Advancement 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 Practical Research Needs
At least two discussion tracks	
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	Practical 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	Practical Regulatory/Public Policy
Consistency in Enforcement – consistency in application of mandated seismic requirements; consistency in how requirements are are enforced on individual projects; and development of guidance on peer review	Practical Regulatory/Public Policy

7.2.3 Conclusions

Information developed during the Research Needs breakout discussion track was used to identify and prioritize existing research needs, from the perspective of practicing seismic design professionals, in support of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) program, to foster development of more effective existing building evaluation and rehabilitation techniques. The resulting recommendations are contained 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).

Information from the plenary discussions and other breakout discussion tracks was used to identify the current status of seismic evaluation and rehabilitation practice, policy, and regulation. This information is contained in the 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, 2009a).

Observations and findings regarding the highest priority issues identified in each discussion track, consolidated needs in each area, and high priority issues and themes that resonated across multiple discussion tracks have been used to develop a comprehensive seismic rehabilitation guidance package for FEMA, including necessary implementation strategies for the creation, update, and maintenance of seismic evaluation and rehabilitation documents for existing buildings as part of the next phase of FEMA's Existing Buildings Program. This information is contained in the ATC-71 Report, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 3: Action Plan for the FEMA Existing Buildings Program* (ATC, 2009b).

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Appendix C

Pre-Workshop Existing Building Issues

Table C-1 contains the complete list of existing building issues identified during workshop planning activities. This list is based on an initial list of issues developed by the workshop planning group, and subsequent input obtained during pre-workshop interviews with invitees and other key representatives from target stakeholder groups. Issues were assigned codes identifying applicability to one or more of the following categories:

- General (G) – All issues were assigned this code and numbered consecutively in this category.
- Technical (T) – Issues related to the technical provisions of available existing building resource documents.
- Practical (P) – Issues related to the practical application of available existing building resource documents.
- Regulatory/Public Policy (R-PP) – Issues related to the building code/permit approval process or setting of effective public policy.

Based on the above coding, issues were assigned to breakout discussion tracks. As shown in Table C-1, issues with a multi-disciplinary focus were assigned to more than one breakout track.

Following Table C-1 are more detailed issue statements and expanded discussion on each issue (when available). This information was used to set the workshop structure, seed workshop discussion, and target workshop content to address the most pressing issues in existing building rehabilitation practice, regulation, policy, and research.

Issues are presented in their pre-workshop format, and recorded in this appendix for future reference. Issues that resonated with consensus, and were prioritized, combined or otherwise revised during breakout discussions, are reported in Chapter 6.

Table C-1 Pre-Workshop Issue Numbers and Breakout Track Assignments

Pre-Workshop Issue No.	Pre-Workshop Issue Name	Breakout Track Assignment		
		Technical	Practical	Regulatory/ Public Policy
G001	Judgment vs. Analysis	X	X	X
G002	Role of Industry Organizations	X	X	X
G003	Transferring Research into Practice	X	X	X
G004	Multihazard Coordination and Linkage with other Building Mitigation Actions		X	X
G005	Voluntary vs. Mandatory Triggers		X	X
G006	Historic Structures		X	X
G007	Education of Practitioners		X	
G008	Education of Building Officials		X	X
G009	Standards Update Process		X	X
G010	Accessibility of Information		X	
G011	Role of Technical Journals	X	X	
G012	Typical Costs for Seismic Rehabilitation (see also G055)		X	X
G013	New Design vs. Rehabilitation Design		X	
G014	Evaluation Process vs. Design Process		X	
G015	Development of Simplified Procedures	X	X	
G016	Incremental Seismic Rehabilitation		X	X
G017	Example Applications		X	X
G018	Consistency Between Resource Documents (see also G072)	X	X	
G019	Consideration of Uncertainty	X	X	X
G020	Improvement of Foundation Design	X	X	
G021	Nonstructural Components	X	X	
G022	Development of Peer Review Guidelines and Standards		X	
G023	Mandate of Peer Review for Seismic Rehabilitation		X	X
G024	Conservative Bias of ASCE 41	X	X	
G025	Material and Component Test Data	X	X	
G026	Development of Nonlinear Analysis Modeling Guidelines	X	X	
G027	Illustrated History and Evolution of Seismic Resources		X	
G028	FEMA 356 / ASCE 41 – Improve Target Displacement Determination	X		
G029	FEMA 356 / ASCE 41 – Clarify Force Delivery Reduction Factor "J"	X		
G030	FEMA 356 / ASCE 41 – Simplify m-factor Determination for New Construction	X		
G031	FEMA 356 / ASCE 41 – Reduce Conservatism in Overturning Factor R_{OT}	X		
G032	FEMA 356 / ASCE 41 – Simplify Classification of Primary vs. Secondary Components	X	X	

Table C-1 Pre-Workshop Issue Numbers and Breakout Track Assignments (continued)

G033	FEMA 356 / ASCE 41 – Simplify Classification of Force- vs. Deformation-Controlled Elements	X	X	
G034	FEMA 356 / ASCE 41 – Simplify the "Simplified Procedure"	X	X	
G035	Seed or Grant Money for Seismic Strengthening			X
G036	Development of Business Continuity Planning Guidelines		X	X
G037	Validation of the Value of Advanced Analysis in Saving Construction Costs		X	X
G038	Development of Design Guidance for Heavy Industrial Facilities in the Northeastern United States	X	X	
G039	Education of Building Owners and Users on Seismic Risk		X	X
G040	FEMA 356 / ASCE 41 – Further Development of Nonstructural Component Requirements	X	X	
G041	Improved Global Damage Prediction	X	X	
G042	Correlation between ASCE 31 and ASCE 41	X	X	
G043	FEMA 356 / ASCE 41 Foundation Requirements	X		
G044	FEMA 356 / ASCE 41 Diaphragm Requirements	X		
G045	Development of Guidelines for Soil-Structure Interaction in Nonlinear Static Analyses	X		
G046	FEMA 356 / ASCE 41 – Consideration of Global Ductility	X	X	
G047	ASCE 31 and ASCE 41 Standardization Conundrum	X	X	X
G048	Devolution of ASCE 41 into a Loading Standard	X	X	
G049	Incorporation of Performance-Based Design in Future Resource Documents	X	X	
G050	Improvement in Consistency of Code Enforcement		X	X
G051	Improvement in Software Tools for Assessing ASCE 31 and ASCE 41 Acceptance Criteria	X	X	
G052	Buildings with Multiple Owners/Condominiums			X
G053	Levels of Acceptable Risk	X		X
G054	Consideration of Multiple Public Objectives			X
G055	Typical Costs for Seismic Rehabilitation (see also G012)		X	X
G056	Explicit Consideration of Building Adjacencies	X		X
G057	Advocacy to Encourage More Seismic Retrofit			X

Table C-1	Pre-Workshop Issue Numbers and Breakout Track Assignments (continued)			
G058	Uniformity in Seismic Retrofit Requirements			X
G059	Public Incentives for Seismic Rehabilitation (see also G079)			X
G060	Private Incentives ("change levers") for Seismic Rehabilitation (see also G079)			X
G061	Unfinished Business in the 2005 Strategic Plan			X
G062	Legal Implications of Seismic Rehabilitation			X
G063	Seismic Rehabilitation Materials for College/University Instruction		X	X
G064	Case Studies to Correlate Seismic Design with Actual Damage	X		
G065	Comprehensive and Systematic Collection of Damage and Loss Data	X		
G066	Development of a Uniformly Acceptable Standard Building Performance Rating System	X	X	X
G067	Development of Rehabilitation Guidelines for Non-Engineered Buildings	X	X	X
G068	Development of Prescriptive Procedures		X	X
G069	Vacant Buildings			X
G070	Identification of Plan Review Requirements		X	X
G071	Integration of Risk Analysis Methods	X		X
G072	Consistency Between Resource Documents (see also G018)	X	X	
G073	Selection and Scaling of Ground Motions	X	X	
G074	Evaluation and Rating Process for New Technical Information	X	X	X
G075	Improvement of Advanced Structural Analysis Procedures	X	X	
G076	Soil Structure Interaction	X	X	
G077	Improvement of Seismic Assessments of Existing Buildings	X	X	
G078	"Over-Conservatism" of ASCE 41	X	X	
G079	Incentives for Seismic Rehabilitation (see also G059, G060)			X
G080	Development of a Realistic and Valid Methodology for Cost/Benefit Analysis			X
G081	Integration with the Green Building Movement			X

The following tables provide more detailed explanations and expanded discussion (when available) for each issue identified in Table C-1.

Category: R-PP/P/T	**No.:** G001	**Issue name:** **Judgment vs. Analysis**
Issue statement: What is the role of judgment in engineering practice today? How do we responsibly manage the use of complex and advanced emerging technologies in engineering practice?		
Discussion:		

Category: R-PP/P/T	**No.:** G002	**Issue name:** **Role of Industry Organizations**
Issue statement: What is the role of materials organizations and industry groups?		
Discussion: Traditionally, material (concrete, steel, masonry, wood) trade organizations maintain committees and sponsor research to develop improved practical design and engineering information. How can these resources be mobilized?		

Category: R-PP/P/T	**No.:** G003	**Issue name:** **Transferring Research into Practice**
Issue statement: How can technical research be more quickly transferred to engineering practice?		
Discussion: *PEER, MCEER,* and *MAE* are all developing relevant materials. They are responsible for making efforts to get their products into practice. NEES is also responsible for reaching out to the practicing community. What actions can be taken to capitalize on this leading edge research? Can material and component testing results be cataloged to facilitate improvements to acceptability criteria?		

Category: R-PP/P	**No.:** G004	**Issue name:** **Multihazard Coordination and Linkage with other Building Mitigation Actions**
Issue statement: What are the best strategies for coordinating seismic concerns with other natural and man-made hazards and other building mitigation activities?		
Discussion: Examples of opportunities include: Americans with Disabilities Act (ADA) compliance, and fire and life safety upgrades.		

Category:	No.:	Issue name:
R-PP/P	G005	**Voluntary vs. Mandatory Triggers**
Issue statement: What are the pros and cons of mandatory versus voluntary seismic retrofit programs?		
Discussion: When is it appropriate for a community to make building owners and occupants aware of the risks they face due to seismic exposure? When is it appropriate for a community to establish a minimum level of protection against earthquake loss? Some jurisdictions have implemented voluntary seismic retrofit programs; some have adopted mandatory programs; some have first gone with the voluntary approach and then switched to making the requirements mandatory. What works and what doesn't?		

Category:	No.:	Issue name:
R-PP/P	G006	**Historic Structures**
Issue statement: Should special policies and guidelines be developed that address the unique challenges posed by Historic Structures?		
Discussion: On the one hand, cultural resources deemed "historic" warrant a level of property protection that seems higher than the community has placed on non-historic structures. On the other hand, improving the seismic performance of historic structures will likely require the incorporation of new building materials that will compromise historical features.		

Category:	No.:	Issue name:
P	G007	**Education of Practitioners**
Issue statement: What options are currently available for education of engineering practitioners, and what is needed?		
Discussion: Existing materials FEMA has generated numerous training seminars and workshops for many documents related to seismic evaluation and rehabilitation. There is also a lot of other material developed by other organizations (e.g. ATC , EERI) that could be very applicable. How can these be assembled, adapted, and maintained for future use? Existing training programs FEMA, EERI, ASCE, SEAOC and other organizations have ongoing workshops and seminars. How can these programs help? College Curricula Materials Preparing curricula materials could promote instruction of emerging professionals in the current methodologies and seed the dissemination of this material into the world of practice. New technologies Web-based seminars, DVD's, and other new technologies are now being used extensively for training purposes. How can these be brought to bear?		

Category:	No.:	Issue name:
R-PP/P	G008	**Education of Building Officials**

Issue statement:
What options are currently available for education of building officials, and what is needed?

Discussion:

Building officials
Performance-based procedures pose a major challenge for building officials and plan checkers. How can materials aimed specifically at these stakeholders be developed and disseminated?

Existing materials
FEMA has generated numerous training seminars and workshops for many documents related to seismic evaluation and rehabilitation. There is also a lot of other material developed by other organizations (e.g. ATC, EERI) that could be very applicable. How can these be assembled, adapted, and maintained for future use?

Existing training programs
FEMA, EERI, ASCE, SEAOC and other organizations have ongoing workshops and seminars. How can these programs help?

New technologies
Web-based seminars, DVD's, and other new technologies are now being used extensively for training purposes. How can these be brought to bear?

Category:	No.:	Issue name:
R-PP/P	G009	**Standards Update Process**

Issue statement:
How can current standards best be updated to reflect new information that improves the technical accuracy and application of provisions?

Discussion:
ASCE and others normally update standards on a multi-year cycle. Supplements may be issued out of cycle. Are models used for the *NEHRP Provisions* and *ASCE 7* for new construction applicable to evaluation and rehabilitation standards? Do other models make better sense given the significant regional differences in earthquake hazard, professional practice and the existing building stock?

Category:	No.:	Issue name:
P	G010	**Accessibility of Information**

Issue statement:
What can be done to make rehabilitation resources more readily accessible and to assist practitioners in choosing the best resources for their particular needs?

Discussion:

Category:	No.:	Issue name:
P/T	G011	**Role of Technical Journals**

Issue statement:
What part do journals play in accelerating transfer of new information?

Discussion:
EERI, ASCE, and other organizations sponsor peer-reviewed publications of relevant technical data. For example, Spectra, the EERI journal, makes provision for "technical notes" that are papers directed toward practical application. What role can these credible processes play?

Category:	No.:	Issue name:
R-PP/P	G012, G055	**Typical Costs for Seismic Rehabilitation**

Issue statement:
In contrast with new construction, cost estimation for rehabilitation projects is highly variable, depends on a lot of factors, and is expensive to develop (requires a study, preliminary scheme, and estimate). How can cost estimating procedures and information be improved?

Discussion:
The FEMA typical seismic rehabilitation cost data set has been purged and statistically improved over the last 15 years, yet leaves much to be desired in terms of accuracy. The task is to devise an affordable means to collect improved data, organize the data in a manner that is useful to the various users, and disseminate new information.

Category:	No.:	Issue name:
P	G013	**New Design vs. Rehabilitation Design**

Issue statement:
What are the differences between the design process for new construction and the design of seismic rehabilitation of existing buildings?

Discussion:
Should the process of rehabilitation simplify as the problem approaches new construction?

Category:	No.:	Issue name:
P	G014	**Evaluation Process vs. Design Process**

Issue statement:
What are the most important distinctions between the evaluation and design processes that should be reflected in the standards?

Discussion:

Category:	No.:	Issue name:
P/T	G015	**Development of Simplified Procedures**

Issue statement:
Can and should simplified procedures be developed that address unique properties associated with some model building types?

Discussion:
Many engineers are concerned that existing standards are too complicated for very simple and/or smaller buildings. Current guidance for these cases may result in unnecessarily complex analysis and costly rehabilitation.

<table>
<tr><td><u>Category:</u>
R-PP/P</td><td><u>No.:</u>
G016</td><td><u>Issue name:</u>
Incremental Seismic Rehabilitation</td></tr>
<tr><td colspan="3"><u>Issue statement:</u>
How can incremental steps in a mitigation program be more widely embraced and incorporated into policy to facilitate a reduction in anticipated future losses?</td></tr>
<tr><td colspan="3"><u>Discussion:</u>
Over time, small increments of rehabilitation can have a significant effect on the overall vulnerability of a large population of highly vulnerable structures. Incremental approaches to addressing a population of vulnerable buildings are presently impeded by a lack of readily available technical guidelines and acceptance by building officials. Can the dissemination of existing materials on this subject stimulate the use of this process in reducing community vulnerability?

The incremental approach to seismic rehabilitation contained in the current FEMA publications is not based on performance-based design (PBD) because this concept did not exist when incremental rehabilitation was first developed. Existing PDB approaches should be reviewed for applicability to incremental seismic rehabilitation, and documentation should be prepared to facilitate their use.

FEMA should develop and implement a dissemination plan that is linked to the current curriculum being developed by FEMA on incremental seismic rehabiliation.</td></tr>
</table>

<table>
<tr><td><u>Category:</u>
R-PP/P</td><td><u>No.:</u>
G017</td><td><u>Issue name:</u>
Example Applications</td></tr>
<tr><td colspan="3"><u>Issue statement:</u>
Can more widespread availability of example applications on actual projects be used to illustrate successes, increase use of the methodology, and identify shortcomings in mitigation?</td></tr>
<tr><td colspan="3"><u>Discussion:</u></td></tr>
</table>

<table>
<tr><td><u>Category:</u>
P/T</td><td><u>No.:</u>
G018,
G072</td><td><u>Issue name:</u>
Consistency Between Resource Documents</td></tr>
<tr><td colspan="3"><u>Issue statement:</u>
How should currently available evaluation and rehabilitation resource documents be coordinated to provide consistent results?</td></tr>
<tr><td colspan="3"><u>Discussion:</u></td></tr>
</table>

<table>
<tr><td><u>Category:</u>
R-PP/P/T</td><td><u>No.:</u>
G019</td><td><u>Issue name:</u>
Consideration of Uncertainty</td></tr>
<tr><td colspan="3"><u>Issue statement:</u>
There is a need to better incorporate the level of uncertainty that is present in identifying seismic hazard and assessing structural performance.</td></tr>
<tr><td colspan="3"><u>Discussion:</u></td></tr>
</table>

Category:	No.:	Issue name:
P/T	G020	**Improvement of Foundation Design**

Issue statement:
How can foundation design procedures be improved?

Discussion:
Foundation demands predicted from currently used linear and nonlinear analyses procedures frequently exceed capacity values conventionally assigned to soils systems, yet few failures have been observed to occur in real buildings. How can foundation design be modified to more accurately reflect these performance observations?

Category:	No.:	Issue name:
P/T	G021	**Nonstructural Components**

Issue statement:
How should evaluation and rehabilitation of nonstructural components and systems be addressed?

Discussion:

Category:	No.:	Issue name:
P	G022	**Development of Peer Review Guidelines and Standards**

Issue statement:

Discussion:
Guidelines and standards for peer review of seismic rehabilitation designs will help to define the role of the engineer of record and that of the reviewer. It will establish a basis for reasonable expectations for all parties involved regarding the level of involvement of the reviewer and important issues that need to considered.

Category:	No.:	Issue name:
P	G023	**Mandate of Peer Review for Seismic Rehabilitation**

Issue statement:

Discussion:
Mandating Peer Review of Seismic Rehabilitation, especially in low to moderate seismic regions, could have the effect of improving the quality of the design and the expected performance of buildings.

Category:	No.:	Issue name:
P	G024	**Conservative Bias of ASCE 41**

Issue statement:
Some practitioners feel that there is bias present in ASCE 41 technical criteria that is conservative relative to codes for new construction.

Discussion:
The evolution of this document from FEMA 273 to FEMA 356 to ASCE 41 has shown a steady progression to reducing the inherent conservatism of this design approach. The latest example is in the upcoming release of Supplement 1 addressing unnecessary conservatism. The use of mandatory language in ASCE 41 makes this issue more pressing.

Category: P/T	**No.:** G025	**Issue name:** **Material and Component Test Data**
Issue statement: Additional test data is needed for materials and components present in existing buildings and used in seismic rehabilitation design.		
Discussion: More data on material and component response and damage states are necessary in order to move from a framework of prescriptive into more probabilistic performance assessment and design.		

Category: P/T	**No.:** G026	**Issue name:** **Development of Nonlinear Analysis Modeling Guidelines**
Issue statement: Additional guidance is needed for complicated design, supported by increasingly sophisticated software tools, in order to yield consistent results among different practitioners.		
Discussion:		

Category: P	**No.:** G027	**Issue name:** **Illustrated History and Evolution of Seismic Resources**
Issue statement: A reference tool, such as a diagram that illustrates the broad families of available resource documents, and their evolutionary history, is needed.		
Discussion: There exists a great body of work in the development of documents, guidelines, standards, and codes that pertain to seismic rehabilitation. A reference tool that illustrates the broad families of resource documents and their evolutionary history would be a helpful resource in itself. This tool could also be manifested in a website that would link a user to all relevant resources.		

Category: T	**No.:** G028	**Issue name:** **FEMA 356 / ASCE 41 – Improve Target Displacement Determination**
Issue statement:		
Discussion: ASCE 41 has shortcomings in determining target displacements and in the identification of capacities of key existing elements to perform to the levels required by these target displacements.		

Category: T	**No.:** G029	**Issue name:** **FEMA 356 / ASCE 41 – Clarify Force Delivery Reduction Factor "J"**
Issue statement: Clarification or a direct solution for the determination of factor will improve the functionality of the standard.		
Discussion: The force delivery reduction factor "J" for force-controlled actions needs to be clarified. It is time consuming to determine the lowest DCR ratio in the entire load path to a single element. However, plan checkers have shown reluctance to the use of default values from section 3.4.2.1.2.		

Category:	No.:	Issue name:
T	G030	**FEMA 356 / ASCE 41 – Simplify m-factor Determination for New Construction**

Issue statement:
Simplification of ASCE 41 m-factor determination for new construction components used in seismic rehabilitation is needed.

Discussion:
Many m-factors are based on the properties of the members itself (such as b/t ratios), which are known quantities when evaluating existing members, but is cumbersome and requires iteration when designing new members.

Category:	No.:	Issue name:
T	G031	**FEMA 356 / ASCE 41 – Reduce Conservatism in Overturning Factor R_{OT}**

Issue statement:
The FEMA 356 / ASCE 41Overturning Factor, R_{OT}, is overly conservative.

Discussion:

Category:	No.:	Issue name:
P/T	G032	**FEMA 356 / ASCE 41 – Simplify Classification of Primary vs. Secondary Components**

Issue statement:
Simplification of the determination of Primary versus Secondary components will improve the clarity and functionality of the standard.

Discussion:
What is trying to be accomplished in ASCE 41 makes sense, but in looking at an actual building, it is very time consuming to determine the stiffness of secondary components and elements to determine if they need to reclassified as primary based on the 25% limit. It seems that this process could be simplified if it is clear that the secondary components and elements will not significantly impact the behavior of the building.

Category:	No.:	Issue name:
P/T	G033	**FEMA 356 / ASCE 41 – Simplify Classification of Force- vs. Deformation-Controlled Elements**

Issue statement:
Simplification of the determination of Force- vs. Deformation-Controlled Elements will improve the clarity and functionality of the standard.

Discussion:
The reasons behind classifying the elements as force-controlled (brittle) vs. deformation-controlled (ductile) makes a lot of sense, but the process of making this classification is not at all practical. Technically, a force-deformation curve for each action of each element must be created in order to make the determination. On some really obvious cases (such as a moment frame beam being ductile) this process can be avoided, but many times engineers are forced to prove that members are going to be deformation-controlled when it seems pretty clear. This process needs to be simplified in order to be practical.

