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RECOMMENDATIONS OF PROJECT ’17 PLANNING COMMITTEE FOR NEXT-GENERATION GROUND MOTION MAPS FOR BUILDING CODES

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Abstract

During the period January to September 2015, a joint committee of United States Geological Survey (USGS) representatives and Building Seismic Safety Council (BSSC) volunteers and staff conducted planning for Project ‘17. Project ‘17 is envisioned as a joint USGS-BSSC effort intended to facilitate the coordination of practicing engineers and USGS scientists engaged in formulating the rules by which next-generation seismic design value maps will be developed. These seismic design value maps are different from the hazard maps produced by USGS in that they modify the hazard to values deemed appropriate as a basis for structural design. The Project ‘17 effort must be completed in sufficient time to facilitate balloting and inclusion of the new maps in the 2020 NEHRP Recommended Provisions for Seismic Regulations of New Buildings and Other Structures. The Project ’17 Planning Committee conducted two meetings and several teleconferences, and conducted public outreach. During the course of its initial meeting, the Committee identified a series of 13 issues that could be considered in the Project ‘17 effort. These ranged from procedural issues associated with the timing of map production, and means of delivery of mapped seismic design values, to technical issues associated with the underlying risk basis for the maps and detailed issues of seismic hazard calculation. Following development of these issues, the Committee prepared a series of written issue summaries, which it then presented in a series of 3 webinars to interested and invited members of the public including practicing engineers, state and local geologists, regulators and academics. Interested participants were invited to provide oral and written comment and were also asked to participate in a poll to rank the importance of the issues. Following receipt of public comment, the Committee met a final time to review the information received and develop a consolidated set of recommendations for the conduct of Project ‘17. The Committee recommended an effort of approximately 30-month duration, during which the USGS will develop draft maps based on the rules proposed for addressing the key issues, with time allowed for evaluation and refinement of the proposed rules. The committee is comprised of a main committee and four task committees tasked with evaluating each of the key issues identified in the planning effort: (i) Balancing uncertainty and precision in the maps; (ii) definition of acceptable risk; (iii) development of multi-period spectral parameter values and spectra; and (iv) definition of procedures for computing deterministic maps. The main committee and each of the task committees plan to meet once per quarter throughout the duration of the project to resolve these issues and develop their recommendations for the technical basis and procedures to be followed in preparing next-generation seismic design value maps for inclusion in the NEHRP Provisions. This paper for the 16th World Conference on Earthquake Engineering summarizes the key issues identified.

Keywords: design criteria; ground motion maps; building codes

1. Introduction

1.1 Purpose

This paper summarizes the recommended scope of a joint United States Geological Survey (USGS) and Federal Emergency Management Agency (FEMA) project (Project '17) to develop a consensus basis for next-generation seismic design value maps and/or tools for adoption by the 2020 NEHRP Recommended Provisions for New Buildings and Other Structures (NEHRP Provisions), the ASCE 7-22 Minimum Design Loads and Criteria for Buildings and Other Structures, and the 2024 International Building Code. These recommendations were prepared by a joint committee of volunteer engineers empaneled by the Building Seismic Safety Council (BSSC) and USGS engineers and earth scientists. BSSC provided secretariat functions for this joint committee. The purpose of these recommendations is to provide FEMA guidance in planning for the Project '17 effort.

1.2 Background

An important goal of the National Earthquake Hazards Reduction Program (NEHRP) is to promote the development, improvement, and adoption of reliable, nationally applicable, building code requirements for earthquake-resistant construction. In furtherance of this goal, FEMA has supported the BSSC's periodic development and update of the NEHRP Provisions. Since 1992, the NEHRP Provisions has been the primary resource document for seismic design criteria contained in the ASCE-7 standard, and more recently, the International Building Code. The NEHRP Provisions assign seismic loading through reference to a series of national seismic design value maps produced by the United States Geological Survey (USGS) in cooperation with BSSC. In this process, BSSC typically defines the rules by which the maps are produced (e.g. designation of parameters, hazard levels, etc.) while the USGS has applied the science necessary to produce the maps.

The USGS has periodically updated the national seismic design value maps in support of updates to the NEHRP Provisions. Typically, the updated maps have followed rules established by BSSC in prior editions of the NERHP Provisions, but with updated scientific basis (fault locations, activity rates, ground motion prediction models, etc.) applied to produce more current values for the mapped parameters. Approximately one time each decade, BSSC and USGS have collaborated to re-examine the basis for the maps, and the rules under which they are produced, resulting in major change to the basis and values contained on the maps.

