

## **MINUTES FROM SEISMIC LESSONS-LEARNED PANEL OCTOBER 6, 2009**

### **Background**

The Chief of Nuclear Safety (CNS) and the Office of Environmental Management (EM) hosted the fifth meeting of the seismic lessons-learned panel at the DOE Forrestal Building on October 6, 2009. This panel was originally commissioned by the CNS in August 2007, and it meets approximately twice per year. 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 and improve project performance.

### **Participants**

John Ake, U.S. Nuclear Regulatory Commission (NRC)  
Said Bolourchi, Simpson Gumpertz & Heger  
Carl Costantino, CJC & Associates  
Brent Gutierrez, DOE-Savannah River  
Robert Jackson, Schnabel Engineering, LLC  
Jeff Kimball, Defense Nuclear Facilities Safety Board (DNFSB)  
Chip Lagdon, DOE-CNS  
Fred Loceff, Frederick Loceff Technical Services  
Steve McDuffie, DOE-CNS  
Gerry Meyers, DOE Office of Health, Safety, and Security (HSS)  
Larry Salomone, Savannah River Nuclear Solutions (SRNS)  
J. Carl Stepp, Earthquake Hazard Solutions  
Ali Tabatabai, Link Technologies

### **Summary**

Mr. Lagdon opened the workshop with a summary of DOE organizational changes. His CNS position is again reporting to the Under Secretary of Energy, and Bob Raines will fulfill Mr. Lagdon's prior role of managing construction project reviews for EM. Mr. Lagdon plans to provide funding to complete the Central and Eastern U.S. Seismic Source Characterization (CEUS-SSC) project in fiscal year 2010, and he hopes to have some funding available for the Next Generation Attenuation – East (NGA-East) project. His group is refocusing its efforts on nuclear facilities with the potential for low-probability, high-consequence accidents. Mr. Lagdon emphasized his desire to see the panel's efforts bring positive results to DOE.

### **Status of Past Panel Recommendations and Proposed Projects – Steve McDuffie**

Dr. McDuffie reviewed the past recommendations provided by the lessons-learned panel. Nine technical and eight programmatic recommendations were presented in the March 2009 meeting, and he discussed the progress on implementing each. Several recommendations have been implemented; most of these through completion of the

Seismic Design Expectations Report in August 2009. This report is being incorporated into the EM Standard Review Plan (SRP), and it provides lines of inquiry for project reviewers to ensure that seismic characterization and design are properly managed in construction projects. One technical recommendation—for DOE to provide guidance for selecting seed earthquakes—is being addressed through a paper coauthored by Carl Costantino. The paper will eventually be published by Los Alamos National Laboratory, but the authors are still awaiting feedback from DNFSB staff. While discussing the technical recommendation to change from performance categories to seismic design criteria and limit states for structures, systems, and components, Jeff Kimball mentioned the need to consider limit states for wind as well as seismic hazards. This will require an integrated understanding of functional design requirements and DOE safety basis requirements.

One of the programmatic recommendations—for DOE to specify by contract the experience level of seismic and geotechnical engineers—is still awaiting action. Several panelists provided additional comments on this recommendation. Larry Salomone stated that contractors should not be allowed to change their proposed geotechnical and seismic design subcontractors post-award. Said Bolourchi stated that a quality peer review team cannot substitute for competent contractors to perform the initial work. Brent Gutierrez suggested that guidance could be created to assist Federal Project Directors in selecting peer reviewers, and for Source Evaluation Boards in evaluating geotechnical and seismic design subcontractors. Mr. Kimball and Carl Stepp stated that peer review teams require a strong leader with an integrative mind. Another recommendation awaiting progress is for DOE to develop a list of prequalified soil-structure interaction (SSI) subcontractors for bidders to consider during the procurement process. Dr. Salomone suggested that minimum criteria for SSI contractors should be developed. Mr. Kimball added that a structural design plan should dovetail with this need, as a design plan explains how a contractor will do the design work. DOE can then evaluate, albeit post-contract award, the capabilities of the SSI subcontractor. Dr. Costantino stated that an experienced peer review team is paramount. All agreed that detailed seismic analysis criteria should be established early in a project.

The panel discussed at some length the programmatic recommendation to enforce standards for maintaining critical documents. The original intent of this recommendation was to establish a configuration management policy, but the discussion turned to summary structural reports (SSRs). Fred Loceff noted that SSRs should sometimes be required for a project, but often the need for an SSR is not known until the building is partially designed. Mr. Kimball expressed his skepticism toward SSRs, but any safety-related structure should have a system design description. Dr. Costantino replied that impacts from design modifications are difficult to trace without an SSR. Dr. Bolourchi suggested that DOE mimic the NRC process, in which basic structural design information is required with the initial combined operating license application.

