UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 25, 2015

Mr. Brian D. Boles
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Company
c/o Davis-Besse NPS
5501 N. State Route 2
Oak Harbor, OH 43449-9760

SUBJECT: DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1 - STAFF ASSESSMENT OF INFORMATION PROVIDED PURSUANT TO TITLE 10 OF THE *CODE OF FEDERAL REGULATIONS* PART 50, SECTION 50.54(f), SEISMIC HAZARD REEVALUATIONS FOR RECOMMENDATION 2.1 OF THE NEAR-TERM TASK FORCE REVIEW OF INSIGHTS FROM THE FUKUSHIMA DAI-ICHI ACCIDENT (TAC NO. MF3728)

Dear Mr. Boles:

On March 12, 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a request for information pursuant to Title 10 of the *Code of Federal Regulations*, Part 50, Section 50.54(f) (hereafter referred to as the 50.54(f) letter). The purpose of that request was to gather information concerning, in part, seismic hazards at each operating reactor site and to enable the NRC staff, using present-day NRC requirements and guidance, to determine whether licenses should be modified, suspended, or revoked.

By letter dated March 31, 2014, FirstEnergy Nuclear Operating Company (FENOC, the licensee), responded to this request for Davis-Besse Nuclear Power Station, Unit 1 (DBNPS).

The NRC staff has reviewed the information provided related to the reevaluated seismic hazard for DBNPS and, as documented in the enclosed staff assessment, determined that you provided sufficient information in response to Enclosure 1, Items (1) – (3), (5), (7) and the comparison portion of Item (4) of the 50.54(f) letter. Further, the NRC staff concludes that the licensee's reevaluated seismic hazard is suitable for other actions associated with Near-Term Task Force Recommendation 2.1, "Seismic".

Contingent upon the NRC staff's review and acceptance of the licensee's expedited seismic evaluation process and seismic risk evaluation including the high frequency confirmation and spent fuel pool evaluation (i.e., Items (4), (6), (8), and (9)) for DBNPS, the Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter will be completed.

If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

Frankie G. Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-346

Enclosure:
Staff Assessment of Seismic
Hazard Evaluation and Screening Report

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STAFF ASSESSMENT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO SEISMIC HAZARD AND SCREENING REPORT

DAVIS-BESSE NUCLEAR POWER STATION, UNIT 1

DOCKET NO. 50-346

1.0 INTRODUCTION

By letter dated March 12, 2012 (NRC, 2012a), the U.S. Nuclear Regulatory Commission (NRC or Commission) issued a request for information to all power reactor licensees and holders of construction permits in active or deferred status, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.54(f) “Conditions of license” (hereafter referred to as the “50.54(f) letter”). The request and other regulatory actions were issued in connection with implementing lessons-learned from the 2011 accident at the Fukushima Dai-ichi nuclear power plant, as documented in the “Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident” (NRC, 2011b)[1]. In particular, the NRC Near-Term Task Force (NTTF) Recommendation 2.1, and subsequent Staff Requirements Memoranda (SRM) associated with Commission Papers SECY-11-0124 (NRC, 2011c) and SECY-11-0137 (NRC, 2011d), instructed the NRC staff to issue requests for information to licensees pursuant to 10 CFR 50.54(f).

Enclosure 1 to the 50.54(f) letter requests that addressees perform a reevaluation of the seismic hazards at their sites using present-day NRC requirements and guidance to develop a ground motion response spectrum (GMRS).

The required response section of Enclosure 1 requests that each addressee provide the following information:

(1) Site-specific hazard curves (common fractiles and mean) over a range of spectral frequencies and annual exceedance frequencies,

(2) Site-specific, performance-based GMRS developed from the new site-specific seismic hazard curves at the control point elevation,

(3) Safe Shutdown Earthquake (SSE) ground motion values including specification of the control point elevation,

(4) Comparison of the GMRS and SSE. A high frequency evaluation (if necessary),

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[1] Issued as an enclosure to Commission Paper SECY-11-0093 (NRC, 2011a).

(5) Additional information such as insights from NTTF Recommendation 2.3 walkdown and estimates of plant seismic capacity developed from previous risk assessments to inform NRC screening and prioritization,

(6) Interim evaluation and actions taken or planned to address the higher seismic hazard relative to the design basis, as appropriate, prior to completion of the risk evaluation (if necessary),

(7) Statement if a seismic risk evaluation is necessary,

(8) Seismic risk evaluation (if necessary), and

(9) Spent fuel pool (SFP) evaluation (if necessary).