Under the 1997 Provisions update cycle, BSSC and USGS performed Project '97. Project '97 included a group of more than 30 leading engineers and earth scientists representing private practice and government research and regulatory agencies, who over a period of two years formed a series of subcommittees to explore a variety of topics associated with seismic design procedures and design seismic hazards. In conjunction with this evolution in the national seismic hazard maps, BSSC made major revision to the seismic design procedures contained in the NEHRP Provisions. As a result of the Project '97 recommendations, the 1997 NEHRP Provisions [1,2] adopted a series of innovations into the seismic design procedures referenced by the building codes, including: (i) Definition of a Maximum Considered Earthquake (MCE) shaking hazard level for which mapped values would be provided. (ii) Establishment of a 2%-in-50-year exceedance probability for MCE shaking, except in areas near major active faults, where deterministic limits were placed on mapped values. (iii) Establishment of MCE spectral response acceleration for a reference site class condition (S_S and S_1) as the mapped parameters. (iv) Establishment of rules for setting a deterministically derived limit on the mapped values of S_S and S_1. (v) Establishment of site-adjusted design spectral acceleration values S_{DS} and S_{D1}–taken as 2/3 of the MCE values, following adjustment for Site Class effects–as the parameters used to determine required seismic strength. The resulting maps formed the basis for the 1997, 2000 and 2003 editions of the NEHRP Provisions [1, 3, 4]; ASCE 7-98 [5], ASCE 7-02 [6] and ASCE 7-05 [7]; and, the 2000, 2003, 2006 and 2009 editions of the International Building Code [8, 9, 10, 11] and International Residential Code [12, 13, 14, 15].

During the 2009 NEHRP Provisions update cycle, BSSC and USGS collaborated in an effort known as Project '07, again resulting in substantive changes to the design basis underlying the NEHRP Provisions and the design value maps referenced by the Provisions. Significant changes included: (i) Establishment of probabilistic MCE shaking hazards on a uniform risk, rather than uniform hazard basis [16]. (ii) Selection of a notional 1%-in-50-year collapse risk as the primary design goal for ordinary occupancy structures located in regions where design seismic values are probabilistically rather than deterministically based. (iii) Selection of maximum direction, as opposed to geomean values, for mapped parameters. (iv) Adjustment of the deterministic caps to a true 84th percentile rather than 150% of the median. The resulting maps formed the basis for the 2009 NEHRP Provisions [17], ASCE 7-10 [18], and the 2012 and 2015 editions of the International Building Code [19, 20] and International Residential Code [21, 22].

During development of the 2015 NEHRP Provisions [23, 24], the BSSC Provisions Update Committee (PUC) considered a proposal to adopt new maps developed by USGS. USGS had produced the new maps using the basic rules established previously by the Project '97 and Project '07 efforts, but incorporating updated databases on source activity rates and segmentation, and updated ground motion prediction equations. As would be anticipated, mapped values in some locations increased and in others decreased, with the amplitude of change generally falling under 20%, but sometimes reversing directional trends observed in recent prior map revisions. Of particular note were changes to a number of deterministic zones associated with faults having low activity rate. After review of early drafts of the maps, the PUC suggested revision of the deterministic zone definitions, the USGS revised the maps, and the PUC adopted the revised maps. However, this adoption was not by unanimous vote and several PUC members expressed dissatisfaction with the process for developing the maps and the lack of opportunity for the structural engineering community to provide input to map development. This dissatisfaction carried over into the ASCE-7 committee, which initially rejected (but ultimately accepted) the new maps for inclusion in ASCE 7-16. FEMA conceived of the concept for Project '17 to address these concerns and authorized the planning effort, which resulted in a report [25] that is summarized by this paper.

1.3 Project Participants

The Project '17 Planning Committee included a group of structural and geotechnical engineers who have been active in the BSSC Provisions Update process, together with USGS engineers and earth scientists, and with FEMA representatives and a secretary provided by BSSC. Table 1 below presents the project participants.

