



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 11, 2016

Mr. Edward D. Halpin
Senior Vice President and Chief
Nuclear Officer
Pacific Gas and Electric Company
P.O. Box 56
Mail Code 104/6
Avila Beach, CA 93424

SUBJECT: AUDIT REPORT REGARDING PACIFIC GAS AND ELECTRIC COMPANY'S
SEISMIC SOURCE MODELS RELATED TO THE NEAR-TERM TASK FORCE
RECOMMENDATION 2.1 - SEISMIC FOR: DIABLO CANYON POWER PLANT,
UNIT NOS. 1 AND 2 (CAC NOS. MF5275 AND MF5276)

Dear Mr. Halpin:

On March 12, 2012¹, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.54(f). The purpose of that request was to gather information concerning, in part, the seismic hazard at operating reactor sites to enable the NRC to determine whether licenses should be modified, suspended, or revoked. The "Required Response" section of Enclosure 1 of the request indicated that licensees should provide a seismic hazard evaluation and screening report. By letters² dated March 11, 2015, August 12, 2015, September 16, 2015, December 2, 2015, and December 21, 2015, Pacific Gas and Electric Company (PG&E, the licensee) submitted for NRC review its Seismic Hazard and Screening Report (SHSR), Pursuant to 10 CFR 50.54(f), Request for Information Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident for Diablo Canyon Power Plant, Unit Nos. 1 and 2 (DCPP, Diablo Canyon).

By letter dated August 14, 2015³, the NRC issued a regulatory audit plan, which identified the technical areas for review during the audit related to DCPP's SHSR seismic source models and all the associated and relevant supporting documentation used in the development of these models. The purpose of this audit was to enable the NRC staff to come to a better understanding of the licensee's seismic source characterization performed for the Diablo Canyon site. The information gained from this audit will support the NRC staff's review and subsequent development of its staff assessment. By letter dated December 2, 2015, the licensee provided a response to technical requests made during the staff's regulatory audit, which was held on August 26 and 27, 2015.

¹ The letter can be found under Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340.

² The letters can be found under ADAMS Accession Nos. ML15071A046, ML15071A046, ML15259A600, ML15349A874, and ML15362A569, respectively.

³ The audit plan can be found in ADAMS Accession No. ML15217A356.

E. Halpin

- 2 -

If you have any questions, please contact me at (301) 415-1115 or by e-mail at Nicholas.DiFrancesco@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Nicholas DiFrancesco", with a long horizontal flourish extending to the right.

Nicholas J. DiFrancesco, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-275 and 50-323

Enclosure:
Audit Report

cc w/encl: Distribution via Listserv



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

REPORT OF REGULATORY AUDIT REGARDING PACIFIC GAS AND ELECTRIC
COMPANY'S SEISMIC SOURCE MODELS RELATED TO THE NEAR-TERM TASK FORCE

RECOMMENDATION 2.1 - SEISMIC FOR
DIABLO CANYON POWER PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-275 AND 50-323

BACKGROUND

On March 12, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12053A340), the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.54(f). The purpose of that request was to gather information concerning, in part, the seismic hazard at operating reactor sites to enable the NRC to determine whether licenses should be modified, suspended, or revoked. The "Required Response" section of Enclosure 1 of the request indicated that licensees should provide a seismic hazard evaluation and screening report. By letters dated March 11, 2015, August 12, 2015, September 16, 2015, December 2, 2015, and December 21, 2015 (ADAMS Accession Nos. ML15071A046, ML15071A046, ML15259A600, ML15349A874, and ML15362A569, respectively), Pacific Gas and Electric Company (PG&E, the licensee) submitted for NRC review its Seismic Hazard and Screening Report (SHSR), Pursuant to 10 CFR 50.54(f), Request for Information Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident for Diablo Canyon Power Plant, Unit Nos. 1 and 2 (DCPP, Diablo Canyon).

By letter dated August 14, 2015 (ADAMS Accession No. ML15217A356), the NRC issued a regulatory audit plan, which identified the technical areas for review during the audit related to the Diablo Canyon's SHSR seismic source models and all associated and relevant supporting documentation used in the development of these models, methodologies, process information, calculations, and computer models. The purpose of this audit was to enable the NRC staff to come to a better understanding of the licensee's seismic source characterization performed for the Diablo Canyon site. The information gained from this audit will support the staff's review and subsequent development of its staff assessment.