Present-day NRC requirements and guidance with respect to characterizing seismic hazards use a probabilistic approach in order to develop a risk-informed performance-based GMRS for the site. Regulatory Guide (RG) 1.208, A Performance-based Approach to Define the Site- Specific Earthquake Ground Motion (NRC, 2007), describes this approach. As described in the 50.54(f) letter, if the reevaluated seismic hazard, as characterized by the GMRS, is not bounded by the current plant design-basis SSE, further seismic risk evaluation of the plant is merited.

By letter dated November 27, 2012 (Keithline, 2012), the Nuclear Energy Institute (NEI) submitted Electric Power Research Institute (EPRI) report “Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1 Seismic" (EPRI, 2012), hereafter called the SPID. The SPID supplements the 50.54(f) letter with guidance necessary to perform seismic reevaluations and report the results to NRC in a manner that will address the Requested Information Items in Enclosure 1 of the 50.54(f) letter. By letter dated February 15, 2013 (NRC, 2013b), the NRC staff endorsed the SPID.

The required response section of Enclosure 1 to the 50.54(f) letter specifies that Central and Eastern United States (CEUS) licensees provide their Seismic Hazard and Screening Report (SHSR) by 1.5 years after issuance of the 50.54(f) letter. However, in order to complete its update of the EPRI seismic ground motion models (GMM) for the CEUS (EPRI, 2013), industry proposed a six-month extension to March 31, 2014, for submitting the SHSR. Industry also proposed that licensees perform an expedited assessment, referred to as the Augmented Approach, for addressing the requested interim evaluation (Item (6) above), which would use a simplified assessment to demonstrate that certain key pieces of plant equipment for core cooling and containment functions, given a loss of all alternating current power, would be able to withstand a seismic hazard up to two times the design-basis. Attachment 2 to the April 9, 2013 (Pietrangelo, 2013), letter provides a revised schedule for plants needing to perform (1) the Augmented Approach by implementing the Expedited Seismic Evaluation Process (ESEP) and (2) a seismic risk evaluation. By letter dated May 7, 2013 (NRC, 2013a), the NRC determined that the modified schedule was acceptable and by letter dated August 28, 2013 (NRC, 2013c), the NRC determined that the updated GMM (EPRI, 2013) is an acceptable GMM for use by CEUS plants in developing a plant-specific GMRS. .

By letter dated April 9, 2013 (Pietrangelo, 2013), industry committed to following the SPID to develop the SHSR for existing nuclear power plants. By letter dated September 11, 2013 (Belcher, 2013), FirstEnergy Nuclear Operating Company (FENOC, the licensee) submitted partial site response information for Davis-Besse Nuclear Power Station, Unit 1 (DBNPS). By letter dated March 31, 2014 (Sana, 2014), FENOC submitted its SHSR for DBNPS.

2.0 REGULATORY BACKGROUND

The structures, systems, and components (SSCs) important to safety in operating nuclear power plants are designed either in accordance with, or meet the intent of Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 2: "Design Bases for Protection Against Natural Phenomena;" and Appendix A to 10 CFR Part 100, "Reactor Site Criteria." The GDC 2 states that SSCs important to safety at nuclear power plants shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

For initial licensing, each licensee was required to develop and maintain design bases that, as defined by 10 CFR 50.2, identify the specific functions that an SSC of a facility must perform, and the specific values or ranges of values chosen for controlling parameters as reference bounds for the design. The design bases for the SSCs reflect appropriate consideration of the most severe natural phenomena that had been historically reported for the site and surrounding area. The design bases also considered limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The seismic design bases for currently operating nuclear power plants were either developed in accordance with, or meet the intent of GDC 2 and 10 CFR Part 100, Appendix A. Although the regulatory requirements in Appendix A to 10 CFR Part 100 are fundamentally deterministic, the NRC process for determining the seismic design-basis ground motions for new reactor applications after January 10, 1997, as described in 10 CFR 100.23, requires that uncertainties be addressed through an appropriate analysis such as a probabilistic seismic hazard analysis (PSHA).

