



Department of Energy
Washington, DC 20585

May 21, 2009

MEMORANDUM FOR: DISTRIBUTION

FROM: RICHARD H. LAGDON, JR. 
OFFICE OF SAFETY MANAGEMENT AND OPERATIONS
OFFICE OF ENVIRONMENTAL MANAGEMENT

SUBJECT: Summary of the Fourth Seismic Lessons-Learned Workshop
Held March 24-25, 2009

Enclosed is a summary of discussions at the fourth seismic lessons-learned workshop held in Washington, DC in the last week of March 2009. These workshops, held semiannually, provide an opportunity for experts involved with seismic hazard assessments and design efforts across the DOE complex to share their knowledge and experience. The goal is to improve the Department's performance in assessing seismic hazards and designing facilities to mitigate them.

The workshop featured experts from DOE, the U.S. Nuclear Regulatory Commission, the Defense Facilities Nuclear Safety Board, as well as private-sector consultants, sharing knowledge of recent activities and developments in this field. Highlights included a discussion on modeling engineered fill; proposed guidance on design, analysis, and qualification of certain equipment; a review of Structural Summary Reports for the Hanford Waste Treatment Plant and Salt Waste Processing Facility; and new American Nuclear Society Standards related to seismic hazard characterization.

The workshop also provided a status report for the Central and Eastern U.S. (CEUS) Seismic Source Characterization project. This project started in May 2008, and is on schedule for completion in late 2010. The project will create a model reflecting current understanding of seismic sources in the CEUS, which has improved significantly since the existing model was created about 20 years ago. The model will be generically applicable to nuclear facilities in the CEUS, benefiting both DOE and the commercial nuclear industry. The project is equally funded by DOE and the Electric Power Research Institute, with the DOE share to date provided by the Office of Nuclear Energy and the Office of the Chief of Nuclear Safety. The project plays a key role toward improving natural hazard assessment and design at DOE facilities.



A focus of the fourth workshop was identifying specific steps that DOE can take in the coming months to improve DOE's project management as it relates to seismic design. One such action was developing questions for appropriate EM Standard Review Plan (SRP) modules that will lead projects to consider seismic hazard characterization earlier in the process, engage peer review teams at multiple steps in the design process, and ensure that facility and component design proceeds in a logical manner with regard to seismic loads. These questions are now being integrated into the EM SRP. Panel members also suggested specific guidance that can be issued by DOE to improve performance, and reduce redundancy, in contractors' seismic design efforts across the DOE complex. EM staff are reviewing these recommendations and considering the development of such guidance, and how it might integrate with planned efforts by the Office of Health, Safety and Security to revise the DOE natural phenomena hazard standards and guidance documents.

This lessons-learned workshop will continue to be held semiannually. DOE or contractor personnel interested in attending should contact Dr. Stephen McDuffie at (509) 373-6766 or Dr. Brent Gutierrez at (803) 208-2969. The next workshop is tentatively planned for October 2009.

Attachment

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**MINUTES FROM THE SEISMIC LESSONS-LEARNED PANEL
MARCH 24-25, 2009**

Background

The Office of Environmental Management (EM) hosted the fourth meeting of the seismic lessons-learned panel at DOE Headquarters in March 2009. This panel was originally commissioned by the Chief of Nuclear Safety (CNS) in August 2007, and EM continues to sponsor the work. These workshops are intended for experts involved in seismic hazard assessments and resulting facility designs across the DOE complex to share experience from their work. The workshops occur approximately twice per year.

Participants

John Ake, U.S. Nuclear Regulatory Commission (NRC)
George Antaki, Becht Engineering
Tim Arcano, DOE-EM
Said Bolourchi, Simpson Gumpertz & Heger
Brent Gutierrez, DOE-Savannah River
Robert Jackson, Schnabel Engineering, LLC
Jeff Kimball, Defense Nuclear Facilities Safety Board (DNFSB)
Chip Lagdon, DOE-EM
Fred Loceff, Frederick Loceff Technical Services
Jennifer McCloskey, DOE-EM
Steve McDuffie, DOE-EM
Jerry Meyers, DOE Office of Health, Safety, and Security (HSS)
Tom Miller, DOE Office of Nuclear Energy (NE)
Jim O'Brien, DOE-HSS
Rich Reister, DOE-NE
Larry Salomone, Savannah River Nuclear Solutions (SRNS)
Caroline Serafinas, DOE-EM
J. Carl Stepp, EHS