Enclosure

AUDIT ACTIVITIES

The NRC audit team consisted of:

- Nicholas DiFrancesco, Japan Lessons-Learned Division, Office of Nuclear Reactor Regulation
- Diane Jackson, Division of Site Safety and Environmental Analysis, Office of New Reactors
- Clifford Munson, Division of Site Safety & Environmental Analysis, Office of New Reactors
- Jon Ake, Division of Engineering, Office of Nuclear Regulatory Research
- Vladimir Graizer, Division of Site Safety & Environmental Analysis, Office of New Reactors
- Scott Stovall, Division of Engineering, Office of Nuclear Regulatory Research
- Thomas Weaver, Division of Engineering, Office of Nuclear Regulatory Research
- John Stamatakis, Director of Technical Programs, Center for Nuclear Waste Regulatory Analyses (CNWRA) consultant to the NRC
- Miriam Juckett, CNWRA consultant to the NRC
- Alan Morris, CNWRA consultant to the NRC

The licensee supporting staff consisted of:

- Jearl Strickland (PG&E Technical Services, Director)
- Nozar Jahangir (PG&E Technical Services, Manager)
- Steve Thompson (Lettis Consultants International, Inc)
- Hans AbramsonWard (Lettis Consultants International, Inc.)
- Glenn Biasi (University of Nevada Reno)

The audit team reviewed the following documents:

- PG&E, Presentation on Audit Topics 1 through 5, August 26 – 27, 2015
- PG&E, March 2015, Seismic Source Characterization for Diablo Canyon Power Plant, San Luis Obispo County, California
 - Fault Geometry Models
 - Fault Slip Rate Model
 - Rupture Models
 - Magnitude Distribution Models
 - Time Dependency Model
- PG&E, Central Coastal California Seismic Imaging Project, Offshore Studies
 - Offshore Low Energy Seismic Reflection Studies in Estero Bay, San Luis Bay, and Point Sal Areas
 - Stratigraphic Framework for Assessment of Fault Activity Offshore of the Central California Coast Between Point San Simeon and Point Sal

- LCI, Abramson Ward et al, Bulletin of the Seismological Society of America (BSSA), April 23, 2015, Presentation, Stratigraphic Framework of the Central California Shelf for Assessment of Quaternary Activity of Offshore Faults.
- Abramson Ward et al., April 2015, BSSA, Poster, Restoring Fault Slip, Testing Alternative Correlations of Faulted Channels Buried Beneath the Outer Continental Shelf in Estero Bay and the Implications for Slip Rate of the Hosgri Fault
- McLaren, et al., 2008, BSSA, Figure 6 through 9 "Complex Faulting of 2008 M 6.5 San Simeon Earthquake"
- Hanson, et al 1994, San Simeon-Oso terrace strandline
- Johnson et al 2014, Point Estero slip rate
- PG&E, NRC public meeting slides, April 28, 2015

Summary of Audit Discussions

Topic 1: Licensee's Implementation of Multiple Rupture Scenarios for the Seismic Source Characterization for Diablo Canyon

The NRC staff audited licensee's implementation of multiple rupture scenario models. The licensee followed the UCERF 3 modeling approach which not only considers faults as singular fault segments but also considers potential linkages with other nearby faults covering multiple rupture scenarios. This approach captures the range of potential complex rupture topologies observed in previous earthquakes. The licensee described how a portion of the total slip rate for a given fault is allocated amongst each of the rupture scenarios. The use of multiple rupture scenarios including the potential for interactions between nearby faults in complex and splay rupture models captures the aleatory uncertainty. Epistemic uncertainty is implemented through the logic tree approach generally using three point sampling of different fault parameters. The staff also audited the impact on the total hazard of additional rupture scenarios that were not modeled by the licensee. The licensee stated that its seismic source characterization does not capture all of the possible scenarios; however it considers the large number of implemented rupture scenarios to adequately sample the magnitudes, distances, and slip types representative of the fault systems near DCCP.