Section 50.54(f) of 10 CFR states that a licensee shall at any time before expiration of its license, upon request of the Commission, submit written statements, signed under oath or affirmation, to enable the Commission to determine whether or not the license should be modified, suspended, or revoked. On March 12, 2012, the NRC staff issued requests for licensees to reevaluate the seismic hazards at their sites using present-day NRC requirements and guidance, and identify actions planned to address plant-specific vulnerabilities associated with the updated seismic hazards.

Attachment 1 to Enclosure 1 of the 50.54(f) letter describes an acceptable approach for performing the seismic hazard reevaluation for plants located in the CEUS. Licensees are expected to use the CEUS Seismic Source Characterization (CEUS-SSC) model in NUREG- 2115 (NRC, 2012b) along with the appropriate EPRI (2004, 2006) GMMs. The SPID provides further guidance regarding the appropriate use of GMMs for the CEUS. Specifically, Section 2.3 of the SPID recommends the use of the updated GMM (EPRI 2013) and, as such, licensees used the NRC-endorsed updated EPRI GMM instead of the older EPRI (2004, 2006) GMM to develop PSHA base rock hazard curves. Finally, Attachment 1 requested that licensees conduct an evaluation of the local site response in order to develop site-specific hazard curves and GMRS for comparison with the plant SSE.

2.1 Screening Evaluation Results

By letter dated March 31, 2014 (Sana, 2014), the licensee provided the SHSR for the DBNPS. The licensee's SHSR indicated that the site GMRS exceeds the SSE for the DBNPS over the frequency range of approximately 6 – 100 Hertz (Hz). As such, DBNPS screens-in to perform a seismic risk evaluation, SFP evaluation and high frequency confirmation. The licensee indicated that the risk evaluation would address the high frequency exceedance.

On May 9, 2014 (NRC, 2014), the NRC staff issued a letter providing the outcome of its 30-day screening and prioritization evaluation. As indicated in the letter, the NRC staff confirmed the licensee's screening results. The licensee's GMRS exceeds the SSE for DBNPS over the frequency range of 6 to 100 Hz; the confirmatory GMRS, developed by the NRC staff, exceeds the SSE for DBNPS over the frequency range of approximately 8 to 100 Hz. Therefore, based on the licensee's GMRS, DBNPS screens-in for conducting a seismic risk evaluation, high frequency confirmation and SFP evaluation.

3.0 TECHNICAL EVALUATION

The NRC staff evaluated the licensee's submittal to determine if the provided information responded appropriately to Enclosure 1 of the 50.54(f) letter with respect to characterizing the reevaluated seismic hazard.

3.1 Plant Seismic Design-Basis

Enclosure 1 of the 50.54(f) letter requests the licensee provide the SSE ground motion values, as well as the specification of the control point elevation(s) for comparison to the GMRS. For operating reactors licensed before 1997, the SSE is the plant licensing basis earthquake and is characterized by 1) a peak ground acceleration (PGA) value which anchors the response spectra at high frequencies (typically at 20 – 30 Hz for the existing fleet of nuclear power plants; 2) a response spectrum shape which depicts the amplified response at all frequencies below the PGA; and 3) a control point where the SSE is defined.

In Section 3.1 of its SHSR, the licensee described its seismic design bases for DBNPS. The licensee stated that the SSE for DBNPS was developed in accordance with 10 CFR Part 100, Appendix A. The licensee reported a Maximum Possible Earthquake, similar to the SSE ground motion, and a Maximum Probable Earthquake, similar to the operating basis earthquake. The Maximum Possible Earthquake was developed based on the ground motions from two postulated events: a Modified Mercalli Intensity (MMI) VI representing the Lake Erie and South Central Michigan earthquakes, and a MMI VII event representing the Anna, Ohio earthquake of 1937 (updated final safety analysis report (UFSAR),Toledo Edison, 2012). The licensee, using the developed correlations between MMI and PGA (e.g., Esteva et al., 1964; Seed et al., 1969), estimated a maximum PGA of 0.15 g and noted that the SSE is a Newmark shape anchored at 5 percent damping.