Table 1. Project 17 Planning Committee Participants

Name	**Affiliation**
David Bonneville[1,3]	Degenkolb Engineers
C.B. Crouse[2,3,5,6]	AECOM
Ned Field	United States Geological Survey
Art Frankel[6]	United States Geological Survey
Ronald Hamburger[2,3,4,6,7]	Simpson Gumpertz & Heger Inc.
Robert Hanson[3,11]	University of Michigan (Emeritus)
James Harris[2,3,5,6]	J.R. Harris and Associates
William Holmes[2,5,6]	Rutherford & Chekene
John Hooper[2,5,8]	Magnusson Klemencic Associates
Charles Kircher[2,3,4,6]	Kircher & Associates
Nico Luco[2,3,5]	United States Geological Survey
Morgan Moschetti	United States Geological Survey
Robert Pekelnicky[2,3,9]	Degenkolb Engineers
Mark Petersen	United States Geological Survey

Peter Powers	United States Geological Survey
Sanaz Razaeian[3]	United States Geological Survey
Phillip Schneider[10]	Building Seismic Safety Council
Mai Tong[12]	Federal Emergency Management Agency

Notes:

1. Chair 2015 Provisions Update Committee
2. Member 2015 Provisions Update Committee
3. Member ASCE-7 Seismic Subcommittee
4. Chair Project 07
5. Member Project 07 Committee
6. Member Project 97 Committee
7. Chair, Project 17 Planning Committee
8. Chair, ASCE-7 Seismic Subcommittee
9. Chair, ASCE-41 Committee
10. Executive Director, BSSC
11. Consultant to FEMA
12. FEMA Project Officer

1.4 Process

The Project '17 Planning Committee was formed in January 2015 with a teleconference. The committee first met on 12 February to talk through the project intent, and to identify key issues that the committee members believed should be addressed by the Project '17 effort. Team members then produced a series of summary write-ups for each issue that described the particular issue, why it was important, and approximately, the preferred means of resolving the issue, and required resources. These were combined into a consolidated document (Appendix C of [25]), reviewed by the team as a whole and edited, based on team member comments.

The committee met by teleconference several times in April and May 2015 to plan for a limited effort of public outreach in which knowledgeable and interested members of the public were invited to provide input to the committee as to additional issues that should be considered, and the relative priority of the various issues. The committee then held a series of three webinars on June 25, July 20 and July 27, 2015. The first of these webinars provided a broad overview of the Project '17 goals, and an overview of the issues identified by the planning committee. Participation in this webinar was made widely available. The two follow-on webinars, in which participation was by invitation, presented focused and more detailed discussion of the individual issues. Participants were invited to ask questions on the materials presented, and to provide input to the committee. Following the webinars, invited participants were asked to participate in a poll to assist in prioritizing the issues. Appendix A of [24] includes the slides used by the webinar presenters. Appendix B of [25] summarizes the participant poll results.

On 12 August 2015, the planning committee met again to review public input, and to formulate its recommendations for the Project '17 effort, as summarized herein.

2. Issues

The Project '17 Planning Committee initially identified the following issues as important for consideration in the Project '17 effort: (1) Timing for Updated Map Publication; (2) Design Value Conveyance; (3) Precision and Uncertainty; (4) Acceptable Collapse Risk; (5) Collapse Risk Definition; (6) Maximum Direction Ground Motion Components; (7) Multi-Period Spectral Values; (8) Duration as a Mapped Parameter; (9) Damping Levels; (10) Vertical Motion Parameters; (11) Use and Definition of Deterministic Parameters; (12) Basin Effects; and (13) Use of 3-D Simulation to Develop Long Period Parameters. These range from procedural issues, such as how often updates to the maps should be made; to design procedure issues such as the acceptable risk levels upon which the maps should be based; to detailed technical issues as to how hazards analysis should be conducted in support of the maps, e.g. for long period parameters. Appendix C of [25] presents a brief summary of each issue describing the issue itself, reasons why the issue should be considered, potential disadvantages to incorporation of the issue in the project, and assessment on a preliminary basis of the needed resources.

In addition to the above issues, the Planning Committee also considered several other potential issues including: (a) Providing Mapped Parameters for additional levels of hazard including potential Service and/or Function Level earthquakes; (b) Decoupling Seismic Design Categories from site class effects; (c) Inclusion of induced seismicity in seismic hazard calculation. After initial discussion, the committee elected not to continue further discussion of these three additional issues, and did not develop summary write-ups for them. The committee decided not to continue consideration of additional mapped hazard levels or seismic design category determination within the Project '17 scope because it observed that the BSSC Provisions Update Committee is the more appropriate body to evaluate these issues.

