

## PMComanchePeakPEm Resource

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**Sent:** Wednesday, July 15, 2009 3:25 PM  
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**Cc:** Kallan, Paul; ComanchePeakCOL Resource  
**Subject:** Comanche Peak RCOL, Section 2.5.1, RAI 21  
**Attachments:** RAI 3015 (RAI 21).doc

The NRC staff has identified that additional information is needed to continue its review of the combined license application. The staff's request for additional information (RAI) is contained in the attachment.

The response to this RAI is due within **35 calendar days** after **July 30, 2009**.

Note: If changes are needed to the safety analysis report, the NRC staff requests that the RAI response include the proposed wording changes.

thank you,

Stephen Monarque  
U. S. Nuclear Regulatory Commission  
NRO/DNRL/NMIP  
301-415-1544

**Hearing Identifier:** ComanchePeak\_COL\_Public  
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Request for Additional Information (RAI) No. 3015

RAI 21

7/15/2009

Comanche Peak Units 3 and 4  
Luminant Generation Company, LLC.  
Docket No. 52-034 and 52-035  
SRP Section: 02.05.01 - Basic Geologic and Seismic Information  
Application Section: 2.5.1 Basic Geologic and Seismic Information

QUESTIONS for Geosciences and Geotechnical Engineering Branch 2 (RGS2)

02.05.01-3

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.1 states "this section discusses the physiography, geologic history, stratigraphy, and tectonic setting within a 200-mi radius of [Comanche Peak Nuclear Power Plant] CPNPP." The Quaternary Period, particularly the Holocene, is the most important segment of geologic time from a seismic safety standpoint.

"Quaternary alluvial sequences" and "Quaternary terrace and alluvial units" are mentioned in FSAR Section 2.5.1.2.3. Please describe how the Quaternary terrace and alluvial units relate to the geologic history of the site. Please provide a more thorough discussion of the geologic history and stratigraphy of the site region and site vicinity during the Quaternary period (especially the past few hundred thousand years), particularly episodes of erosion and deposition in response to climate and sea-level changes of the late Quaternary.

02.05.01-4

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.1.2, and other sections, reference figures such as FSAR Figures 2.5.1-202 and 2.5.1-205, which show that the thick crust underlying the CPNPP site transitions to much thinner crust less than 100 km to the east, and to rocks of the southern Oklahoma aulacogen a similar distance to the northeast. Thus, the geologic setting and tectonic history of the eastern and northeastern parts of the site region are similar to other extended margins where large historic earthquakes have occurred, such as the 1886 Charleston and the 1811-1812 New Madrid earthquakes. Please provide a complete discussion (with additional figures, if needed) of the potential for large earthquakes on known or unknown structures within thick and thin transitional crust (i.e., extended margin) in the site region. Please explain how conclusions provided by Schulte and Mooney (2005) may influence your assessment of the CPNPP site.

References:

[“An updated global earthquake catalogue for stable continental regions; reassessing the correlation with ancient rifts,”](#) Geophysical Journal International, v. 161, p. 707-721, Schulte, S.M., and Mooney, W.D., 2005.

02.05.01-5

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Subsection 2.5.1.1.3.1 describes a circular gravity anomaly in the southeastern portion of the site region associated with the Llano Uplift. However, FSAR Figure 2.5.1-205 shows the Llano Uplift in the southwestern portion of the site region. Please clarify if the circular gravity anomaly is associated with the Llano Uplift in the southwestern portion of the site region, or with another feature in the southeastern portion of the site region.

02.05.01-6

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Subsection 2.5.1.1.4.1.2 describes the regional tectonic history up to the Late Oligocene and Early Miocene periods. Please describe the regional tectonic history from the Early Miocene period to the present.

02.05.01-7

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Subsection 2.5.1.1.4.3.4.2 discusses Mesozoic age normal faults, including the Luling-Mexia-Talco fault zone.