Finally, Dr. McDuffie provided the status of four recommendations made during the March 2009 meeting. One of these was to provide guidance on when to model backfill, and how to select and model backfill. Drs. Bolourchi, Costantino, and Salomone all

offered their assistance in drafting such guidance, which could be based in part on criteria from the NRC and the Nuclear Energy Institute's seismic issues task force.

#### Soft Zone Investigation Program Status – Brent Gutierrez

Dr. Gutierrez provided an update on the soft zone investigation program at Savannah River (SR). This work is contracted to the Georgia Institute of Technology, and field work began in January 2009. The primary project goal is to determine whether static or cyclic issues exist that could lead to soft zone collapse beneath SR facilities. At this time the results are insufficient to preclude soft zone settlement as an issue, so work will continue into 2010. The 2009 work followed four lines of inquiry: geochemical analysis, laboratory testing, field testing, and settlement prediction; each of which has a corresponding work focus. The 2009 field work was conducted within the Accelerator Production of Tritium Site, approximately one mile long and one-half mile wide. This site has less prevalent soft zones than some other parts of the SR Site. Data collected include 1 video cone penetrometer test, 5 seismic cone penetrometer tests, 18 cone penetrometer tests, 6 borings, and 40 undisturbed samples. Soil mineralogy was characterized through X-ray diffraction and a scanning electron microscope (SEM), and the SEM photos are shaping the thinking of how these materials behave. On a macroscale, the soft zone samples appear to consist of sand and silt embedded in a fine-grained matrix, and SEM photos show the matrix to be a mixture of clay sheets and needle-like crystals. Laboratory testing has revealed "worm holes" indicating that soft zone dissolution was not uniform, but followed preferred pathways. The 2010 research will pursue the same lines of inquiry as 2009, with field work focusing on geophysical and alternate sampling techniques.

#### Hanford Probabilistic Seismic Hazard Assessment (PSHA) – Steve McDuffie

Dr. McDuffie provided a brief overview of the PSHA published for the Hanford Site in 1996. This effort predated the guidance provided by the Senior Seismic Hazard Analysis Committee (SSHAC) on performing PSHAs. The Hanford PSHA assigned a probability of activity of 0.25 to most of the Yakima Fold seismic sources, which have the greatest impact on Hanford's seismic hazard. The response spectra at the Waste Treatment Plant were revised in 2007 after subsurface data were collected for that location, but the seismic source characterization and ground motion attenuation have not been reviewed since the 1996 study. The draft Mid-Columbia PSHA report issued in July 2009 reinterpreted the Yakima Fold sources in modeling seismic hazards at several dams on the Columbia River. Applying this new model at Hanford would likely lead to a significant increase in seismic hazard for the Site.

## PSHA Project for the Mid-Columbia Dams – Carl Stepp

Dr. Stepp provided an overview of the draft Mid-Columbia PSHA report commissioned by three public utility districts that own six dams upstream of Hanford along the Columbia River. He reviewed the tectonic framework and ground motion modeling in the study and summarized the results. He did not review the logic tree of the model. One of the unsettled issues in the Yakima Fold Belt is thick-skinned versus thin-skinned fault behavior, and Dr. Stepp suggested the seismic velocity profile and the mostly shallow historical seismicity argue for thin-skinned faulting. For longer period ground motion, near-source, magnitude 6-7 events provide the greatest contribution to hazard. The model uses Next Generation Attenuation ground motion relationships, which appear to be appropriate for the region, but it also assumes a  $V_{s30}$  of 760 meters/second, which may not be appropriate for the Columbia Basin. Dr. Stepp believes that the ground motion modeling from subduction zone earthquakes is inadequate. He suggests that any future such modeling in the Columbia Basin employ the techniques used in the BC Hydro PSHA, which he considers the state of the practice. Dr. Stepp believes that, for several reasons, the Mid-Columbia PSHA is not suitable to serve as the DOE-required 10-year update to the Hanford PSHA. However, the study can serve as a useful resource if DOE performs a new Hanford PSHA using Level 3 of the SSHAC guidance. He sees the study as a conservative consensus hazard estimate of the mid-Columbia seismic sources. Mr. Kimball added that the U.S. Army Corps of Engineers recommended several years ago that a new PSHA for Hanford is appropriate. Jon Ake mentioned that the NRC staff is not reviewing the Mid-Columbia PSHA results and is not concerned with seismic hazard analyses around the Hanford Site at this time.