Category:	No.:	Issue name:
P/T	G034	**FEMA 356 / ASCE 41 – Simplify the "Simplified Procedure"**
Issue statement: Further simplification is needed to apply the ASCE 41 "Simplified Procedure" to simple structural systems.		
Discussion: ASCE 41 is complicated, but as a document that attempts to be generally applicable to all situations, it is possibly necessarily so. In areas of low to moderate seismicity the infrequent use of this standard has made it difficult to utilize because of a steep learning curve. Greater simplification through either prescriptive models or emphasis on load-path alone (tying building elements together) would be helpful.		

Category:	No.:	Issue name:
R-PP	G035	**Seed or Grant Money for Seismic Strengthening**
Issue statement: Public monies in support of seismic strengthening efforts are needed to provide building owners with greater incentive to implement seismic rehabilitation.		
Discussion:		

Category:	No.:	Issue name:
P	G036	**Development of Business Continuity Planning Guidelines**
Issue statement: Guidelines that foster a consistent basis for business continuity planning and cost/benefit analysis are needed.		
Discussion: Seismic rehabilitation strategies built around business continuity planning considering cost/benefit analysis has been a proven rationale for implementing seismic rehabilitation.		

Category:	No.:	Issue name:
P	G037	**Validation of the Value of Advanced Analysis in Saving Construction Costs**
Issue statement: For cases where advanced analyses are used to perform rehabilitation designs, validation of the trade-off between additional engineering costs and savings in construction costs is needed.		
Discussion: Many design professionals feel that more sophisticated designs, greater effort, and additional time and expense invested in the design phase will save far more money in construction costs. A study that evaluates this premise would be beneficial in validating this perspective, and would help identify the magnitude of potential returns.		

Category:	No.:	Issue name:
P/T	G038	**Development of Design Guidance for Heavy Industrial Facilities in the Northeastern United States**

Issue statement:
Improved design guidance is needed for heavy industrial buildings that are common to the northeastern United States.

Discussion:
Many buildings once used for industry in the northeastern United States are being adapted for new uses as housing and retail occupancies. These buildings, many built before the turn of the century, are unreinforced masonry with heavy timber truss construction. Specific design guidance for this type of construction is needed.

Category:	No.:	Issue name:
P	G039	**Education of Building Owners and Users on Seismic Risk**

Issue statement:
Education of building owners and users on the inherent seismic risks associated with existing buildings will foster intelligent decision making when considering the value of seismic rehabilitation.

Discussion:

Category:	No.:	Issue name:
P/T	G040	**FEMA 356 / ASCE 41 – Further Development of Nonstructural Component Requirements**

Issue statement:
Improvement of ASCE 41 requirements for nonstructural components is needed to bring them more in-line with the requirements for new construction.

Discussion:
Major losses are associated with non-structural components, particularly when evaluated on a probabilistic basis. In low to moderate seismic regions this may represent the best value solution in an incremental strengthening approach. Particular attention should be paid to industrial components like shelving and piping.

Category:	No.:	Issue name:
P/T	G041	**Improved Global Damage Prediction**

Issue statement:
ASCE 41 needs to be modified to better estimate potential damage.

Discussion:
Based on pushover analysis and current acceptance criteria, ASCE 41 may tend to overestimate the amount of damage that will occur versus what is observed after an event. Many buildings have toughness that is not characterized in available standards. Improvements are needed in predicting what will happen in a global sense. Additionally, it is important to link the financial aspects of damage and loss predictions to cost/benefit analyses.

Category:	No.:	Issue name:
P/T	G042	**Correlation between ASCE 31 and ASCE 41**
Issue statement: The evolutionary development of ASCE 31 (for evaluation) and ASCE 41 (for rehabilitation) on separate, but parallel paths has resulted in slight differences in philosophy and technical criteria that need to be reconciled.		
Discussion: Recurring questions include the use of reduced demands in ASCE 31, and differences in acceptance criteria between the two documents that result in an apparent difference in performance objectives.		

Category:	No.:	Issue name:
T	G043	**FEMA 356 / ASCE 41 Foundation Requirements**
Issue statement: ASCE-41 requirements for foundations are more restrictive than the building code for new construction.		
Discussion:		

Category:	No.:	Issue name:
T	G044	**FEMA 356 / ASCE 41 Diaphragm Requirements**
Issue statement: ASCE-41 Requirements for diaphragm are more restrictive than the building code for new construction.		
Discussion:		

Category:	No.:	Issue name:
T	G045	**Development of Guidelines for Soil-Structure Interaction in Nonlinear Static Analyses**
Issue statement: Guidelines for properly accounting for soil-structure interaction effects in nonlinear static analyses are needed		
Discussion: The overturning and foundation requirements, not only in ASCE-41 but also in the building code for new buildings are not well defined. Inclusion of soil springs and nonlinearity of the soil can improve the expected behavior of a structure, but for the most part designers are using static procedures. Soils are highly nonlinear, energy dissipating elements, unless prone to liquefaction. Static forces applied to rigidly supported shear walls require larger foundations than necessary, considering observations in past events in which failures occur due to liquefaction rather than bearing failure. Better static procedures for foundation design are needed.		

Category: P	**No.:** G046	**Issue name:** **FEMA 356 / ASCE 41 – Consideration of Global Ductility**
Issue statement: ASCE 41 evaluation of acceptance criteria strictly at the component level does not adequately account for global ductility that may be present in the structure.		
Discussion: ASCE 41 addresses ductility entirely at the component level, without consideration of global ductility. For example if a single component fails to meet DCR acceptance ratios then by definition the entire system is non-compliant; however, failure of any one component may not impact the overall response of the building system. Transferring component classifications from primary to secondary will not always permit a rational consideration of reasonable behavior. Consideration of statistics on component acceptability might provide a more rational characterization of global performance.		

Category: P	**No.:** G047	**Issue name:** **ASCE 31 and ASCE 41 Standardization Conundrum**
Issue statement: Standardization of ASCE 31 and ASCE 41 from their FEMA source documents (FEMA 310 and FEMA 356, respectively) has resulted in requirements that are difficult or unreasonable to apply in practice.		
Discussion: The standardization of ASCE 31 and ASCE 41 has resulted in implementation problems that reflect unfavorably on the documents. The development of ASCE 41, Supplement 1 is a unique, but positive response to the unrealistic constraints imposed by ASCE 41 acceptance criteria on non-ductile concrete. Mandatory language in the documents has constrained their use with respect to requirements that might not be applicable, have rarely been applied in practice, or are not technically achievable in a given building. A specific example of this is the extent of material testing that is required, even for buildings that have otherwise good documentation of the original design and construction.		

Category: P	**No.:** G048	**Issue name:** **Devolution of ASCE 41 into a Loading Standard**
Issue statement: ASCE 41 would better serve as a loading standard for existing buildings, similar to the role that ASCE 7 plays for new construction.		
Discussion: The devolution of ASCE 41 into loading standard, with material requirements and acceptance criteria provided separately and maintained by the various material-specific codes and standards committee, will bring seismic rehabilitation into better alignment with the approach used for new construction.		

Category: P	**No.:** G049	**Issue name:** **Incorporation of Performance-Based Design in Future Resource Documents**
Issue statement: Future guidelines/codes/standards need to migrate to a performance-based approach.		
Discussion: Future guidelines/codes/standards need to migrate from a capacity/demand (Factor of Safety or LRFD) approach to a performance-based approach considering reliability and risk tolerance.		

Category:	No.:	Issue name:
P	G050	**Improvement in Consistency of Code Enforcement**

Issue statement:
Consistency in the application and enforcement of code and standard requirements needs to be improved

Discussion:

Category:	No.:	Issue name:
P	G051	**Improvement in Software Tools for Assessing ASCE 31 and ASCE 41 Acceptance Criteria**

Issue statement:
Improvements are needed in software tools that can implement the evaluation of ASCE 31 and ASCE 41 acceptance criteria directly within the analysis.

Discussion:

Category:	No.:	Issue name:
R-PP	G052	**Buildings with Multiple Owners/Condominiums**

Issue statement:
How can seismic risk be managed in situations where buildings are controlled by multiple owners, such as in the case of condominiums?

Discussion:
Seismic rehabilitation may require work in areas of a building that are owned (or shared) by others. Such work will improve the performance and value of the building as a whole, and hence benefit the all owners. What are the responsibilities of each owner to act responsibly with regard to seismic safety issues, and what legal covenants may be needed to facilitate cooperative actions between multiple owners of a building?

Category:	No.:	Issue name:
R-PP/T	G053	**Levels of Acceptable Risk**

Issue statement:
What level of risk is acceptable to different stakeholders? How can effective public policy be developed to incorporate the potentially diverse viewpoints of building owners, managers and occupants on this issue?

Discussion:

Category:	No.:	Issue name:
R-PP	G054	**Consideration of Multiple Public Objectives**

Issue statement:
What institutional arrangements or analytical practices might be devised to incorporate seismic safety along with other public objectives, such as: community and regional access to hospital facilities, costs of healthcare, understaffing of hospital facilities.

Discussion:
In order to establish a platform on which seismic safety can be traded off in public policy against other risks, a uniform cost/benefit analysis must be applied to all risks. Both the Departments of Transportation and Health and Human Services discount the value of future benefits, including reduced deaths and injuries. The CDC uses a 3% discount rate for future injuries and deaths.
With whom, and to what extent, might seismic safety be traded off in public policy against other legitimate and perhaps more urgent and life-threatening risks, given that resources are always scarce?

Category:	No.:	Issue name:
R-PP/P	G012, G055	**Typical Costs for Seismic Rehabilitation**

Issue statement:
In contrast with new construction, cost estimation for rehabilitation projects is highly variable, depends on a lot of factors, and is expensive to develop (requires a study, preliminary scheme, and estimate). How can cost estimating procedures and information be improved?

Discussion:
The FEMA typical seismic rehabilitation cost data set has been purged and statistically improved over the last 15 years, yet leaves much to be desired in terms of accuracy. The task is to devise an affordable means to collect improved data, organize the data in a manner that is useful to the various users, and disseminate new information.

Category:	No.:	Issue name:
R-PP	G056	**Explicit Consideration of Building Adjacencies**

Issue statement:
Should detailed guidelines for the assessment of pounding of adjacent buildings be developed and incorporated into currently available resource documents?

Discussion:
Is it an acceptable policy to have a significant percentage of urban structures poised within pounding distance of other buildings? What obligations do adjacent building owners have to their neighbors?

Category:	No.:	Issue name:
R-PP	G057	**Advocacy to Encourage More Seismic Retrofit**

Issue statement:
What tools would help building officials advocate seismic retrofit to building owners, and encourage them to retrofit their buildings to a greater extent?

Discussion:
It has been noted that there is a lot of negotiation that goes on when determining how much retrofit needs to be done. What negotiation tools have worked to motivate and inspire owners to go forward with retrofits? Would a very short video that could be quickly shown to owners be helpful?

What are some stories of how seismic retrofit ordinances failed? What are some lessons learned from building officials on what's worked and what hasn't?

Category:	No.:	Issue name:
R-PP	G058	**Uniformity in Seismic Retrofit Requirements**
Issue statement: Jurisdictions vary widely on what is required as far as seismic retrofit is concerned. Some have gone with Chapter 34 of the IBC, some with the IEBC, some have replaced Chapter 34 of the IBC with their own provisions, and some have created their own ordinances. Would it be beneficial to the design community if some uniformity can be achieved?		
Discussion: Are seismic retrofit issues so unique to each jurisdiction that there is no way around these multiple, unique approaches?		

Category:	No.:	Issue name:
R-PP	G059, G079	**Public Incentives for Seismic Rehabilitation**
Issue statement: More attention needs to be spent identifying financing mechanisms for rehabilitation—essentially developing public incentives for property owners. Such incentive options might include tax incentives, low interest loans, phased implementation, and a statewide pooled bond financing program. Information on the effectiveness of the various incentives being used by local jurisdictions should be collected and analyzed. New practical incentives should be developed and disseminated to potential users.		
Discussion:		

Category:	No.:	Issue name:
R-PP	G060, G079	**Private Incentives ("change levers") for Seismic Rehabilitation**
Issue statement: More attention needs to be spent identifying financing mechanisms for rehabilitation—essentially developing private incentives for property owners. Such incentive options might include insurance and financing incentives. If lenders and insurers require rehabilitation as a specific option in their due diligence and underwriting activities, owners will take notice. Information on the effectiveness of current due diligence practices should be collected and analyzed. New practices should be developed and disseminated to potential users.		
Discussion: In the case of institutional buildings the "change levers" may be harder to identify because they may vary by state. For healthcare facilities it is the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). If through JCAHO addressed seismic rehabilitation in their standards, healthcare facilities would pay more attention to seismic rehabilitation outside California.		

Category:	No.:	Issue name:
R-PP	G061	**Unfinished Business in the 2005 Strategic Plan**

Issue statement:
There are several projects recommended in the 2005 Strategic Plan (FEMA 315) which have not yet been undertaken. This list should be reviewed, and projects that are still relevant for addressing current challenges should be identified.

Discussion:
For example:
Objective 3: develop new tools, including building case studies (G017); loss data (G036, G041, G064, G065), simplified building rehabilitation (G015, G034, G068), improved analytical tools (G051), repair guidelines, pounding issues (G056), and geology/soils (G020, G043, G045).

Objective 4: set new directions, including incremental/partial rehabilitation (G016), building rating system (G066), building performance data (G041, G046, G064), multihazard mitigation (G004), non-engineered buildings (G067), and building inventory methods.

Category:	No.:	Issue name:
R-PP	G062	**Legal Implications of Seismic Rehabilitation**

Issue statement:
Although tort and case law varies by state, there is a more universal need to address legal principles and concerns (especially liability implications) concerning implementation of risk-reduction policy; engineering practices and standards of care; owner decisions regarding performance objectives and subsequent obligations to tenants, building occupants, and the public; local government code adoption and enforcement; and movement from traditional perspective and specification standards to performance-based engineering designs.

Discussion:

Category:	No.:	Issue name:
R-PP	G063	**Seismic Rehabilitation Materials for College/University Instruction**

Issue statement:
Materials for seismic design courses, or emphasis in existing courses, should be collected, developed, and organized for those who would teach such courses.

Discussion:
Faculty training courses could be offered to increase instructional capabilities. Materials should be aimed at senior or graduate level students, and at practitioners who might be able to attend extension courses for continuing education.

Category:	No.:	Issue name:	Date:	By:
T	G064	**Case Studies to Correlate Seismic Design with Actual Damage**	8/21/07	FEMA 315

Issue statement:
Though a wide array of building damage information is collected following earthquakes, there is a significant need to conduct detailed analyses and performance assessments of both original construction and rehabilitated buildings, in order to test and validate seismic design methods in currently available resource documents.

Discussion:
Within another activity, FEMA is supporting a program of 36 case studies (trial analyses and designs) of federal buildings to compare the results of FEMA 178 building evaluations to FEMA 273 seismic rehabilitation designs.

Category:	No.:	Issue name:
T	G065	**Comprehensive and Systematic Collection of Damage and Loss Data**

Issue statement:
Looking beyond earthquakes, and taking advantage of existing information systems and data sources, there is a need to build a comprehensive national disaster loss information system.

Discussion:
With such a system, FEMA, other agencies and organizations, practitioners and researchers, and others could understand loss relationships, define cost-effective mitigation techniques, and support policy and program decision making. The Existing Buildings Program would be only one component of this major but necessary undertaking, and coordination would be required with efforts in other programs. A necessary element of this system would be development of standard data collection guidelines, protocols, and research methods to provide sets of consistent and comparable data over time to support improved analyses. This task suggests that there also be greater collaboration between the practicing and research engineers so that the results are more directly applicable.

Category:	No.:	Issue name:
R-PP	G066	**Development of a Uniformly Acceptable Standard Building Performance Rating System**

Issue statement:
There is a need to extend currently available building evaluation methods into a uniformly acceptable standard building performance rating system that is useful to more stakeholders for decision making.

Discussion:
Such a rating system is needed to better portray relative risk, help set rehabilitation priorities, and provide consistent results nationwide. This system would combine engineering concepts of building performance with site conditions, occupancy, and other information to provide comparable results for understanding relative risk, deciding appropriate rehabilitation priorities and measures, establishing more accurate risk-based insurance rates, and assisting the financial community in making rehabilitation investment decisions.

Category:	No.:	Issue name:
R-PP/P	G067	**Development of Seismic Rehabilitation Guidelines For Non-Engineered Buildings**

Issue statement:
The vast majority of smaller and simpler buildings in the United States have been designed and built without the involvement of design professionals. Collectively, these represent that largest pool of candidate buildings for seismic rehabilitation. Because of the complexities of rehabilitation, however, there is a need to provide design professionals and other users with guidance on cost-effectively rehabilitating these smaller and simpler buildings. There is substantial experience that could be used to prepare such guidelines.

Discussion:

Category:	No.:	Issue name:
R-PP/P	G068	**Development of Prescriptive Procedures**
Issue statement: Should prescriptive procedures be developed for certain model building types that are prevalent in high exposure regions of the country?		
Discussion: One possibility would include defining a prototypical "acceptable" structure of this kind and describing its minimally acceptable characteristics.		

Category:	No.:	Issue name:
R-PP	G069	**Vacant Buildings**
Issue statement:		
Discussion: Do vacant buildings pose a unique problem when it comes to seismic rehabilitation? Are vacant buildings a result of too restrictive seismic retrofit requirements? If a vacant building is reoccupied with the same use, should seismic retrofit be a mandatory consideration?		

Category:	No.:	Issue name:
R-PP/P	G070	**Identification of Plan Review Requirements**
Issue statement:		
Discussion: What kind of a plan review should a seismic retrofit be subjected to? Is special knowledge and expertise beyond that of a jurisdictional plan checker required? Do plan reviewers have access to the training necessary to review plans for a seismic retrofit project?		

Category:	No.:	Issue name:
R-PP/T	G071	**Integration of Risk Analysis Methods**
Issue statement: How can risk analysis methods (assessment of deaths/dollars/downtime) be integrated into the seismic rehabilitation process?		
Discussion: If such a methodology is to be widely used and accepted by both proponents and opponents of seismic rehabilitation, it must be based on sound economic principles and include the discounting of future costs and benefits. If a zero discount rate is proposed for future benefits, as done in the recent NIBS report to Congress, then a sensitivity analysis should be provided for alternative rates, and the scope of the related ideological debate be presented. Owner/occupant costs (logistics, diminished capacity during retrofit, etc.) should be incorporated, and improved means for assigning economic life of existing structures, based on configuration and use, should be devised.		

Category:	No.:	Issue name:
P/T	G018, G072	**Consistency Between Resource Documents**
Issue statement: How should currently available evaluation and rehabilitation resource documents be coordinated to provide consistent results?		
Discussion:		

Category:	No.:	Issue name:
P/T	G073	**Selection and Scaling of Ground Motions**

Issue statement:
What are appropriate methods for selection and scaling of ground motions for seismic evaluation and rehabilitation?

Discussion:

Category:	No.:	Issue name:
R-PP/P/T	G074	**Evaluation and Rating Process for New Technical Information**

Issue statement:
Should there be an agency or process for review of technical proposals for the incorporation of new information in current resource documents?

Discussion:
A process could be established whereby appropriately qualified experts could review technical materials (e.g. acceptability criteria for specific building components) submitted by engineers or others and make recommendations with respect to the use of the material in conjunction with a standard. Similar processes are used for fire resistance and product-specific design information. The review process might be partially funded by applicants for project-specific or product-specific materials. This could encourage innovative designs, improved procedures, and more realistic acceptability criteria.

Category:	No.:	Issue name:
P/T	G075	**Improvement of Advanced Structural Analysis Procedures**

Issue statement:
What are the most important needs for improving nonlinear analysis procedures?

Discussion:
Current linear procedures are particularly problematic and prone to invalid and expensive results. More sophisticated nonlinear analysis procedures (e.g. nonlinear static) are known to have significant limitations (e.g. degrading strength, multiple degree of freedom effects). Guidance on nonlinear dynamic procedures is currently very sparse. What can be done to facilitate more accurate evaluation and less costly rehabilitation measures? How can we verify component models

Category:	No.:	Issue name:
P/T	G076	**Soil Structure Interaction**

Issue statement:
What aspects of soil-structure interaction require further research and development?

Discussion:
Current use of fixed-base models and free field ground motions significantly over-predicts demand, leading to very conservative estimates of the ability of existing and rehabilitated buildings to resist earthquakes. What aspects of soil structure interaction should be researched to more reasonably predict structural demands, and how should this material be used to update technical guidelines?

Category: P/T	**No.:** G077	**Issue name:** **Improvement of Seismic Assessments of Existing Buildings**
Issue statement: What is required to significantly improve seismic assessments so that results are more reliable and more consistent among evaluators?		
Discussion:		

Category: P/T	**No.:** G078	**Issue name:** **"Over-Conservatism" of ASCE 41**
Issue statement: Some design professionals have concluded that ASCE 41 and its supporting documentation are overly conservative and tend to increase the cost of seismic rehabilitation. This could be discouraging rehabilitation efforts by otherwise interested building owners.		
Discussion: The tasks are: a) to identify the specific engineering approaches that lead to this over-conservatism; b) cull the available research results for possible solutions and make them available to design professionals; c) describe and disseminate additional research that is required to provide solutions to the remaining problem areas; and d) compare the cost of current approaches with the new solutions.		

Category: R-PP	**No.:** G079, G059, G060	**Issue name:** **Incentives for Seismic Rehabilitation**
Issue statement: Public Incentives: More attention needs to be spent identifying financing mechanisms for rehabilitation—essentially developing public incentives for property owners. Such incentive options might include tax incentives, low interest loans, phased implementation, and a statewide pooled bond financing program. Information on the effectiveness of the various incentives being used by local jurisdictions should be collected and analyzed. New practical incentives should be developed and disseminated to potential users. Private Incentives ("change levers"): More attention needs to be spent identifying financing mechanisms for rehabilitation—essentially developing private incentives for property owners. Such incentive options might include insurance and financing incentives. If lenders and insurers require rehabilitation as a specific option in their due diligence and underwriting activities, owners will take notice. Information on the effectiveness of current due diligence practices should be collected and analyzed. New practices should be developed and disseminated to potential users.		
Discussion: In the case of institutional buildings the "change levers" may be harder to identify because they may vary by state. For healthcare facilities it is the Joint Commission on Accreditation of Healthcare Organizations (JCAHO). If through JCAHO addressed seismic rehabilitation in their standards, healthcare facilities would pay more attention to seismic rehabilitation outside California		

Category:	No.:	Issue name:
R-PP/T	G080	**Development of a Realistic and Valid Methodology for Cost/Benefit Analysis**

Issue statement:
There is a need to develop a cost/benefit analysis methodology based on sound economic principles, including the discounting of future costs and benefits.

