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DE FOIA Resource

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**From:** Kammerer, Annie *1/24/11*  
**Sent:** Wednesday, August 24, 2011 6:21 PM  
**To:** Kammerer, Annie; Li, Yong; Manoly, Kamal; Khanna, Meena; Wilson, George  
**Cc:** Karas, Rebecca; Munson, Clifford; Ake, Jon; Chokshi, Niles  
**Subject:** short and 1-page version of the information  
**Attachments:** Summary of Ground Motion Information for the North Anna NPP as of August 24 V2.docx;  
Summary of Ground Motion Information for the North Anna NPP as of August 24  
SHORT.docx

Here are the short and long versions.

Annie

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**From:** Kammerer, Annie  
**Sent:** Wednesday, August 24, 2011 6:00 PM  
**To:** Li, Yong; Manoly, Kamal; Khanna, Meena; Wilson, George  
**Cc:** Karas, Rebecca; Munson, Clifford; Ake, Jon  
**Subject:** updated sheet

Here's the long version...

*E/18 (2)*

## Summary of Ground Motion Information for the North Anna NPP as of August 24, 2011

For discussion and clarification purposes, we have developed the attached figures, which compare relevant the design ground motions for the existing and proposed reactors and current estimates of the ground motion experienced at the NPP during the August 23, 2001 earthquake.

Several takeaways come from these comparisons:

- It can be seen that the current estimates of hazard as provided as a Ground Motion Response Spectrum (GMRS) from the Combined Operating License (COL) application for North Anna 3 are much higher than the earlier hazard estimates that were used for the Unit 1 and 2 Safe Shutdown Earthquake (SSE) ground motion. This was already understood and was being addressed through the GI-199 program.
- A comparison of the best estimate of the ground motion from the earthquake and the ground motion estimates in the COL application show that the ground motion from the earthquake would not have exceeded the Unit 3 SSE. These ground motion level was not a surprise. This appears to validate the NRC's current seismic hazard assessment approaches and models, as well as the basis for the GI-199 reviews.
- The current best estimate from the USGS for the August 23, 2011 earthquake is very close to the 84<sup>th</sup> percentile ground motion that was calculated by Staff's independent analysis.
- There appears to be a high likelihood that the SSE for Units 1 and 2 has been exceeded a wide frequency range, primarily at high frequencies.

Figure 1 shows a comparison between the SSE and OBE for Units 1 and 2 and the Unit 3 COL application GMRS spectrum. The rock SSE for Units 1 and 2 are free field ground motions that are based on Newmark spectral shape anchored at a PGA (peak ground acceleration or zero period acceleration) of 0.12g. The SSE for soil (not shown) is the Newmark spectral shape anchored to 0.18g to account for site effects. Although we often discuss SSE in terms of the PGA, it is important to note that the SSE is a response spectrum curve that covers multiple structural frequencies, not just a single value. The IPEEE review ground motion (not shown) was anchored at 0.16g with a similar spectrum. Finally the figure shows the Ground Motion Response Spectrum (GMRS) for rock from the COL application. The GMRS is the ground motion associated with the  $10^{-4}$  annual probability of exceedance and is the basis of the site-specific SSE for the new NPPs.

Figure 2 shows the same curves as Figure 1, but also includes the current best estimate of the August 24, 2011 earthquake ground motions from the USGS (ShakeCast version 6) and the median and standard deviation motions using the EPRI ground motion prediction equations. There appears to be a high likelihood that the SSE for Units 1 and 2 has been exceeded a wide frequency range.

The USGS values predicted at the plant are developed based on based on two types of input. The principal value used is theoretical predicted motions that come from analyses in which recorded motions at seismograph stations are extended to the NPP sites using ground motion

prediction equations (also called attenuation relationships). This theoretical prediction is then modified based on intensity information that comes from the USGS "Did You Feel It?" (DYFI) system. The DYFI system is a method for using large numbers of inputs from affected persons to develop intensity maps that are used as a "ground truth". As of this writing, the USGS has received nearly 123,000 submitted reports.

NRC staff also performed an independent analysis using the best estimate of the earthquake location and magnitude using the EPRI ground motion prediction equations. The median and  $\pm 1$  standard deviation curves are shown. It can be seen that the 84<sup>th</sup> percentile ground motions calculated by staff are close to the USGS predictions, although there is considerable uncertainty overall. This makes sense because the USGS theoretical values were increased due to the intensity information that came out of the DYFI system.

