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REVIEW OF DRAFT REPORT: CENTRAL AND EASTERN UNITED STATES SEISMIC SOURCE CHARACTERIZATION FOR NUCLEAR FACILITIES
WD-10-099-03
DRAFT

In accordance with the subject Work Directive, a technical review has been carried out of the subject report. General comments are enclosed on Attachment 1. Detailed comments have been noted electronically in the portable document format (.pdf) files that were provided for review. These files are included on the enclosed compact disc. The files included on the CD are:

CEUS SSC draft report-RQ
Appendix A - Project Database-RQ
Appendix B - Earthquake Catalog-RQ
Appendix C - Data Evaluation Tables-RQ
Appendix D - Data Summary Tables-RQ
Appendix E - Paleoliquefaction-RQ
Appendix F - Workshop Summaries-RQ
Appendix G - Biographies-RQ
Appendix H - HID-RQ
Appendix I - PPRP Review Comments-RQ
Appendix J - Magnitude Recurrence Maps-RQ
Appendix K - SCR Databases-RQ
Comments on Draft CEUS SSC Report-RQ (this is a duplicate of Attachment 1)

Attachment 1

1. Chapter 2 of the report emphasizes the project goal of developing a seismic source model whose component probability distributions are consistent with the center, body, and range of distributions from the informed technical community. This goal is subsequently modified, however, through the implementation of a "hazard-informed" approach to seismic source definition and characterization (Section 4.3.1). Uncertainties that are judged to not affect significantly the overall determination of seismic hazard are, in some cases, not included in the seismic source model. While this practical approach is warranted, care must be taken to clearly indicate in the report the cases in which the informed technical community's distribution is being "trimmed" because the uncertainties have a negligible impact on hazard. It is important for potential users of the CEUS SSC to know if a particular characterization represents the Technical Integration team's assessment of the center and full body and range of the informed technical community's distribution or whether that distribution is a hazard-informed, truncated version. Are uncertainties not included in the model because the informed technical community gives them zero credibility or because including them with an appropriate probability has a negligible impact on seismic hazard? There is a sharp contrast between this approach and the previous EPRI-SOG effort in which evaluation of the seismic potential of all credible tectonic feature-based sources was the goal.

   It is recommended that the "hazard-informed" adjunct to the concept of the center, body, and range of the informed technical community be introduced in Chapter 2 and mentioned in the Executive Summary. Also, the documentation of seismic source characterization should be reviewed to explicitly identify instances in which the hazard-informed criterion is being applied.

2. It is understood that the Repeated Large-Magnitude Earthquake (RLME) sources are defined to facilitate use of paleoseismic data in characterizing earthquake recurrence. Understanding of the RLME source concept would be enhanced by describing its relation to the characteristic earthquake model and the maximum moment model of earthquake recurrence. Is the conceptual model that of a fault or fault system that ruptures only in large-magnitude earthquakes? Or does it produce a range of earthquake magnitudes and the RLME source decouples the consideration of the large, characteristic events from the smaller events whose magnitudes are exponentially distributed and considered as part of an area source? Also, inconsistencies in the report regarding the magnitude criterion for an earthquake to be considered as a possible RLME (e.g., $M > 6$ in Executive Summary, $M > 6.5$ in Section 1.4.1) need to be resolved.

It is recommended that the RLME source concept be discussed with respect to its relation to the characteristic and maximum moment earthquake models. Also, inconsistencies in the stated magnitude criterion for a RLME should be resolved.

3. Approaches to assess completeness, event dependency, and conversion to a uniform magnitude scale for the earthquake catalog are reasonable and well described. However, there is no discussion of whether these approaches represent the center, body, and range of approaches that the informed technical community would use. Other hazard assessments for the CEUS have used alternative or multiple approaches, which suggests that a range of approaches are considered credible by the technical community (although maybe the technical community is not "informed"). There are no Data Summary Forms or Data Evaluation Forms documenting the approaches considered and the basis for the current assessment.

   It is recommended that discussions be added to the report on how the technical approaches used to develop the earthquake catalog represent the center, body, and range of the approaches that would be used by the informed technical community, or how a hazard-informed criterion was used to limit the approaches implemented. What approaches were considered, what proponent experts consulted, and what interactions facilitated to understand the strengths and weaknesses of different approaches. [Note that this comment also applies to the approach used to develop recurrence parameters.]

4. Given the importance from a regulatory perspective in establishing confidence that the CEUS SSC represents the center, body, and range of the informed technical community (modified by hazard-informed truncations that have a negligible impact on hazard), consider adding subsections to Chapters 3 (Earthquake Catalog) and 5 (SSC Model: Overview and Methodology) that explicitly address how the methodology approaches that are used represent the center, body, and range of the informed technical community.