The NRC staff reviewed the licensee's description of the SSE for DBNPS and confirms that the SSE, as described in the SHSR, is consistent with information provided in the UFSAR. The licensee specified that the SSE control point is located at the base of the Reactor Building foundation at elevation 540 ft [165 m] (Toledo Edison, 2012). The NRC staff confirmed that the selection of the control point is consistent with guidance provided in Section 2.4.2 of the SPID to define the control point.

3.2 Probabilistic Seismic Hazard Analysis

In Section 2.2 of its SHSR, the licensee stated that, in accordance with the 50.54(f) letter and the SPID, it performed a PSHA using the CEUS-SSC model and the updated EPRI GMM for the CEUS (EPRI, 2013). For its PSHA, the licensee used a minimum moment magnitude, **M**5.0 as specified in the 50.54(f) letter. The licensee further stated that it included CEUS-SSC background sources out to a distance of 400 miles [640 km] and included the Charlevoix, Charleston, New Madrid Fault System, Eastern Rift Margin Fault northern southern segments, Marianna Zone, Commerce Fault, and Wabash Valley repeated large magnitude earthquake (RLME) sources, which lie within 620 miles [1000 km] of the site. The RLME sources are those source areas or faults for which more than one large magnitude (**M** ≥ 6.5) earthquake has occurred in the historical or paleo-earthquake (geologic evidence for prehistoric seismicity) record. The licensee used the mid-continent version of the updated EPRI GMM (EPRI, 2013) for each of the CEUS-SSC sources. Consistent with the SPID, the licensee did not provide base rock seismic hazard curves in SHSR Section 2.2.2 because it performed a site response analysis to determine the control point seismic hazard curves. The licensee provided its control point seismic hazard curves in Section 2.4 of its SHSR. The NRC staff's review of the licensee's control point seismic hazard curves is provided in Section 3.3 of this staff assessment.

As part of its confirmatory analysis of the licensee's GMRS, the NRC staff performed PSHA calculations for base rock site conditions at the DBNPS site. As input, the staff used the CEUS- SSC mode,l as documented in NUREG-2115 (NRC, 2012b), along with the updated EPRI GMM model (EPRI, 2013). Consistent with the guidance provided in the SPID, the NRC staff included all CEUS-SSC background seismic sources within a 310 mi [500 km] radius of the DBNPS site. In addition, the NRC staff included all of the RLME sources falling within a 620 mi [1000 km] radius of the site, which includes the Charleston, Commerce, Eastern Rift Margin Fault northern segment, Eastern Rift Margin Fault southern segment, Marianna, New Madrid Fault System, and Wabash Valley RLME sources. For each of the CEUS-SSC sources used in the PSHA, the NRC staff used the mid-continent version of the updated EPRI GMM (EPRI, 2013). The NRC staff used the resulting base rock seismic hazard curves together with a confirmatory site response analysis, described in the next section, to develop control point seismic hazard curves and a GMRS for comparison with the licensee's results.

Based on its review of the SHSR, the NRC staff concludes that the licensee appropriately followed the guidance provided in the SPID for selecting the PSHA input models and parameters for the site. This includes the licensee's use and implementation of the CEUS-SSC model and the updated EPRI GMM.

3.3 Site Response Evaluation

After completing PSHA calculations for reference rock site conditions, Attachment 1 to Enclosure 1 of the 50.54(f) letter requests that the licensee provide a GMRS developed from the site-specific seismic hazard curves at the control point elevation. In addition, the 50.54(f) letter specifies that the subsurface site response model, for both soil and rock sites, should extend to sufficient depth to reach the generic or base rock conditions as defined in the ground motion models used in the PSHA. To develop site-specific hazard curves at the control point elevation, Attachment 1 requests that licensees perform a site response analysis.

Detailed site response analyses were not typically performed for many of the older operating plants; therefore, Appendix B of the SPID provides detailed guidance on the development of site-specific amplification factors (including the treatment of uncertainty) for sites that do not have detailed, measured soil and rock parameters to extensive depths.

The purpose of the site response analysis is to determine the site amplification that will occur as a result of bedrock ground motions propagating upwards through the soil/rock column to the surface. The critical parameters that determine what frequencies of ground motion are affected by the upward propagation of bedrock motions are the layering of soil and/or soft rock, the thicknesses of these layers, the shear-wave velocities and low-strain damping of the layers, and the degree to which the shear modulus and damping change with increasing input bedrock amplitude.