Discussion:
If a zero discount rate is proposed for future benefits, as done in the recent NIBS report to Congress, then a sensitivity analysis should be provided for alternative rates, and the scope of the related ideological debate be presented. Owner/occupant costs (logistics, diminished capacity during retrofit, etc.) should be incorporated, and improved means for assigning economic life of existing structures, based on configuration and use, should be devised.

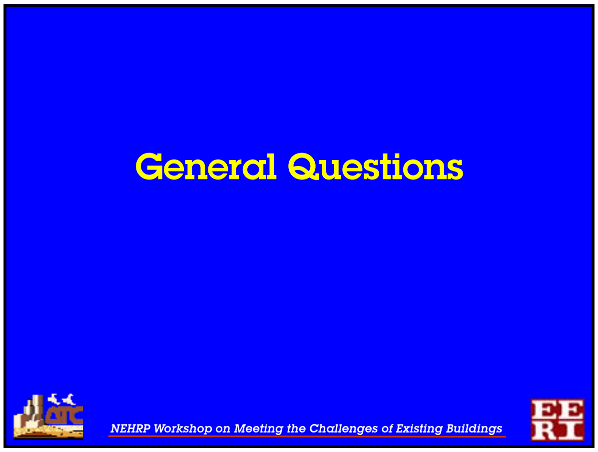
Category:	No.:	Issue name:
R-PP	G081	**Integration with the Green Building Movement**

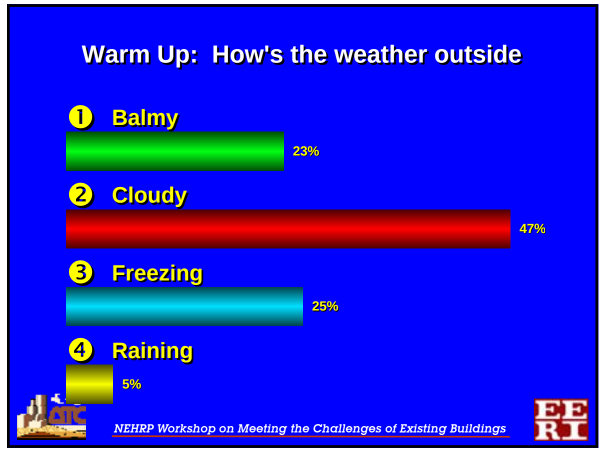
Issue statement:
There may be an opportunity to incorporate seismic rehabilitation objectives in the current increased momentum for green and sustainable building practices.

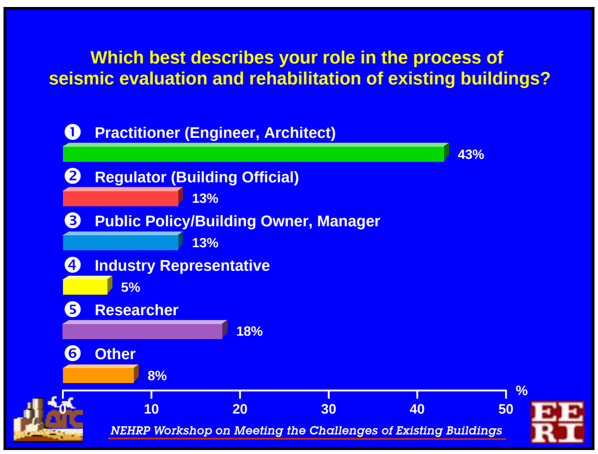
Discussion:
It seems self-evident to the earthquake community that earthquake safety is an issue of sustainability, and buildings that adopt greener practices should address this issue as well. However, currently earthquake safety is not integrated in the green building movement. As this movement gains momentum, it might be appropriate for the earthquake engineering community to argue that earthquake resistant design features contribute to a building's sustainability. A first step might be adding earthquake resistant design features to the LEED certification checklist.

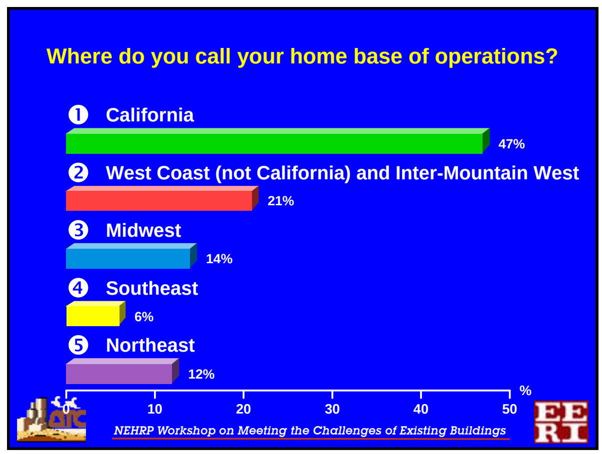
Appendix D
Plenary Ballot Results

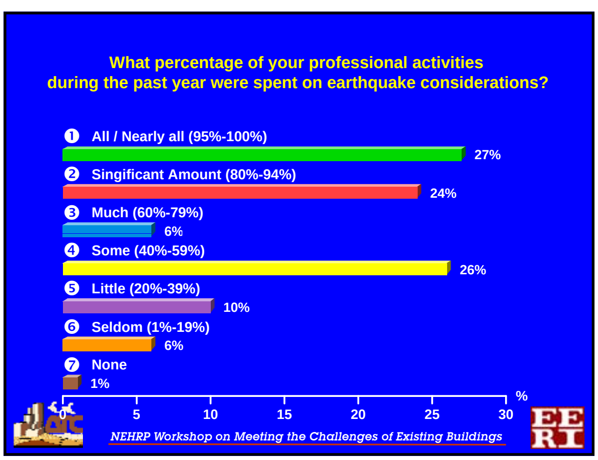
Selected technical, practical, and regulatory/public policy issues identified in pre-workshop activities were reformatted into questions and balloted in a plenary session at the end of Day 1. Pre-workshop issues related to research needs that were developed within the context of the other focus areas were included in the ballot. Balloting was conducted with electronic voting devices that permitted instantaneous posting of results. This appendix contains the complete set of ballot questions and plots showing the results of electronic voting.

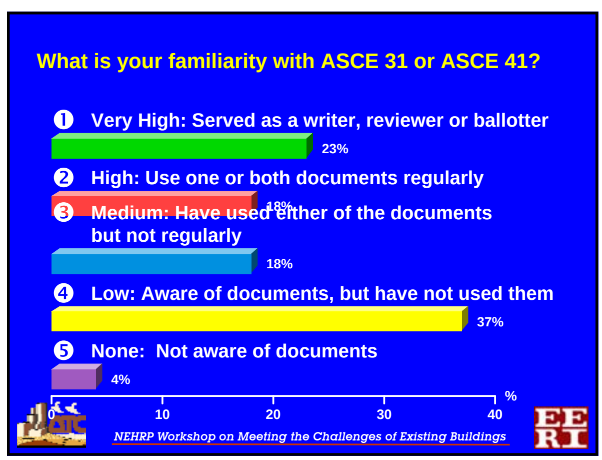

General Questions
NEHRP Workshop on Meeting the Challenges of Existing Buildings

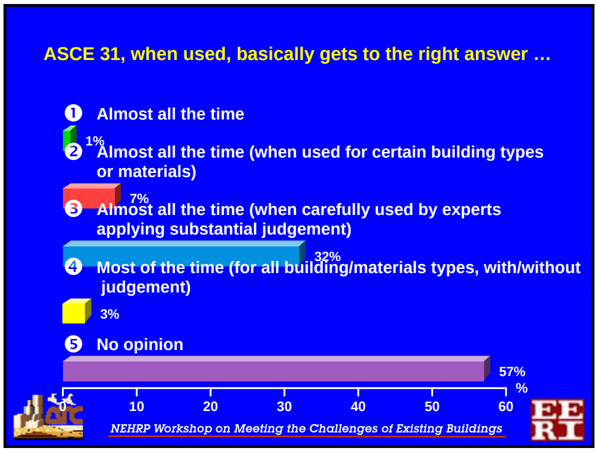

Warm Up: How's the weather outside
1 Balmy
23%
2 Cloudy
47%
3 Freezing
25%
4 Raining
5%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

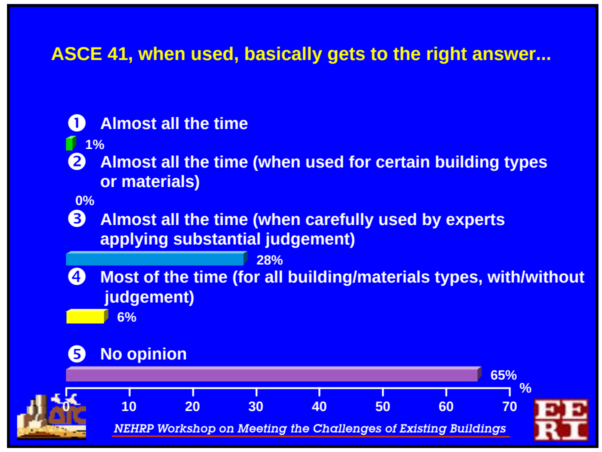

Which best describes your role in the process of
seismic evaluation and rehabilitation of existing buildings?
1 Practitioner (Engineer, Architect)
43%
2 Regulator (Building Official)
13%
3 Public Policy/Building Owner, Manager
13%
4 Industry Representative
5%
5 Researcher
18%
6 Other
8%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

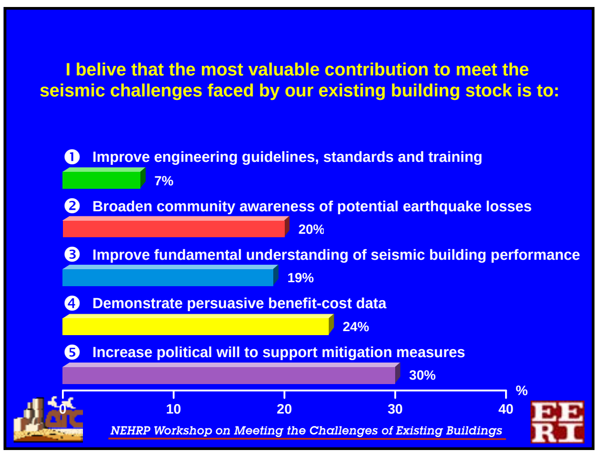

Where do you call your home base of operations?
1 California
47%
2 West Coast (not California) and Inter-Mountain West
21%
3 Midwest
14%
4 Southeast
6%
5 Northeast
12%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

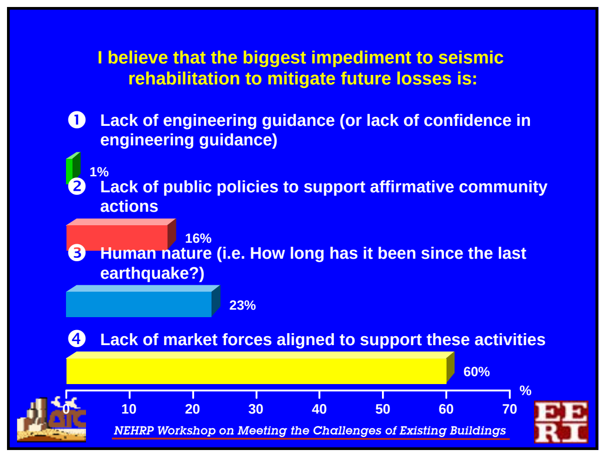

What percentage of your professional activities
during the past year were spent on earthquake considerations?
1 All / Nearly all (95%-100%)
27%
2 Significant Amount (80%-94%)
24%
3 Much (60%-79%)
6%
4 Some (40%-59%)
26%
5 Little (20%-39%)
10%
6 Seldom (1%-19%)
6%
7 None
1%
0 5 10 15 20 25 30 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

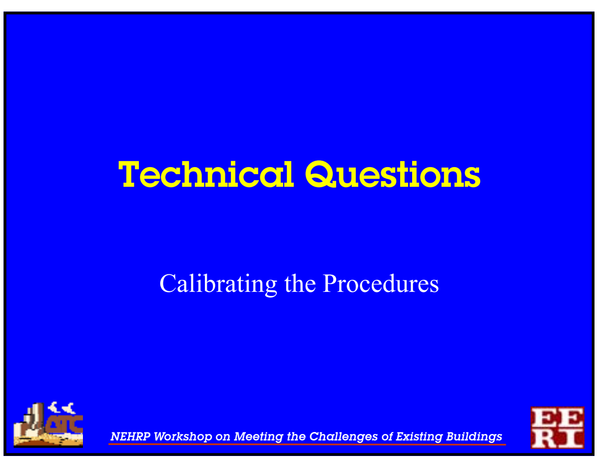

What is your familiarity with ASCE 31 or ASCE 41?
1 Very High: Served as a writer, reviewer or ballotter
23%
2 High: Use one or both documents regularly
3 Medium: Have used either of the documents
but not regularly
18%
4 Low: Aware of documents, but have not used them
37%
5 None: Not aware of documents
4%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

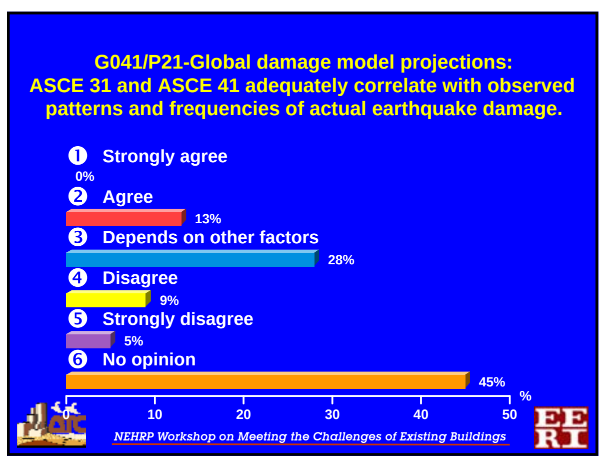

ASCE 31, when used, basically gets to the right answer …
1 Almost all the time
1%
2 Almost all the time (when used for certain building types or materials)
7%
3 Almost all the time (when carefully used by experts applying substantial judgement)
32%
4 Most of the time (for all building/materials types, with/without judgement)
3%
5 No opinion
57%
0 10 20 30 40 50 60 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

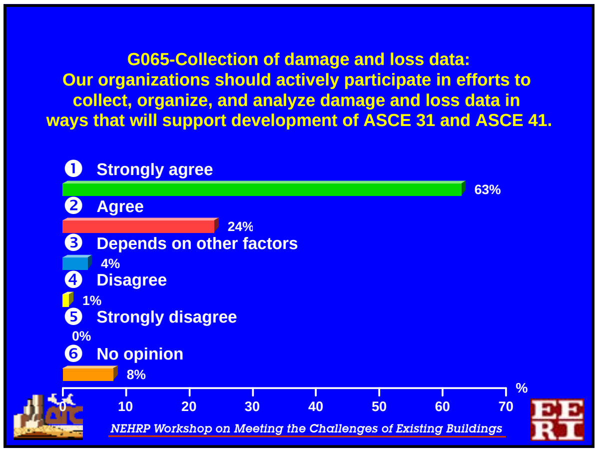

ASCE 41, when used, basically gets to the right answer...
1 Almost all the time
1%
2 Almost all the time (when used for certain building types or materials)
0%
3 Almost all the time (when carefully used by experts applying substantial judgement)
28%
4 Most of the time (for all building/materials types, with/without judgement)
6%
5 No opinion
65%
0 10 20 30 40 50 60 70 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

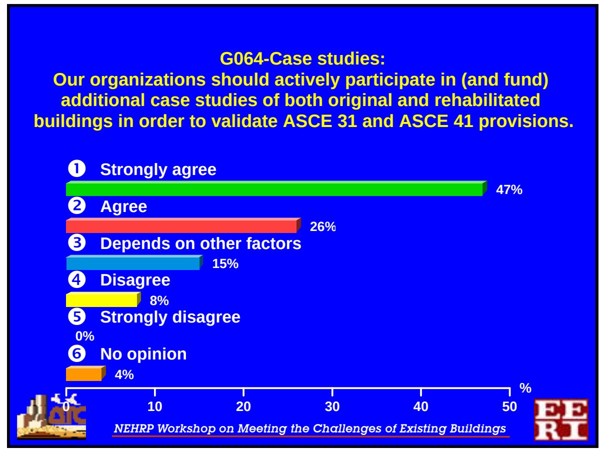

I belive that the most valuable contribution to meet the seismic challenges faced by our existing building stock is to:
1 Improve engineering guidelines, standards and training
7%
2 Broaden community awareness of potential earthquake losses
20%
3 Improve fundamental understanding of seismic building performance
19%
4 Demonstrate persuasive benefit-cost data
24%
5 Increase political will to support mitigation measures
30%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

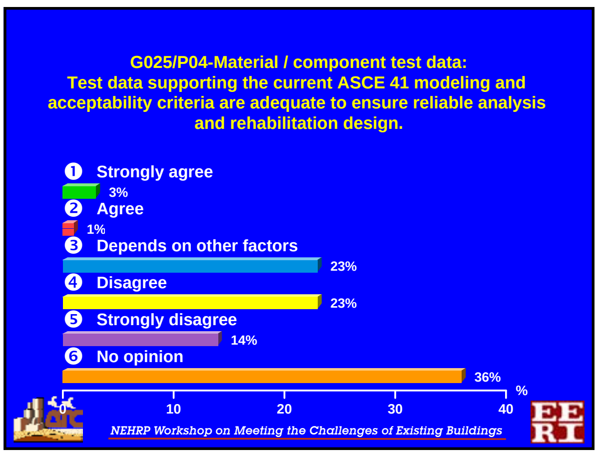

I believe that the biggest impediment to seismic rehabilitation to mitigate future losses is:
1 Lack of engineering guidance (or lack of confidence in engineering guidance)
1%
2 Lack of public policies to support affirmative community actions
16%
3 Human nature (i.e. How long has it been since the last earthquake?)
23%
4 Lack of market forces aligned to support these activities
60%
0 10 20 30 40 50 60 70 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

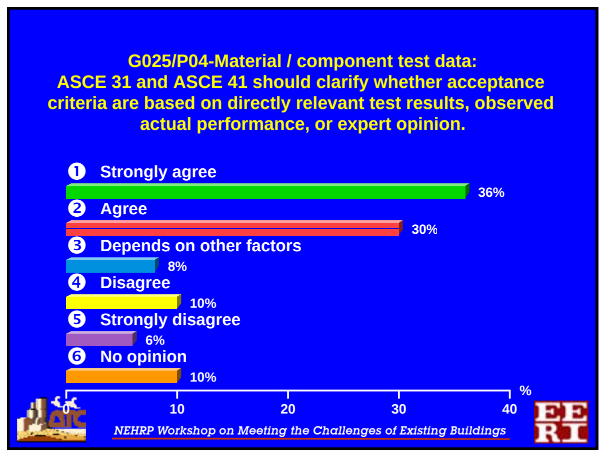

Technical Questions
Calibrating the Procedures
NEHRP Workshop on Meeting the Challenges of Existing Buildings

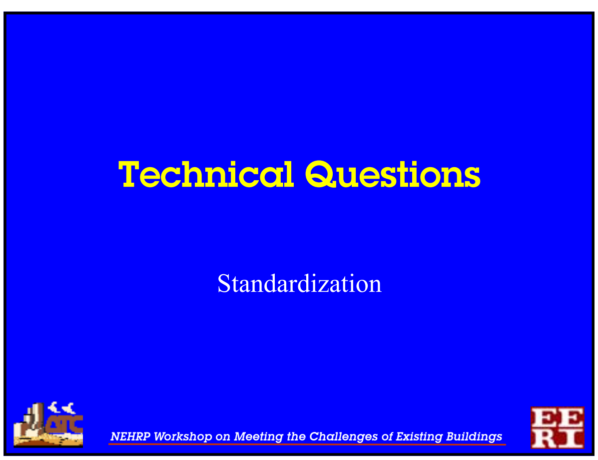

G041/P21-Global damage model projections: ASCE 31 and ASCE 41 adequately correlate with observed patterns and frequencies of actual earthquake damage.
1 Strongly agree
0%
2 Agree
13%
3 Depends on other factors
28%
4 Disagree
9%
5 Strongly disagree
5%
6 No opinion
45%
10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

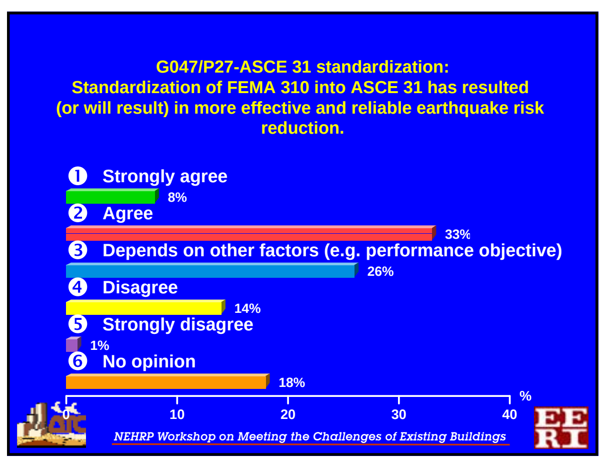

G065-Collection of damage and loss data:
Our organizations should actively participate in efforts to collect, organize, and analyze damage and loss data in ways that will support development of ASCE 31 and ASCE 41.
1 Strongly agree
63%
2 Agree
24%
3 Depends on other factors
4%
4 Disagree
1%
5 Strongly disagree
0%
6 No opinion
8%
0 10 20 30 40 50 60 70 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

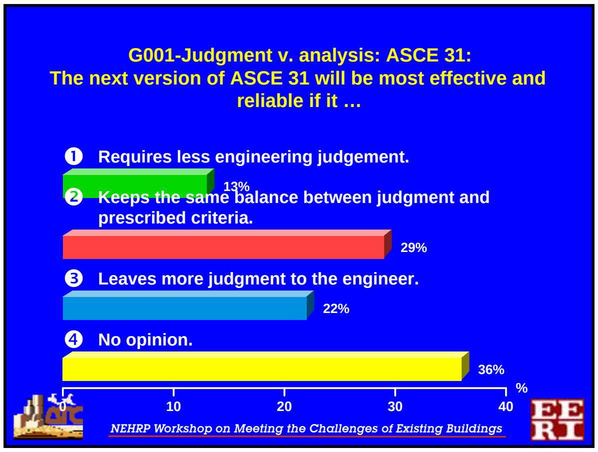

G064-Case studies:
Our organizations should actively participate in (and fund) additional case studies of both original and rehabilitated buildings in order to validate ASCE 31 and ASCE 41 provisions.
1 Strongly agree
47%
2 Agree
26%
3 Depends on other factors
15%
4 Disagree
8%
5 Strongly disagree
0%
6 No opinion
4%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