## Application of the EM SRP to the U-233 Downblending Project Civil-Structural Review – Fred Loceff

Mr. Loceff described a recent review of this project, which will result in major modifications to the 3019 Building at Oak Ridge. The review, which served as a 60 percent design review, relied on lines of inquiry in the EM SRP as guidance. Less than a week was allowed for the review, and the volume of calculations, drawings, and computer codes did not allow for a thorough review. Mr. Loceff noted that some of the new structures, systems, and components in this facility will be supported by concrete anchored on rock, while others will be on slabs based in soil. The prime contractor and subcontractors were very accommodating and receptive to reviewer comments. One observation was that calculations were performed to revision 0 of the design criteria rather than the current revision 3. In addition, Mr. Loceff noted that the site design spectrum was not clearly seismic site Class A, and the selection of seismic site class was not consistent among buildings, structures, and supported equipment. He found that oversimplified assumptions were used to model the confinement steel, process cell, and their interaction and that selection of structural steel code was inconsistent. He believes that the identified issues can be resolved before the 90 percent design review. Regarding the short review time, Mr. Loceff noted that in the past, DNFSB staff have been highly

critical of peer reviews that do not provide adequate expertise and time to perform a thorough review.

#### SSI Analysis Including Ground Motion Incoherency Effects – Carl Costantino

Dr. Costantino originally presented this information on incorporating ground motion incoherency into SSI at the Uranium Processing Facility (UPF) meeting on September 29. Spatial incoherency describes the similarity of the phase angles between two locations recording ground motions. Incoherency between two points increases with ground motion frequency and distance between points. Measuring incoherency during earthquakes requires a dense recording array. The Pinyon Flat array, on hard rock near the Salton Sea, has provided much quality data to guide development of empirical models. In May 2008, the NRC staff accepted the use of hard rock coherency functions based on these data, as described in an Electric Power Research Institute (EPRI) report. Dr. Costantino discussed the implementation of incoherency models in the SSI codes System for Analysis of Soil-Structure Interaction (SASSI) and Continuum Linear Analysis of Soil-Structure Interaction (CLASSI), as well as some caveats to their use. The EPRI study used simplified stick models; current efforts are running full finite element models. The finite element runs are yielding inconsistent results. Dr. Costantino does not believe these variable results are the result of incoherence, but rather how the models are run. The stick model for the design of the Westinghouse AP1000<sup>TM</sup> pressurized water reactor shows good agreement among the SASSI and CLASSI codes, but finite element modeling of incoherence needs more work. He believes that success will come in time, but he is uncertain about developing a useful tool for NRC staff to use. Finally, he noted that structural demands pose no problem; calculating demands on equipment is the current challenge.

#### Status of Seismic Design Issues at the Waste Treatment Plant at Hanford (WTP) and the UPF – Fred Loceff

Mr. Loceff provided a status of structural design issues at these two facilities from his perspective on the design peer review teams. WTP has a final SSR, although it is still subject to change. The DNFSB staff still has a number of open questions about the high-level waste (HLW) facility at WTP, and responses are gradually being provided to the staff. Composite beam modeling at HLW and UPF remains a key outstanding issue; modeling the steel and concrete connection has not been resolved. The peer review team for WTP design has asked Bechtel National to perform additional modeling, but Mr. Loceff expects this issue to be resolved shortly. The peer review focus will then turn to HLW structural steel calculations. The finite element mesh coarseness is a concern at UPF. The number of elements between floors is currently deemed inadequate, although the peer reviewers for the design subcontractors believe the mesh is adequate. Mr. Loceff would like to see the mesh criteria used at WTP applied at UPF. A movement is underway to add some mesh criteria to the American Society for Civil Engineers (ASCE) Standard 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary* (ASCE 4).

## Update on the CEUS SSC Project – Larry Salomone

Dr. Salomone updated the panelists on the progress of this project, which has been discussed at past meetings. During this presentation, a variety of related seismic characterization topics were discussed. Dr. Salomone noted that the NGA-East project will begin producing ground motion models in three to five years, at which time the SSHAC process (at Level 3 or higher) will be applied to that project. Dr. Ake stated that NGA-East results have the potential for a greater impact on hazard results than the SSC project. Dr. Salomone stated that CEUS seismic monitoring is sparser than desired, and improved data collection can benefit the NGA-East project. He has had discussions with Congressional representatives who are receptive to providing funding for operation and maintenance of seismic monitoring equipment in the CEUS. The panelists discussed the past decision to conduct the CEUS SSC project at SSHAC Level 3 versus Level 4; the consensus is that Level 3 is appropriate for this study. Discussion also touched on actions NRC will need to take to formally accept the CEUS SSC model for use in licensing nuclear power plants. The NRC staff has been asked by the Advisory Committee on Reactor Safeguards to inform the Committee of how the staff will go about adopting the report. Dr. Ake stated that the NRC staff can do little to begin this process before a completed product is available. Dr. Stepp mentioned that a SSHAC Level 3 study, capturing the full range of the informed technical community, should meet the NRC definition of providing reasonable assurance. Dr. Salomone stated that a recent letter from the CEUS project peer review panel declares that the project is implementing the SSHAC process well so far. Dr. Stepp, co-chairman of that panel, concurred that the project is being managed well.