Summary

The first day of the workshop was held in the DOE Germantown facility. Mr. Lagdon, host of the workshop, provided introductory remarks thanking participants for their attendance and discussing recent organizational changes within DOE. The EM organization will likely get reshaped under the guidance of a new Assistant Secretary in coming weeks, and he expects a new emphasis on cost controls within major construction projects. Mr. Lagdon emphasized the need for the panel to provide tangible recommendations and products in the coming months to help DOE improve its performance in, and its guidance for, seismic characterization and design of nuclear facilities. In May 2009, Mr. Lagdon plans to provide a briefing for the new Assistant Secretary on the accomplishments of the lessons-learned panel and the work that lies

ahead. The workshop was facilitated by his staff members Steve McDuffie and Tim Arcano.

Past Panel Recommendations – Steve McDuffie

Dr. McDuffie summarized the past recommendations provided by the lessons-learned panel. Most of the recommendations were provided at the first meeting in August 2007; from which the minutes are available. The recommendations were classified as either technical or programmatic. Dr. McDuffie presented nine technical recommendations relating to existing guidance and technical practices of seismic design. The eight programmatic recommendations related to improving contract and project management. Dr. McDuffie asked the panel members to consider actions that might be taken to address some of the past recommendations. One past recommendation is for DOE to provide guidance on selecting seed earthquakes. Jeff Kimball mentioned that the DNFSB staff plans to provide written comments on Carl Costantino's draft paper on this topic and then meet with Dr. Costantino to discuss it. Another recommendation is to require contractors to create a seismic equipment list. This might be appropriate for DOE G 420.1-2, except that Guides should not contain requirements. It can be considered for addition to DOE O 420.1B, which is slated for revision in 2010. Several programmatic recommendations relate to the DOE procurement process and providing more specificity for seismic design in contracts. Panel members commented that DOE must make expectations clear in requests for proposals, and keep in mind that contractors are likely to subcontract out geotechnical analyses and seismic design. Prequalification of bidders can be helpful for screening out unqualified bidders, but technical staff need to work closely with procurement staff to explain the merits of this approach. Requiring peer review early in a project enhances integration across disciplines and reveals any shortcomings in the seismic design process. Another programmatic recommendation is to clarify DOE's backfit requirements. No current policy controls backfits to changing requirements, but the forthcoming Policy on establishing code of record, DOE P 427.X.X should largely address the issue. This topic led to extensive discussion among the group. Finally, regarding the recommendation on standards for maintaining critical documents, Fred Loceff noted that summary structural reports clearly identify all design documents that should be preserved.

Lessons Learned from Modeling Engineered Fill – Said Bolourchi

Dr. Bolourchi discussed some recent experience modeling the effect of fill on soil structure interaction (SSI) responses. Backfill properties are often poorly constrained, and codes and standards for modeling backfill are lacking. He reviewed modeling performed for three DOE facilities: the Pit Disassembly and Conversion Facility (PDCF), the Integrated Waste Treatment Unit (IWTU), and Chemistry and Metallurgy Research Replacement (CMRR); as well as the ultimate heat sink for a commercial plant in Texas. The PDCF faced challenges due to uneven fill thickness and an unknown borrow source, so the range of fill properties was increased to account for the uncertainty. IWTU had fill both under and around the structure. No consensus was reached on how to model this fill for SSI, so it too was modeled with a high range of fill properties and an

additional higher bound soil. At CMRR, modeling the side backfill was undesirable due to model run time, so a two-dimensional parametric analysis was performed. Mr. Antaki suggested that modeling fill is a good example where modeling guidance provided in advance can help avoid the use of excessively conservative model inputs resulting from soil property uncertainties. Both bounding and parametric studies have advantages and disadvantages. Bounding can allow more flexibility in borrow material properties, but may impact the design and increase cost. Parametric can improve the design and reduce construction cost, but narrow the acceptable range of soil properties. Dr. Bolourchi closed by recommending that modeling work should include parametric analyses to determine the effects of fill variation on SSI responses, as well as the sensitivity. Furthermore, guidance on when and how to model fill would be useful for DOE to issue. Mr. Antaki added that guidance on selecting fill would be helpful. Finally, concern was expressed that the commercial nuclear industry is taking steps to modify ASCE 4, *Seismic Analysis of Safety-Related Nuclear Structures*, to include modeling guidance that is more complex than necessary for DOE facilities.