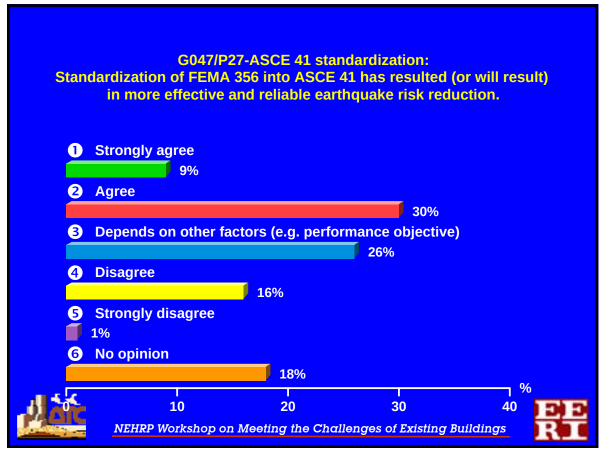

G025/P04-Material / component test data:
Test data supporting the current ASCE 41 modeling and acceptability criteria are adequate to ensure reliable analysis and rehabilitation design.
1 Strongly agree
3%
2 Agree
1%
3 Depends on other factors
23%
4 Disagree
23%
5 Strongly disagree
14%
6 No opinion
36%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

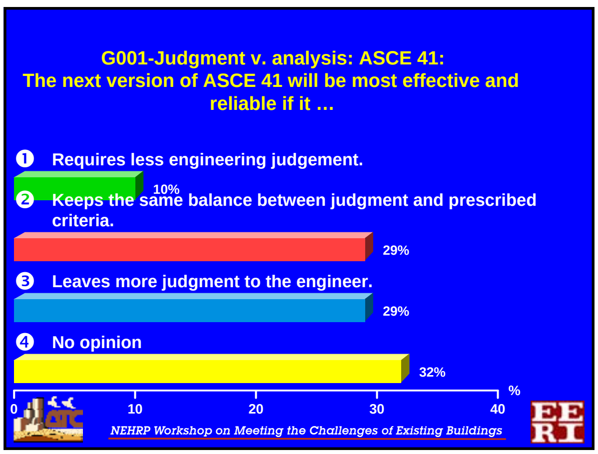

G025/P04-Material / component test data:
ASCE 31 and ASCE 41 should clarify whether acceptance criteria are based on directly relevant test results, observed actual performance, or expert opinion.
1 Strongly agree
36%
2 Agree
30%
3 Depends on other factors
8%
4 Disagree
10%
5 Strongly disagree
6%
6 No opinion
10%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

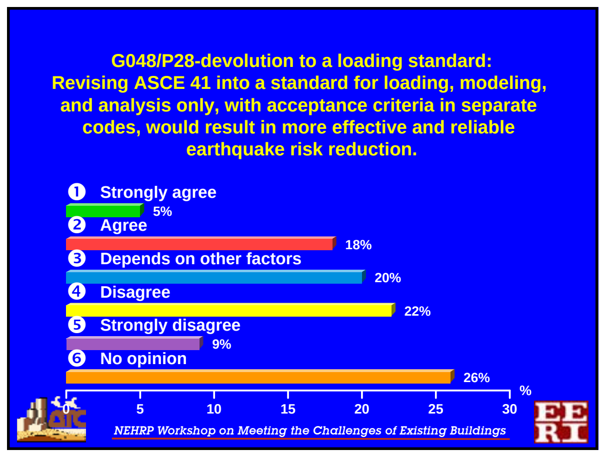

Technical Questions
Standardization
NEHRP Workshop on Meeting the Challenges of Existing Buildings

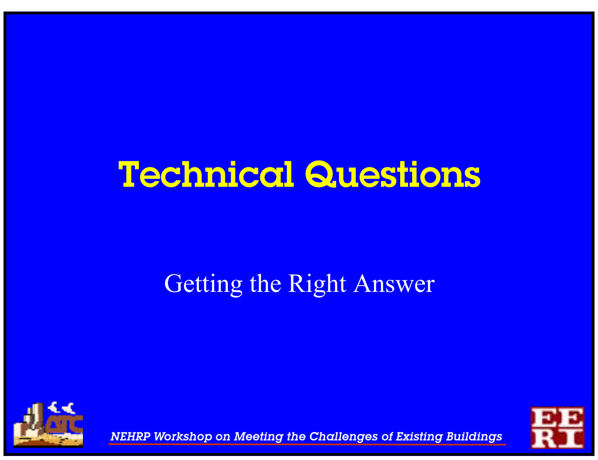

G047/P27-ASCE 31 standardization:
Standardization of FEMA 310 into ASCE 31 has resulted (or will result) in more effective and reliable earthquake risk reduction.
1 Strongly agree
8%
2 Agree
33%
3 Depends on other factors (e.g. performance objective)
26%
4 Disagree
14%
5 Strongly disagree
1%
6 No opinion
18%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

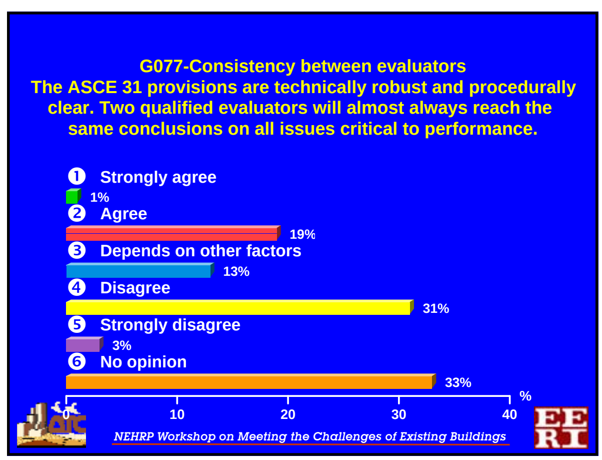

G001-Judgment v. analysis: ASCE 31:
The next version of ASCE 31 will be most effective and reliable if it …
1 Requires less engineering judgement.
13%
2 Keeps the same balance between judgment and prescribed criteria.
29%
3 Leaves more judgment to the engineer.
22%
4 No opinion.
36%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

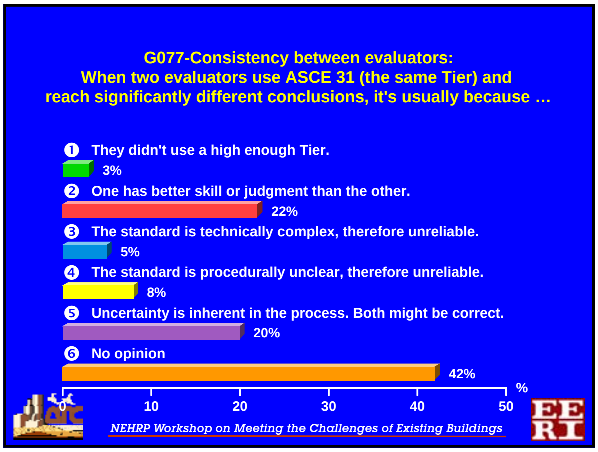

G047/P27-ASCE 41 standardization:
Standardization of FEMA 356 into ASCE 41 has resulted (or will result) in more effective and reliable earthquake risk reduction.
1 Strongly agree
9%
2 Agree
30%
3 Depends on other factors (e.g. performance objective)
26%
4 Disagree
16%
5 Strongly disagree
1%
6 No opinion
18%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

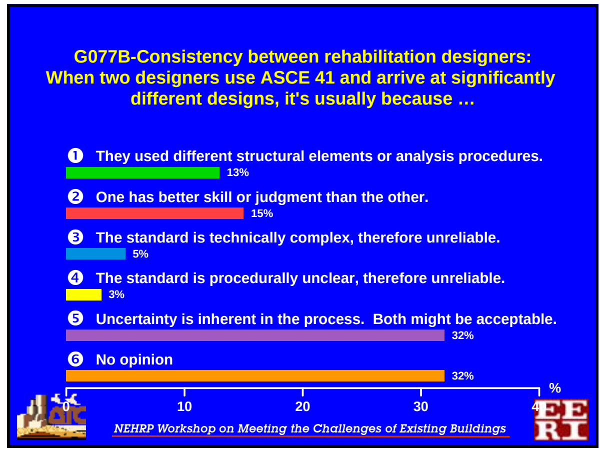

G001-Judgment v. analysis: ASCE 41:
The next version of ASCE 41 will be most effective and reliable if it …
1 Requires less engineering judgement.
10%
2 Keeps the same balance between judgment and prescribed criteria.
29%
3 Leaves more judgment to the engineer.
29%
4 No opinion
32%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

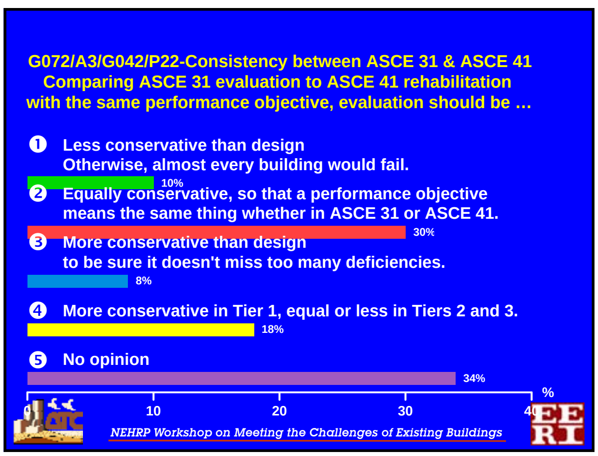

G048/P28-devolution to a loading standard:
Revising ASCE 41 into a standard for loading, modeling, and analysis only, with acceptance criteria in separate codes, would result in more effective and reliable earthquake risk reduction.
1 Strongly agree
5%
2 Agree
18%
3 Depends on other factors
20%
4 Disagree
22%
5 Strongly disagree
9%
6 No opinion
26%
0 5 10 15 20 25 30 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

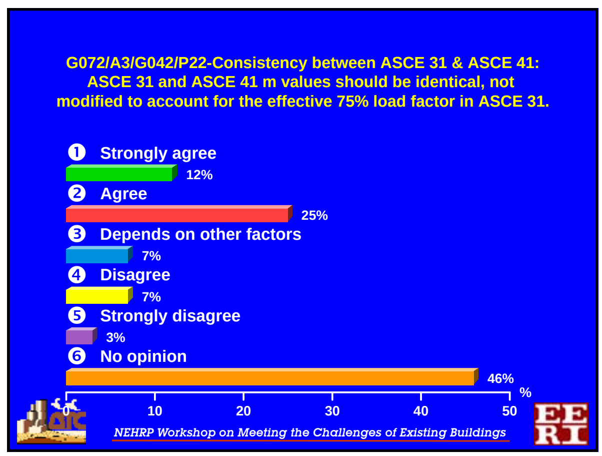

Technical Questions
Getting the Right Answer
NEHRP Workshop on Meeting the Challenges of Existing Buildings

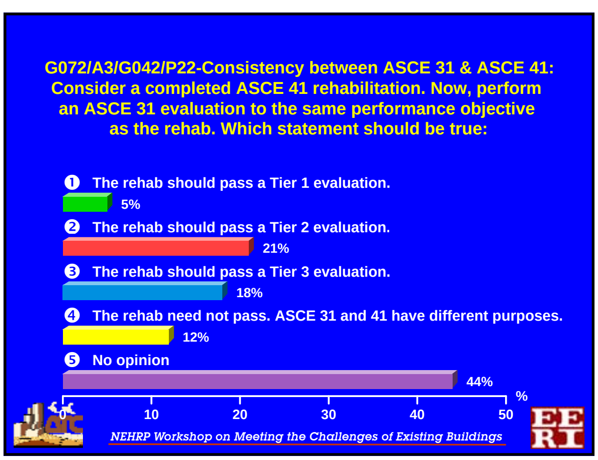

G077-Consistency between evaluators
The ASCE 31 provisions are technically robust and procedurally clear. Two qualified evaluators will almost always reach the same conclusions on all issues critical to performance.
1 Strongly agree
1%
2 Agree
19%
3 Depends on other factors
13%
4 Disagree
31%
5 Strongly disagree
3%
6 No opinion
33%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

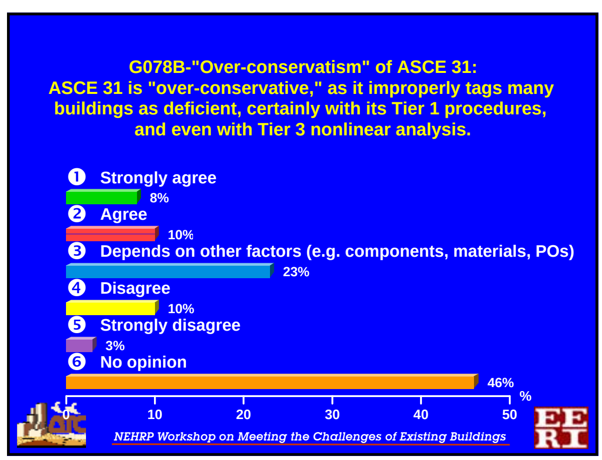

G077-Consistency between evaluators:
When two evaluators use ASCE 31 (the same Tier) and
reach significantly different conclusions, it's usually because …
❶ They didn't use a high enough Tier.
3%
❷ One has better skill or judgment than the other.
22%
❸ The standard is technically complex, therefore unreliable.
5%
❹ The standard is procedurally unclear, therefore unreliable.
8%
❺ Uncertainty is inherent in the process. Both might be correct.
20%
❻ No opinion
42%
%
0 10 20 30 40 50
NEHRP Workshop on Meeting the Challenges of Existing Buildings

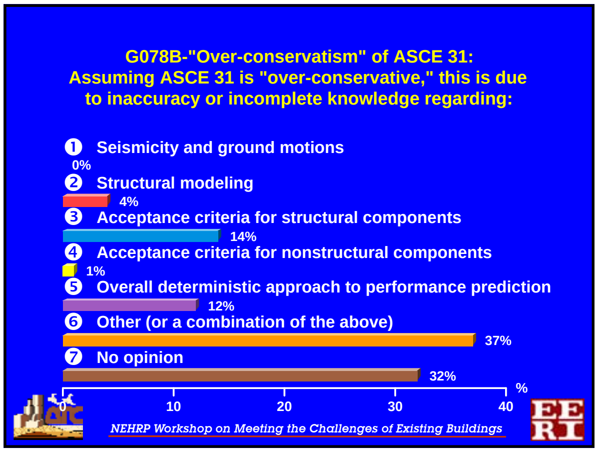

G077B-Consistency between rehabilitation designers:
When two designers use ASCE 41 and arrive at significantly
different designs, it's usually because …
❶ They used different structural elements or analysis procedures.
13%
❷ One has better skill or judgment than the other.
15%
❸ The standard is technically complex, therefore unreliable.
5%
❹ The standard is procedurally unclear, therefore unreliable.
3%
❺ Uncertainty is inherent in the process. Both might be acceptable.
32%
❻ No opinion
32%
%
0 10 20 30 40
NEHRP Workshop on Meeting the Challenges of Existing Buildings

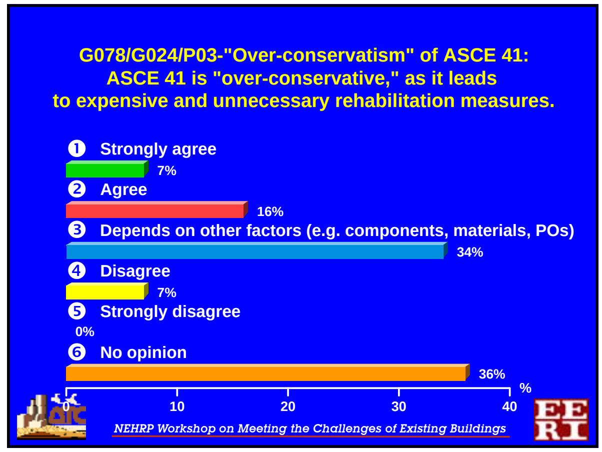

G072/A3/G042/P22-Consistency between ASCE 31 & ASCE 41
Comparing ASCE 31 evaluation to ASCE 41 rehabilitation
with the same performance objective, evaluation should be …
❶ Less conservative than design
Otherwise, almost every building would fail.
10%
❷ Equally conservative, so that a performance objective
means the same thing whether in ASCE 31 or ASCE 41.
30%
❸ More conservative than design
to be sure it doesn't miss too many deficiencies.
8%
❹ More conservative in Tier 1, equal or less in Tiers 2 and 3.
18%
❺ No opinion
34%
%
0 10 20 30 40
NEHRP Workshop on Meeting the Challenges of Existing Buildings

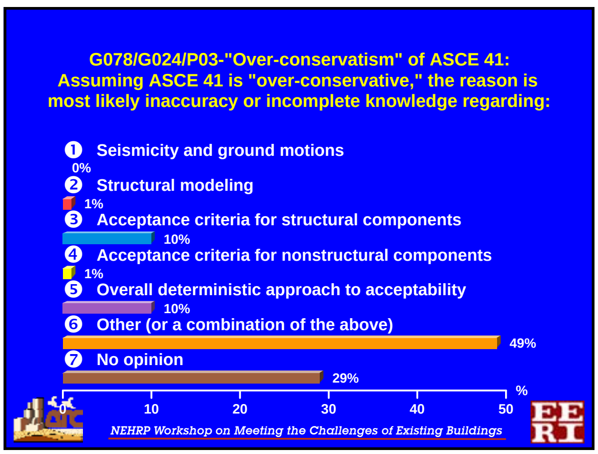

G072/A3/G042/P22-Consistency between ASCE 31 & ASCE 41:
ASCE 31 and ASCE 41 m values should be identical, not
modified to account for the effective 75% load factor in ASCE 31.
❶ Strongly agree
12%
❷ Agree
25%
❸ Depends on other factors
7%
❹ Disagree
7%
❺ Strongly disagree
3%
❻ No opinion
46%
%
0 10 20 30 40 50
NEHRP Workshop on Meeting the Challenges of Existing Buildings

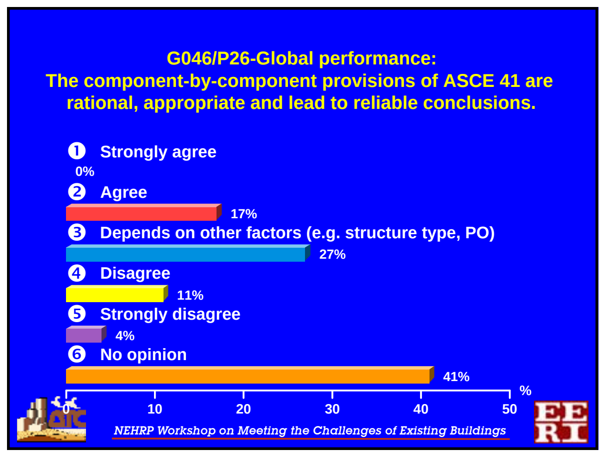

G072/A3/G042/P22-Consistency between ASCE 31 & ASCE 41:
Consider a completed ASCE 41 rehabilitation. Now, perform
an ASCE 31 evaluation to the same performance objective
as the rehab. Which statement should be true:
❶ The rehab should pass a Tier 1 evaluation.
5%
❷ The rehab should pass a Tier 2 evaluation.
21%
❸ The rehab should pass a Tier 3 evaluation.
18%
❹ The rehab need not pass. ASCE 31 and 41 have different purposes.
12%
❺ No opinion
44%
%
0 10 20 30 40 50
NEHRP Workshop on Meeting the Challenges of Existing Buildings

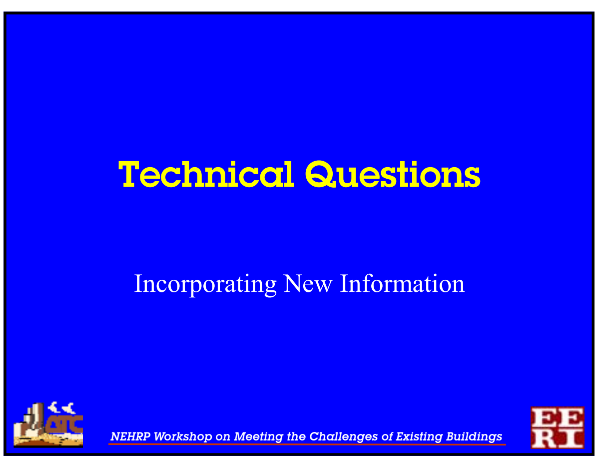

G078B-"Over-conservatism" of ASCE 31:
ASCE 31 is "over-conservative," as it improperly tags many
buildings as deficient, certainly with its Tier 1 procedures,
and even with Tier 3 nonlinear analysis.
❶ Strongly agree
8%
❷ Agree
10%
❸ Depends on other factors (e.g. components, materials, POs)
23%
❹ Disagree
10%
❺ Strongly disagree
3%
❻ No opinion
46%
%
0 10 20 30 40 50
NEHRP Workshop on Meeting the Challenges of Existing Buildings

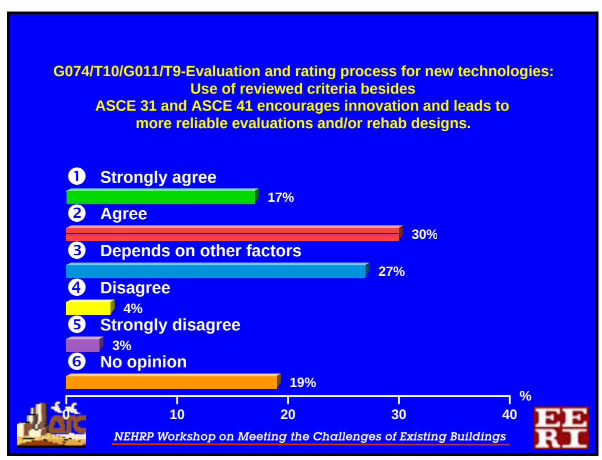

G078B-"Over-conservatism" of ASCE 31:
Assuming ASCE 31 is "over-conservative," this is due
to inaccuracy or incomplete knowledge regarding:
❶ Seismicity and ground motions
0%
❷ Structural modeling
4%
❸ Acceptance criteria for structural components
14%
❹ Acceptance criteria for nonstructural components
1%
❺ Overall deterministic approach to performance prediction
12%
❻ Other (or a combination of the above)
37%
❼ No opinion
32%
0
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