- (1) Please explain the evidence for your conclusion that the Luling fault zone is geologically associated with the Mexia-Talco fault system and whether this entire fault system is related to the movement of “Jurassic salt at depth.”
- (2) Please explain the statement that “this fault system is spatially coincident with the Pennsylvanian Ouachita fold and thrust belt...” and provide a more thorough discussion of the Luling fault zone including:
  - a. evidence that displacement associated with the Luling fault zone is related to salt movement at depth, or that it is related to basement structures,

- b. the relationship between the Luling fault zone and the Tertiary-age Balcones fault zone
- c. evidence that displacement on the Luling fault zone may be related to reactivation of Ouachita structures, and
- d. evidence for Cenozoic displacement or seismicity that may be linked to ongoing deformation of the Luling fault zone.

02.05.01-8

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Sub-section 2.5.1.1.4.3.4.2 describes the normal faults of the Mount Enterprise-Elkhart Graben (MEEG) system. Both pre-1986 and post-1986 publications suggest, as the FSAR points out, that there is evidence for Quaternary deformation associated with the MEEG. Please provide additional evidence, explanation and discussion to support your conclusion that "there is no new information bearing on the Quaternary activity of the MEEG fault system requiring a revision of the [Electric Power Research Institute] EPRI seismic source characterization of this region." Specifically,

- (1) Please provide a detailed figure that shows the locations of the geographic and structural features mentioned in FSAR Section 2.5.1.1.4.3.4.2, including the locations of the published evidence for displacement on the MEEG.
- (2) Please provide a more detailed summary of the data (including deposits, landform morphology, and age estimation) for late Quaternary faulting on the MEEG. Please also explain the evidence that supports the "estimated age of 37 thousand years for the late Quaternary gravels" stated in the FSAR.
- (3) The FSAR states "Presumably, this was the evaluation of the EPRI Earth Science Teams (ESTs)," regarding the MEEG fault system. Please provide the evidence and any relevant sources that support the assumption that the MEEG is not a source of tectonic deformation.
- (4) The FSAR states that Ewing (FSAR reference 2.5-228) suggested that seismicity associated with the MEEG may indicate "continuing deformation." Please explain the origin of the seismicity and why this seismicity is or is not an indicator of displacement on the MEEG faults.
- (5) The FSAR points out that Crone and Wheeler (FSAR Reference 2.5-271), a compilation of data, did not identify or discuss the MEEG as a potential tectonic fault. Please address whether Crone and Wheeler evaluated all potential tectonic features in the CEUS (central and eastern United States). If not, please explain specifically how this information supports the FSAR conclusion that the MEEG is not a capable tectonic structure.
- (6) FSAR Section 2.5.1.1.4.3.4.2 states that [William Lettis & Associates] WLA "conducted a field reconnaissance study" of the MEEG. Please describe this study in greater detail, including the locations investigated, the types of outcrops, surfaces and sediments examined, and the descriptions of evidence,

or lack of evidence, found at each location. Please justify the applicant's conclusion, based on these investigations, that no evidence was found "to support post-Eocene tectonic activity on the MEEG."

- (7) Several references listed in FSAR Section 2.5.1.1.4.3.4.2 indicate recent movement on the faults of the MEEG. Please justify your conclusion, based on these publications, that this is not a capable tectonic feature.
- (8) Provide a more detailed discussion of whether or not salt movement at depth could produce modern slip of 4 mm/yr on overlying normal faults, and whether stratigraphic relations of the displaced gravel favor sudden surface displacement of tens of centimeters or gradual creep. Please cite examples of other places in the Gulf Coast region, or other similar regions, where salt movement has caused similar rates of surface deformation.

#### 02.05.01-9

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.1.4.3.5, discusses the Tertiary-age Balcones fault zone, and states that there is some evidence (FSAR References 2.5-266 and 2.5-274) for post-Eocene movement on the Balcones faults. Please provide a detailed description of the Balcones fault zone and address the capability of this fault zone, including any seismicity, or lack of seismicity, that may be associated with this fault zone, and the potential for these geologic structures to be reactivated in the current stress regime.