3.3.1 Site Base Case Profiles

The licensee provided a detailed description of the site profile in Sections 2.3.1 and 2.3.2 of its SHSR based on the information documented in the UFSAR (Toledo Edison, 2012). The information used to create the site geologic profile at the site is shown in Tables 2-2 and 2-3 of the SHSR. According to Table 2-3, the SSE Control Point at Elevation 540 ft [165 m], lies in the dolomite bedrock, which most major structures of DBNPS are founded.

Tables 2-2 and 2-3 of the SHSR show the stratigraphic column, description, depth, best estimate shear-wave velocity and velocity range. Depth to hard crystalline basement rock is at 1390 ft [424 m]. To determine shear-wave velocities for the uppermost layers beneath the DBNPS site, the licensee used the shear-wave velocity measurements from a seismic refraction investigation at the site and rock core borings reported in the UFSAR (Toledo Edison, 2012). To determine the shear wave velocities for the deeper layers, the licensee used nearby deep well logs in the vicinity of the site, which were obtained from the Ohio Geological Survey. The licensee stated that the site stratigraphy that it constructed from the regional well log data is consistent with the Regional and Local Geology discussed in Appendix 2C of the UFSAR. The licensee stated that it converted the sonic well log data to shear wave velocities based on an established methodology that considers the material type, porosity, density and lithology.

To capture the uncertainty in the shear wave velocity profile due to the limited on-site measurements for the upper layers and use of regional data rather than on-site measurements for the deeper layers, the licensee developed three base case velocity profiles. Table 2-4 of the SHSR provides the licensee's shear-wave velocity profiles (P1, P2, P3). To develop the best estimate for base case shear-wave velocity profile, the licensee set the initial shear-wave velocity at the SSE control point (at an elevation of 540 ft [165 m] MSL) to 4948 ft/s [1508 m/s]. According to the SHSR, based on the well-characterized nature of the flat-lying geologic unit beneath the site, the licensee used a factor of 1.15 (natural-log standard deviation of 0.11) to obtain the upper and lower range velocity profiles. Figure 3.3-1 of this assessment shows the three base case profiles developed by the licensee.

To model the potential dynamic material properties of the subsurface, the licensee selected two alternative characterizations. For the upper 500 ft [152 m] of the profile, the licensee modeled the rock behavior as either linear or non-linear. To model the potential non-linear dynamic material properties, the licensee used the EPRI rock dynamic material property curves. To model the linear behavior of the rock, the licensee used the low strain damping values (approximately 3 percent) from the EPRI rock curves for each of the layers. The licensee weighted these alternative material behaviors equally. From 500 ft [152 m] to the reference or basement rock the licensee assumed a linear response and used a constant damping value of 1.25 percent.

The licensee also considered the impact of kappa, or small strain damping, on site response. Kappa is measured in units of seconds (sec), and is the damping contributed by both intrinsic hysteretic damping as well as scattering due to wave propagation in heterogeneous material. The licensee used guidance in Appendix B-5.1.3.1 of the SPID for a firm rock site with less than 3000 ft [1000 m] of firm rock in thickness to estimate kappa. The estimated total site kappa for the base, lower, and upper velocity profiles are 0.014, 0.015, and 0.013 sec, respectively. Because these three kappa values are very close, the licensee increased the kappa estimate for the lower base case profile (P2) by 50 percent to 0.023 sec. The licensee used this higher value of 0.023 sec, as well as its original estimated value of 0.015 with weights of 0.6 and 0.4, respectively. Similarly, for the higher base case velocity profile (P3), the licensee reduced the kappa estimate by 50 percent to 0.009 sec. The licensee used this lower value of 0.009 sec along with its original estimate of 0.013 sec as the two kappa values for profile P3 with weights of 0.6 and 0.4, respectively.

To account for randomness in material properties across the plant site, the licensee stated that it randomized its base case shear-wave velocity profiles consistent with Appendix B of the SPID. The licensee did not randomize the depth-to-basement rock due to the availability of the deep-well log data in the vicinity of the site.

3.3.2 Site Response Method and Results

In Section 2.3.4 of its SHSR, the licensee stated that it followed the guidance in Appendix B of the SPID to develop input ground motions for the site response analysis and in Section 2.3.5, the licensee described its implementation of the random vibration theory (RVT) approach to perform its site response calculations. Finally, Section 2.3.6 of the SHSR shows the resulting amplification functions and associated uncertainties for 2 of the 11 input loading levels for the base case profile and EPRI rock shear modulus and damping curves.