Seismic Equipment List Recommendation – George Antaki

Mr. Antaki offered advice for DOE that he believes will help improve seismic design performance by DOE contractors. First, he addressed the need for a seismic equipment list. This list would identify individual components, their function, and their seismic design category (or performance category) and limit states. This should not be just a listing; rather, piping and instrumentation diagrams should be marked with system boundaries and individual components should be identified. Mr. Antaki stated that the ASCE/SEI 43-05 standard, section 8.2.3.1, is much too vague in its requirement for determining component capacity when performing seismic qualification by analysis. He sees a need for guidance on seismic design, analysis, and qualification of certain equipment and components where existing standards are insufficient. These guides would ideally provide one or more modeling examples. The objective of such component-specific guides and modeling examples is three-fold: achieve consistent, high-quality seismic qualification across the DOE complex; prevent duplication of effort by multiple projects; and avoid rework and delays resulting from peer, DOE, or DNFSB reviews. The most pressing needs are for guides on pressure vessels, gloveboxes, fire protection piping systems, and safety-class confinement ducts. Completion of these four guides will also convey to contractors clear design expectations from DOE, leading to better cost estimates and less mid-project rework. Prior to the conclusion of the workshop, Mr. Antaki provided proposals for creating the guides. Jeff Kimball suggested that EFCOG might be willing to support such work, lessening the cost to DOE. Mr. Antaki also stated that contractors can benefit from a roadmap through the DOE and national standards as they apply to seismic design of components, and he shared a proposal for such a roadmap.

Observations from DNFSB – Jeff Kimball

Dr. Kimball provided comments on natural phenomena hazard (NPH) work within DOE. He stated that the recent work on seed record selection by Carl Costantino will be useful

and represents a technical advancement stemming from the work of the panel. Dr. Kimball suggests that DOE's entire approach to NPH should be reviewed. He thinks the forthcoming ANS 2.3 standard on wind loads will be quite useful, although its release may be a year or more in the future. He emphasized the value of the NPH conferences that DOE held regularly until the mid-1990s, and reviving these could add significant value to the Department.

Structural Summary Report Review – Fred Loceff

Structural Summary Reports (SSRs) originated from the need for contractors to specify the seismic load path for structures and the structural response of complex, safety-class building structures. The reports allow reviewers to assess the structural design and adequacy of the supporting analysis. In addition, they are useful in understanding how an existing structure may be impacted by modifications or mission changes. Mr. Loceff described the information that should be contained in an SSR, and he demonstrated the format similarity between the SSRs for the Salt Waste Processing Facility (SWPF) and Waste Treatment and Immobilization Plant (WTP). He provided the detailed tables of contents for these SSRs, as well as some general observations. For example, SSRs are best prepared after major design work is complete. Jeff Kimball concurred, stating that the SSR should summarize how design problems were solved; it should not be the document to solve the problems. Mr. Loceff noted that SWPF prepared a preliminary load path study before much analysis and design was initiated, and the load path report included recommendations that resulted in an improved structural design. Structural drawings should not be included in an SSR since they are living documents and easily accessible outside the SSR. Mr. Loceff recommends that DOE require SSRs as deliverables for most major construction projects, depending on complexity, and forewarn contractors that SSR preparation is not a trivial effort. Contractors should be provided expectations for SSR content. In addition, he thinks that early load path evaluations should be required.

Development of the Central and Eastern U.S. (CEUS) Seismic Source Characterization Model – Larry Salomone

Dr. Salomone provided a progress report on the CEUS project. This project will replace the existing seismic source models dating to 1989 and 1993, using the level 3 Senior Seismic Hazard Analysis Committee (SSHAC) process to capture the current knowledge and uncertainties of the scientific community. The project is funded by DOE, the Electric Power Research Institute, and the U.S. Nuclear Regulatory Commission. The completed CEUS seismic source model will greatly streamline seismic characterization work at DOE sites in the CEUS, as well as benefit the commercial nuclear industry by limiting alternative interpretations during plant licensing. Dr. Salomone discussed the project organization and schedule; it began in June 2008, and is slated for completion in late 2010. The preliminary model is currently being developed by the technical integrator team, and it will be presented to the participatory peer review panel in May. A workshop in August 2009 will provide feedback on the model. One challenge still facing the project is identifying the remainder of DOE's share of funding; \$555K is still needed

during fiscal years 2009 and 2010. Jeff Kimball mentioned that this project will provide stability in the probabilistic seismic hazard assessments (PSHAs) for CEUS sites, which is very important for performance-based design. Following the presentation, participants discussed the differences and merits of performing a SSHAC level 3 study for this project versus level 4.