#### 02.05.01-10

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

The MEEG system is located approximately 129 miles from the CPNPP site. Based on suggestions that this system may exhibit post-Eocene displacements, you conducted a field reconnaissance study to look for post-Eocene deformation. The Balcones fault zone is located approximately 75 miles (at its closest mapped position) from the CPNPP site and may also exhibit post-Eocene movement. In addition, Collins et al., (1990) suggests that a paleoseismic study is needed to determine if there is recent activity on the Balcones fault zone.

Please explain what, if any, post-Eocene deformation, including paleoseismic features, may be associated with the Balcones fault zone, or the Luling-Mexia-Talco fault system, and if a field investigation was conducted to look for such deformation. If a field investigation was not conducted to evaluate deformation on the Balcones or Luling-Mexia-Talco fault systems, please explain why an investigation was not necessary.

#### Reference:

"Faults and fractures in the Balcones fault zone, Austin region, central Texas," Guidebook 13, Austin Geological Society, Austin Texas, 12 p., Collins, E.W., and Laubach, S.E., 1990.

02.05.01-11

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.1.4.3.6 states that "Only one fault within the site region has been identified as demonstrating possible evidence for Quaternary activity: the Meers fault in Oklahoma." Please explain, in light of the FSAR's sixteen pages documenting evidence for very late Quaternary faulting on the Meers fault, the FSAR's conclusion that Quaternary activity on the Meers is "possible."

02.05.01-12

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

Section 2.5.1.1.4.3.6.2 describes the Criner fault. In order for the NRC staff to fully evaluate the potential for (or lack of) Quaternary activity on the Criner fault, additional information is needed.

- (1) Please provide a more detailed figure illustrating the locations of the geographic and structural features mentioned in FSAR Sub-section 2.5.1.1.4.3.6.2, including the investigated sites that are described in the FSAR.
- (2) Describe in greater detail the 1989 reconnaissance investigation of the Criner fault, including the "insufficient evidence available to prove or disprove the capability of the fault." Please explain in detail why the assumption of an M7 earthquake on the fault would have "...no safety impact on the plant."
- (3) Describe in greater detail the ..." follow-up studies conducted by Geomatrix Consultants," including evidence for landslides and the age of the small alluvial fans.
- (4) The FSAR (p. 2.5-37) states that WLA "conducted a field reconnaissance study" along the escarpment of the Criner fault. In your discussion please include the locations investigated; the types of outcrops, surfaces and sediments examined; descriptions of evidence, or lack of evidence, found at each location; and the expertise of those conducting the relevant investigations. Please provide a thorough justification of your conclusions regarding the capability of the Criner fault, based on evidence gathered in this investigation.

02.05.01-13

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.1.4.3.7.2, describing the Cheraw fault, notes that Crone et al. (1997) (FSAR Reference 2.5-323) found evidence for three surface-rupturing events in the past 25,000 years. Please explain whether the Cheraw fault is a capable fault, and whether it is included as a seismic source in the FSAR.

02.05.01-14

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

Despite its distance from the CPNPP site, FSAR Section 2.5.1.1.4.3.7.3 discusses the current understanding of the New Madrid seismic zone (NMSZ) as a seismic source because it is one of the closest sources to the CPNPP site. The updated NMSZ source model does not include new paleoseismic results related to the southern end of the Reelfoot Rift system.

- (1) Please explain whether the southern end of the Reelfoot Rift system, which is closer than the NMSZ (approximately 580 km from the CPNPP site), is also capable of M>7 earthquakes. Please discuss the applicability of studies by Tuttle, et al., (2006), and Cox, et al., (2007), and explain how the extended NMSZ source impacts the seismic hazard at the CPNPP site.
- (2) Please discuss if and to what extent paleoliquefaction features in southeastern Arkansas and northeastern Louisiana indicate that previously unrecognized seismogenic sources may exist in those areas. Please discuss studies by Al-Shukri, et al. (2005); Cox, et al, (2004); and Tuttle, et al., (2006), and explain how these other seismogenic sources, which are closer to CPNPP than the NMSZ, impact the seismic hazard at the CPNPP site.