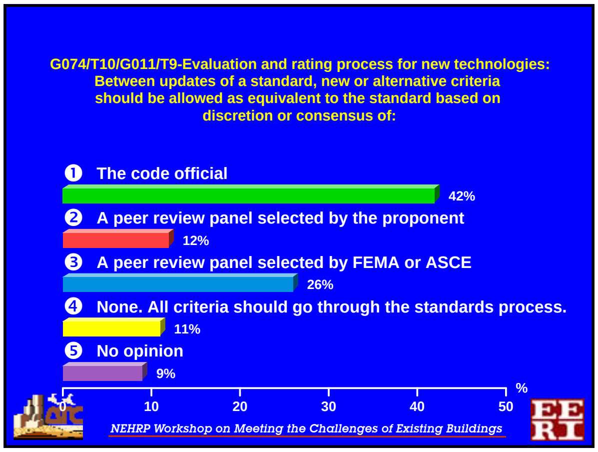

G078/G024/P03-"Over-conservatism" of ASCE 41:
ASCE 41 is "over-conservative," as it leads
to expensive and unnecessary rehabilitation measures.
❶ Strongly agree
7%
❷ Agree
16%
❸ Depends on other factors (e.g. components, materials, POs)
34%
❹ Disagree
7%
❺ Strongly disagree
0%
❻ No opinion
36%
0
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

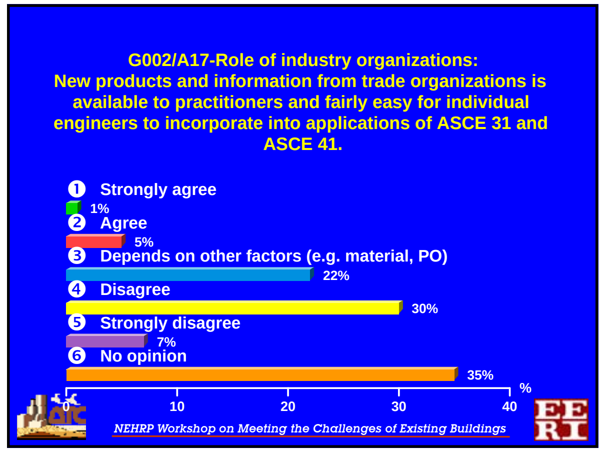

G078/G024/P03-"Over-conservatism" of ASCE 41:
Assuming ASCE 41 is "over-conservative," the reason is
most likely inaccuracy or incomplete knowledge regarding:
❶ Seismicity and ground motions
0%
❷ Structural modeling
1%
❸ Acceptance criteria for structural components
10%
❹ Acceptance criteria for nonstructural components
1%
❺ Overall deterministic approach to acceptability
10%
❻ Other (or a combination of the above)
49%
❼ No opinion
29%
0
10
20
30
40
50
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

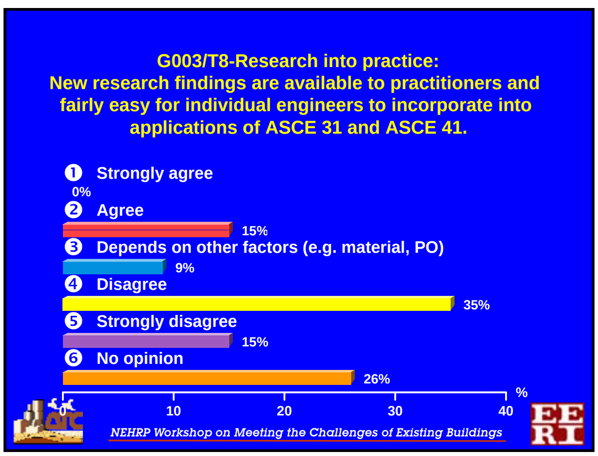

G046/P26-Global performance:
The component-by-component provisions of ASCE 41 are
rational, appropriate and lead to reliable conclusions.
❶ Strongly agree
0%
❷ Agree
17%
❸ Depends on other factors (e.g. structure type, PO)
27%
❹ Disagree
11%
❺ Strongly disagree
4%
❻ No opinion
41%
0
10
20
30
40
50
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

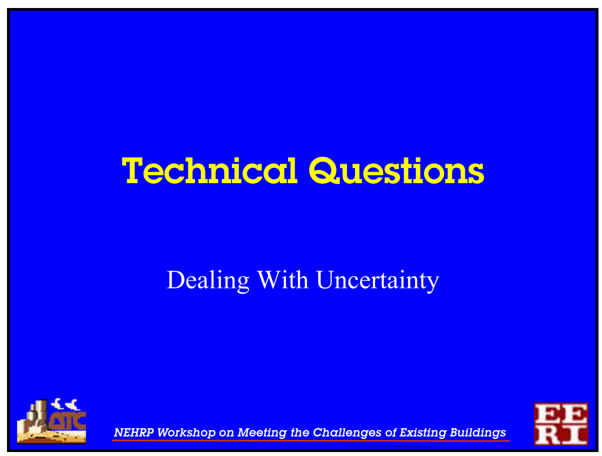

Technical Questions
Incorporating New Information
NEHRP Workshop on Meeting the Challenges of Existing Buildings

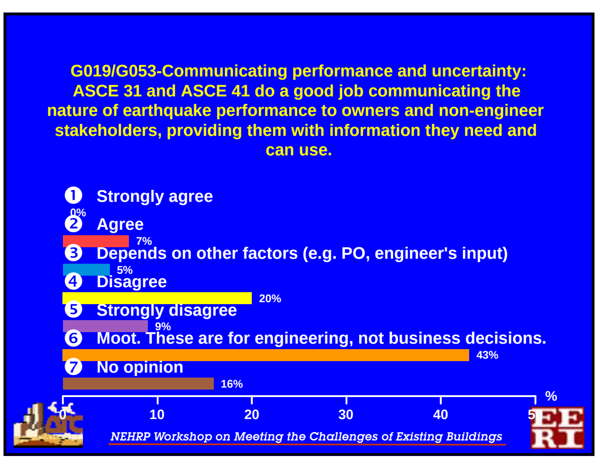

G074/T10/G011/T9-Evaluation and rating process for new technologies:
Use of reviewed criteria besides
ASCE 31 and ASCE 41 encourages innovation and leads to
more reliable evaluations and/or rehab designs.
❶ Strongly agree
17%
❷ Agree
30%
❸ Depends on other factors
27%
❹ Disagree
4%
❺ Strongly disagree
3%
❻ No opinion
19%
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings

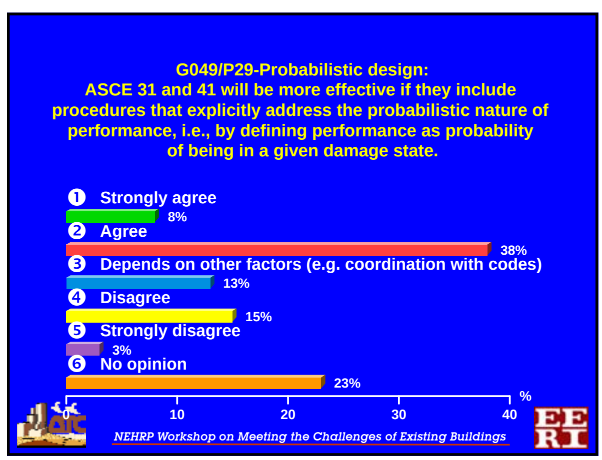

G074/T10/G011/T9-Evaluation and rating process for new technologies:
Between updates of a standard, new or alternative criteria should be allowed as equivalent to the standard based on discretion or consensus of:
1 The code official
42%
2 A peer review panel selected by the proponent
12%
3 A peer review panel selected by FEMA or ASCE
26%
4 None. All criteria should go through the standards process.
11%
5 No opinion
9%
0
10
20
30
40
50
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

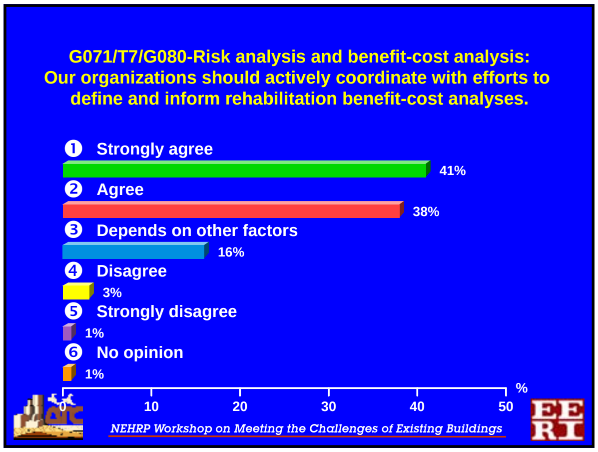

G002/A17-Role of industry organizations:
New products and information from trade organizations is available to practitioners and fairly easy for individual engineers to incorporate into applications of ASCE 31 and ASCE 41.
1 Strongly agree
1%
2 Agree
5%
3 Depends on other factors (e.g. material, PO)
22%
4 Disagree
30%
5 Strongly disagree
7%
6 No opinion
35%
0
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

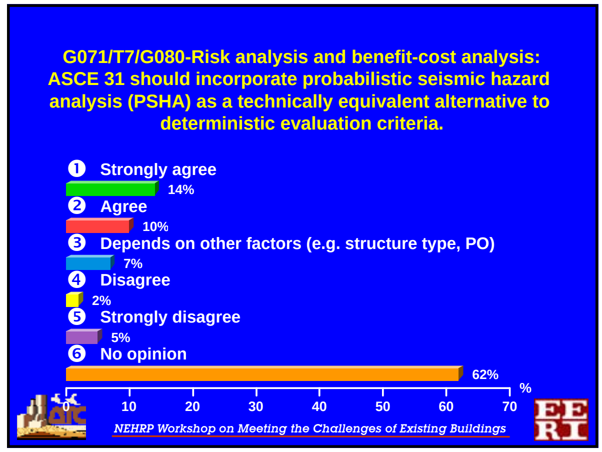

G003/T8-Research into practice:
New research findings are available to practitioners and fairly easy for individual engineers to incorporate into applications of ASCE 31 and ASCE 41.
1 Strongly agree
0%
2 Agree
15%
3 Depends on other factors (e.g. material, PO)
9%
4 Disagree
35%
5 Strongly disagree
15%
6 No opinion
26%
0
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

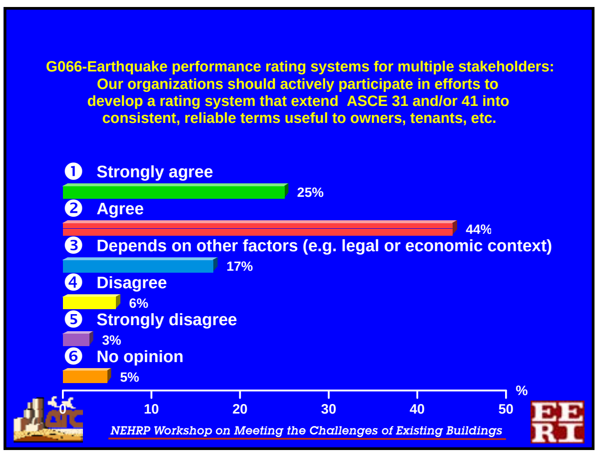

Technical Questions
Dealing With Uncertainty
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

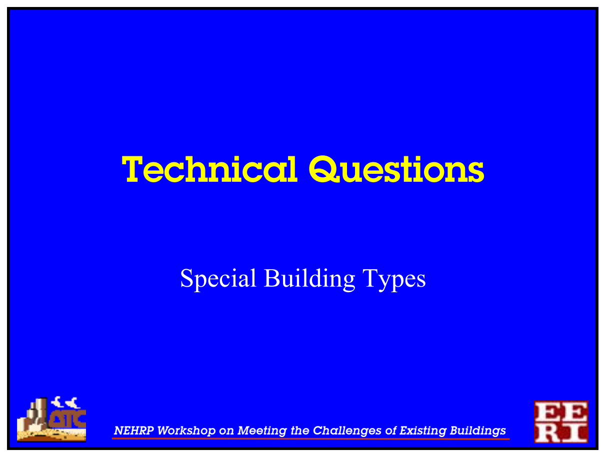

G019/G053-Communicating performance and uncertainty:
ASCE 31 and ASCE 41 do a good job communicating the nature of earthquake performance to owners and non-engineer stakeholders, providing them with information they need and can use.
1 Strongly agree
0%
2 Agree
7%
3 Depends on other factors (e.g. PO, engineer's input)
5%
4 Disagree
20%
5 Strongly disagree
9%
6 Moot. These are for engineering, not business decisions.
43%
7 No opinion
16%
0
10
20
30
40
50
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

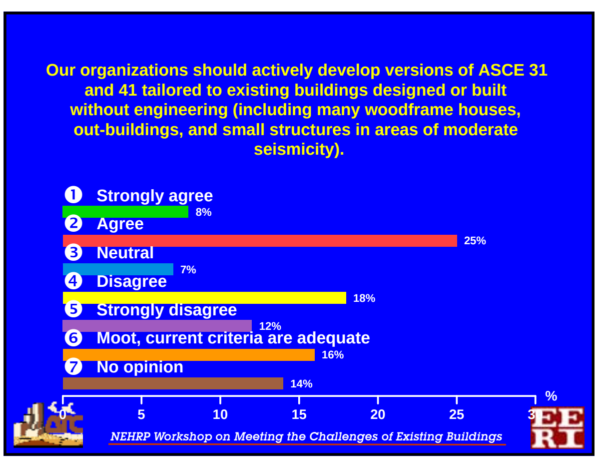

G049/P29-Probabilistic design:
ASCE 31 and 41 will be more effective if they include procedures that explicitly address the probabilistic nature of performance, i.e., by defining performance as probability of being in a given damage state.
1 Strongly agree
8%
2 Agree
38%
3 Depends on other factors (e.g. coordination with codes)
13%
4 Disagree
15%
5 Strongly disagree
3%
6 No opinion
23%
0
10
20
30
40
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

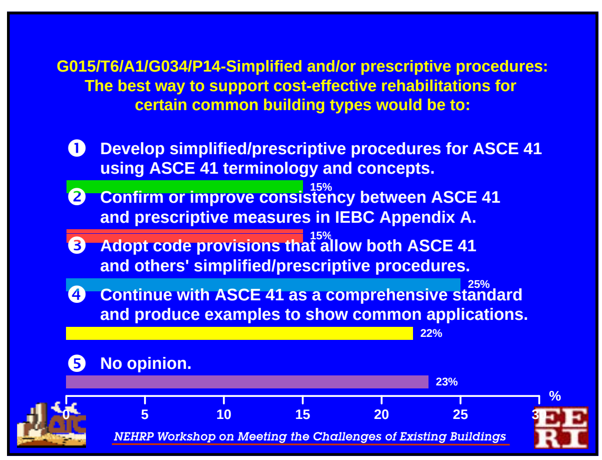

G071/T7/G080-Risk analysis and benefit-cost analysis:
Our organizations should actively coordinate with efforts to define and inform rehabilitation benefit-cost analyses.
1 Strongly agree
41%
2 Agree
38%
3 Depends on other factors
16%
4 Disagree
3%
5 Strongly disagree
1%
6 No opinion
1%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

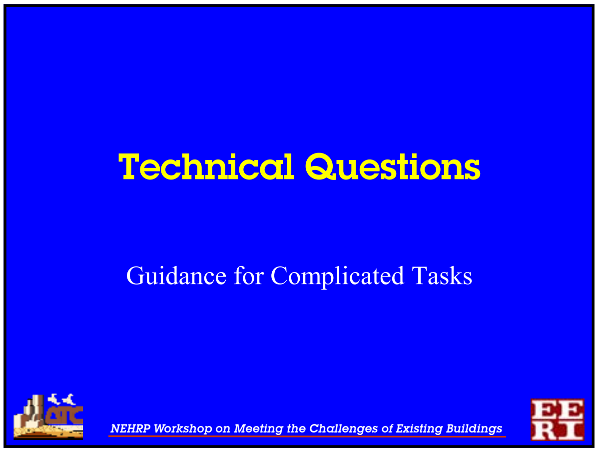

G071/T7/G080-Risk analysis and benefit-cost analysis:
ASCE 31 should incorporate probabilistic seismic hazard analysis (PSHA) as a technically equivalent alternative to deterministic evaluation criteria.
1 Strongly agree
14%
2 Agree
10%
3 Depends on other factors (e.g. structure type, PO)
7%
4 Disagree
2%
5 Strongly disagree
5%
6 No opinion
62%
0 10 20 30 40 50 60 70 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

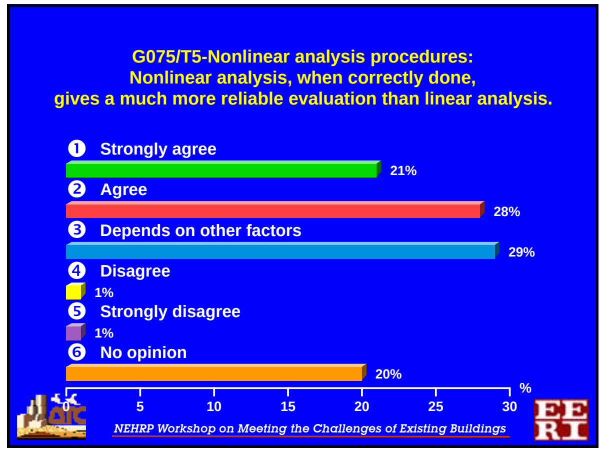

G066-Earthquake performance rating systems for multiple stakeholders:
Our organizations should actively participate in efforts to develop a rating system that extend ASCE 31 and/or 41 into consistent, reliable terms useful to owners, tenants, etc.
1 Strongly agree
25%
2 Agree
44%
3 Depends on other factors (e.g. legal or economic context)
17%
4 Disagree
6%
5 Strongly disagree
3%
6 No opinion
5%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

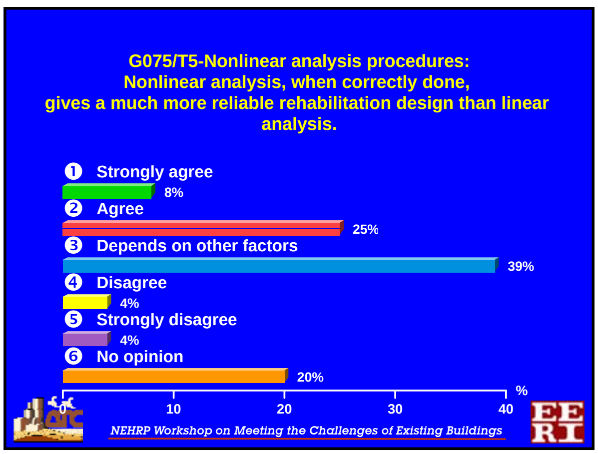

Technical Questions
Special Building Types
NEHRP Workshop on Meeting the Challenges of Existing Buildings

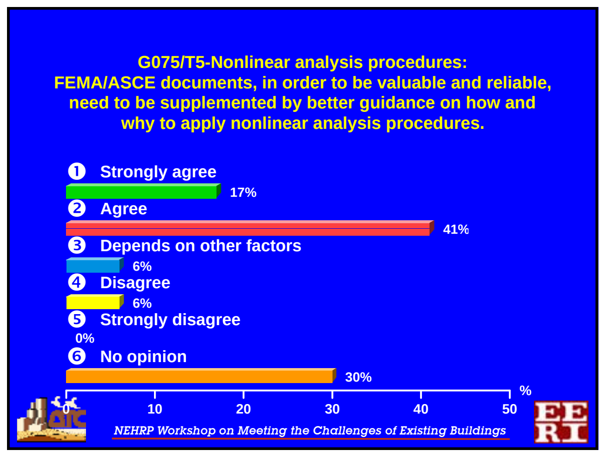

Our organizations should actively develop versions of ASCE 31 and 41 tailored to existing buildings designed or built without engineering (including many woodframe houses, out-buildings, and small structures in areas of moderate seismicity).
1 Strongly agree
8%
2 Agree
25%
3 Neutral
7%
4 Disagree
18%
5 Strongly disagree
12%
6 Moot, current criteria are adequate
16%
7 No opinion
14%
0 5 10 15 20 25 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

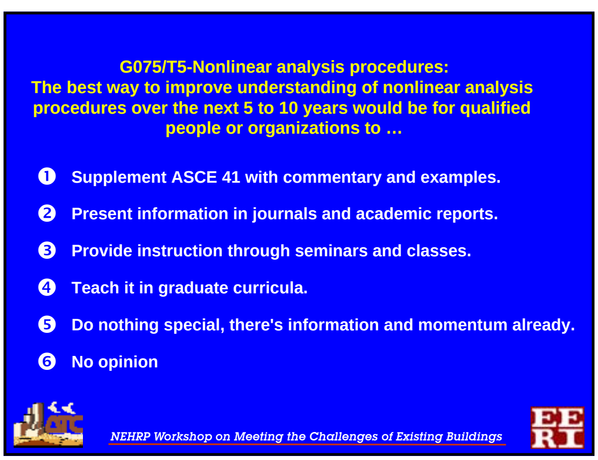

G015/T6/A1/G034/P14-Simplified and/or prescriptive procedures:
The best way to support cost-effective rehabilitations for certain common building types would be to:
1 Develop simplified/prescriptive procedures for ASCE 41 using ASCE 41 terminology and concepts.
15%
2 Confirm or improve consistency between ASCE 41 and prescriptive measures in IEBC Appendix A.
15%
3 Adopt code provisions that allow both ASCE 41 and others' simplified/prescriptive procedures.
25%
4 Continue with ASCE 41 as a comprehensive standard and produce examples to show common applications.
22%
5 No opinion.
23%
0 5 10 15 20 25 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings

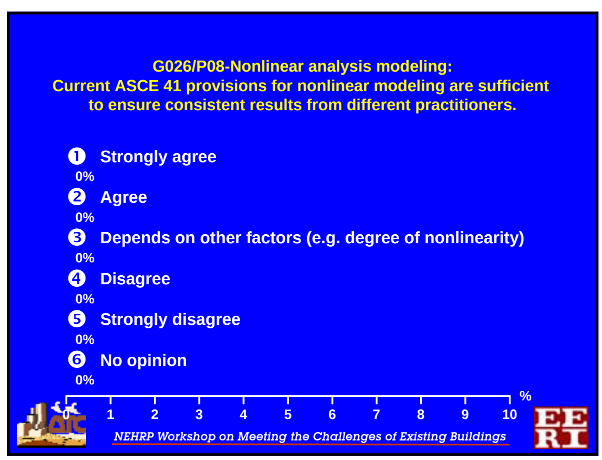

Technical Questions
Guidance for Complicated Tasks
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G075/T5-Nonlinear analysis procedures:
Nonlinear analysis, when correctly done,
gives a much more reliable evaluation than linear analysis.
1 Strongly agree
21%
2 Agree
28%
3 Depends on other factors
29%
4 Disagree
1%
5 Strongly disagree
1%
6 No opinion
20%
0 5 10 15 20 25 30 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G075/T5-Nonlinear analysis procedures:
Nonlinear analysis, when correctly done,
gives a much more reliable rehabilitation design than linear analysis.
1 Strongly agree
8%
2 Agree
25%
3 Depends on other factors
39%
4 Disagree
4%
5 Strongly disagree
4%
6 No opinion
20%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G075/T5-Nonlinear analysis procedures:
FEMA/ASCE documents, in order to be valuable and reliable,
need to be supplemented by better guidance on how and
why to apply nonlinear analysis procedures.
1 Strongly agree
17%
2 Agree
41%
3 Depends on other factors
6%
4 Disagree
6%
5 Strongly disagree
0%
6 No opinion
30%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G075/T5-Nonlinear analysis procedures:
The best way to improve understanding of nonlinear analysis
procedures over the next 5 to 10 years would be for qualified
people or organizations to …
1 Supplement ASCE 41 with commentary and examples.
2 Present information in journals and academic reports.
3 Provide instruction through seminars and classes.
4 Teach it in graduate curricula.
5 Do nothing special, there's information and momentum already.
6 No opinion
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G026/P08-Nonlinear analysis modeling:
Current ASCE 41 provisions for nonlinear modeling are sufficient
to ensure consistent results from different practitioners.
1 Strongly agree
0%
2 Agree
0%
3 Depends on other factors (e.g. degree of nonlinearity)
0%
4 Disagree
0%
5 Strongly disagree
0%
6 No opinion
0%
0 1 2 3 4 5 6 7 8 9 10 %
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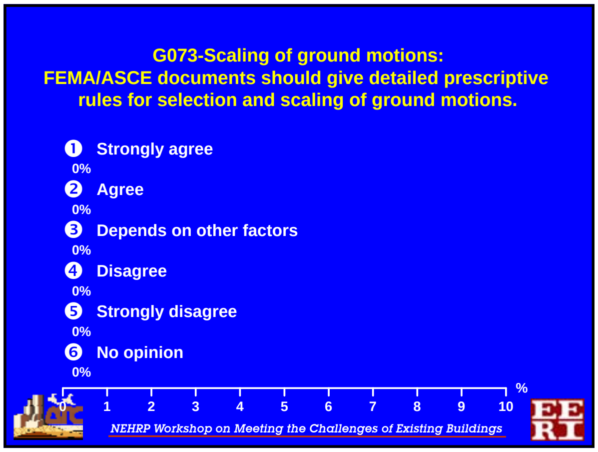
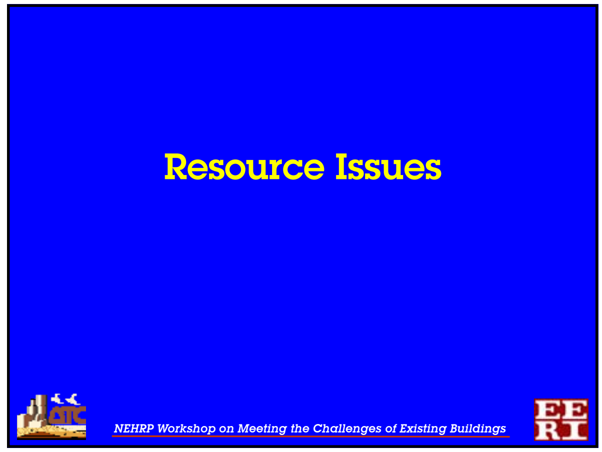
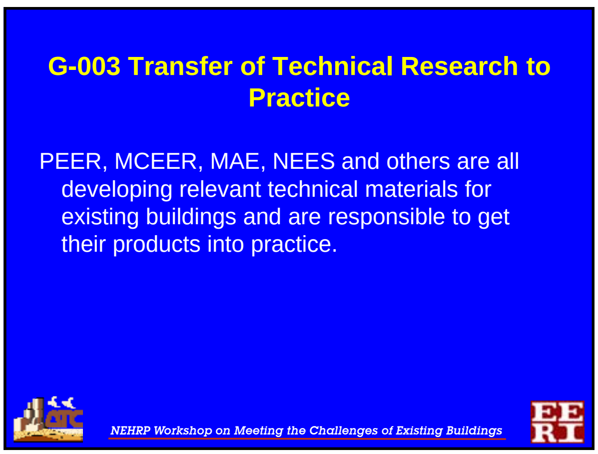
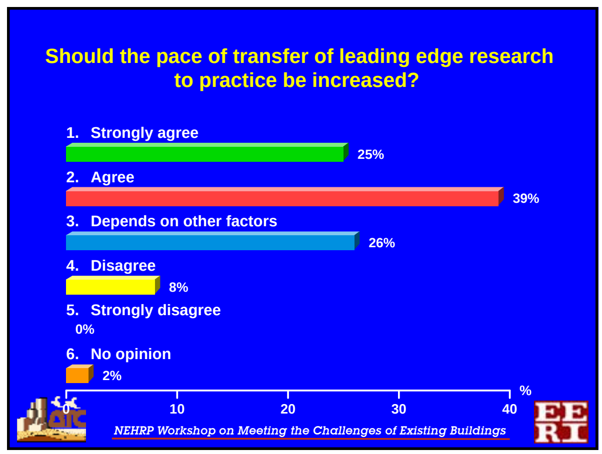
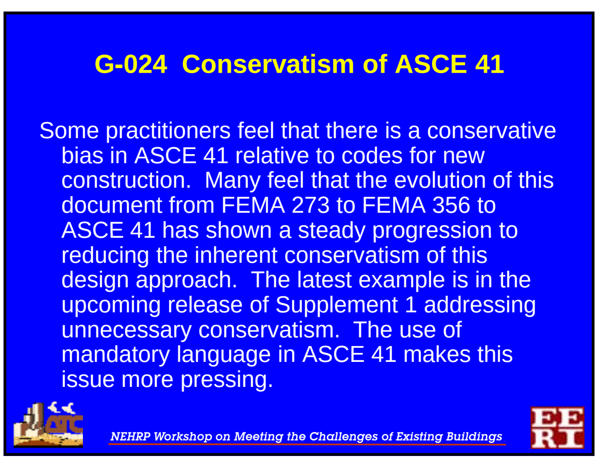

G073-Scaling of ground motions:
FEMA/ASCE documents should give detailed prescriptive rules for selection and scaling of ground motions.
❶ Strongly agree
0%
❷ Agree
0%
❸ Depends on other factors
0%
❹ Disagree
0%
❺ Strongly disagree
0%
❻ No opinion
0%
0 1 2 3 4 5 6 7 8 9 10 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


Resource Issues
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G-003 Transfer of Technical Research to Practice
PEER, MCEER, MAE, NEES and others are all developing relevant technical materials for existing buildings and are responsible to get their products into practice.
NEHRP Workshop on Meeting the Challenges of Existing Buildings


Should the pace of transfer of leading edge research to practice be increased?
1. Strongly agree
25%
2. Agree
39%
3. Depends on other factors
26%
4. Disagree
8%
5. Strongly disagree
0%
6. No opinion
2%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G-024 Conservatism of ASCE 41
Some practitioners feel that there is a conservative bias in ASCE 41 relative to codes for new construction. Many feel that the evolution of this document from FEMA 273 to FEMA 356 to ASCE 41 has shown a steady progression to reducing the inherent conservatism of this design approach. The latest example is in the upcoming release of Supplement 1 addressing unnecessary conservatism. The use of mandatory language in ASCE 41 makes this issue more pressing.
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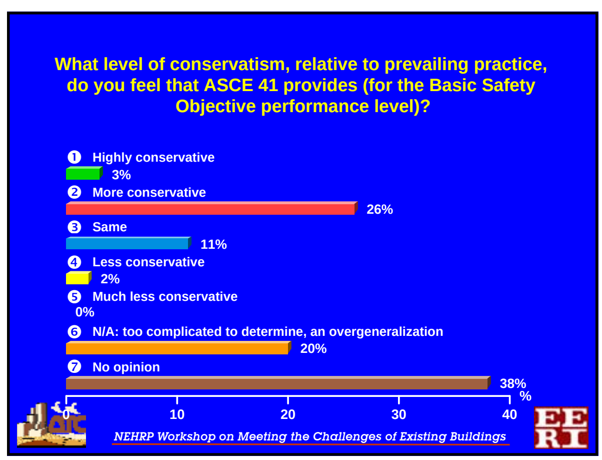
What level of conservatism, relative to prevailing practice, do you feel that ASCE 41 provides (for the Basic Safety Objective performance level)?
❶ Highly conservative
3%
❷ More conservative
26%
❸ Same
11%
❹ Less conservative
2%
❺ Much less conservative
0%
❻ N/A: too complicated to determine, an overgeneralization
20%
❼ No opinion
38%
0 10 20 30 40 %
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G-002 The Role of Materials Organizations and Industry Groups in Existing Buildings

Traditionally, material (concrete, steel, masonry, wood) trade organizations maintain committees and sponsor research to develop improved practical design and engineering information. However, with existing buildings these groups have been less engaged.

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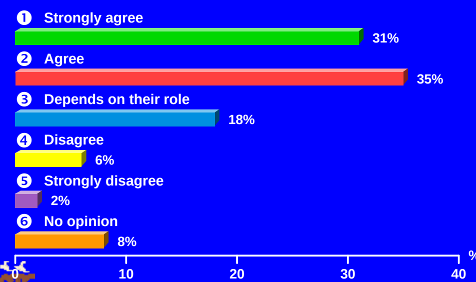
Do you feel that these organizations should play a more significant role in developing technical data for existing buildings



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G063 Seismic Rehabilitation Materials for College/University Instruction

The development of seismic design courses, or increasing emphasis in existing courses, requires a considerable amount of effort. This will be especially true of seismic rehabilitation. Materials should be collected, developed, and organized for those who would teach such courses. Faculty training courses could be offered to increase instructional capabilities. The materials should be aimed at senior or graduate level students and at practitioners who might be able to attend extension courses.

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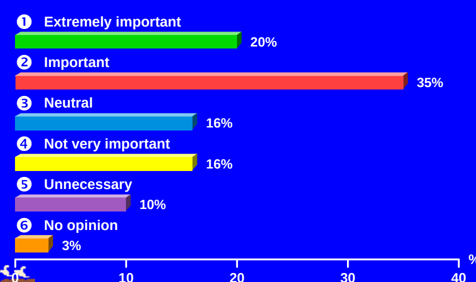
How important is the development of university instructional material and courses specifically for seismic rehabilitation?



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Practice Issues

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G-001 Judgment vs. Analysis

As an engineering practitioner, the exercise of judgment is a critical tool in the design and evaluation process.

