PMSummerColpEM Resource

From: Sebrosky, Joseph
Sent: Friday, April 22, 2011 10:51 AM
To: Wang, Weidong
Cc: Akstulewicz, Frank; PMSummerColpEM Resource; Karas, Rebecca; Cook, Christopher; Munson, Clifford; Cruz, Jeffrey; Stirewalt, Gerry; Martin, Jody
Subject: Information: change being considered for the V.C. Summer Nuclear Station FSER based on ACRS interactions
Attachments: changes to summer FSER chapter 2 - section 2_5_2_4_2 - to address Dr Hinze comment.docx

Weidong,

Per your request attached is a redline/strikeout of the change that the staff is considering to its V.C. Summer Nuclear Station (VCSNS) final safety evaluation report (FSER) section 2.5.2.4.2 to address the comment from Dr. Hinze regarding an update to the 2008 US Geologic Survey (USGS) report. The updated is described in USGS Open-File Report 2008-1128, "Documentation for the 2008 Update of the United States National Seismic Hazard Maps."

As you are aware the staff commitment to consider revising the VCSNS FSER was being tracked as an action item on the AP1000 Subcommittee tracking list. The redline/strikeout change is based on the VCSNS advanced safety evaluation report that was previously provided to the ACRS. The entire section is provided to place the proposed change in context. The change will be documented in the VCSNS FSER that the staff expects to issue later this year.

Because of the unique nature of this request you should be aware of the following:

- NRO's office instruction on signature authority provides guidance that suggests written interactions with the ACRS should be done at the Division Director level. To this end, Frank Akstulewicz has been informed and has approved me sending you this information.

- This email will be captured as a public record on the Summer Unit 2 and 3 dockets (52-27 and 52-28).

If you have any questions please let me know.

Sincerely,

Joe Sebrosky

From: Wang, Weidong
Sent: Wednesday, April 20, 2011 1:18 PM
To: Sebrosky, Joseph
Subject: RE: Re:Summer rev SAR

Hi Joe, can we have the document in my earlier e-mail to you below?
Thanks,
Weidong

From: Wang, Weidong
Sent: Tuesday, April 12, 2011 10:47 AM
To: Sebrosky, Joseph
Subject: FW: Re:Summer rev SAR

Hi Joe,

Dr. Hinze is asking the following information, do you have that? – thanks - Weidong

"at the January 11th meeting of the ACRS committee, the staff indicated that they were going to evaluate the 2008 USGS seismic hazard study in their revised SAR…has that been done and is it available to me? I am interested to learn of their evalution…"

Hearing Identifier: VCSummer_COL_Public
Email Number: 351

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Subject: Information: change being considered for the V.C. Summer Nuclear Station FSER based on ACRS interactions
Sent Date: 4/22/2011 10:51:01 AM
Received Date: 4/22/2011 10:51:02 AM
From: Sebrosky, Joseph

Created By: Joseph.Sebrosky@nrc.gov

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Files	**Size**	**Date & Time**
MESSAGE	2227	4/22/2011 10:51:02 AM
changes to summer FSER chapter 2 - section 2_5_2_4_2 - to address Dr Hinze comment.docx	39461	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

2.5.2.4.2 Geologic and Tectonic Characteristics of the Site and Region

VCSNS COL FSAR Section 2.5.2.2 describes the seismic sources and seismicity parameters used by the applicant to calculate the seismic ground motion hazard for the VCSNS site. Specifically, the applicant described the seismic source interpretations from the 1986 EPRI Project (EPRI NP-4726), relevant post-EPRI seismic source characterization studies, and its updated EPRI seismic source zone for the Charleston area (UCSS). The staff previously reviewed and approved the UCSS as part of its review of the VEGP ESP application (NUREG-1923). RG 1.208, specifies that applicants may use the 1986 EPRI seismic source model as a starting point for characterizing regional seismic sources. As such, the staff focused on the applicant's investigation of post-EPRI seismic source studies and its decision to either use the original EPRI source models or updated source models.

