GEOLOGY SITE AUDIT REPORT

COMANCHE PEAK NUCLEAR POWER PLANT, UNITS 3 AND 4

This report describes the U.S. Nuclear Regulatory Commission (NRC) staff's audit activities at the Comanche Peak Nuclear Power Plant (CPNPP). The NRC staff had requested this audit to review additional information necessary for the performance of NRC confirmatory calculations and design reviews that pertain to the NRC staff's safety review of Chapter 2.5, "Geology, Seismology, and Geotechnical Engineering" for Part 2 of the Combined License (COL) Final Safety Analysis Report (FSAR). Luminant Generation Company, LLC (Luminant), applied for a COL to construct and operate two new United States - Advanced Pressurized Reactors (US-APWR), CPNPP Units 3 and 4, adjacent to the existing two units at the Comanche Peak site near Granbury, Texas.

Meeting Sites

July 28, 2009, Comanche Peak Nuclear Power Plant, Somervell County, Texas

July 29 - 30, 2009, CPE/PPC building and NOSF Auditorium, CPNPP, near Somervell County, Texas

Objective

To conduct a site audit at which the applicant, Luminant and Luminant's consultants (Fugro, Risk Engineering, and William Lettis & Associates, Inc.), can discuss and clarify to the NRC and its consultants (United States Geological Survey), seismological, geological, and geotechnical information contained in the FSAR of Luminant's application for a COL. This Audit Report focuses on discussions of portions of Sections 2.5.1, 2.5.2, and 2.5.3 in the FSAR, referred to as Requests for Additional Information (RAI) that the NRC staff had sent to Luminant (July 1 - 17, 2009).

Key Issues Discussed

1. Character, orientation, and bearing capacity of zones of fractures and joints in boreholes near CPNPP, Units 3 and 4.

2. Character and significance of folds in Glen Rose limestone and the Paluxy sandstone within five miles of the Comanche Peak site.

3. Interpretation of evidence for Quaternary movement on principle regional faults including the Mount Enterprise-Elkhart Graben (MEEG) system and Criner fault.

4. Development of the velocity model and source characterization for the probabilistic seismic hazard assessment.

SUMMARY OF STAFF ACTIVITIES

Tuesday, July 28, 2009

NRC Staff Site Audit

Following introductions and the site safety briefing, Luminant provided a brief synopsis of the field trip on and around the Comanche Peak site to observe bedrock exposures, the location of folds mentioned in the FSAR, and some of the Quaternary surfaces near the site. The first stop provided the NRC staff an opportunity to examine and discuss cores from boreholes B1000 and B2000, which represent the stratigraphy at CPNPP, Unit 4 and Unit 3, respectively. The site is underlain by about 230 feet of Cretaceous Glen Rose limestone (including Units A - E3) over 230 feet of Twin Mountains Formation (Units F - I), which unconformably overlies the Mineral Wells Formation. The NRC staff did not visit an outcrop of the latter on the field trip however, based on deep geotechnical borings and exposures of correlative units located outside of the site area, it is mostly comprised of shale. The NRC staff found that much of the core that was examined displays some fracturing however, locally some parts of the displayed cores below 540 feet were not fully recovered. The significance of this recovery was discussed between Luminant and the NRC staff. Luminant indicated that velocity breaks correlate with lithologic changes in the core and the geophysics is consistent from hole to hole. The applicant stated that "the poor recovery was due to drilling issues, not because the rock was weak."

The next stop was to look at the geomorphic expression of the upper part of the Glen Rose limestone. The NRC staff took a short walk across Unit A (a 50-foot-thick limestone) and Unit B (a thinner shale unit) to the top of Unit C. The upper two units will be removed and the foundation of Units 3 and 4 will be on Unit C of the Glen Rose limestone, which is a massive limestone. Units A and B form gentle slopes and the latter is very friable, whereas the NRC staff observed that the more resistant Unit C is cliff-forming.

A brief stop on the Dam afforded a distant view of one of the folds on Figure 2.5.1-217 of the FSAR, identified as the fold near Dam (lat. 32.29124, long. -97.75764). Although the fold is obvious even from this great distance, it is a minor inflection of less than 1 foot and beds below the fold are flat lying. The fold is thought to be the result of intra-strata karst processes and not tectonic in nature. The fold overlies a planar tan-colored layer (prominent layer above road grade in Figure 1B) that extends well beyond the fold. The NRC staff stopped near the bottom of the Dam on a Quaternary terrace of Squaw Creek (shown in Figure 1B) and at a location adjacent to the Brazos River. Frank Syms and Randy Cumbest of William Lettis and Associates (Lettis) presented a summary of the lineament investigations, which included examination of aerial photographs (including photographs of the Squaw Creek fluvial deposits prior to the filling of Squaw Creek Reservoir) for evidence of liquefaction of Quaternary deposits as well as lineament analysis. Their discussion did not suggest that a comprehensive evaluation of the youngest part of the section was performed, the ages of these deposits appear to be unconstrained, and apparently there was no follow-up investigation of exposures in the field.

