

**SUMMARY OF METHODOLOGY USED FOR THE SEISMIC  
CAPACITY EVALUATION OF GMRS MITIGATION  
COMPONENTS FOR OCONEE NUCLEAR STATION**

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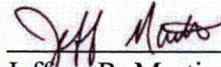
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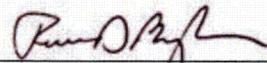
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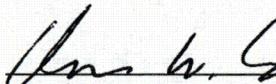
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### Summary of Methodology Used for the Seismic Capacity Evaluation of GMRS Mitigation Components for Oconee Nuclear Station

The Duke Energy Oconee Expedited Seismic Evaluation Process (ESEP) Nuclear Regulatory Commission (NRC) Submittal Report [1] references OSC-11188 [2], Attachment 3, as the basis for screening components in the Standby Shutdown Facility (SSF), and several components in the Auxiliary Building (AB) and Reactor Buildings (RBs). This discussion summarizes the analysis in OSC-11188 [2] and explains why it meets the intent of the ESEP requirements outlined in Electric Power Research Institute (EPRI) Report 3002000704 [3].

The analysis in OSC-11188 [2], Attachment 3 computed High-Confidence-of-a-Low-Probability-of-Failure (HCLPF) values for various components and compared the HCLPF to the Ground Motion Response Spectrum (GMRS) submitted to the U.S. Nuclear Regulatory Commission in Reference 4. All of the components evaluated in the SSF, AB, and RBs were found to have a HCLPF that exceeded the GMRS. The methodology used to compute the HCLPF was the deterministic Conservative Deterministic Failure Margin methodology described in EPRI Report NP-6041-SL [5]. This is the same as the methodology used for the ESEP, with the only exception being that the evaluation in OSC-11188 [2], Attachment 3 used the GMRS (including dominant frequency scaling of the in-structure response spectra [ISRS]) while the ESEP evaluation used the Review Level Ground Motion (RLGM) of 2 times the SSE (including scaling of the ISRS throughout the frequency range). The dominant frequency scaling of the ISRS (described in detail below) meets the intent of the ESEP which also scales the ISRS based upon the difference between the GMRS and the SSE ground response spectrum (limited to an amplification factor of 2).

#### Standby Shutdown Facility

The plot in Figure 1 shows a comparison of the GMRS, the RLGM, and the SSF Safe Shutdown Earthquake (SSE).