Discussion of Questions for the Standard Review Plan Module

The balance of day 1 was devoted to discussing the EM Standard Review Plan (SRP) module, the need to include seismic design in this module, and possible questions that can become part of the module. Tim Arcano began the discussion by providing some background on the SRP, Technical Authority, and the forthcoming DOE Policy on code of record. The SRP modules will provide the bases for key decisions and deliverables associated with the critical decision (CD) process, and the specific lines of inquiry can be tailored to the project. Each phase of a project (CD-0, CD-1, preliminary design, etc.) will have unique review questions. The project reviews will be led by the Federal Project Director, with oversight by the Technical Authority. In the case of a seismic or structural design review, a team of qualified experts will use the SRP questions to perform a review. Jeff Kimball provided a list of seismic characterization and design actions to be taken at various stages of nuclear facility development, and these can serve as a starting point for SRP questions. Brent Gutierrez had some additional questions, and he agreed to combine the two lists. The combined list will be sent to the group for review and additions.

Suitability of ANSI/ANS 2.26, 2.27, 2.29, and ASCE/SEI 43-05 for Implementation of DOE-STD-1189-2008 – Brent Gutierrez and Carl Stepp

The second day of the workshop was held in the DOE Forrestal Building. Drs. Gutierrez and Stepp began the second day of the workshop with a discussion of the role the new ANS standards might play in DOE's implementation of DOE-STD-1189-2008, *Integration of Safety Into the Design Process*. Standards 2.26 and 43-05 were published in 2004 and 2005, respectively, and Appendix A of 1189 specifies how to apply those two standards to seismic design of DOE facilities. Standards 2.27 and 2.29 were published in late 2008. Standard 1189 was issued earlier in 2008 with the statement in Appendix A that until 2.27 and 2.29 are issued and adopted by DOE, DOE Standards DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria*, and DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria*, should continue to be used. Dr. Gutierrez stated an opinion that the panel should formally recommend that DOE adopt 2.27 and 2.29, and no dissent was noted, but Jim O'Brien said DOE-HSS must review the Standards before DOE formally adopts them. Despite this suite of new national standards that is largely based on DOE experience in applying seismic guidance in the 1020 series of Standards, they do not provide all necessary design guidance. Appendix A of 1189 provides some supplemental guidance for implementing 2.26, but additional guidance for 2.27 and 2.29 appears necessary. Table 1 of 2.27 refers to a maximum considered earthquake, but for consistency with 43-05, this should be restated as an annual probability of hazard exceedance. Moreover, Table 1 of 2.27 calls for

characterizing seismic sources contributing 5 percent or more to a site hazard, but for DOE purposes this should probably be 1 percent, to ensure a complete hazard analysis. Finally, Section 4.4 of 2.27 on characterization for site response analysis should reference Section 5.4 of 2.29, which contains very good guidance for site response analysis. Regarding 2.29, Drs. Gutierrez and Stepp recommended that Section 5.1.1 on lower-bound magnitude include further guidance to use EPRI TR 1012965, *Use of CAV (cumulative absolute velocity) in determining effects of magnitude earthquakes on seismic hazard analysis*.

General Discussion of Standards and Action Items

The final presentation segued into a more general discussion of the national standards and how they should be implemented within DOE. Dr. Kimball mentioned that the new national standards stem from an agreement between DOE and DNFSB long ago to transition from the 1020 series to new ANS standards. The 1020 series can still be used for other NPH considerations, but he pointed out that the consequences from seismic hazards generally bound all NPH. Jim O'Brien stated that DOE is planning to revise the 1020 standards, removing the seismic hazard portions. This will be in part a response to 1189 implementation, with its reliance on the ANS standards for seismic hazards, but will not occur until the new ANS 2.3 standard is issued. Dr. O'Brien is concerned that some valuable guidance in the 1020 standards might be lost in this process, and DOE-HSS is working to prevent such a loss. Jerry Meyers stated that DOE O 420.1B and DOE G 420.1-2 will also be revised, and some key aspects in the Guide might be moved into the Order so they become requirements rather than guidance. Dr. Gutierrez stated that DOE staff across the complex are only generally aware of the new standards and their criteria. He suspects that safety analysts will have more difficulty transitioning from the 1020 series and its nomenclature than will the seismic and structural engineers.