Squaw Creek Reservoir now inundates the only lineament identified within a five-mile radius of the site as possibly Quaternary deposits.

Figure 1. (A) View from Squaw Creek Reservoir of fold near Dam. (B) View of fold at stop (lat. 32.29124, long. -97.75764).

The NRC staff visited additional field localities of the Glen Rose limestone. In outcrop, the bedrock is locally friable and locally deformed along mostly nearly horizontal bedding planes. The final stop was at the second fold identified on Figure 2.5.1-217 of the COL, Part 2 FSAR. This fold was larger in scale than the other and is identified as coinciding with a lineament identified in the lineament analysis.

Wednesday, July 29, 2009

NRC Staff Site Audit

During the morning meeting at CPNPP, Lettis provided detailed presentations on the geotechnical and seismological investigations for CPNPP Units 3 and 4. Lettis presented an introduction to the regional and site-specific geologic and physiographic setting. The physiography of the region is generally an expression of the resistant versus non-resistant lithologies present. Lettis also discussed the lineament investigation, which included an assessment of the historical aerial photography for evidence of lineaments or liquefaction on alluvial surfaces that are now inundated by Squaw Creek Reservoir, as well as those not covered by the lake. In this assessment, Lettis identified 184 lineaments, of which 37 were field checked.

Lettis summarized field studies of potential seismic sources in the area (including the MEEG) and modeling of those sources. The MEEG is an Eocene, probably shallow, salt-rooted structure. Quaternary movement is highly questionable. Lettis conducted a field evaluation of previously recognized Quaternary displacement and determined that the movement was due to localized land sliding and not tectonic. He suggested, the reported change in leveling data may reflect growth faults at depth. The Criner fault shares many of the same lines of evidence that it is not a Quaternary fault, which is supported by the conclusion that the surficial expression of the Criner is a fault line scarp according to Briggs, Fuller, Kelson, and Unruh (2008) in their Geological Society of America abstract.

NRC Staff's Public Meeting with Luminant

The NRC staff adjourned the audit and convened the public meeting, in the NOSF Auditorium of CPNPP, to review RAIs pertaining to Sections 2.5.1 and 2.5.3 of the FSAR. Refer to the NRC staff's public Meeting Summary, dated November 30, 2009 (ML093221041), for additional information. Many RAIs involve clarification and addition of figures or correction of figures that more clearly explain seismological or structural relations and geologic history in the site vicinity. Luminant addressed how it intended to respond to some of the RAIs discussed.

All of the RAIs were reviewed during the public meeting. The following RAIs are those of particular note. Luminant discussed its response to RAI 02.05.01-3, regarding the general lack of documentation of Quaternary deposits on and near the site. Luminant intends to augment the geologic history with climate change along with erosional and depositional history of the site. Additionally, Luminant, in its response to RAI 02.05.01-8 regarding the MEEG system, will provide a more detailed description of results of their field evaluation in contrast to conclusions reached in recent paper by Collins.

NRC Staff Site Audit

The afternoon was dedicated to discussions of Chapter 02.05.02 by Risk Engineering that included site response.

The velocity model developed for CPNPP, Units 3 and 4, is based on 15 borings with suspension logs. Luminant indicated that the suspension logs reflect down hole changes in lithology and problems in drilling are the ultimate case of poor core recovery. The methodology used to define contacts was presented.

One general concern is that the borings do not go down to a hard-rock depth, thus, the depth of hard rock with Vs>3000 m/s is an issue that could potentially affect site response calculations. The hard-rock depth was inferred by Luminant from regional considerations, specifically a single distant borehole well log, rather than any direct measurements at or in the vicinity of the site. The NRC staff asked, if inference from regional mapping an adequate site characterization for this hard-rock depth, what is the contrast in Vs at this hard-rock interface, and how can regional mapping be claimed to shed light on this contrast.

NRC Staff's Public Meeting with Luminant

The NRC staff adjourned and convened the public meeting in the CPE/PPC building to review RAIs pertaining to Sections 02.05.02 of the FSAR. Refer to the NRC staff's Public Meeting Summary, dated November 30, 2009 (ML093221041), for additional information. Many RAIs involve clarification and addition of figures or correction of figures that more clearly explain seismological or structural relations and geologic history in the site vicinity. Luminant addressed how they intend to respond to many of the RAIs discussed.