## Discussion of ASME Standard NQA-1, *Quality Assurance Requirements for Nuclear Facility Applications*, Subpart 2.20

Several months prior to this meeting, panelists were provided with the current version of NQA-1, Subpart 2.20, *Quality Assurance Requirements for Subsurface Investigations for Nuclear Power Plants*. CNS staff are currently compiling comments for a forthcoming revision, and comments from the panelists were solicited. Dr. Stepp suggested that the Subpart could be improved by including references to other documents such as NRC Regulatory Guides and by requiring a peer review. He also believes that this document is written at a higher level (i.e., less detailed) than he would expect for a quality assurance requirement. Dr. Bolourchi noted that Subpart 2.20 refers to unspecified ASTM International standards; listing the actual standards would be more helpful. Dr. Jackson found the document to be similar to an International Organization for Standardization (ISO) 9000 document, describing the types of procedures that need to be in place. Dr. Costantino provided written comments before the meeting, and he likewise noted the lack of references to ASTM standards and Regulatory Guides.

## Discussion of Other Committees

Dr. McDuffie discussed his recent contacts with the Interagency Committee on Seismic Safety in Construction (ICSSC), a Federal government interagency committee, and the

International Seismic Safety Center (ISSC) of the International Atomic Energy Agency (IAEA). Mr. Kimball shared his historical knowledge of the ICSSC, which became inactive several years ago but seems to be rekindled. The ICSSC was established in response to Executive Orders 12699 and 12941 on the seismic safety of federally owned buildings. Drs. McDuffie and Gutierrez participated in a conference call of the ICSSC in August 2009, concluding that the discussions were marginally relevant to DOE nuclear facilities.

The ISSC was established by the IAEA in October 2008, largely through the initiative of Japan after the 2007 Niigataken Chuetsu-Oki earthquake. Dr. Stepp served on this committee for a short time and shared his perspective. He believes the committee plans to examine seismic safety at a number of nuclear power plants around the world. Dr. Ake shared his experience on how IAEA member nations have different views of “reasonable assurance.”

### DOE Directive Updates

Gerald Meyers reported on updates to DOE directives. DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and NonNuclear Facilities*, has been rewritten to include references to the new standards ANSI/ANS-2.26, -2.27, and -2.29, as well as some information on lightning protection. The Directives Review Board has some concerns, and Mr. Meyers has no estimate of when the revision might enter the DOE RevCom system for review. An action from the March 2009 meeting was to provide some guidance to accompany the adoption of the standards ANSI/ANS-2.27 and -2.29. This guidance can be recommended as an addition when the new version of DOE G 420.1-2 enters RevCom. Once the ANS-2.3 standard is issued, DOE plans to adopt it for designing against extreme winds and tornadoes. An update to DOE O 420.1B, *Facility Safety*, is also planned, but Mr. Meyers is unsure whether it will occur on schedule.

### Results of Paducah Independent Review

Dr. McDuffie summarized the activities of the Paducah Independent Review Team over the last year. This team, which included Dr. Gutierrez and Mr. Loeff, was commissioned to advise DOE’s Portsmouth and Paducah Project Office (PPPO) on necessary site characterization activities as they consider whether to construct a waste disposal cell on the Paducah Site. The team provided an initial report with eight recommendations in January 2009, then a final report considering PPPO comments in June 2009. The team held a teleconference with PPPO staff, contractors, and regulators that same month to discuss the recommendations. PPPO staff and regulators disagreed with some of the recommendations, and the team had a teleconference with just PPPO staff and contractors in August 2009 to reiterate certain DOE requirements for characterizing seismic hazards.

**Follow-up Actions:**

<b>Action</b>	<b>Due Date</b>	<b>Lead</b>
Select and commission one or more topics, suggested by panelists, for guidance development.	12/31/2009	S. McDuffie
Provide draft guidance to accompany adoption of ANSI/ANS-2.27 and -2.29 to include in the next revision to DOE G 420.1-2.	2/28/2010	B. Gutierrez
Dr. Costantino and CNS staff meet with DNFSB staff to discuss time history work for SSI analysis.	3/31/2010	S. McDuffie
Provide guidance to DOE Federal Project Directors for selecting seismic design peer reviewers and to DOE Source Evaluation Boards for evaluating geotechnical and seismic design subcontractors.	6/30/2010	B. Gutierrez