5. Three fundamental interpretations underlie the CEUS SSC: (1) earthquake occurrence is spatially and temporally stationary, (2) the rate of occurrence of different size earthquakes is exponentially distributed, and (3) large earthquakes (or earthquake sequences) that have repeated in the past will have the same magnitude when they next occur in the future. These interpretations are used in assessing earthquake recurrence parameters, earthquake catalog completeness, earthquake dependency, and RLME source magnitude. Bits and pieces of a technical basis are distributed through the report. Given their importance, however, consider enhancing the discussion in the report of their technical basis and the assessment that the informed technical community gives negligible credibility to alternative interpretations or that inclusion of alternative interpretations would have a negligible impact on hazard.

6. The CEUS SSC is described as being "useful for engineering applications that will entail up to approximately the next 50 years." This is an important aspect of the conceptual framework for the model, the implications of which should be discussed more completely. To what degree are assessments by the informed technical community on spatial and temporal stationarity and whether RLME sources are "in-cluster" or "out-of-cluster" dependent on the 50-year perspective?

   It is recommended that, when an interpretation is colored by the 50-year time frame for application, that fact be explicitly identified and discussed as part of the technical basis.

7. In assessing the center, body, and range of the informed technical community, care must be taken to avoid or mitigate the impacts of motivational and cognitive biases. The report is currently silent on this issue. If the center, body, and range of the technical community are biased, are actions taken to compensate in making an "informed" assessment? Also, care must especially be taken when dismissing "preliminary" and "initial" data that while uncertain, challenge status quo interpretations or when taking a "cautious approach." In such cases a strong technical basis should be provided that indicates anchoring and under-estimation of uncertainty have been avoided.

   It is recommended that actions taken by the TI team to avoid or mitigate the impacts of motivational and cognitive biases be explicitly discussed in the report.

8. The report discusses use of the CEUS SSC model in nuclear power plant license applications. For a specific site, it discusses the need to evaluate whether any significant local sources exist. However, it does not address the possibility of distant sources of large-magnitude earthquakes that lie outside the study area. For example, large plate boundary earthquakes in the Caribbean may be important to hazard at low structural frequencies for sites in bordering the Gulf of Mexico.

   It is recommended that discussions on the use of the CEUS SSC model to assess seismic hazard at potential nuclear power plant sites include the need to consider distant sources of large-magnitude earthquakes occurring outside the CEUS study area.

9. The CEUS SSC model in some sense replaces or supersedes the EPRI-SOG and LLNL models from the 1980's, including updates incorporated in COLA and ESP applications. The report, however, does not give explicit guidance on future use of the EPRI-SOG and LLNL models. Are they considered equivalent regional models that should be discarded? Or do their source zone interpretations need to be addressed as potential local sources in future license applications?

   It is recommended that the report address explicitly the envisioned role of EPRI-SOG and LLNL models in assessing local seismic sources for hazard assessment at a specific NPP site. Ultimately, this clarification will need to come from the NRC.

10. In discussing specific earthquakes as they relate to seismic source characterization, sometimes a moment magnitude is provided and sometimes magnitude determined on a different scale. This hinders comparison of the size of different earthquakes.

    It is recommended that, when earthquake magnitude is given in the text for a specific earthquake, the uniform moment magnitude determined for the earthquake catalog be cited. If desired, the originally determined magnitude and scale can also be provided in parentheses.

11. The concept of Data Summary and Data Evaluation tables to supplement the characterization summaries in the main report is a good one. However, the description of the purpose of each type of table needs to be enhanced. Also, the quality of the implementation for the Data Evaluation tables is variable. In the evaluation of data, "Discussion of data use" is often a description of the data and/or their quality without indicating how they were used or why they have a certain level of being relied upon. In at least one case, data indicated as of moderate reliance (3) are not even cited in the main body of the report, while in other cases data discussed in the report are not listed in the data evaluation table. Also, there is limited transparency or traceability of the reason that some considered data (i.e., listed in the Data Summary table) were not used (i.e., not included in the Data Evaluation table). The different groupings of data (by characterization purpose in the Data Summary tables and by data type in the Data Evaluation tables) make it difficult to track information between the tables.

    It is recommended that the Data Evaluation tables be enhanced to meet the expectations raised by the table column headings and discussion in the main report. The Data Evaluation tables should explain for what aspects of the source characterization a particular data source were used and how they were used. Rationales for the reliance level should be addressed. The tables should be integrated and consistent with the characterization summaries in the main body of the report. Use of a single table rather than two tables might solve integration issues between the tables. Alternatively, if the above is beyond the scope of the current study, the purpose of the tables and their intended level of detail should be clarified.