The committee acknowledged that induced seismicity, e.g., seismicity associated with human activity, including deep ground water injection and fracturing of oil-bearing rock formations, is an important concern because earthquakes associated with these activities are increasing in some regions that have not historically had significant seismicity, causing both damage and significant concern in some communities. However, the committee did not consider it appropriate to include this effect in national seismic hazard maps intended for reference by the building codes because the present understanding of this phenomena is immature, resulting in great uncertainty as to hazard severity; and, the regions in which induced seismicity may occur in the future can be quite transitory, depending on the economic effectiveness of this particular extraction technique and life of specific production fields.

During the committee's deliberations it was noted that the ASCE 41 [26] standard also references seismic design value maps and that these maps have a somewhat different basis than do the maps referenced by the ASCE 7 standard and the building codes. Consideration was given to expanding the scope of Project '17 to address the additional maps referenced by ASCE 41. The committee acknowledged the importance of this standard, and also a need for an appropriate group to establish the rules by which design value maps for existing buildings are developed. However, after much discussion, the committee decided that this would represent an expansion of the project scope for which there were not adequate resources. Instead, the committee recommends establishment of strong liaison between the Project '17 Committee and the ASCE 41 standard committee so that the ASCE 41 Committee has knowledge of and can benefit from the Committee's work.

3. Recommendations

3.1 Primary Issues

The Project '17 Planning Committee recommended that Project '17 be charged with consideration of the following issues: (A) Balancing uncertainty and precision in the maps; (B) Definition of acceptable risk; (C) Development of multi-period spectral parameter data and spectra; and (D) Definition of procedures for computing deterministic maps. Brief discussion of these issues, why they are deemed important, and preliminary insights into possible resolution of these issues follows.

3.1.1 Balancing Precision and Uncertainty

Prior to publication of the 1997 NEHRP Provisions, seismic design value maps referenced by U.S. building codes portrayed design values imprecisely, either in the form of seismic zones or Ca and Cv coefficients. The seismic zones assigned uniform values of the mapped seismic design value to broad regions, using single digit values of the mapped parameters (e.g. 0.4g, 0.3g etc). Ca and Cv coefficients also were portrayed with limited precision, to cover broad regions. Commentary to the building codes suggested that the mapped values represented, in an approximate manner, the intensity of shaking having a 10% probability of exceedance in 50 years, but that there was considerable uncertainty and variability associated with the values at any site relative to the mapped value. Most engineers understood that the mapped values represented approximations of the true seismic hazard at a site, that there was considerable probability that actual ground motions experienced would be either greater or less than the mapped value, and that the mapped value simply represented a minimum value deemed acceptable for design. In part because the maps portrayed seismic hazard in an imprecise manner, and in part because research progress in seismic hazards was limited, the maps were stable from one building code edition to the next, with relatively few changes in the specified design values. This enabled engineers to be comfortable with the values, regardless of their accuracy, and more important, the detailing and structural system requirements prescribed by the building code, which are inherently tied to the ground motion design values, also remained stable.

Following the publication of the 1997 NEHRP Provisions, the maps presented design values in the form of parameter contour lines, where contour values were indicated with two or in some cases three digit values. Despite the publication of design values to three significant figures, the uncertainties inherent in the parameter values are quite high. The apparent precision in the contour values masks these high uncertainties. Further, small changes in the science basis underlying the maps, from edition to edition, creates significant changes in contour values, sometimes up, sometimes down, when often these changes in values are not statistically significant. These seemingly small changes in mapped values can have significant effect on design requirements, and create loss of confidence among the design populace that the maps are believable and suitable for use.

Under this task, the Project '17 Committee should seek to develop engineering interpretation of the computed values based on science that can be portrayed as design values having precision appropriate to the uncertainty associated with their calculation, potentially allowing for increased stability of the values in future map editions. This can be accomplished through a return to the use of zones, through plotting of contours on a coarser gradation, or other means.