In order to develop probabilistic site-specific control point hazard curves, as requested in Requested Information Item 1 of the 50.54(f) letter, the licensee used Method 3, described in Appendix B-6.0 of the SPID. The licensee's use of Method 3 involved computing the site- specific control point elevation hazard curves for a broad range of spectral accelerations by combining the site-specific bedrock hazard curves, determined from the initial PSHA (Section 3.2 of this assessment), and the amplification functions and their associated uncertainties, determined from the site response analysis.

3.3.3 Staff Confirmatory Analysis

To confirm the licensee's site response analysis, the NRC staff performed site response calculations for the DBNPS site. For its site response calculations, the NRC staff employed the RVT approach and developed input ground motions in accordance with Appendix B of the SPID.

Because the licensee used on-site geophysical measurements and rock cores to estimate the shear wave velocities for the upper rock layers and nearby well log data to estimate the velocities for the deeper layers, the staff adopted the licensee's best estimate base case profile (P1) as its middle base case profile. However, due to the limited amount of on-site geophysical measurements and the use of off-site well log data, the staff used a natural-log standard deviation of 0.35, instead of the licensee's value of 0.11, to develop its lower and upper velocity profiles. The licensee used a lower standard deviation due to the generally flat lying geologic units and the availability of nearby well log data; however, the staff concluded that a somewhat higher standard deviation was warranted since the closest well log is 2-3 miles from the site. As a result, as shown in Figure 3.3-1 of this assessment, the NRC staff's lower and upper velocity profiles are farther from the middle or best estimate profile than the licensee's lower and upper profiles. To characterize the dynamic material behavior of the site response profile, the staff used the same approach as the licensee, which is described above in Section 3.3.1 of this assessment.

To determine kappa, the NRC staff used guidance provided in the SPID for sites with less than 3000 ft [1000 m] of firm sedimentary rock. The NRC staff's total kappa value for the middle base case velocity profile is 0.014 sec, which is the same value determined by the licensee. To capture the uncertainty in kappa, the NRC staff used a natural-log standard deviation of 0.40 (a factor of 1.67) about the mean base-case kappa value of 0.014 sec to estimate kappa values for the lower and upper velocity profiles (0.023 and 0.008 sec, respectively).

Figure 3.3-2 of this assessment shows a comparison of the NRC staff's and the licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. As shown in this figure, the licensee's amplification functions peak at around 0.9 Hz and 8.5 Hz, with a trough at 2.5 Hz. The two peaks could approximately be associated with resonance in two columns of firm rock above the crystalline basement with thicknesses of about 1390 ft [424 m] and 170 ft [52 m], respectively. The NRC amplification functions are on average slightly lower than those of the licensee, with resonance frequencies shifted to lower values. The differences in amplification function values are mainly due to differences in the choice of velocity profiles rather than in differences between the licensee and NRC analysis methods.

Figure 3.3-2 of this assessment shows a comparison of the NRC staff's and the licensee's median site amplification functions and uncertainties (±1 standard deviation) for two of the eleven input loading levels. The amplification functions are highest at frequencies of less than 1 Hz and decrease with increasing frequency. Amplification functions calculated by the NRC staff and the licensee are similar, however uncertainties are higher for the staff's profiles. This is due to the greater epistemic uncertainty in the staff's kappa values and damping parameters.

The licensee's approach to modeling the subsurface rock properties and their uncertainty results in similar site amplification factors to those produced by the NRC staff. As shown in Figure 3.3-3 of this assessment, minor differences in site amplification and uncertainty have a very minor impact on the control point seismic hazard curves and the resulting GMRS, discussed below. Appendix B of the SPID provides guidance for performing site response analyses, including capturing the uncertainty for sites with less subsurface data; however, the guidance is neither entirely prescriptive nor comprehensive. As such, various approaches in performing site response analyses, including the modeling of uncertainty, are acceptable for this application.

In summary, the staff concludes that the licensee's site response was conducted using present- day guidance and methodology, including the NRC-endorsed SPID. The staff performed independent calculations which confirmed that the licensee's amplification factors and control point hazard curves adequately characterize the site response, including the uncertainty associated with the subsurface material properties, for the DBNPS site.