Of particular note, were the following responses that Luminant provided to the NRC staff. RAI 02.05.02-3 discusses the results of a sensitivity study that supports the use of the 1989 Electric Power Research Institute (EPRI) earthquake rates.

Luminant indicated that new earthquakes in the past 21 years show a lower rate compared to EPRI-SOG therefore, they did not need to account for the additional (post 1989) earthquakes. However, the NRC staff found that Luminant's study was not a comprehensive test of all regions, indeed it was limited to two regions. The selection criteria for these two regions were somewhat arbitrary and inconsistent with the guidelines, for example, one region, the Oklahoma aulacogen, was selected because of an apparent high-seismicity rate in the recent catalog. Luminant's expectation was that this region was the most likely test region to show an increase in moment release rate. Unfortunately, their analysis showed that the high-seismicity rate in the last 21 years is simply a result of the catalog magnitude size completeness being lowered rather than a true increase in moment release. Thus, the event rate appears to go up but there is a lower rate of large magnitude events. Thus, Luminant's justification of this particular test region was inconsistent. The NRC staff indicated that a more comprehensive test of all regions would be necessary to satisfactorily address this issue.

Next Luminant discussed RAI 02.05.02-4, regarding the 1995 Alpine, Texas, earthquake. The Alpine earthquake is located near the boundary between the seismically active Rio Grande rift and the stable Texas craton. Luminant's decision regarding which province the earthquake belongs may impact hazards at this site. If the M5.8 earthquake is considered a cratonic source (the earthquake is larger than M_{max} defined for the craton by three of the four EPRI teams), the Texas craton M_{max} should be increased to a value greater than M5.8. However, if the earthquake occurred on a fault tectonically related to regional extension in the Rio Grande rift, as suggested by Luminant, the M5.8 event does not impact the site based on their sensitivity study. Luminant did not consider the possibility that the Texas craton M_{max} should have a minimum value greater than M5.8, and what the impact of a larger M_{max} in the craton would be on the hazards at Comanche Peak.

The NRC staff discussed the response to RAI 02.05.02-12, in regard to Luminant's revision of the probability of activity for Oklahoma aulocogen in light of the recognition of the Meers fault with associated probability of activity of 1.0. Luminant responded that the EPRI SOG teams already knew about most of the research on the Meers fault when they were contemplating Probability of Activity (Pa) of the aulocogen, and, therefore, further paleoseismic investigations do not affect their Pa estimates. However, considerable research on the Meers fault has occurred in the years since EPRI-SOG. The research indicates, sources in the aulocogen have been active in the Holocene. Therefore, the aulocogen is by definition active, *i.e.*, has a Pa of 1.0. Although the Oklahoma aulocogen boundaries are somewhat uncertain, most characterizations put the Meers fault within the aulocogen.

RAI 02.05.02-15 was discussed with regards to the methodology used to calculate maximum magnitude for the Meers fault. Luminant defended their maximum magnitude for the Meers fault based on the regression relation of magnitude versus maximum displacement because this particular regression is more robust than the other displacement versus magnitude relations. However, Luminant's interpretation produces a maximum magnitude lower than would be otherwise estimated and, therefore, doesn't qualify as a conservative approach.

Finally, Risk Engineering discussed RAI 02.05.02-16, the graphs of deaggregated hazard at CPNPP. Risk Engineering stated that the dominance of the New Madrid seismic zone source was due to its short recurrence time, on the order of 166 years if you consider the three sources within the cluster, which has mean recurrence of about 500 years. Risk Engineering also commented that they were taking another look at the Meers fault calculation, and they had identified a potential problem in the calculations.

Thursday, July 30, 2009

NRC Staff Site Audit

The NRC staff reviewed sample calculations for static and dynamic engineering properties of earth pressure against embedded walls, and reviewed comparisons of pressure capacities of a critical embedded wall panel for the United States Advanced Pressurized Water Reactor design. The NRC staff discussed with Luminant, a need to perform a sensitivity study to evaluate the inter-bedded layers and to evaluate its impact on Soil Structure Interaction (SSI). The NRC staff discussed with Luminant, the need to update the fill specifications limits of excavation and examine its impact on SSI. The NRC staff discussed with Luminant a need to further study the impacts of different depths of in situ materials to the north and south. The NRC staff also discussed a need to expand the discussion of the site uniformity and the impact on weak material.

At the conclusion of the audit, the NRC staff conducted an exit meeting. The NRC staff discussed its observation findings and concerns with Luminant. These observations are discussed in Enclosure 3.

NRC Staff's Public Meeting with Luminant

The NRC staff adjourned and convened the public meeting in the CPE/PPC building to review RAIs pertaining to Sections 02.05.04 of the FSAR. Refer to the NRC staff's Public Meeting Summary, dated November 30, 2009 (ML093221041), for additional information.