Summary of EPRI Seismic Sources

VCSNS COL FSAR Sections 2.5.2.2.1.1 through 2.5.2.2.1.6 provide a summary of the primary seismic sources developed in the 1980s by each of the six EPRI ESTs. Each EST described its set of seismic source zones for the CEUS in terms of source geometry, probability of activity, recurrence, and M_{max}. Each EPRI EST identified one or more seismic source zones that include the VCSNS site. In VCSNS COL FSAR Section 2.5.2.2.1.2 and Table 2.5.2-204, the Dames and Moore EST source characterization parameters derived for the EPRI/SOG assessment are presented for Zones 41 (the Southern Cratonic Margin) and 53 (the Southern Appalachian Mobile Belt). Relatively low probabilities were assigned to these two zones by the Dames and Moore EST. In RAI 2.5.2-3, the staff asked the applicant to justify the source characterization parameters used by the Dames and Moore EST for Zones 41 and 53 to assess seismic hazard of the region surrounding the VCSNS site. In response, the applicant stated that industry strongly believes that the integrity of the original EPRI/SOG ESTs should be maintained as part of the individual site seismic hazard evaluations in order to provide the diversity and range of interpretations of the scientific community. In addition, the applicant performed a sensitivity study to compare total mean seismic hazard at the VCSNS site to mean seismic hazard calculated by simply removing the Dames and Moore team's contribution and averaging the results from the remaining five ESTs. The applicant stated that the results of its sensitivity study show that deleting the Dames and Moore team's contribution increases the hazard at the original GMRS amplitudes by between 0.8 percent (at 0.5 Hz) and 8.4 percent (at 100 Hz). The applicant noted that discarding the Dames and Moore team's contribution incorporates not only any effects from alternative characterization of probability of activity for Dames and Moore source Zones 41 and 53, but also any relative differences between the Dames and Moore's model for the Charleston source and the Charleston source models of the remaining ESTs. The applicant further noted that for the VCSNS site, contributions to total hazard from Dames and Moore source Zones 41 and 53 are much less than from the Charleston sources; therefore, modifications to the probability of activity of these zones is relatively insignificant. That is, because the Dames and Moore total hazard for the VCSNS site is somewhat less than for the remaining ESTs, and because this team's relative contribution to total hazard at the VCSNS site has little to do with Dames and Moore source Zones 41 and 53, elimination of the Dames and Moore team's contribution exaggerates the effect of modifying the probability of Zones 41 and 53.

The staff reviewed the applicant's response to RAI 2.5.2-3 and identified a discrepancy between the applicant's RAI response and the VCSNS COL FSAR text. Specifically, the applicant, in its RAI response stated "It should be noted that discarding the Dames & Moore team's contribution incorporates not only any effects from alternative characterization of probability of activity for

Dames & Moore source Zones 41 and 53, but also any relative differences between the Dames & Moore's model for the Charleston source and the Charleston source models of the remaining ESTs." However, VCSNS COL FSAR Section 2.5.2.4.4 states that "these EPRI team Charleston sources were removed from the seismic hazard analysis." The FSAR also states that the EPRI team Charleston sources were then replaced by the UCSS model. Thus, in RAI 2.5.2-21, the staff asked the applicant to address the discrepancy between the response to RAI 2.5.2-3 and the FSAR text. In response to RAI 2.5.2-21, the applicant stated that the implication in its response to RAI 2.5.2-3 that the original EPRI EST Charleston seismic source models were included in the seismic hazard analysis is incorrect. In its response, the applicant confirmed that the UCSS model was used instead of the original EPRI-SOG Charleston seismic source models for all ESTs so that the contribution to earthquake hazard at the VCSNS site from all EST's is the same. The applicant also stated that the fundamental conclusion drawn in response to RAI 2.5.2-3; "deleting the Dames & Moore team from the V. C. Summer seismic hazard analysis would not lead to a significant change in hazard at the GMRS amplitudes," under the proposed criterion for "significance" given, also remains correct.

As stated above in response to RAI 2.5.2-3, the results of the applicant's sensitivity study showed that deleting the Dames and Moore team's contribution only increases the hazard at the original GMRS amplitudes by between 0.8 percent (at 0.5 Hz) and 8.4 percent (at 100 Hz). Thus, in spite of the issues identified in RAI 2.5.2-3, that the Dames and Moore team did not adequately characterize the regional seismic hazard, the staff considers RAIs 2.5.2-3 and 2.5.2-21 resolved because the Dames and Moore team's contribution to the total mean hazard at the VCSNS site is not significant and the applicant confirmed that it used the UCSS model rather than the original EPRI EST Charleston seismic source models.