Dr. Kimball reiterated the importance of guidance for site response analysis, particularly in generating randomized profiles for site response. Dr. Stepp suggested that Standard 2.29 include additional guidance on selecting a site response approach based on the facility hazard classification. He suggested that someone with Carl Costantino's expertise (panel member absent from this meeting) would be a first choice for drafting such guidance. Dr. Gutierrez suggested that such guidance could be issued by DOE or DOE-EM, and might be tied to 1189. Dr. Stepp further explained the difference between deconvolving ground motions from the surface versus generating randomized profiles. Randomized profiles avoid deconvolution, but this method must consider the overburden from the profile point of ground motion extraction. Dr. Stepp also sees benefit to guiding DOE sites in the CEUS in performing their site-specific analyses to accompany the analysis to be provided by the CEUS project, and guiding western U.S. sites on the level of site-specific PSHA to perform. Mr. Antaki mentioned that WTP is performing some state-of-the-art seismic analyses, and this knowledge should be disseminated. Dr. Arcano stated that part of the vision for Technical Authority within EM is to facilitate such information flow across projects. Bob Jackson noted that a database on site geotechnical data would be helpful; apparently Savannah River has such a database.

Mr. Antaki discussed his proposal for creating guidance on seismic design, analysis, and qualification of pressure vessels, gloveboxes, fire protection piping systems, and safety-class confinement ducts. On March 26, 2009, he provided DOE with cost and schedule estimates for completing these guides, and DOE staff will consider them for funding. Dr. Kimball mentioned that the CMRR and Uranium Processing Facility (UPF) projects are performing glovebox shake-table testing, and Mr. Antaki expressed an interest in learning more about this. Dr. McDuffie committed to provide Mr. Antaki more information on these tests. Mr. Loceff offered to write proposals for establishing finite element modeling mesh requirements, as well as instruction and content requirements for SSRs. These were provided to DOE on March 31. Mr. Loceff also offered to take action toward reviving the DOE-wide NPH conference. Dr. Gutierrez offered to write implementation guidance to accompany the new ANS standards, as he recommended in his presentation.

An important action without a clear deliverable at this time is for Dr. McDuffie to maintain regular communication with HSS on 1189 implementation and how adopting the ANS standards and modifying the 1020 series Standards, DOE O 420.1B, and DOE G 420.1-2 will dovetail with 1189 implementation.

Some extra time remained before scheduled adjournment, so Mr. Meyers raised a question about Table VI-4 in DOE M 440.1-1A, the DOE Explosives Safety Manual. Drs. Kimball and Gutierrez provided some insights to aid Mr. Meyers.

Follow-up Actions:

Action	Due Date	Lead
Provide proposals for creating guidance on seismic design, analysis, and qualification of pressure vessels, gloveboxes, fire protection piping systems, and safety-class confinement ducts.	3/26/2009 COMPLETE	G. Antaki
Provide a combined list of questions on seismic design for an SRP module.	3/31/2009 COMPLETE	B. Gutierrez
Provide proposals for establishing finite element modeling mesh requirements and instruction and content requirements for SSRs.	3/31/2009 COMPLETE	F. Loceff
Provide Mr. Antaki with information on glovebox shake table tests from the CMRR and UPF projects.	4/17/2009 COMPLETE**	S. McDuffie
Provide proposal for re-establishing the DOE NPH conference.	6/30/2009	F. Loceff
Prioritize proposals from panel members for funding.	4/30/2009 COMPLETE	S. McDuffie
Provide draft guidance for implementing ANS Standards 2.27 and 2.29.	7/30/2009	B. Gutierrez
Brief EM senior management on panel activities.	7/30/2009	S. McDuffie

Action	Due Date	Lead
Dr. Costantino and EM staff meet with DNFSB staff to discuss time history work for SSI analysis.	7/30/2009	S. McDuffie
Shape final list of questions into lines of inquiry for incorporation into the SRP module.	5/29/2009 COMPLETE	S. McDuffie

** No information on shake table tests is currently available. No tests have been conducted, and none are scheduled at this time due to project changes.