3.1.2 Acceptable Risk

As mentioned above, prior to publication of the 1997 NEHRP Provisions, design seismic value maps contained in the building codes portrayed hazards approximating ground motion parameters having a 10% probability of exceedance in 50 years (475 year mean return period). The 1997 NEHRP Provisions adopted seismic design value maps portraying parameters having a 2% probability of exceedance in 50 years, with deterministic caps in some regions, because it was felt necessary to go to this exceedance probability to capture large events in the eastern U.S. that had occurred in historic times, such as the 1811-1812 New Madrid series of events and the 1886 Charleston earthquake. The deterministic caps were necessary to limit design ground motions in areas close to major active faults, such as some sites in Los Angeles, Salt Lake City and San Francisco to credible values approximating those that had been actually recorded, and having reasonably small probability of exceedance considering what was thought to be the maximum magnitude earthquakes that could occur on the controlling faults. In order to retain the use of the R values, historically used to adjust design ground motions to required design force levels for different systems, the 1997 NEHRP Provisions simultaneously adopted a philosophy that the mapped values represented Maximum Considered values, for which collapse avoidance was desired, and that design values, for which Life Safety performance was desired, could be taken as 2/3 the mapped values.

The 2009 NEHRP Provisions adopted a revised basis for the MCE maps consisting of ground motions that would results in a 1% collapse risk in 50 years for buildings having a fragility with a 10% probability of collapse given the occurrence of MCE motion. This definition resulted in somewhat different probabilities of exceedance for ground motion across the U.S. depending on the slope of the hazard curve, that is, the rate of change of shaking intensity with increasing probability of exceedance. Across much of the western U.S., however, the exceedance probability remains at approximately 2% in 50 years. Deterministic caps were retained.

Since the 1997 NEHRP Provisions were developed, earth scientists have developed different understanding of the likely recurrence interval for large magnitude earthquakes in the New Madrid seismic zone. Current thinking suggests that exceedance probabilities on the order of 5% in 50 years would adequately capture recurrence of the New Madrid events. Had this 5%-in-50-year exceedance probability been selected originally, this may have avoided the need to adopt deterministic caps on mapped ground motion parameter values.

Under this issue, the Project '17 Committee is charged with evaluating whether it would be advisable at this time, to adopt the 5%-in-50-year hazards or other exceedance probability as the basis for the MCE maps, and whether or not the values are adjusted to achieve uniform collapse risk, as was done in the 2009 NEHRP Provisions. Assuming that it is decided to adopt a reduced hazard level for the MCE maps, determination should be made whether deterministic caps need still be applied.

Consideration should also be given to whether adjustment of the mapped values to obtain uniform collapse risk is appropriate. This was done in part to moderate the values of design ground motions in the eastern U.S., something which may not be desirable or necessary if an alternative hazard level is selected. Advantages of retaining the uniform collapse risk definition would provide a measure of stability in the code-specified procedures. However, return to a uniform hazard definition would considerably simplify both the hazard calculation procedures and engineers' ability to explain the ground motion basis to other stakeholders.

Finally, if the uniform collapse risk definition is retained, the way this is portrayed in commentary should be revisited. While the 1%-in-50-year collapse risk, which underlies the current maps, is consistent with the FEMA P-695 procedure, this procedure was not really developed specifically for that purpose. Knowledgeable engineers generally believe that the FEMA P-695 procedures significantly overestimate the collapse risk of most real buildings. Improved discussion of these issues or, alternatively, use of somewhat different fragility definitions to perform the collapse risk evaluation, would reduce the current incongruity between code commentary, map basis, and actual expectations for building performance.

3.1.3 Multi-Period Spectral Values

During the closing months of the 2015 PUC cycle, study was undertaken of compatibility of current Site Class coefficients, F_a and F_v with the NGA ground motion prediction equations (GMPEs) used by USGS to produce the design maps. In the course of this study, it was discovered that the standard spectral shape derived from the S_{DS}, S_{D1}, and T_L parameters is not appropriate for soft soil sites (Site Class D or softer) where hazard is dominated by large magnitude events. Specifically, on such sites, the standard spectral shape overstates the spectral demands for short period structures, and substantially understates spectral demand for moderately long period structures. The PUC initiated a proposal to move to specification of spectral acceleration values over a range of periods, abandoning the present three parameter format, as this would provide better definition of likely ground motion demands. However, this proposal was ultimately not adopted due to both the complexity of implementing such a revision in the design procedure and time constraints. Instead, the PUC adopted a proposal prohibiting the use of the general three-parameter spectrum, and instead requiring site-specific hazard determination, for longer period structures on soft soil sites.