VCSNS COL FSAR Section 2.5.2.2.1.5 describes the source zones developed by the Weston Geophysical team for the EPRI PSHA. RAI 2.5.2-10 relates to a discrepancy between the text on FSAR page 2.5.2-16 and FSAR Table 2.5.2-207. Specifically, FSAR page 2.5.2-26 states "The largest M_{max} assigned by the Weston Geophysical team to these combination zones is m_b 6.6 (**M** 6.5)." However, in VCSNS COL FSAR Table 2.5.2-207 (page 2.5.2-69), the M_{max} for combination zone C33 is listed as m_b 7.2 at 10 percent weight. The staff thus asked the applicant to address this discrepancy. In response, the applicant stated that FSAR Table 2.5.2-207 correctly states the M_{max} distributions for Weston Geophysical's combination zones, while FSAR Section 2.5.2.2.1.5 incorrectly states the largest M_{max} value assigned by Weston Geophysical to their combination zones. In addition, the applicant stated that this error has no effect on downstream analyses performed for the VCSNS Units 2 and 3 site and that it intends to revise FSAR Section 2.5.2.2.1.5 to correctly state that the M_{max} upper-bound for Weston Geophysical combination zones is m_b 7.2 (**M** 7.5). The staff concludes that the applicant's response to RAI 2.5.2-10 is adequate because the discrepancy is the result of a typographical error and has no effect on any of the applicant's subsequent analyses. Furthermore, the applicant updated the FSAR accordingly.

Post-EPRI Seismic Source Characterization Studies

VCSNS COL FSAR Section 2.5.2.2.2 describes three PSHA studies that were completed after the 1989 EPRI PSHA and which involved the characterization of seismic sources within the VCSNS site region. These three studies include the USGS National Seismic Hazard Mapping Project (Frankel et al. 1996, 2002), the SCDOT seismic hazard mapping project (Chapman and Talwani 2002), and the NRC TIP study (NUREG/CR-6607, "Guidance for Performing Probabilistic Seismic Hazard Analysis for a Nuclear Plant Site: Example Application to the Southeastern United States"). The applicant provided a description of both the USGS and

SCDOT models, as well as a comparison of these more recent studies with the EPRI source PSHA models.

U.S. Geological Survey

The USGS has developed a PSHA for areas of the CEUS that encompass the VCSNS site region. FSAR Section 2.5.2.2.2.1 provides a description of the USGS study and a comparison of its seismic source model parameters with the 1989 EPRI PSHA. The USGS produces seismic hazard maps on a six-year cycle based on its PSHA for the continental United States. These hazard maps are primarily intended for national building codes and standards and not for critical facilities such as nuclear power plants. The USGS hazard maps target 500 to 2500 year ground motion return periods. In contrast, RG 1.208 specifies that the GMRS developed for nuclear power plant siting have a minimum ground motion return period of 10,000 years.

USGS 2002 Hazard Map

The applicant described the 2002 USGS PSHA used to produce the seismic hazard maps and compared the source model parameters such as maximum magnitude, probability of activity, recurrence rate, as well as the source geometries with the EPRI PSHA. The primary difference between the USGS and EPRI PSHAs are the number of source zones used to characterize the seismic hazard for the CEUS. The USGS uses two regional source zones referred to as the exteneded margin and stable craton background zones. In addition to these large zones, the USGS also models the Charleston and New Madrid sources using paleoliquefaction data. For the extended margin background zone, the USGS defines a single maximum magnitude value of 7.5. In contrast, EPRI developed multiple source models for the eastern seaboard and Appalachians with a range of maximum magnitudes, recurrences, and probabilities of activity. The staff reviewed the EPRI source model parameters and found that the overall mean maximum magnitude is about 6.2. Based on this comparison of seismic source model parameters outside of the major Charleston source, the staff concludes that an overall magnitude of 6.2 together with the multiple source zone geometries, maximum magnitudes, and recurrences better reflects the large uncertainty in the region. For the Charleston source, the USGS uses a similar maximum magnitude range and recurrence interval as the UCSS, which is described in this section below.