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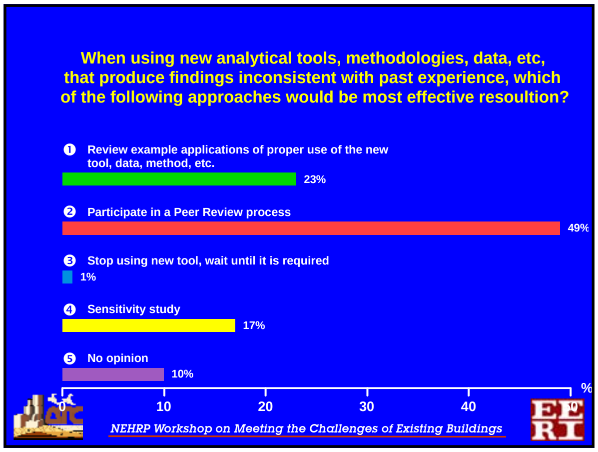
When using new analytical tools, methodologies, data, etc, that produce findings inconsistent with past experience, which of the following approaches would be most effective resoultion?
1 Review example applications of proper use of the new tool, data, method, etc.
23%
2 Participate in a Peer Review process
49%
3 Stop using new tool, wait until it is required
1%
4 Sensitivity study
17%
5 No opinion
10%
0
10
20
30
40
%
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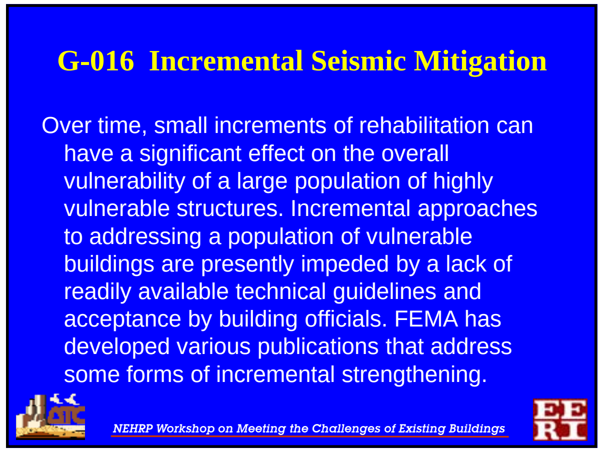
G-016 Incremental Seismic Mitigation
Over time, small increments of rehabilitation can have a significant effect on the overall vulnerability of a large population of highly vulnerable structures. Incremental approaches to addressing a population of vulnerable buildings are presently impeded by a lack of readily available technical guidelines and acceptance by building officials. FEMA has developed various publications that address some forms of incremental strengthening.
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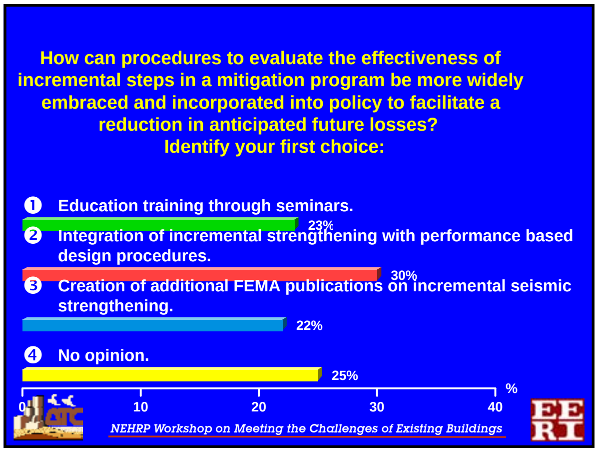
How can procedures to evaluate the effectiveness of incremental steps in a mitigation program be more widely embraced and incorporated into policy to facilitate a reduction in anticipated future losses?
Identify your first choice:
1 Education training through seminars.
23%
2 Integration of incremental strengthening with performance based design procedures.
30%
3 Creation of additional FEMA publications on incremental seismic strengthening.
22%
4 No opinion.
25%
0
10
20
30
40
%
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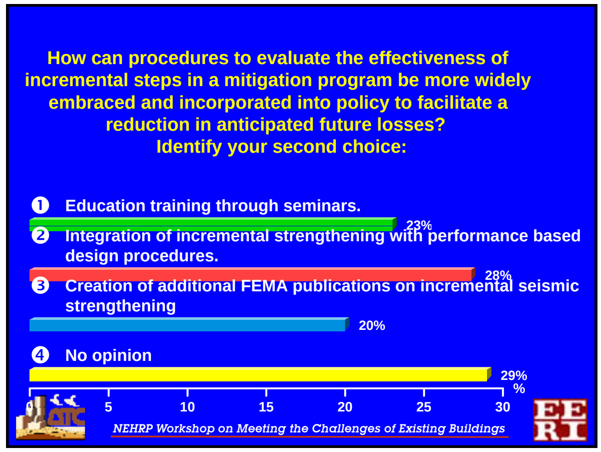
How can procedures to evaluate the effectiveness of incremental steps in a mitigation program be more widely embraced and incorporated into policy to facilitate a reduction in anticipated future losses?
Identify your second choice:
1 Education training through seminars.
23%
2 Integration of incremental strengthening with performance based design procedures.
28%
3 Creation of additional FEMA publications on incremental seismic strengthening
20%
4 No opinion
29%
0
5
10
15
20
25
30
%
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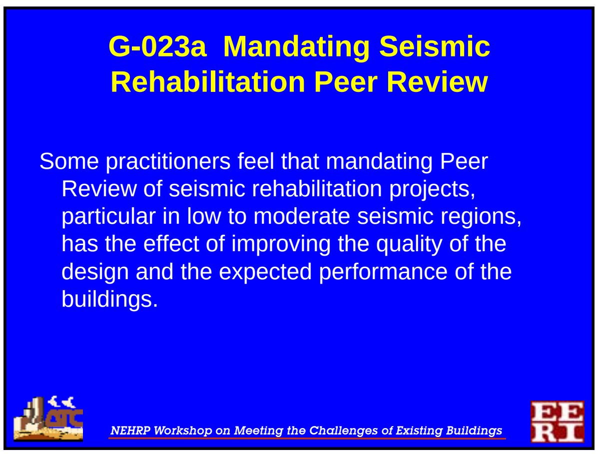
G-023a Mandating Seismic Rehabilitation Peer Review
Some practitioners feel that mandating Peer Review of seismic rehabilitation projects, particular in low to moderate seismic regions, has the effect of improving the quality of the design and the expected performance of the buildings.
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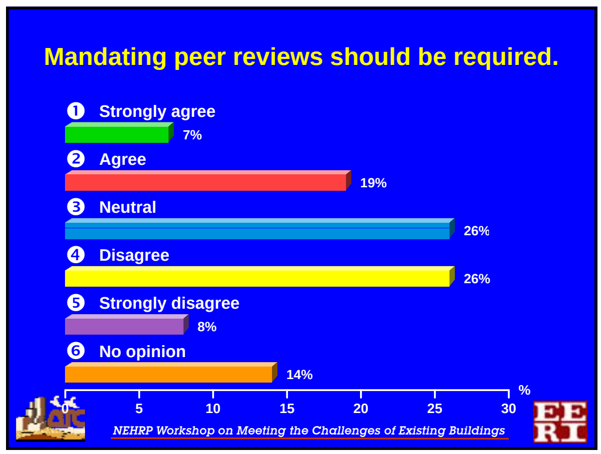
Mandating peer reviews should be required.
1 Strongly agree
7%
2 Agree
19%
3 Neutral
26%
4 Disagree
26%
5 Strongly disagree
8%
6 No opinion
14%
0
5
10
15
20
25
30
%
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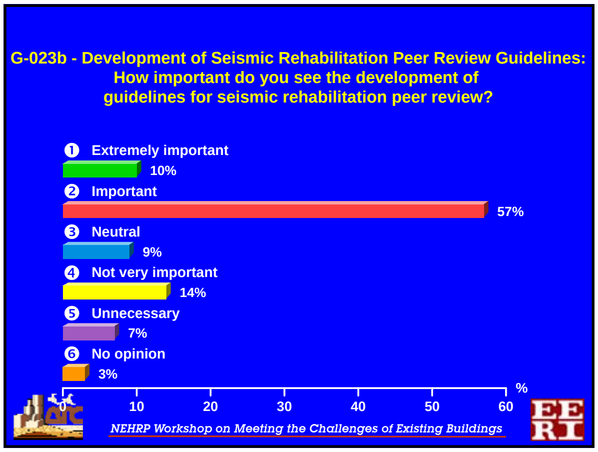
G-023b - Development of Seismic Rehabilitation Peer Review Guidelines:
How important do you see the development of
guidelines for seismic rehabilitation peer review?
1 Extremely important
10%
2 Important
57%
3 Neutral
9%
4 Not very important
14%
5 Unnecessary
7%
6 No opinion
3%
0 10 20 30 40 50 60 %
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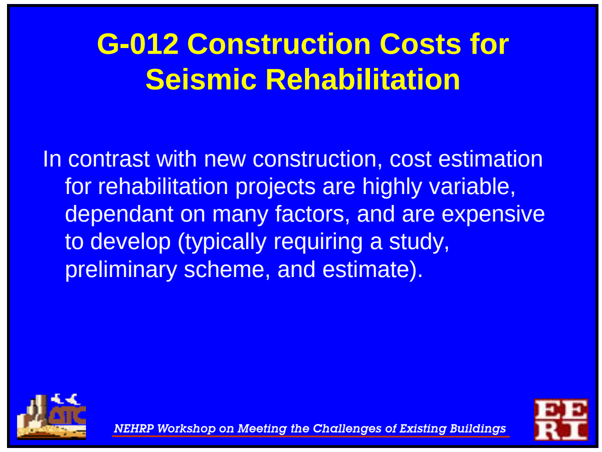
G-012 Construction Costs for Seismic Rehabilitation
In contrast with new construction, cost estimation for rehabilitation projects are highly variable, dependant on many factors, and are expensive to develop (typically requiring a study, preliminary scheme, and estimate).
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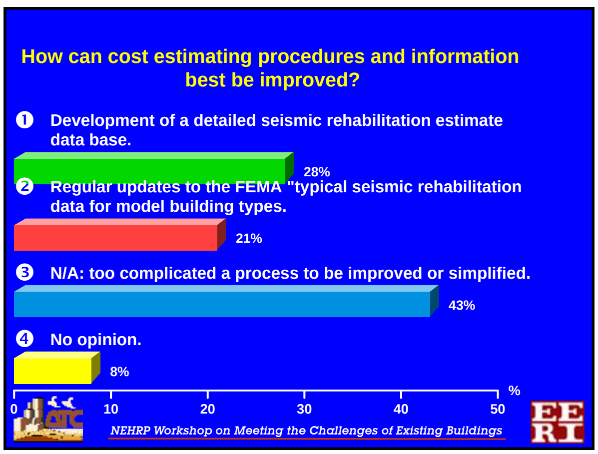
How can cost estimating procedures and information best be improved?
1 Development of a detailed seismic rehabilitation estimate data base.
28%
2 Regular updates to the FEMA "typical seismic rehabilitation data for model building types.
21%
3 N/A: too complicated a process to be improved or simplified.
43%
4 No opinion.
8%
0 10 20 30 40 50 %
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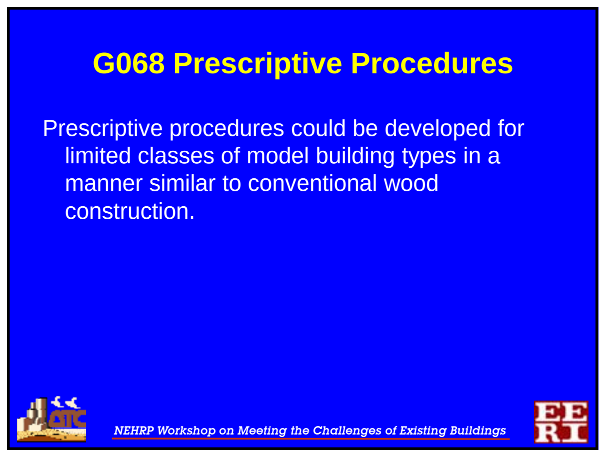
G068 Prescriptive Procedures
Prescriptive procedures could be developed for limited classes of model building types in a manner similar to conventional wood construction.
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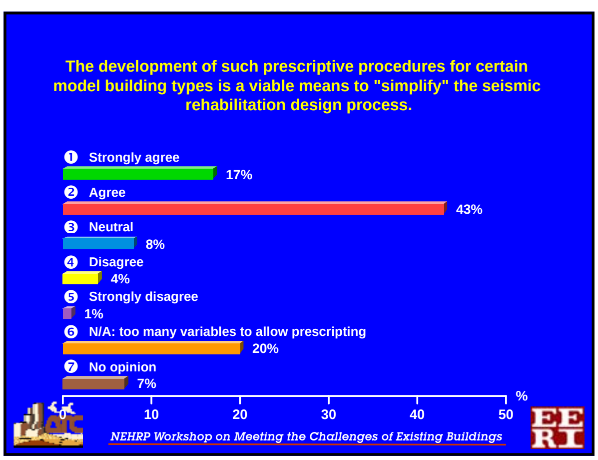
The development of such prescriptive procedures for certain model building types is a viable means to "simplify" the seismic rehabilitation design process.
1 Strongly agree
17%
2 Agree
43%
3 Neutral
8%
4 Disagree
4%
5 Strongly disagree
1%
6 N/A: too many variables to allow prescripting
20%
7 No opinion
7%
0 10 20 30 40 50 %
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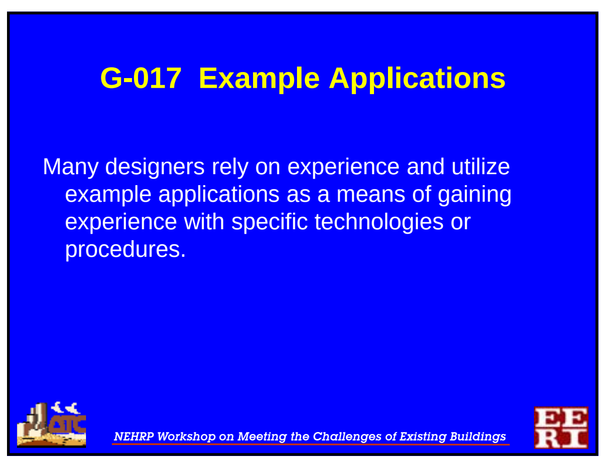
G-017 Example Applications
Many designers rely on experience and utilize example applications as a means of gaining experience with specific technologies or procedures.
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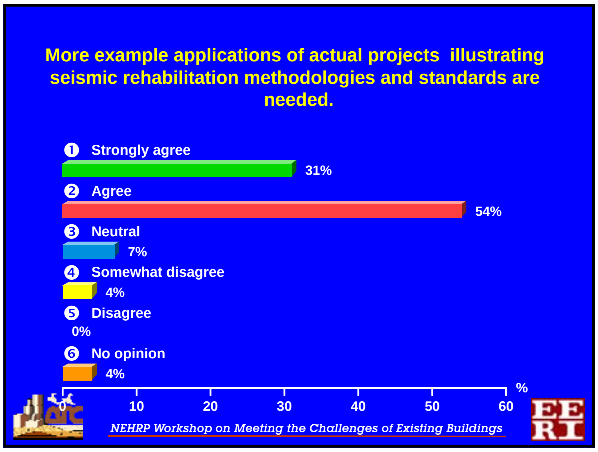
More example applications of actual projects illustrating seismic rehabilitation methodologies and standards are needed.
1 Strongly agree
31%
2 Agree
54%
3 Neutral
7%
4 Somewhat disagree
4%
5 Disagree
0%
6 No opinion
4%
0 10 20 30 40 50 60 %
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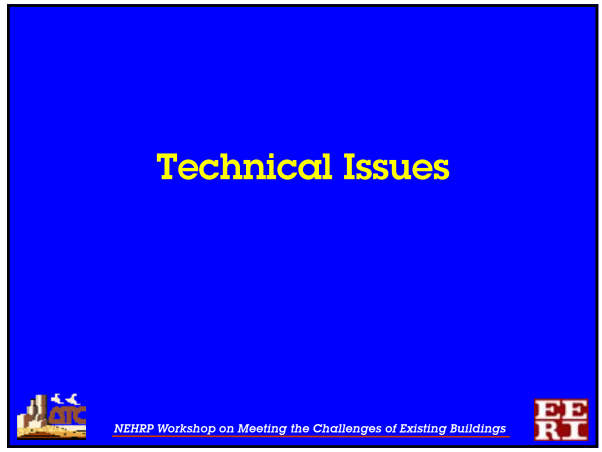
Technical Issues
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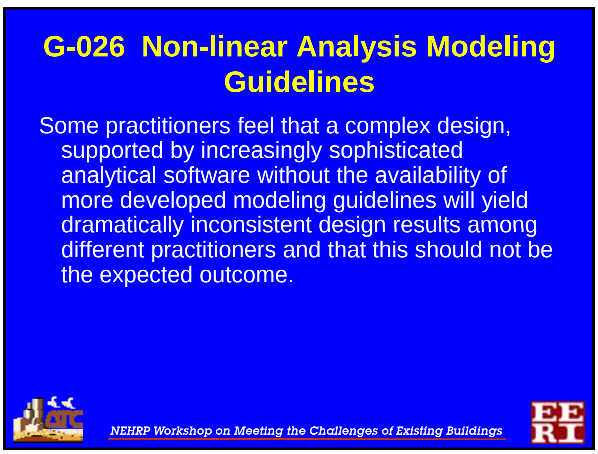
G-026 Non-linear Analysis Modeling Guidelines
Some practitioners feel that a complex design, supported by increasingly sophisticated analytical software without the availability of more developed modeling guidelines will yield dramatically inconsistent design results among different practitioners and that this should not be the expected outcome.
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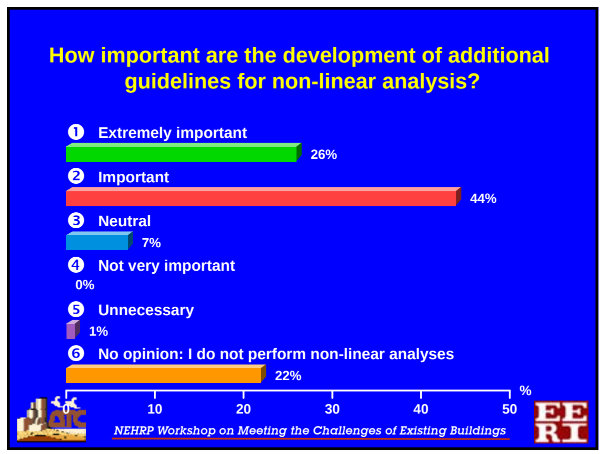
How important are the development of additional guidelines for non-linear analysis?
1 Extremely important
26%
2 Important
44%
3 Neutral
7%
4 Not very important
0%
5 Unnecessary
1%
6 No opinion: I do not perform non-linear analyses
22%
0 10 20 30 40 50 %
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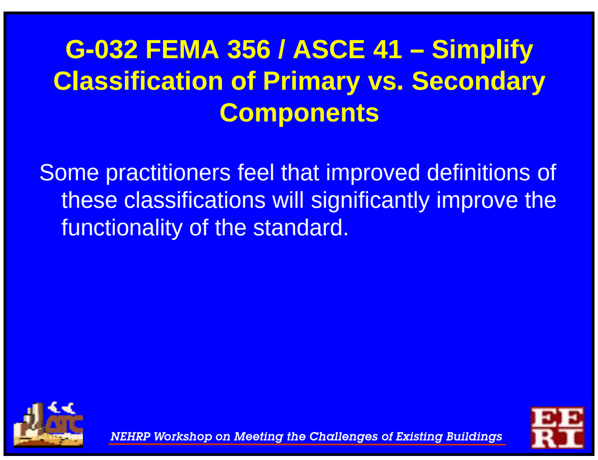
G-032 FEMA 356 / ASCE 41 – Simplify Classification of Primary vs. Secondary Components
Some practitioners feel that improved definitions of these classifications will significantly improve the functionality of the standard.
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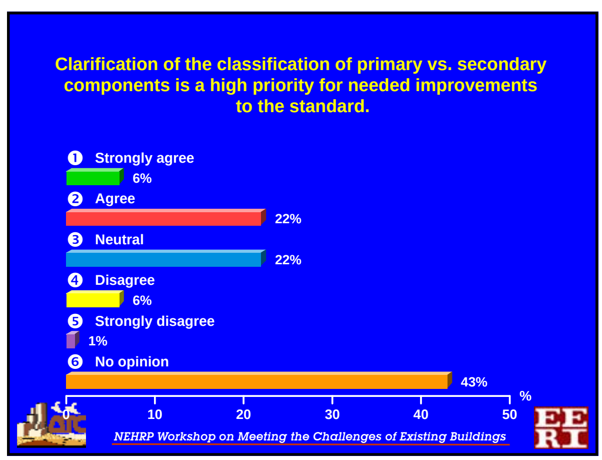
Clarification of the classification of primary vs. secondary components is a high priority for needed improvements to the standard.
1 Strongly agree
6%
2 Agree
22%
3 Neutral
22%
4 Disagree
6%
5 Strongly disagree
1%
6 No opinion
43%
0 10 20 30 40 50 %
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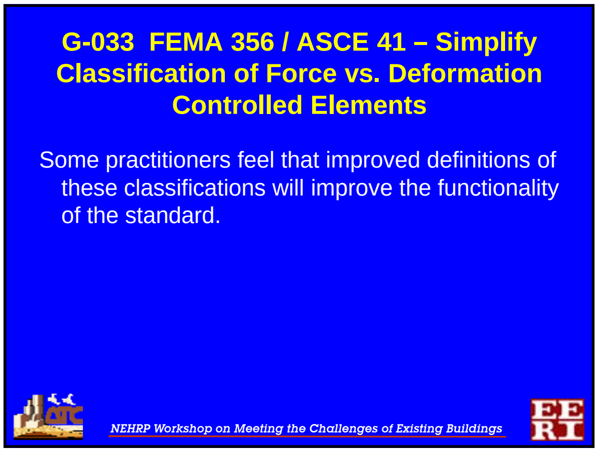
G-033 FEMA 356 / ASCE 41 – Simplify Classification of Force vs. Deformation Controlled Elements
Some practitioners feel that improved definitions of these classifications will improve the functionality of the standard.
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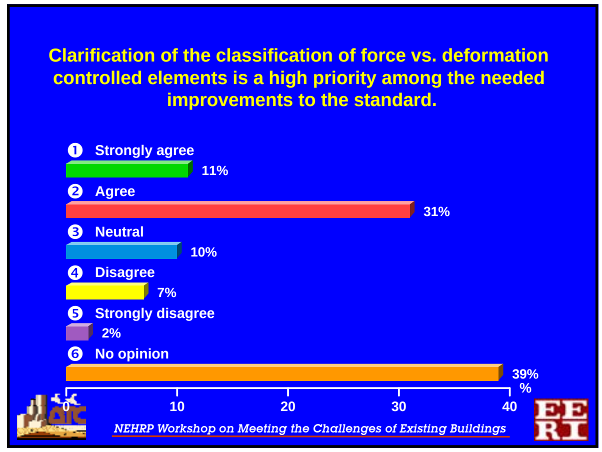
Clarification of the classification of force vs. deformation controlled elements is a high priority among the needed improvements to the standard.
1 Strongly agree
11%
2 Agree
31%
3 Neutral
10%
4 Disagree
7%
5 Strongly disagree
2%
6 No opinion
39%
0
10
20
30
40
%
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Regulators
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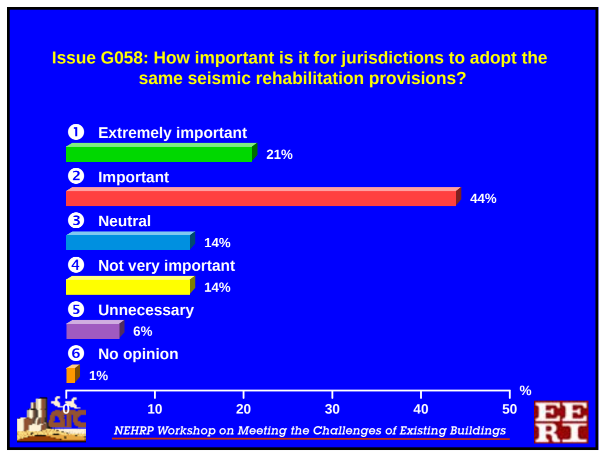
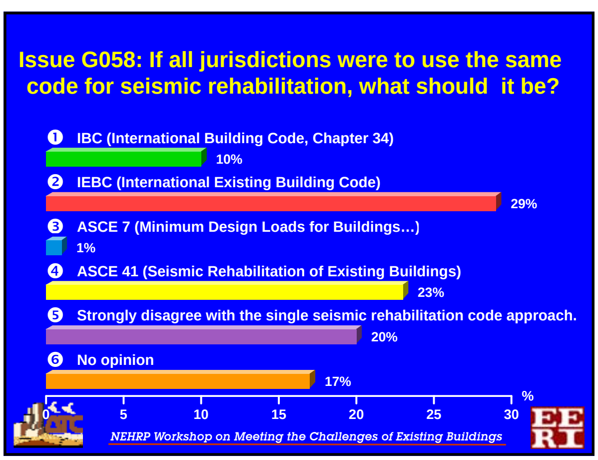

Issue G058: How important is it for jurisdictions to adopt the same seismic rehabilitation provisions?
1 Extremely important
21%
2 Important
44%
3 Neutral
14%
4 Not very important
14%
5 Unnecessary
6%
6 No opinion
1%
0
10
20
30
40
50
%
NEHRP Workshop on Meeting the Challenges of Existing Buildings


Issue G058: If all jurisdictions were to use the same code for seismic rehabilitation, what should it be?
1 IBC (International Building Code, Chapter 34)
10%
2 IEBC (International Existing Building Code)
29%
3 ASCE 7 (Minimum Design Loads for Buildings…)
1%
4 ASCE 41 (Seismic Rehabilitation of Existing Buildings)
23%
5 Strongly disagree with the single seismic rehabilitation code approach.
20%
6 No opinion
17%
0
5
10
15
20
25
30
%
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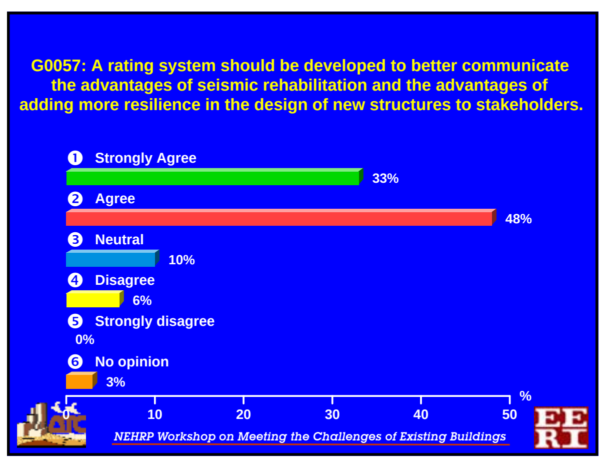
G0057: A rating system should be developed to better communicate the advantages of seismic rehabilitation and the advantages of adding more resilience in the design of new structures to stakeholders.
1 Strongly Agree
33%
2 Agree
48%
3 Neutral
10%
4 Disagree
6%
5 Strongly disagree
0%
6 No opinion
3%
10
20
30
40
50
%
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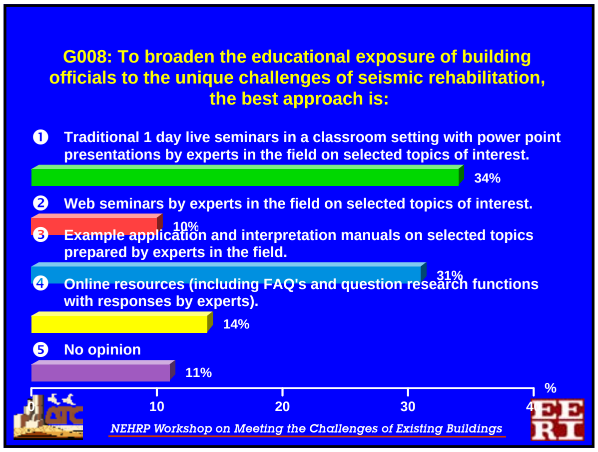
G008: To broaden the educational exposure of building officials to the unique challenges of seismic rehabilitation, the best approach is:
1 Traditional 1 day live seminars in a classroom setting with power point presentations by experts in the field on selected topics of interest.
34%
2 Web seminars by experts in the field on selected topics of interest.
10%
3 Example application and interpretation manuals on selected topics prepared by experts in the field.
31%
4 Online resources (including FAQ's and question research functions with responses by experts).
14%
5 No opinion
11%
0 10 20 30 40 %
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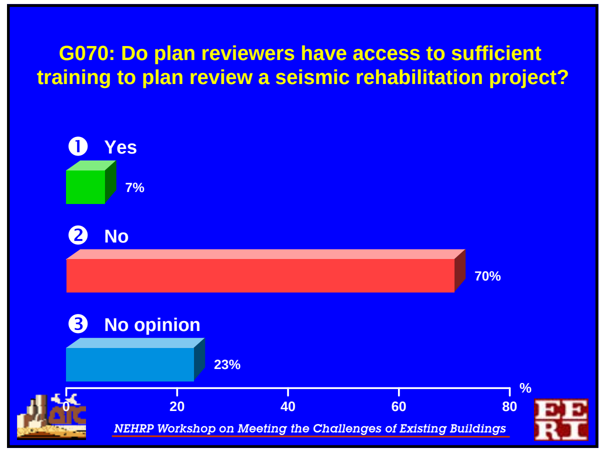
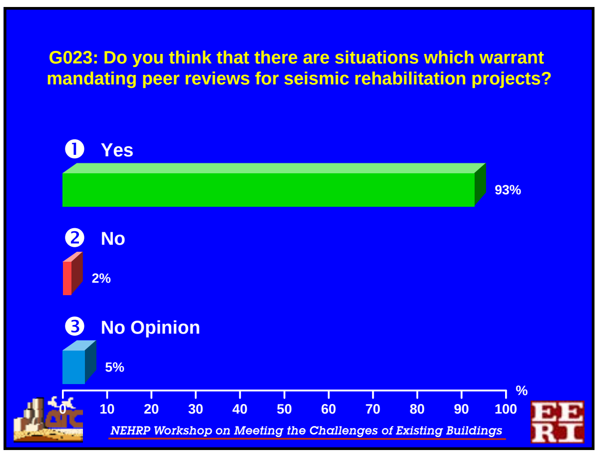
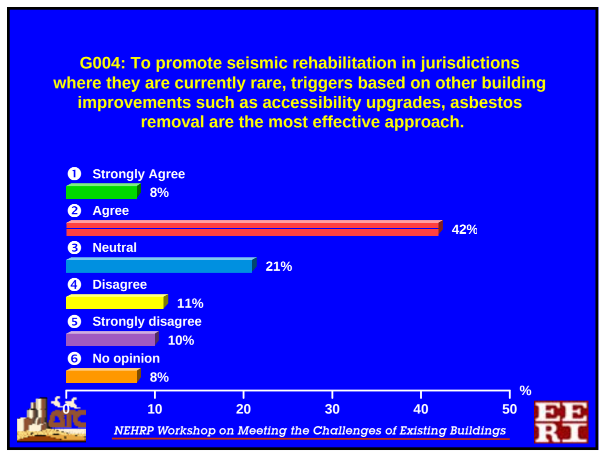
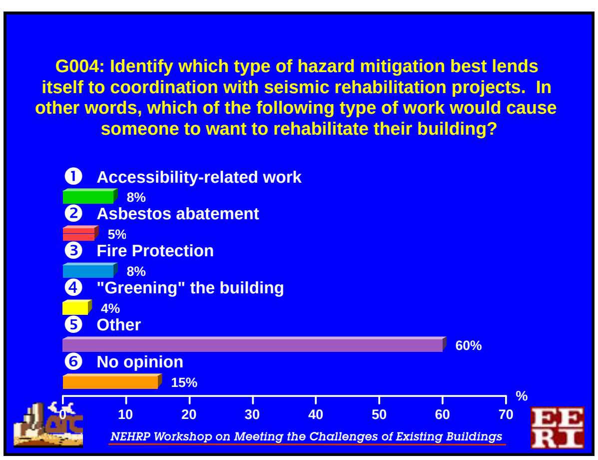
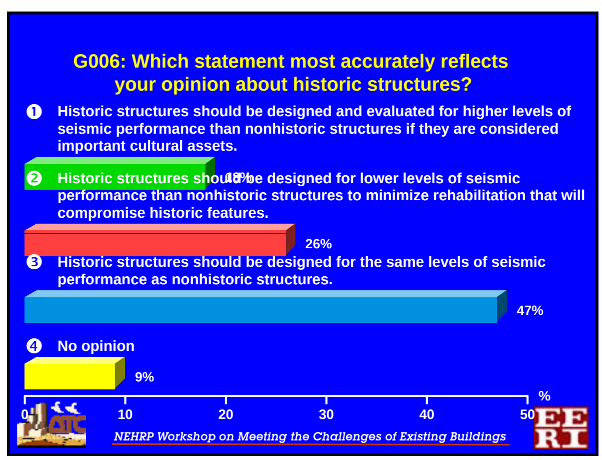
ATC
EERI

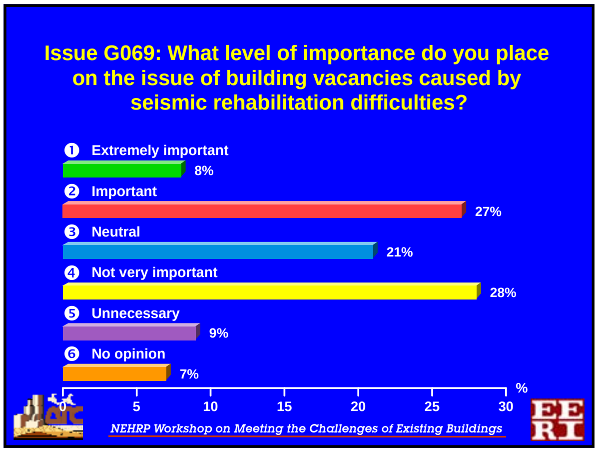

G070: Do plan reviewers have access to sufficient training to plan review a seismic rehabilitation project?
1 Yes
7%
2 No
70%
3 No opinion
23%
0 20 40 60 80 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
ATC
EERI


G023: Do you think that there are situations which warrant mandating peer reviews for seismic rehabilitation projects?
1 Yes
93%
2 No
2%
3 No Opinion
5%
0 10 20 30 40 50 60 70 80 90 100 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
ATC
EERI


G004: To promote seismic rehabilitation in jurisdictions where they are currently rare, triggers based on other building improvements such as accessibility upgrades, asbestos removal are the most effective approach.
1 Strongly Agree
8%
2 Agree
42%
3 Neutral
21%
4 Disagree
11%
5 Strongly disagree
10%
6 No opinion
8%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
ATC
EERI