Please direct questions to Cliff Munson or Annie Kammerer

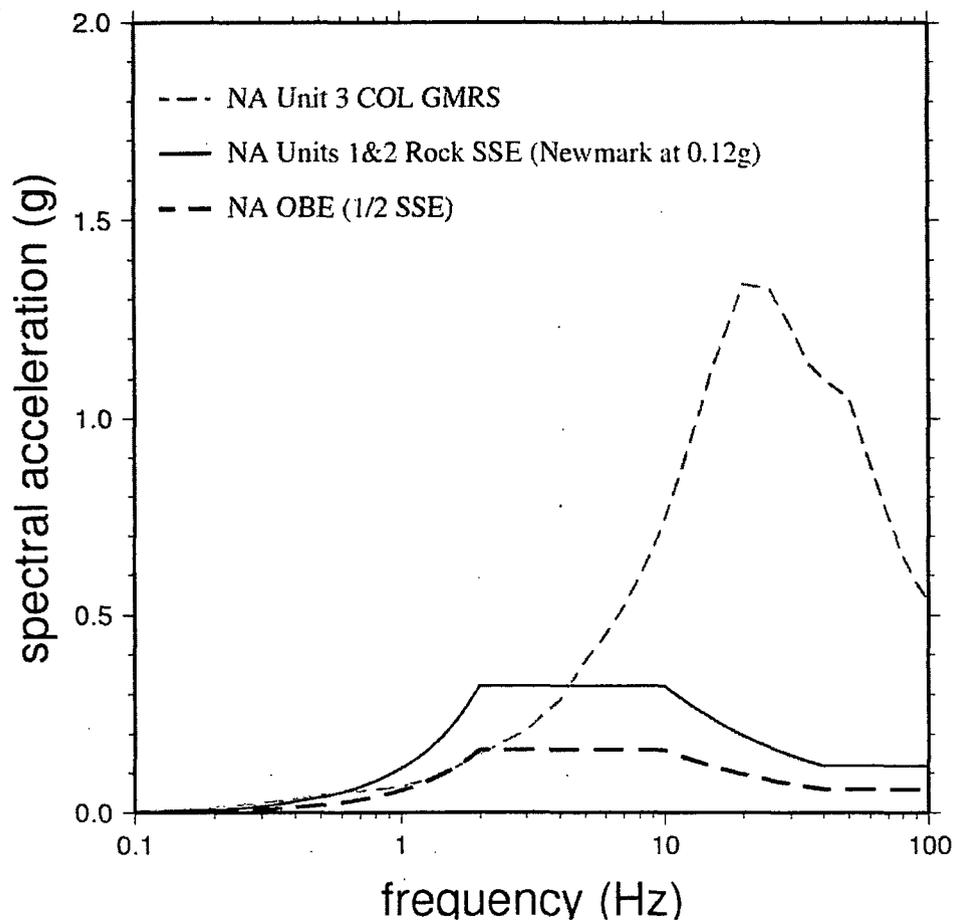


Figure 1: Comparison of the OBE and SSE for Units 1 and 2 and the Unit 3 COL application GMRS spectrum