Project '17 is charged with re-evaluating the use of multi-period spectra as a replacement or supplement to the present three-parameter spectral definition. If the multi-period spectral definition is indeed adopted, then Project '17 should also evaluate whether basin effects, near field effects and other effects typically included in site-specific studies should be considered in development of the maps. It also will be necessary for the Project '17 Committee to consider how the basic design procedures embedded in ASCE 7 should be modified for compatibility with the multi-period spectra.

3.1.4 Deterministic Values

If, in the consideration of acceptable risk, an acceptable risk is selected that requires the continued use of deterministic caps, the Project '17 Committee is charged with development of an updated definition of these caps. Project '97 defined the deterministic caps in terms of characteristic earthquakes on controlling faults. Seismologic practice has recently evolved away from the definition of characteristic earthquakes. Thus, a new definition of the "maximum considered" deterministic event is necessary.

3.2 Other Issues

The Planning Committee combined several of the issues in the original list together and included them in the recommendations contained above. In addition, the Committee determined that several of the issues it originally identified as important to development of next-generation seismic design value maps need not be part of the Project '17 scope. Generally this was either because the Planning Committee observed that other organizations could better deal with the specific issue, or that insufficient knowledge is presently available to allow satisfactory resolution of the issue and inclusion of the needed technology into map generation. In a few cases, the committee observed that there was insufficient need to warrant the expenditure of effort necessary to respond to the issue. The following sections describe the committee's recommendations with regard to these remaining issues.

3.2.1 Combined Issues

The issue of collapse risk definition was combined with the issue of acceptable risk, presented in Section 3.1.2. The issue on consideration of basin effects was combined into the development of multi-period spectral values. The Planning Committee wishes to note concern that, presently, well defined models necessary for inclusion of basin effects are available for the Puget Sound region, and presently under development for the Los Angeles region. Many other regions have such basins. The Planning Committee believes that explicit inclusion of these effects in some regions, and exclusion elsewhere, can be problematic for implementation and enforcement of the building code requirements.

The issue associated with use of 3-D simulations was not directly combined with other issues, nor was it rejected. The Planning Committee has no objection to USGS using such simulations to inform its development of the maps and notes that this will likely be very helpful in the inclusion of basin effects, should the Project '17 Committee elect to proceed with inclusion of these effects.

3.2.2 BSSC-specific Issues

The Planning Committee recommends that BSSC again reconsider two issues previously considered in prior PUC cycles. Specifically, the Planning Committee recommends that the PUC reconsider the use of maximum direction components of ground motion in mapping, and the use of alternative hazard levels associated with functionality, or other performance goals. The decision to use maximum direction component ground motions, as opposed to geomean, was undertaken as part of the Project '07 effort, and included in the 2009 NEHRP Provisions. Despite achieving consensus in the BSSC process, this proposal drew heavy criticism from BSSC member organizations, and from many individual geotechnical engineers and earth scientists. The argument against use of maximum direction ground motions is that it is unlikely that a structure will be oriented such that it will be fully sensitive to this component of motion, and consequently, use of this component, as opposed to geomean motion, represents an increase in the exceedance probability of MCE and design motions. The Planning Committee recommends that the PUC review this argument, and either elect to stay with maximum direction motions; apply a directionality coefficient, similar to wind criteria; or, revert to geomean motions; as deemed most appropriate.

In the 2015 Provisions Update Cycle, two issue teams, IT-02 - Evaluation of Performance Objectives and Re-evaluation of Seismic Design Categories and IT-07 - System Exclusions and Height Limits and SDCs, evaluated extension of the performance objectives inherent in the Provisions to address issues other than structural collapse, including post-earthquake functionality and the performance of nonstructural components in general. The issue teams evaluated materials developed in the ATC-84 project [27], but could not come to consensus on supplemental performance objectives. In the event that the 2020 PUC does come to such consensus, USGS can proceed to develop maps for the any additional hazard levels required.

In addition to the above two issues, the Planning Committee recommended that BSSC consider evaluation of recent research suggesting improved methods of developing response spectra for damping values other than 5%. It may be appropriate for the PUC to develop a proposal to update damping adjustment factors compatible with the findings of this research.

The Planning Committee also believed that the issue of design value conveyance is one that can be resolved by BSSC without reliance on the Project '17 Committee. If the Project '17 committee moves forward with multi-period spectral values, it will not be practical to convey the information in the form of printed maps. BSSC will need to develop a procedure for appropriate reference of an archive-worthy electronic database with version control. Some concern was expressed that it will be necessary to provide means of verification for any such database and/or tools that are adopted to use such a database.