G004: Identify which type of hazard mitigation best lends itself to coordination with seismic rehabilitation projects. In other words, which of the following type of work would cause someone to want to rehabilitate their building?
1 Accessibility-related work
8%
2 Asbestos abatement
5%
3 Fire Protection
8%
4 "Greening" the building
4%
5 Other
60%
6 No opinion
15%
0 10 20 30 40 50 60 70 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
ATC
EERI


G006: Which statement most accurately reflects your opinion about historic structures?
1 Historic structures should be designed and evaluated for higher levels of seismic performance than nonhistoric structures if they are considered important cultural assets.
18%
2 Historic structures should be designed for lower levels of seismic performance than nonhistoric structures to minimize rehabilitation that will compromise historic features.
26%
3 Historic structures should be designed for the same levels of seismic performance as nonhistoric structures.
47%
4 No opinion
9%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
ATC
EERI


Issue G069: What level of importance do you place on the issue of building vacancies caused by seismic rehabilitation difficulties?
1 Extremely important
8%
2 Important
27%
3 Neutral
21%
4 Not very important
28%
5 Unnecessary
9%
6 No opinion
7%
0 5 10 15 20 25 30 %
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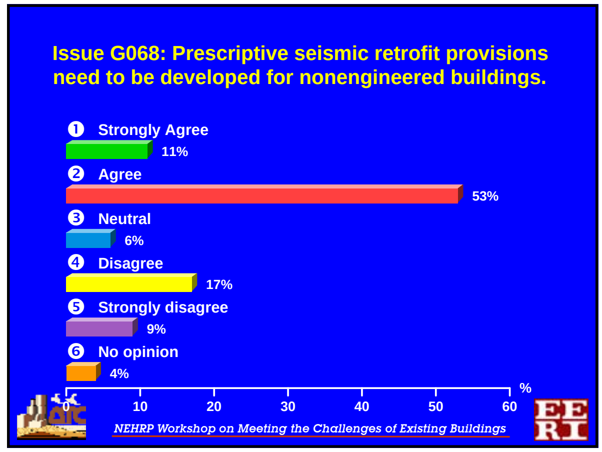
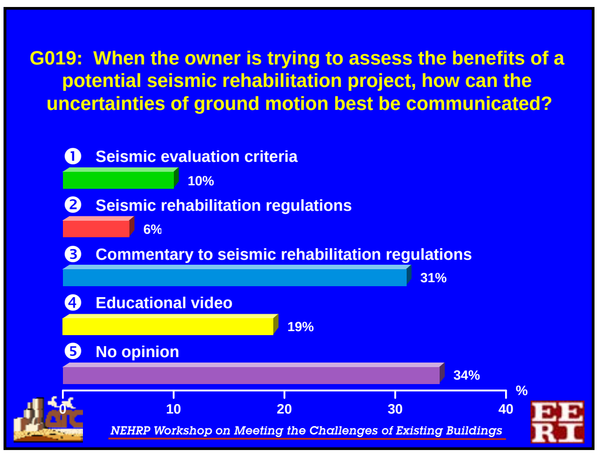

Issue G068: Prescriptive seismic retrofit provisions need to be developed for nonengineered buildings.
1 Strongly Agree
11%
2 Agree
53%
3 Neutral
6%
4 Disagree
17%
5 Strongly disagree
9%
6 No opinion
4%
0 10 20 30 40 50 60 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G019: When the owner is trying to assess the benefits of a potential seismic rehabilitation project, how can the uncertainties of ground motion best be communicated?
1 Seismic evaluation criteria
10%
2 Seismic rehabilitation regulations
6%
3 Commentary to seismic rehabilitation regulations
31%
4 Educational video
19%
5 No opinion
34%
0 10 20 30 40 %
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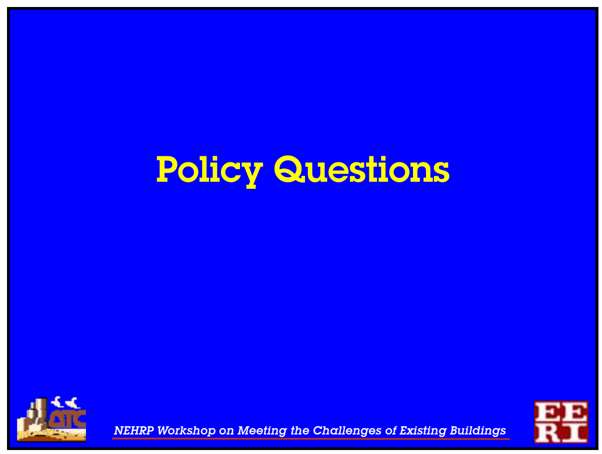
Policy Questions
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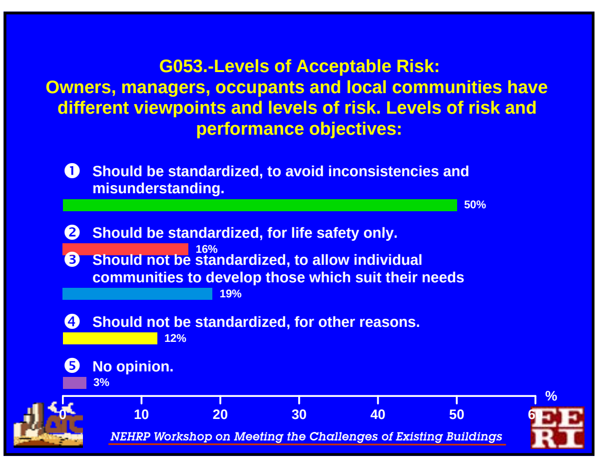
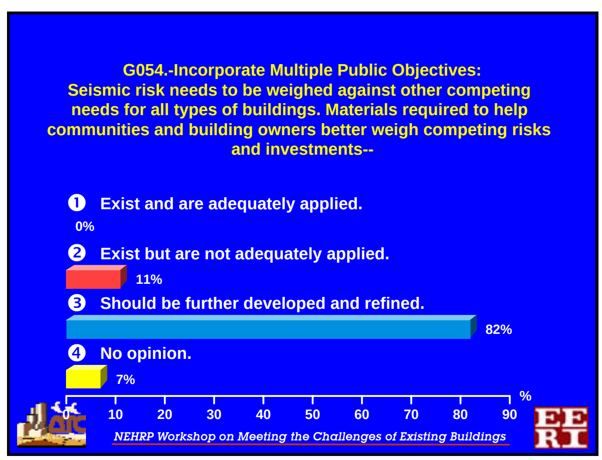
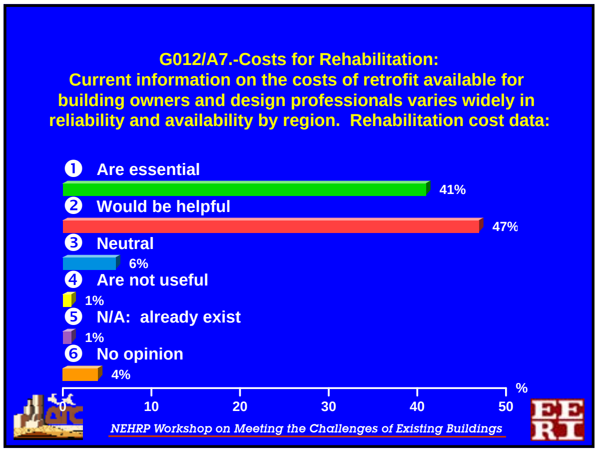

G053.-Levels of Acceptable Risk:
Owners, managers, occupants and local communities have different viewpoints and levels of risk. Levels of risk and performance objectives:
1 Should be standardized, to avoid inconsistencies and misunderstanding.
50%
2 Should be standardized, for life safety only.
16%
3 Should not be standardized, to allow individual communities to develop those which suit their needs
19%
4 Should not be standardized, for other reasons.
12%
5 No opinion.
3%
0 10 20 30 40 50 60 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G054.-Incorporate Multiple Public Objectives:
Seismic risk needs to be weighed against other competing needs for all types of buildings. Materials required to help communities and building owners better weigh competing risks and investments--
1 Exist and are adequately applied.
0%
2 Exist but are not adequately applied.
11%
3 Should be further developed and refined.
82%
4 No opinion.
7%
0 10 20 30 40 50 60 70 80 90 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings


G012/A7.-Costs for Rehabilitation:
Current information on the costs of retrofit available for building owners and design professionals varies widely in reliability and availability by region. Rehabilitation cost data:
1 Are essential
41%
2 Would be helpful
47%
3 Neutral
6%
4 Are not useful
1%
5 N/A: already exist
1%
6 No opinion
4%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
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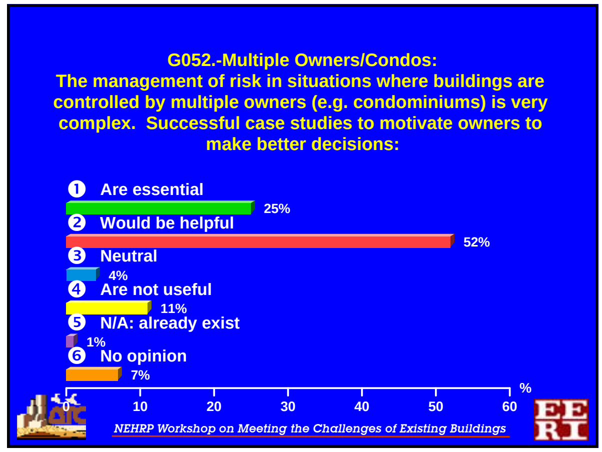
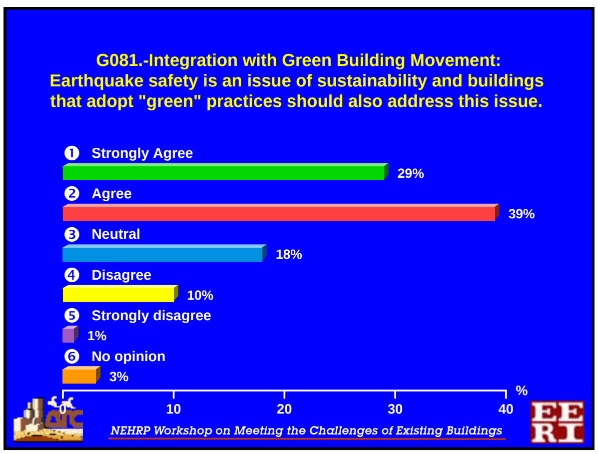

G052.-Multiple Owners/Condos:
The management of risk in situations where buildings are controlled by multiple owners (e.g. condominiums) is very complex. Successful case studies to motivate owners to make better decisions:
1 Are essential
25%
2 Would be helpful
52%
3 Neutral
4%
4 Are not useful
11%
5 N/A: already exist
1%
6 No opinion
7%
0 10 20 30 40 50 60 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI


G081.-Integration with Green Building Movement:
Earthquake safety is an issue of sustainability and buildings that adopt "green" practices should also address this issue.
1 Strongly Agree
29%
2 Agree
39%
3 Neutral
18%
4 Disagree
10%
5 Strongly disagree
1%
6 No opinion
3%
0 10 20 30 40 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
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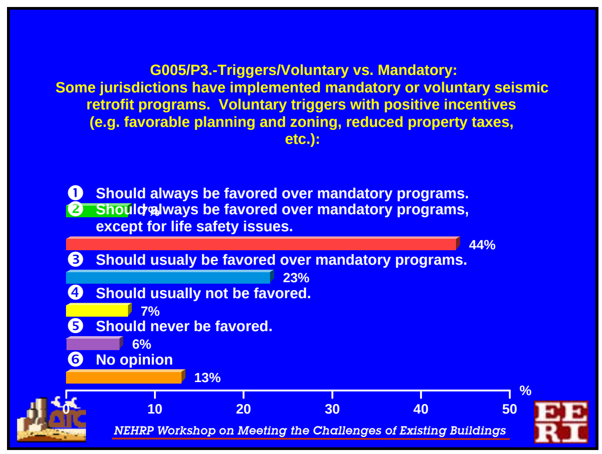
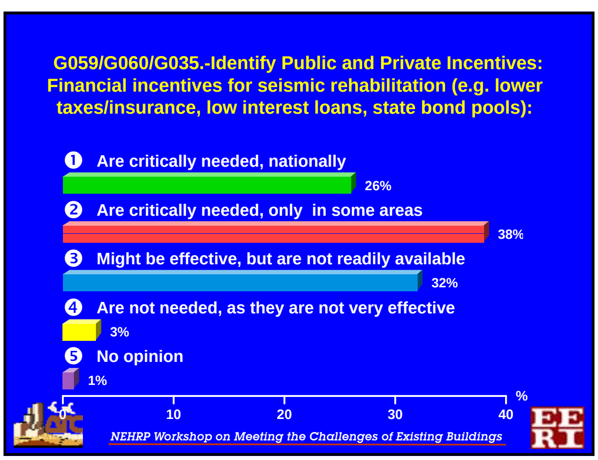

G005/P3.-Triggers/Voluntary vs. Mandatory:
Some jurisdictions have implemented mandatory or voluntary seismic retrofit programs. Voluntary triggers with positive incentives (e.g. favorable planning and zoning, reduced property taxes, etc.):
1 Should always be favored over mandatory programs.
2 Should always be favored over mandatory programs, except for life safety issues.
44%
3 Should usualy be favored over mandatory programs.
23%
4 Should usually not be favored.
7%
5 Should never be favored.
6%
6 No opinion
13%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI


G059/G060/G035.-Identify Public and Private Incentives:
Financial incentives for seismic rehabilitation (e.g. lower taxes/insurance, low interest loans, state bond pools):
1 Are critically needed, nationally
26%
2 Are critically needed, only in some areas
38%
3 Might be effective, but are not readily available
32%
4 Are not needed, as they are not very effective
3%
5 No opinion
1%
10 20 30 40 %
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G062.-Legal Implications of Seismic Rehabilitation:
Building owners may be reluctant to investigate issues of seismic vulnerability in existing buildings because of a fear that if they find a building is seriously vulnerable, they may be considered negligent in not addressing known deficiencies. Providing voluntary seismic improvements that do not completely address identified deficiencies might expose building owners to an unanticipated liability.
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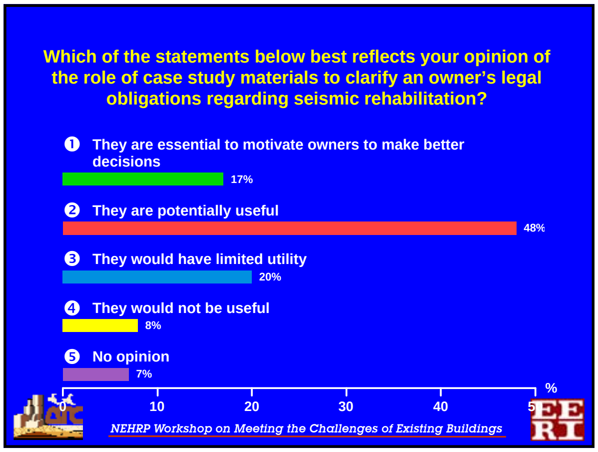
Which of the statements below best reflects your opinion of the role of case study materials to clarify an owner's legal obligations regarding seismic rehabilitation?
❶ They are essential to motivate owners to make better decisions
17%
❷ They are potentially useful
48%
❸ They would have limited utility
20%
❹ They would not be useful
8%
❺ No opinion
7%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
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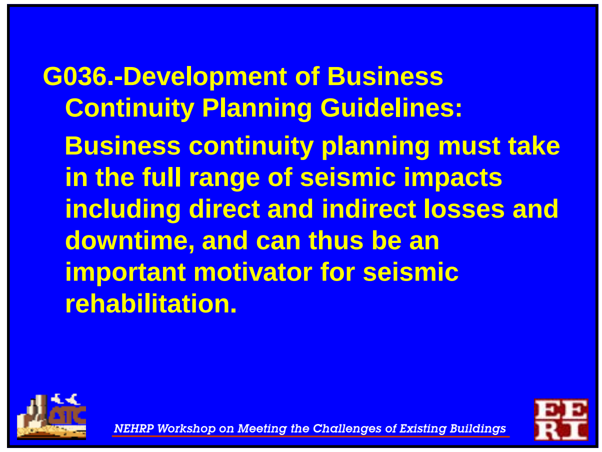
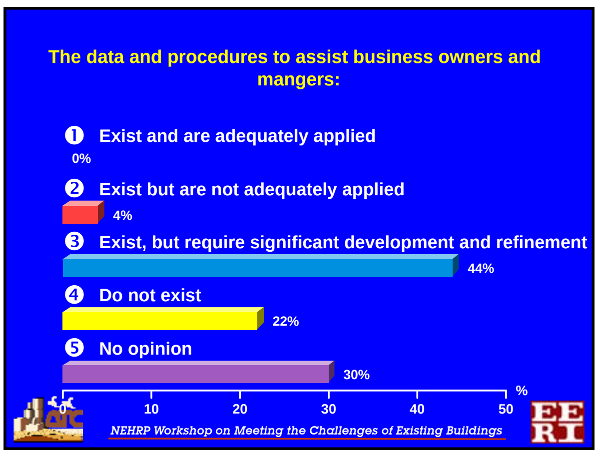
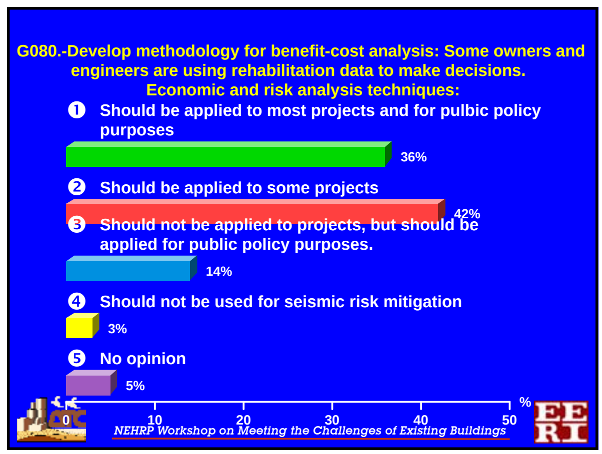
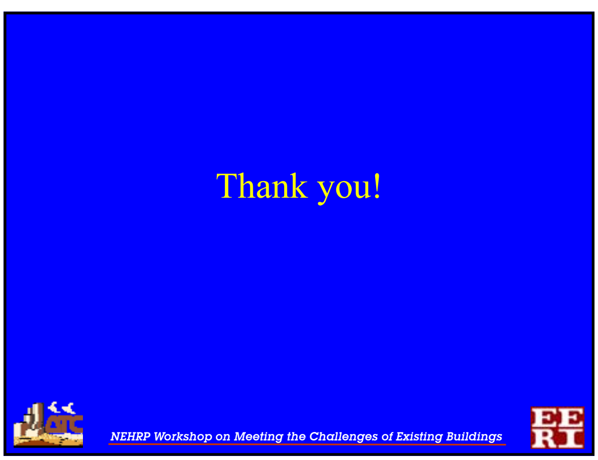

G036.-Development of Business Continuity Planning Guidelines:
Business continuity planning must take in the full range of seismic impacts including direct and indirect losses and downtime, and can thus be an important motivator for seismic rehabilitation.
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI


The data and procedures to assist business owners and mangers:
❶ Exist and are adequately applied
0%
❷ Exist but are not adequately applied
4%
❸ Exist, but require significant development and refinement
44%
❹ Do not exist
22%
❺ No opinion
30%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI


G080.-Develop methodology for benefit-cost analysis: Some owners and engineers are using rehabilitation data to make decisions. Economic and risk analysis techniques:
❶ Should be applied to most projects and for pulbic policy purposes
36%
❷ Should be applied to some projects
42%
❸ Should not be applied to projects, but should be applied for public policy purposes.
14%
❹ Should not be used for seismic risk mitigation
3%
❺ No opinion
5%
0 10 20 30 40 50 %
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI


Thank you!
NEHRP Workshop on Meeting the Challenges of Existing Buildings
EERI

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ASCE, 2006b, *Seismic Rehabilitation of Existing Buildings*, ASCE/SEI 41-06, American Society of Civil Engineers, Reston, Virginia.

ASCE, 2003, *Seismic Evaluation of Existing Buildings*, SEI/ASCE 31-03, American Society of Civil Engineers, Reston, Virginia.

ATC, 2009a, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 2: Status Report on Seismic Evaluation and Rehabilitation of Existing Buildings*, ATC-71 Report, prepared by the Applied Technology Council for the Federal Emergency Management Agency, Redwood City, California.

ATC, 2009b, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Part 3: Action Plan for the FEMA Existing Buildings Program*, ATC-71 Report, prepared by the Applied Technology Council for the Federal Emergency Management Agency, Redwood City, California.

ATC, 2007, *NEHRP Workshop on Meeting the Challenges of Existing Buildings, Prioritized Research for Reducing the Seismic Hazards of Existing Buildings*, ATC-73 Report, prepared by the Applied Technology Council for the National Science Foundation, Redwood City, California.

FEMA 400, 2005, *Incremental Seismic Rehabilitation of Hotel and Motel Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 399, 2004b, *Incremental Seismic Rehabilitation of Retail Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 398, 2004a, *Incremental Seismic Rehabilitation of Multi-Family Apartment Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 397, 2003c, *Incremental Seismic Rehabilitation of Office Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 396, 2003b, *Incremental Seismic Rehabilitation of Hospital Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 395, 2003a, *Incremental Seismic Rehabilitation of School Buildings (K-12)*, Federal Emergency Management Agency, Washington, D.C.

FEMA 356, 2000, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, prepared by the American Society of Civil Engineers for the Federal Emergency Management Agency, Washington, D.C.

FEMA 315, 1998b, *Seismic Rehabilitation of Buildings: Strategic Plan 2005*, Federal Emergency Management Agency, Washington, D.C.

FEMA 310, 1998a, *Handbook for the Seismic Evaluation of Buildings - A Prestandard*, prepared by the American Society of Civil Engineers for the Federal Emergency Management Agency, Washington, D.C.

FEMA 178, 1992, *NEHRP Handbook for the Seismic Evaluation of Existing Buildings*, prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, Washington, D.C.

FEMA 156, 1988b *Typical Costs for Rehabilitation of Existing Buildings*, Federal Emergency Management Agency, Washington, D.C.

FEMA 154, 1988a, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, Federal Emergency Management Agency, Washington, D.C.

FEMA 90, 1985, *An Action Plan for Reducing Earthquake Hazards for Existing Buildings*, Federal Emergency Management Agency, Washington, D.C.

ICC, 2006a, *International Building Code*, International Code Council, Washington, D.C.

ICC, 2006b, *International Existing Building Code*, International Code Council, Washington, D.C.

Applied Technology Council Projects and Report Information

One of the primary purposes of the Applied Technology Council is to develop resource documents that translate and summarize useful information to practicing engineers. 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 Dwellings*, 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 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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