USGS 2008 Hazard Map

The applicant did not have access to the PSHA used by the USGS to develop the 2008 update of the seismic hazard map. This update is described in USGS Open-File Report 2008-1128, "Documentation for the 2008 Update of the United States National Seismic Hazard Maps." As part of its review of the applicant's PSHA using the updated EPRI source model, the staff reviewed the 2008 USGS updates. For its 2008 PSHA, the USGS uses a range of maximum magnitudes from 7.1 to 7.7 (7.1 (0.1), 7.3 (0.2), 7.5 (0.5), 7.7 (0.2)) for the large extended margin background zone rather than a single value of 7.5. In addition for the Charleston source, the USGS extended the southeasten edge of the larger source zone offshore to enclose the Helena Banks fault zone. In addition to updating its source models, the USGS also updated its ground motion prediction equations for the 2008 hazard maps. The net result of these changes is a overall 10 to 15% decrease in the hazard for 1-second spectral acceleration. Other areas of the CEUS, decreased by larger percentages compared to the 2002 maps.

Eastern Tennessee Seismic Zone

In addition to the three PSHA studies mentioned above, the applicant discussed the significance of the ETSZ on the VCSNS site seismic hazard. The ETSZ, which is located approximately 282 km (175 mi) northwest of the VCSNS site, is considered to be one of the most active seismic areas east of the Rocky Mountains. As shown in SER Figure 2.5.2-1, the ETSZ covers a cluster of earthquakes in eastern Tennessee. In VCSNS COL FSAR Section 2.5.2.2.2.5, the applicant stated that, despite being one of the most active seismic zones in Eastern North America, the largest recorded earthquake in the ETSZ is only a magnitude 4.6, and no evidence for larger prehistoric earthquakes, such as paleoliquefaction features, has been discovered. The applicant concluded that no new information regarding the ETSZ had been developed since 1986 that would require a significant revision to the original EPRI seismic source model, specifically with regards to the M_{max} values developed by the ESTs for the ETSZ.

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Recent studies of the ETSZ have postulated that this seismic zone may possess the potential to produce large-magnitude earthquakes. The distribution of upper bound M_{max} values developed by the EPRI ESTs for the ETSZ ranges from 4.8 to 7.5. However, the M_{max} distributions of more recent post-EPRI seismic hazard studies (i.e., the USGS National Seismic Hazard Mapping Project (Frankel et al. 2002), the SCDOT (Chapman and Talwani 2002), and the NRC TIP study (NUREG/CR-6607~~,~~), and the Tennessee Valley Authority (TVA) Dam Safety Study (Geomatrix, 2004)) are weighted more heavily towards the larger magnitudes (i.e., refer to SER Figure 2.5.2-13). Thus, in RAI 2.5.2-2, the staff asked the applicant to provide a discussion and basis for not including these newer source models in the overall final PSHA. In response to RAI 2.5.2-2, the applicant referenced a recent sensitivity study by the Nuclear Energy Institute (NEI) (White Paper on 'Seismic Hazard in the Eastern Tennessee Seismic Zone,' ~~(~~ 2008) and concluded that based on the results of the NEI sensitivity study, potential changes resulting from the updating the EPRI-SOG ETSZ are not significant; therefore, the applicant chose not to update the original EPRI-SOG source models for the ETSZ for the VCSNS site. The applicant also noted that "although the conclusion of the NEI study applies directly to a test site lying near the center of historical seismicity in the ETSZ region, effects for a site at the edges of the ETSZ or farther away, such as the VCSNS site, will certainly have relatively less contribution to total seismic hazard and affect the total overall site specific hazard less, especially since the dominant contribution to hazard at the VCSNS site is from Charleston, South Carolina, seismic sources."