Topic 2: Fault Geometry Models for the San Luis Pismo Block Faults

The NRC staff audited the licensee's modeling of the reverse dip-slip faults of the San Luis Pismo Block, which consists of Los Osos to the north and San Luis Bay and Oceano faults to the south. The licensee described its use of the geometric constraints on the boundaries of uplift as well as the seismogenic thickness to determine the range of fault dip angles. The licensee stated that shallow dip angles were not considered because they would require (1) the fault ramp to be wider than the boundaries of uplift, (2) the faults to sole into a shallow detachment, and (3) the fault tips would need to be several kilometers deep.

Topic 3: Extension associated with the Hosgri fault

The NRC staff audited evidence for transtension along the Hosgri fault as exemplified by numerous extensional features (e.g. half-graben near Cambria, and grabens A and B northwest

of Point Buchon). The licensee stated that evidence for localized transtension on the Hosgri fault was considered together with other evidence for transpression to support the case that the Hosgri is predominantly a strike-slip fault. The licensee reported that some basins include well-understood stratigraphy based on correlation to the regional sequence stratigraphy and others are less understood because they could not be correlated. Based on offset markers and focal mechanisms the Hosgri is well-constrained as a strike-slip fault. The staff requested geologic data to further investigate offset markers.

Topic 4: Use of fault offset markers to derive fault slip rates

The NRC staff audited the licensee's basis for the slip rate of the Hosgri fault given its relative importance to the hazard. The licensee stated that the determination of the distribution of slip rates on the Hosgri is based on data developed from four locations. The licensee discussed the basis for its weighting of slip rate data derived from the four locations. For each location, the licensee discussed the data quality. Overall, the licensee concluded that the resulting Hosgri slip rate cumulative distribution function well represents the variability in the data for the four locations.

Topic 5: Use of time dependent models

The NRC staff audited the licensee's development of time dependent models; particularly how well the lower and upper values of the equivalent Poisson's ratio (EPR) are constrained. The licensee stated that the development of the EPR leverages the known data on slip rate and the time since the most recent large earthquake. Factor such as the range of displacement for large earthquakes, variations in earthquake recurrence, and the historical record all were used by the licensee to develop the time dependent models.

AUDIT SUMMARY

The audit team performed an independent review of the documents referenced above. The team's observations and specific topics included above were discussed with the licensee to further understand the licensee's actions in characterizing the seismic sources for Diablo Canyon, as documented in the SHSR.

Discussions with the licensee led to an increased level of clarity and understanding regarding the licensee's seismic source characterization performed for the Diablo Canyon site.

By discussing in depth with the licensee the specific topics and the documentation specified above, the team was able to meet the objectives of the audit and has a better understanding of the licensee's seismic source characterization and has sufficient information to address the issues identified in the audit plan.

CONCLUSION

The NRC staff was able to obtain information needed to continue the review and supports issuance of a staff assessment.

E.Halpin

- 2 -

If you have any questions, please contact me at (301) 415-1115 or by e-mail at Nicholas.DiFrancesco@nrc.gov.

Sincerely,

/RA/

Nicholas J. DiFrancesco, Senior Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket Nos. 50-275 and 50-323

Enclosure:
Audit Report

cc w/encl: Distribution via Listserv

DISTRIBUTION:

PUBLIC	RidsNrrPMDiabloCanyon Resource
RidsNrrDoriLpl4-1 Resource	
JLD R/F	RidsNRRJLD Resource
FVega, NRR	SLingman, NRR
MShams, NRR	DJackson, NRR
NDiFrancesco, NRR	RidsRgn4MailCenter

ADAMS Accession Number: ML15345A021

***via e-mail**

OFFICE	NRR/JLD/JHMB/PM	NRR/JLD/JHMB/LA	OGC (NLO)
NAME	NDiFrancesco	SLent	JLindell
DATE	12/22/15	12/ /15	12/23/15
OFFICE	NRO/DSEA/RGS1/BC*	NRR/JLD/JHMB/BC	NRR/JLD/JHMB/PM
NAME	DJackson	MShams	NDiFrancesco
DATE	12/23/15	1/5/2016	1/11/2016

OFFICIAL RECORD COPY