Additional References:

"Spatial and temporal characteristics of paleoseismic features in the southern terminus of the New Madrid Seismic Zone in eastern Arkansas," Seismological Research Letters, Volume 76, pp. 502-511, Al-Shukri, H. J., Lemmer, R. E., Mahdi, H. H., Connelly, J. B., 2005.

"Preliminary assessment of sand blows in the southern Mississippi Embayment," Bulletin of the Seismological Society of America, Volume 94, pp.1125-1142, Cox, R. T., Larsen, D., Forman, S. L., Woods, J., Morat, J., and Galluzzi, J., 2004.

"Very large earthquakes centered southwest of the New Madrid seismic zone 5,000-7,000 years ago," Seismological Research Letters, Volume 77, pp.755-770, Tuttle, M. P., Al-Shukri, H., Mahdi, H., 2006.

"Seismotectonic implications of sand blows in the southern Mississippi embayment," Engineering Geology, volume 89, pp. 278-299, Cox, R. T., Hill, A. A., Larsen, D., Holzer, T., Forman, S. L., Noce, T., Gardner, C., and Morat, J., 2007.

02.05.01-15

FSAR Subsection 2.5.1.2.4.1 describes two basement faults beneath the Cretaceous rocks within a 25-mi radius of the CPNPP site. However, the location of these basement faults is not shown in FSAR Figure 2.5.1-216, a geologic map of the site vicinity. Please provide a description of where the basement faults were mapped in the 25-mi radius or illustrate the location of these faults on the appropriate figure.



02.05.01-16

FSAR Subsection 2.5.1.2.4.2 states that “no tectonic structures (such as faults, folds, or shear zones) were found within 5 mi of the CPNPP Units 3 and 4 site” but does describe two disruptions within the site area. FSAR Figure 2.5.1-217 labels these two disruptions as “Fold in Paluxy” and “Fold near Dam.” Please clarify if these map features are folds or the disruptions described in the FSAR.

02.05.01-17

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

Section 2.5.1.2.5.1 mentions a “Field reconnaissance of the region and immediate site area...,” including surveys of “...Quaternary deposits within nearby river and stream valleys...” to evaluate 1) the “...presence of liquefaction features...”, 2) “...signs of deformation...”, and 3) a “...lineament analysis followed by field confirmation surveys.”

- (1) Please describe separately, in detail, each part of the overall field investigation that addressed each of the three types of investigations numbered above (liquefaction features, signs of deformation, and lineament analysis), including:
  - (a) the locations investigated,
  - (b) the types of outcrops, surfaces and sediments examined,
  - (c) the origins of features, and
  - (d) any other evidence found during the surveys that may bear on the Quaternary seismic and deformation history of the site region and site vicinity.

Please fully explain the extent to which each type of investigation indicates “no evidence of seismic activity, either recent or historic.”

- (2) Explain what the phrase “...signs of deformation...” means and provide complete details on possible deformation features that were found and the evidence used in their interpretation.
- (3) For the “...lineament analysis followed by field confirmation surveys.”, please provide a complete description of the surveys and analysis of features with appropriate figures, including details of methods and imagery used, areal extent, identification criteria, identified lineaments, and conclusions regarding the origin of each identified lineament in the site vicinity.

02.05.01-18

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

As discussed in FSAR Sections 2.5.1.1.2 and 2.5.1.1.4, faults that were active during Mesozoic rifting and that are now buried by Mesozoic and Cenozoic deposits are likely to occur below the site region. Direct study of these buried faults in outcrop is not possible. Elsewhere in the Central and Eastern US (CEUS) where similar geologic conditions exist, researchers use liquefaction features induced by large earthquakes to estimate timing, source areas, magnitudes, and recurrence intervals of large prehistoric earthquakes. Partly as a result of such studies, in the last 15 years there is wider recognition that seismicity migrates within crustal zones over periods of thousands to tens of thousands of years (e.g., Nelson et al., 1999; Schweig and Ellis, 1994; Coppersmith, 1999; Tuttle et al., 2006; Cox et al., 2007). Holocene and Late Pleistocene deposits (e.g., fluvial, alluvial deposits) that are likely to be susceptible to liquefaction during large earthquakes occur in the CPNPP site region, for example, along the Brazos River and its tributaries. In the context of the search for liquefaction features mentioned in Section 2.5.1.2.5.1, please explain how the wider recognition that crustal seismicity migrates applies to the CPNPP site region.