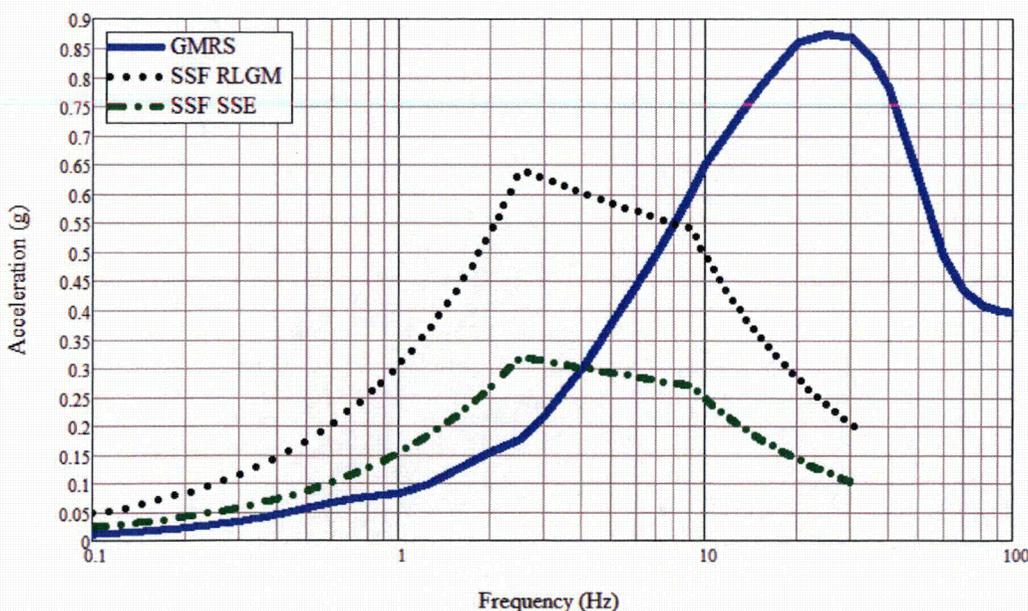


Figure 1 - ONS GMRS vs SSF RLGM and SSF SSE

It can be seen that the GMRS exceeds 2 times the SSF SSE at frequencies above 8 Hz. For SSF components located in the basement, OSC-11188 [2], Attachment 3 used the GMRS directly for comparison to the screening levels in EPRI NP-6041-SL [5]. All of the flexible components used the peak spectral acceleration and rigid components used the Zero Period Acceleration (ZPA). For components located higher in the SSF structure, ISRS were used to compare to 1.5 times the screening levels (EPRI 1019200 [6]). This is the same as for the ESEP components outside the SSF. The GMRS ISRS used in OSC-11188 [2], Attachment 3 were determined by scaling the SSE ISRS. As explained in OSC-11188 [2], Attachment 3, scale factors of 3.65 and 1.79 were used in the N-S and E-W directions, respectively, as these are the ratios of the GMRS to SSE spectral accelerations at the dominant structural frequencies of the SSF (based upon visual inspection of the existing design basis ISRS). The peak spectral accelerations in each direction were then averaged, and the average value was compared to the EPRI NP-6041-SL [5] screening level. The ISRS based on the RLGGM were also determined by scaling. The scale factor was 2.0 for each direction, as this is the ratio of the RLGGM to the SSE. The RLGGM ISRS peak spectral accelerations in each direction were averaged and the average value used for comparison to the EPRI NP-6041-SL [5] screening levels. The average of the 3.65 and 1.79 scale factors is 2.72. The peak spectra accelerations used to compare to the EPRI NP-6041-SL [5] screening level was therefore more than 2 times the SSE ISRS, and if the component screened out in the OSC-11188 [2], Attachment 3, it would also screen out for ESEP.

Some components in OSC-11188 [2], Attachment 3 did not screen out. Capacities for these components were determined by reference to original seismic qualification documents; e.g., seismic test reports. For these components, the larger of the two RLGGM ISRS directions, derived with the 3.65 and 1.79 scale factors, was used for comparison to the test response spectra. Thus, the HCLPF for these components, which all exceeded the GMRS, also exceed the ESEP RLGGM.

In addition to the screening, the anchorage HCLPF was determined and compared to the GMRS. For the components in the basement, the GMRS was used directly, and the results applied to the RLGGM by the same reasoning as for the screening. For components located above the basement, the anchor forces were calculated by applying the unclipped ISRS in each direction. The excitation direction results (e.g., anchor bolt tension and shear) were combined by Square Root of the Sum of the Squares (SRSS). The SRSS of the 3.65 and 1.79 scale factors is 4.1. The SRSS of the RLGGM scale factors (2.0 in both orthogonal directions) is 2.8. Thus, if the anchorage HCLPF in OSC-11188 [2], Attachment 3 was found to exceed the GMRS, it would also exceed the ESEP RLGGM.

The anchorage HCLPF calculations included vertical acceleration. As noted in OSC-11188 [2], Attachment 3 the building did not amplify the SSE ground accelerations. However, in the anchorage calculations, the GMRS peak ground acceleration of 0.4g was used, because the components were rigid in the vertical direction. This is 4.0 times the SSE peak ground acceleration, exceeding the 2.0 scale factor for the RLGGM.

### **Auxiliary Building**

There were several Expedited Seismic Equipment List (ESEL) components located in the AB which were evaluated in OSC-11188 [2], Attachment 3. These components were evaluated using the GMRS as applicable for basemat-mounted components and amplified ISRS for components located above the basemat. Amplifications for the ISRS were performed similar to that for the SSF except that conservative amplifications of 8.7 and 4.0 were applied to the spectral peak and ZPA accelerations, respectively.

The plot in Figure 2 shows a comparison of the GMRS, the RLGGM, and the plant SSE.