3.2.3 USGS-specific Issues

One of the several issues explored by the Planning Committee related to timing for production of the maps. This issue considered whether USGS should publish design maps at more frequent intervals than required for Provisions updates, or not. The Planning Committee ultimately decided that USGS may elect, on its own, to publish maps at any interval it deems appropriate, and it was not the business of the Project '17 Committee to make recommendations on this. However, the Committee did note that in order for updated maps to be referenced by the building code, they would need to be produced in sufficient time to permit the BSSC Provisions Update Committee to review them. For the upcoming cycle, this will require a draft hazard model in 2018 and completion of the maps by mid-2019. Close coordination and communication with the Provisions Update Committee through the development process is recommended.

3.2.4 Duration as a Mapped Parameter

The Planning Committee unanimously agreed that duration is likely a significant factor affecting the destructive intensity of earthquake shaking, and should ultimately be considered in design procedures. However, the Committee noted that significant research into quantification of duration effects on structures will be needed before design procedures can be modified to address this parameter, or maps can be developed that allow appropriate consideration in design. Accordingly, the Committee felt it would be premature to consider a duration parameter at this time in the mapping effort.

3.2.5 Vertical Motion Parameters

Except for seismic design of large storage tanks and some other non-building structures, the NEHRP Provisions consider the effects of vertical ground shaking in an approximate way that does not require quantification of vertical spectral response ordinates. Given the present limited requirement for use of vertical response spectrum parameters in design, and the ability for projects having this need to use site specific study to obtain these parameters, the Planning Committee observed that further consideration of this issue is not warranted at this time.

4. Conclusions

The Project '17 Planning Committee recommended a Project '17 effort involving a main committee, together with 4 supporting task committees, one for each of the issues indicated in Section 3.1 above, that will meet over a period 30 months. As of March 2016, these committees have begun to meet. The committee structure is as follows.

4.1 Main Committee

In addition to USGS-designated participants, the committee consists of 14 participants comprising practicing structural and geotechnical engineers and building officials with expertise in seismic design, and representation of all major regions of the U.S. with significant seismic issues. The Main Committee plans to meet approximately one time each quarter throughout the 30-month project duration, or until the project's tasks are completed. The Main Committee includes individuals selected to provide liaison and coordination with both the Provisions Update Committee and the ASCE 7 Seismic Task Committee.

4.2 Task Committee on Precision and Uncertainty

This committee includes 7 persons comprising practicing structural and geotechnical engineers; a building official from an agency located in a region of high seismicity; USGS liaisons; and, potentially, representatives of community planning and/or insurance organizations. This task committee plans to meet once per quarter for a period of 18 months, then twice per year for the remaining project duration.

4.2 Task Committee on Multi-Period Spectral Values

This committee includes 7 persons comprising practicing structural and geotechnical engineers and USGS representatives. This task committee plans to meet once per quarter for a period of 18 months, then twice per year for the remaining project duration.

4.3 Task Committee on Acceptable Risk

This task committee includes 8 members comprising USGS representatives, structural engineers familiar with the risk basis inherent in the present NERHP Provisions, and persons suggested in the ATC-84 report. Representatives have understanding of the cost impact of design for various intensities of ground shaking. An economist with an ability to provide information on cost-benefit tradeoffs associated with design for better performance might also be added. This task committee plans to meet once per quarter for a period of 18 months, then twice per year for the remainder of the project.

4.4 Task Committee on Deterministic Caps

In as much as alteration of the Acceptable Risk target inherent in the Provisions may negate or substantially alter the need for deterministic caps, the Project '17 Planning Committee recommend this committee not commence its work until the second year, assuming a continuing need for deterministic caps is established. Envisioned is a task committee of three engineers with knowledge of structural/seismic design together with three companion USGS representatives with knowledge of present models for definition of possible rupture events on faults. This task committee will meet quarterly for a period of approximately 12 months to develop its recommendations.

5. Acknowledgements

This draft manuscript is distributed solely for the purposes of scientific peer review. Its content is deliberative and predecisional, so it must not be disclosed or released by reviewers. Because the manuscript has not yet been approved for publication by the USGS, it does not represent any official USGS finding or policy.

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