*Additional References:*

"Quaternary grabens in southernmost Illinois — Deformation near an active intraplate seismic zone," *Tectonophysics*, Volume 305, pp. 381-397, Nelson, W.J., Denny, F.B., Follmer, L.R., and Masters, J.M., 1999.

"Temporal and spatial clustering of earthquake activity in the central and eastern United States," *Seismological Research Letters*, Volume 59, pp. 299-304, Coppersmith, K.J., 1999.

"Reconciling short recurrence intervals with minor deformation in the New Madrid seismic zone," *Science*, Volume 264, pp. 1308-1311, Schweig, E.S., and Ellis, M.A., 1994.

"Very large earthquakes centered southwest of the New Madrid seismic zone 5,000-7,000 years ago," *Seismological Research Letters*, Volume 77, pp.755-770, Tuttle, M. P., Al-Shukri, H., Mahdi, H., 2006.

"Seismotectonic implications of sand blows in the southern Mississippi embayment," *Engineering Geology*, volume 89, pp. 278-299, Cox, R. T., Hill, A. A., Larsen, D., Holzer, T., Forman, S. L., Noce, T., Gardner, C., and Morat, J., 2007.

02.05.01-19

NUREG-0800, Standard Review Plan (SRP), Chapter 2.5.1, 'Basic Geologic and Seismic Information,' establishes criteria that the NRC staff intends to use to evaluate whether an applicant meets the NRC's regulations.

FSAR Section 2.5.1.2.5.10 discusses the effects of man's activities on seismic hazard, such as induced seismicity from oil and gas extraction activities. Natural earthquakes are known or suspected to trigger events far from the mainshock, such as the 1992 Little Skull Mountain earthquake (M5.6) that was far from but triggered by the Landers, California, mainshock, and earthquakes in Ohio possibly triggered by the 1811-1812 New Madrid earthquakes (Hough, 2001).

a) Please explain if there is any potential for triggered seismicity close to the CPNPP site from a natural earthquake, particularly an earthquake in a distant source zone such as the Rio Grande Rift.

b) Please explain how the potential hazard from triggered seismicity is accommodated in the FSAR when the underlying probabilistic seismic hazard analysis (PSHA) assumes independent events.

c) Please clarify the following statement in FSAR Subsection 2.5.1.2.5.10.2.3: "There are almost no cases of human actions causing large earthquakes (FSAR Reference 2.5-359)." Please explain why a reference that only documents Texas earthquakes was cited.

02.05.01-20

Please provide the following text and figural corrections:

a) Please label all features on all figures, including but not limited to all structures mentioned in the text of the FSAR, in Sections 2.5.1.1.4.3.3 (p. 2.5-21) through 2.5.1.1.4.3.4.2 (p 2.5-23)..

b) For Figure 2.5.1-202b, please clarify whether "King and Beikman, 1974" should be included in the reference list, and provide reference numbers for "Nichols and Waddell."

c) Please provide the reference number for "Nichols and Waddell" on Figure 2.5.1-204, provide the citation for the cross section line, and enhance or enlarge the text in the small inset and the key.

d) Please clarify whether "Walper" should be listed as a reference for Figure 2.5.1-208.

e) Please provide the CPNPP site location on FSAR Figure 2.5.1-208

f) For Figure 2.5.1-229, please clarify whether "Pollastro 2007" references the "Pollastro et. al 2007" study.

g) Please provide the correct referenced publication listed as "Reference 2.5-266."