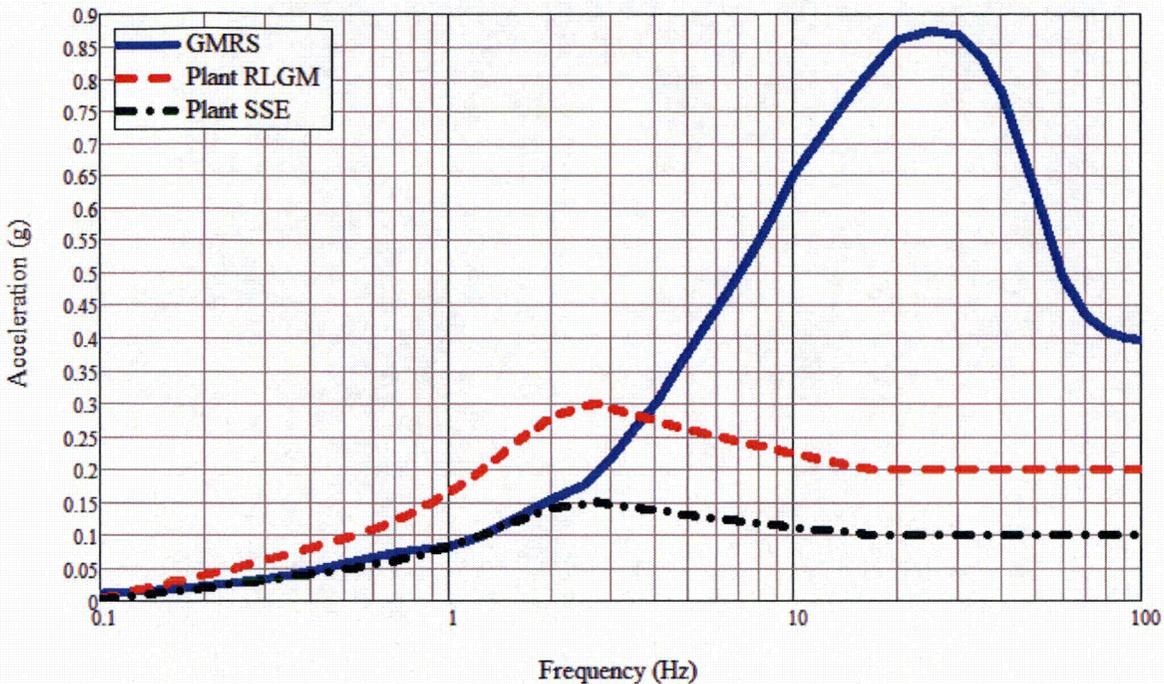


Figure 2 - ONS GMRS vs Plant RLGM and Plant SSE

### **Reactor Building**

Some of the ESEL components located in the RBs were evaluated in OSC-11188 [2], Attachment 3. These components were evaluated using the GMRS as applicable for basemat-mounted components and amplified ISRS for components located above the basemat. Amplifications for the ISRS were performed similar to that for the SSF with amplifications of 4.0 for rigid components and amplifications of 8.7 for non-rigid components.

### **Individual Plant Examination for External Events (IPEEE)**

The Oconee Submittal Report [1] states that ESEL components which were evaluated in the IPEEE, met the screening caveats, and had anchorage capacity exceeding the RLE can be screened out from ESEP seismic capacity determination because the HCLPF capacity exceeds the RLGM. Review of the Oconee Submittal Report [1], Appendix D shows that 77 of the 98 ESEL components located in the SSF were previously evaluated in the IPEEE (“walk-by” versus “walkdown”).

Similarly, all of the AB ESEL components which credit the OSC-11188 [2], Attachment 3 evaluation in the Oconee Submittal Report [1], Appendices A through C were evaluated in the IPEEE. A few of the RB ESEL components which credit the OSC-11188 [2], Attachment 3 evaluation in the Oconee Submittal Report [1], Appendices A through C were evaluated in the IPEEE. The remaining components consist of similar Rosemount transmitters and similar Resistance Temperature Detectors.

The plot in Figure 3 shows a comparison of the IPEEE Review Level Earthquake (RLE), the plant RLGM and the SSF RLGM.