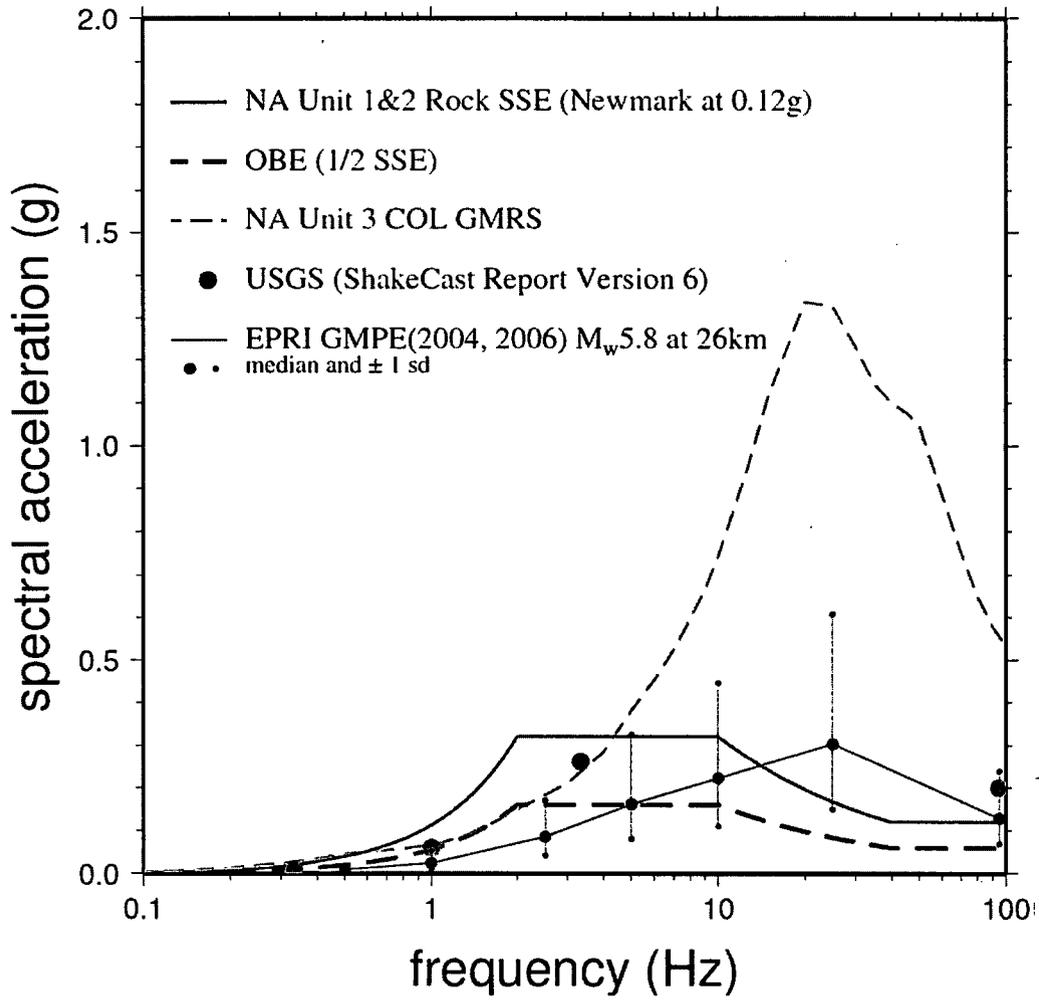


Figure 2: Comparison of the OBE and SSE for Units 1 and 2 and the Unit 3 COL application GMRS spectrum against the best estimate of the ground motions from the USGS (ShakeCast version 6) and the median and standard deviation motions using the EPRI ground motion prediction equations

## Summary of Ground Motion Information for the North Anna NPP as of August 24, 2011

Below is a figure that shows a comparison between the Safe Shutdown Earthquake (SSE) and Operating Basis Earthquake (OBE) for Units 1 and 2, the Unit 3 Combined License (COL) application Ground Motion Response Spectrum (GMRS), the current best estimate of the August 24, 2011 earthquake ground motions from the USGS (ShakeCast version 6), and predicted median and standard deviation earthquake motions using the EPRI ground motion prediction equations. There appears to be a high likelihood that the SSE for Units 1 and 2 has been exceeded over a wide frequency range. The IPEEE review ground motion (not shown) was anchored at 0.16g with a similar spectrum as the SSE. NRC staff also performed an independent analysis of the earthquake ground motions using the best estimate of the earthquake location and magnitude using the EPRI ground motion prediction equations, as shown.

- It can be seen that the current estimates of hazard as provided as a GMRS from the COL application for North Anna 3 are much higher than the earlier hazard estimates that were used for the Unit 1 and 2 SSE ground motion. This was already understood and was being addressed through the GI-199 program.
- A comparison of the best estimate of the ground motion from the earthquake and the ground motion estimates were not a surprise. This appears to validate the NRC's current seismic hazard assessment approaches and models for new reactors, as well as the basis for the GI-199 reviews.
- The current best estimate from the USGS for the August 23, 2011 earthquake is very close to the 84<sup>th</sup> percentile ground motion that was calculated by Staff's independent analysis.
- From these estimates, there appears to be a high likelihood that the SSE for Units 1 and 2 has been exceeded over a wide frequency range, primarily at high frequencies.
- The Staff has been informed that the in-plant seismic instrumentation did not trigger the control room annunciators which are intended to indicate that the OBE has been exceeded. NRR is coordinating with the Region to obtain more information on the response of the instrumentation.