The NEI study, referred in the applicant response to RAI 2.5.2-2, provides the results of comparative analyses of hazard curves and GMRS values calculated using both the original EPRI-SOG source model parameters and updated ETSZ M_{max} values taken from the LLNL TIP study and the TVA Dam Safety Study. The NEI study selected a hypothetical site in the middle of the ETSZ for its assessment with the assumption that the impacts of the ETSZ M_{max} updates would be the highest there and it would represent the worst case scenario. The NEI sensitivity study maintained the original geometries of the EPRI-SOG seismic sources while updating the Mmax values of the four EPRI ESTs source models. The other two ESTs have incorporated the ETSZ in their background sources covering much larger areas; hence, the applicant did not update the M_{max} values for those sources. The results of this NEI sensitivity study are that the proposed higher M_{max} values increase the GMRS values by no more than 6 percent at this hypothetical site across the frequency range of interest. The NEI study further argues that the proposed changes in the EPRI-SOG M_{max} values are not warranted, since no new data is available to justify the need for higher M_{max} values in the ETSZ. Based on these calculations, the NEI study concludes that there is no need to revise the EPRI-SOG ETSZ M_{max} values in COLs' PSHA studies.

The staff reviewed the applicant's response to RAI 2.5.2-2 and notes that in its review of the NEI study as part of the Bellefonte Nuclear Plant (BLN) SER, the staff concluded that potential percentage increases in GMRS due to the ETSZ updates at the hypothetical site as well as at the BLN COL site were relatively minor given the very high hazard contributions of the NMSZ. However, in its review the staff concluded that the NEI ETSZ sensitivity study may not provide a generic answer to all potential COL PSHA studies in the region. Specifically, the staff concluded that the hypothetical site may not represent the worst case scenario for percentage increases of the GMRS due to changes in ETSZ models since the impacts of the ETSZ M_{max} updates on GMRS will vary from site to site depending on the contributions of other seismic sources surrounding a site. To verify that the updated M_{max} distribution used in the NEI sensitivity study does not significantly change the final GMRS for the VCSNS site, the staff performed its own sensitivity study, as described below.

In its assessment the staff used an ETSZ source geometry that encompasses the cluster of ETSZ seismicity, as shown in SER Figure 2.5.2-14. This single source zone geometry for ETSZ differs from the source zone geometries developed by EPRI-SOG for ETSZ, which tend to be broader for the most part and encompass a larger area. At the time of the original mid-1980's EPRI-SOG study, these was not much known about the ETSZ; therefore, as shown in SER Figure 2.5.2-14, some of the ETSZ geometries defined by the EPRI teams are not completely centered over the area of the largest concentration of seismicity in the ETSZ. For its sensitivity study the staff used the same higher M_{max} distribution and accompanying weights (6.3 [0.28], 6.6 [0.44], 6.9 [0.28]) that were used for the NEI sensitivity study. The resulting GMRS values for VCSNS increase only slightly at 1 Hz (0.094 g to 0.104 g) and 10 Hz (0.428 g to 0.468 g); therefore, the results support the applicant's overall conclusion that increasing the original EPRI-SOG M_{max} distributions for ETSZ does not significantly impact the hazard for the VCSNS site.

In SER Section 2.5.1.4.1, the staff also reviewed M_{max} values assigned to the ETSZ. The staff noted that although the VCSNS COL FSAR states that more recent estimates of M_{max} are captured in the range of M_{max} values used by the EPRI/SOG teams, the FSAR cites post-EPRI/SOG M_{max} estimates of **M** 6.3 (Bollinger, 1992) and **M** 7.5 (Frankel and others, 2002), but not the alternate higher estimate of **M** 7.8 by Bollinger (1992), which is presented in FSAR Section 2.5.2.2.2.5. Therefore, in RAI 2.5.1-38, the staff asked the applicant to clarify why FSAR Section 2.5.1.1.3.2.2 does not discuss the Bollinger (1992) M_{max} estimate of **M** 7.8. In response to RAI 2.5.1-38, the applicant agreed to modify FSAR Section 2.5.1.1.3.2.2 to clarify the discussions of the **M** 7.8 value for the ETSZ (Bollinger, 1992) in FSAR Sections 2.5.1.1.3.2.2 and 2.5.2.2.2.5. In its response, the applicant explained that the Bollinger (1992) ETSZ model included the **M** 7.8 value with a low probability of 5 percent in the M_{max} distribution, with **M** 6.3 assigned a 95 percent weight. The applicant also pointed out that the smaller magnitude value is much closer to the mean magnitude (i.e., approximately **M** 6.2) of the EPRI study (EPRI, 1986 and 1989). Based on review of the applicant's response to RAI 2.5.1-38 and the revision to FSAR Section 2.5.1.1.3.2.2, the staff concludes that the applicant adequately addressed the M_{max} values used by Bollinger (1992) for the ETSZ.