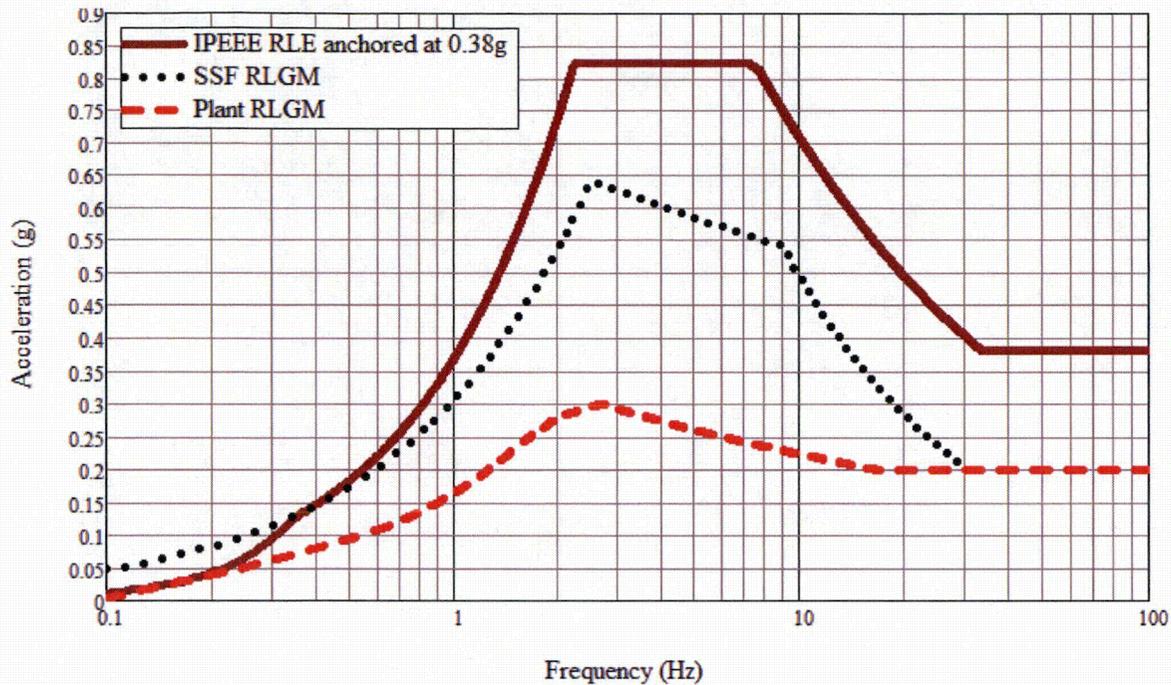


Figure 3 - ONS SSF RLGM and Plant RLGM vs IPEEE RLE

### Summary

On the basis of the above, the components in the SSF, AB, and RBs meet the intent of the ESEP and have a seismic capacity in exceedance of the RLGM, since they were evaluated to the GMRS demand in OSC-11188 [2], Attachment 3.

### References

1. *Expedited Seismic Evaluation Process (ESEP) Report*, Oconee Nuclear Station, Rev. 1, dated November 24, 2014, Duke Energy.
2. Duke Energy Calculation OSC-11188, *ONS Fukushima NTTF 2.1 Seismic Vendor Support Documents for GMRS*, Revision 2, Duke Energy, Seneca, SC.
3. *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 – Seismic*, Electric Power Research Institute, Palo Alto, CA, May 2013, 3002000704.
4. Letter from Scott L. Batson to U.S. Nuclear Regulatory Commission, “Duke Energy Carolinas, LLC (Duke Energy); Oconee Nuclear Station (ONS), Units 1 and 2, Docket Nos. 50-269, 50-270, and 50-287, Renewed License Nos. DPR-38, DPR-47, and DPR-55; Seismic Hazard and Screening Report (CEUS Sites), Response to NRC 10 CFR 50.54(f) Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) regarding Recommendations 2.1, 2.3 and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” dated March 31, 2014, Duke Energy, Seneca, SC.
5. *A Methodology for Assessment of Nuclear Power Plant Seismic Margin*, Electric Power Research Institute, Palo Alto, CA, Rev. 1, August 1991, EPRI NP-6041-SL.
6. *Seismic Fragility Applications Guide Update*, Electric Power Research Institute, Palo Alto, CA, December 2009, EPRI 1019200.