

July 25, 2013

MEMORANDUM TO: Michael J. Case, Director
Division of Engineering
Office of Nuclear Regulatory Research

FROM: Patrick Hiland, Director /RA/
Division of Engineering
Office of Nuclear Reactor Regulation

SUBJECT: REVIEW OF OFFICE OF NUCLEAR REGULATORY
RESEARCH TECHNICAL PAPER "LARGE EARTHQUAKE
PALEOSEISMOLOGY IN THE EAST TENNESSEE SEISMIC
ZONE"

The Mechanical and Civil Engineering Branch (EMCB) of the Division of Engineering, Office of Nuclear Reactor Regulation, performed the requested review of the Office of Nuclear Regulatory Research (RES) Technical Paper entitled "Large Earthquake Paleoseismology in the East Tennessee Seismic Zone." The paper discusses a pilot paleoseismic study implemented in the East Tennessee Seismic Zone to explore the evidence of large historical earthquakes. The paper will be beneficial to the NRC staff and other related readers who are engaged in seismic source characterization for the central and eastern U.S. because there are many unanswered questions regarding the seismic zone and the zone has a potential seismic hazard impact to nearby operating nuclear power plants and prospective reactor sites.

The paper provides a detailed geologic description for several sites in the East Tennessee Seismic Zone based on the field observations. Since the EMCB reviewer did not have a chance to visit these sites, the comments provided are solely based on the descriptions and figures in the paper. One key comment on the technical paper is whether there were any alternative interpretations, such as, pedogenesis or other non-earthquake processes, for some of the evidence interpreted as earthquake genesis in the paper. Also, since the conclusion of this paper is very critical to a regional probabilistic seismic hazard analysis (PSHA), the newly estimated magnitude proposed in this paper will very likely be adopted by the future PSHA source model for this region. Therefore, a more comprehensive approach in soliciting different interpretations and in incorporating different professional opinions on the critical field evidence should be adopted because an accurate seismic hazard model comes from solid data, not from a modeling process. Since the NRC is funding this study, a process similar to the Senior Seismic Hazard Advisor Committee (SSHAC) solicitation process should be considered from the very beginning of the seismic hazard characterization (i.e., during the input data collection).

Please see the attached for detailed comments. If you desire any clarification regarding our comments, please contact Yong Li of my staff.

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Comments on RES Technical Paper “Large Earthquake Paleoseismology in the East Tennessee Seismic Zone”

1. The technical paper (the paper thereafter) named the East Tennessee Seismic Zone as the second most active seismic zone east of the U.S. Rocky Mountains based on the frequency of earthquake occurrence in this zone (although there were no recorded earthquakes with a magnitude > 5.0). However, Arkansas frequently experiences earthquake swarms, such as the one in Guy, Arkansas, and those swarms could have a higher occurrence frequency than the East Tennessee Seismic Zone. If this is the case, we probably cannot call the East Tennessee Seismic Zone the second most active seismic zone east of the Rocky Mountains.
2. Table 1 of the paper lists all the sample ages obtained from the optically simulated luminescence method for the different levels of terraces. It is difficult to tell if the ages of the terraces appear in order, meaning the oldest terraces are dated as the oldest in ages because the sample locations listed in the table cannot be connected with the terrace profile shown in Figure 5. In addition, there appears to be a conflict between the “approximate ages of stream” shown in the terrace profile in Figure 5 (~27 ka and ~12 ka) and the youngest terrace age listed in Table 1(73 ka).
3. The magnitude proposed by the paper is very important to seismic hazard analyses for the central and eastern U.S. because of the proximity of the East Tennessee Seismic Zone to many nuclear power plants and prospective new reactor sites. This newly estimated magnitude and the implied return period for the East Tennessee Seismic Zone are very likely to be used as input source parameters in the next round of the probabilistic seismic hazard analysis (PSHA) for these areas. For a significant seismic source update, the NRC staff generally requires that it is implemented under the framework of the Senior Seismic Hazard Advisor Committee (SHAAC), at various levels, depending on the importance of the source. However, the SSHAC process has so far only been applied during the PSHA modeling process and has not been effectively used during the original data collection. Paleoseismic evidence can be very controversial and can be interpreted with significant differences by various experts. Therefore, since this data will be used in the PSHA modeling, the SSHAC process, or at least a similar process which solicits different interpretations and obtains consensus on the critical field evidence, should be applied to the earlier stage of the modeling process (i.e., the data collection stage), because an accurate seismic hazard model is developed from solid data. Since this project was funded by the NRC, an SSHAC process or some similar processes should be considered for use during the data gathering process.
4. In Figure 16 of the paper, it is difficult to understand what is happening with the post event alluvium that is truncated by the thrust fault (dark line) because the corresponding part of the post event alluvium cannot be observed on the footwall side of the fault in the profile.
5. It is possible that the features shown in Figure 6 are not related to liquefaction but are related to some other non-seismic process, such as pedogenesis.

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6. The paper indicates that fluidization features were found at various levels of the terraces, including both the oldest (highest) and the youngest (lowest) from T1 or T2 to T3 or T4. However, it is difficult to understand how the liquefaction can be triggered at both the higher and the lower level terraces because the hydrologic and other geotechnical settings are usually quite different between these terraces, especially if these fluidization features are considered to be related to earthquake triggered liquefaction.