Based on review of VCSNS COL FSAR Sections 2.5.1.1.3.2.2 and 2.5.2.2.2.5, the applicant's responses to RAIs 2.5.1-38 and 2.5.2-2, and proposed revisions to FSAR Section 2.5.1.1.3.2.2, the staff concludes that the applicant provided a thorough and accurate description of the ETSZ in support of the VCSNS COL application.

Updated EPRI Seismic Sources

Based on the results of several post-EPRI PSHA studies (Frankel et al. 2002; Chapman and Talwani 2002) and the recent availability of paleoliquefaction data (Talwani and Schaeffer 2001) for the Charleston and New Madrid source zones, the applicant updated the EPRI characterization of the Charleston and New Madrid seismic source zones as part of the COL application.

Update of the Charleston Seismic Source

The applicant updated the original EPRI-SOG Charleston seismic source models with the UCSS model, which was originally presented in the SSAR for the VEGP ESP site (Southern Nuclear Company, 2008). The staff reviewed and approved the UCSS model as part of its review of the VEGP ESP application (NUREG-1923). However, in SER Section 2.5.1.4.1, in several RAIs, the staff asked the applicant to address a newly-reported Charleston-area paleoliquefaction feature that was interpreted by Talwani and others (2008) to be associated with the Sawmill Branch fault. Specifically, in RAIs 2.5.1-37 and 2.5.1-54, the staff asked the applicant to discuss this paleoliquefaction feature in regard to any bearing it may have on magnitude and recurrence interval for earthquakes in the VCSNS site region. In response, the applicant stated that Talwani and others (2000) believed the causative earthquake was pre-1886, presumably based on burial depth and observed degree of soil formation. Also in response, the applicant stated that Talwani and others (2008) estimated a magnitude of about 6.9, with the magnitude scale not indicated, for the causative earthquake. The applicant stated that this magnitude falls within the range of M_{max} captured in the UCSS model, and that the feature lies within one of the source area geometries defined for the UCSS model. The applicant concluded that no modifications to the UCSS model are required due to the discovery of this paleoliquefaction feature because none of the information presented by Talwani and others (2008) provided additional constraints on timing, magnitude, or location of an associated paleoearthquake. As discussed in SER Section 2.5.1.4.1, the staff concurs with the applicant that no modification of the UCSS model is required as a result of the discovery of this paleoliquefaction feature. The staff agrees with the applicant because the suggested characteristics of the feature are fully captured in the UCSS.

Update of the New Madrid Seismic Source

In VCSNS COL FSAR Section 2.5.2.4.4, the applicant stated that the updated New Madrid seismic source model described in the SSAR for the Clinton ESP site (Exelon, 2006) formed the basis for determining the potential contribution from the NMSZ to determine the hazard at the VCSNS site. The applicant stated that this model accounts for new information on recurrence intervals for large earthquakes in the New Madrid area, for recent estimates of possible earthquake sizes on each of the active faults, and for the possibility of multiple earthquake occurrences within a short period of time (earthquake clusters). The staff previously reviewed and accepted the New Madrid seismic source model as part of the Clinton ESP application review.

Staff Conclusions of the Geologic and Tectonic Characteristics of the Site and Region

Based upon its review of VCSNS COL FSAR Sections 2.5.2.2 and 2.5.2.4, the staff concludes that the applicant adequately updated the original EPRI seismic source models as the input to its PSHA for the VCSNS site. The staff concludes that the applicant's use of EPRI seismic source models, in addition to the updates of the model, as described by the applicant in FSAR

Sections 2.5.2.2 and 2.5.2.4, forms an adequate basis for the seismic hazard characterization of the site and meets the requirements of 10 CFR 52.79 and 10 CFR 100.23.