3.4 Ground Motion Response Spectra

In Section 2.4 of its SHSR, the licensee stated that it used the control point hazard curves, described in SHSR Section 2.3.7, to develop the 10^{-4} and 10^{-5} (mean annual frequency of exceedance) uniform hazard response spectra (UHRS) and then computed the GMRS using the criteria in RG 1.208.

The NRC staff independently calculated 10^{-4} and 10^{-5} UHRS using the results of its confirmatory PSHA and site response calculations, as described in Sections 3.2 and 3.3 of this staff assessment, respectively. Figure 3.4-1 of this staff assessment shows a comparison of the GMRS determined by the licensee to that determined by the NRC staff.

As shown in Figure 3.4-1, the licensee's and NRC staff's GMRS shapes are generally similar with the peak occurring at similar frequencies. The licensee's GMRS is higher than the NRC staff's confirmatory analysis at frequencies between 6 and 20 Hz, but lower elsewhere. As described above in Section 3.3, the NRC staff concludes that these minor differences over this frequency range are primarily due to the differences in the site response analyses performed by the licensee and staff.

The NRC staff confirms that the licensee used the present-day guidance and methodology outlined in RG 1.208 and the SPID to calculate the horizontal GMRS, as requested in the

50.54(f) letter. The NRC staff performed both a PSHA and site response confirmatory analysis, and achieved results consistent with the licensee's horizontal GMRS. As such, the NRC staff concludes that the GMRS determined by the licensee adequately characterizes the reevaluated hazard for the DBNPS site. Therefore, this GMRS is suitable for use in subsequent evaluations and confirmations, as needed, for the response to the 50.54(f) letter.

4.0 CONCLUSION

The NRC staff reviewed the information provided by the licensee for the reevaluated seismic hazard for the DBNPS site. Based on its review, the staff concludes that the licensee conducted the hazard reevaluation using present-day methodologies and regulatory guidance, it appropriately characterized the site given the information available, and met the intent of the guidance for determining the reevaluated seismic hazard. Based upon the preceding analysis, the NRC staff concludes that the licensee provided an acceptable response to Requested Information Items (1) – (3), (5), (7), and the comparison portion to Item (4), identified in Enclosure 1 of the 50.54(f) letter. Further, the licensee's reevaluated seismic hazard is acceptable to address other actions associated with NTTF Recommendation 2.1: Seismic.

In reaching this determination, the NRC staff agrees the licensee's conclusion that the licensee's GMRS for the DBNPS site exceeds the SSE in the frequency range of approximately 6 to 100 Hz. As such, DBNPS screens in to perform a seismic risk evaluation, SFP evaluation, and high frequency confirmation. The licensee indicated the high frequency confirmation could be performed as part of its seismic risk evaluation. The NRC review and acceptance of FENOC's seismic risk evaluation with the high frequency confirmation, interim ESEP evaluation and SFP evaluation (i.e., Items (4), (6), (8), and (9)) for DBNPS will complete Seismic Hazard Evaluation identified in Enclosure 1 of the 50.54(f) letter.

REFERENCES

Note: ADAMS Accession Nos. refers to documents available through NRC's Agencywide Documents Access and Management System (ADAMS). Publicly-available ADAMS documents may be accessed through http://www.nrc.gov/reading-rm/adams.html.

U.S. Nuclear Regulatory Commission Documents and Publications

NRC (U.S. Nuclear Regulatory Commission), 2007, A Performance-based Approach to Define the Site-Specific Earthquake Ground Motion, Regulatory Guide (RG) 1.208, March 2007.

NRC (U.S. Nuclear Regulatory Commission), 2011a, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," Commission Paper SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011b, "Recommendations for Enhancing Reactor Safety in the 21st Century: The Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," Enclosure to SECY-11-0093, July 12, 2011, ADAMS Accession No. ML11186A950.

NRC (U.S. Nuclear Regulatory Commission), 2011c, "Recommended Actions to be Taken Without Delay from the Near-Term Task Force Report," Commission Paper SECY-11-0124, September 9, 2011, ADAMS Accession No. ML11245A158.

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Figure 3.3- 1 Plot of Staff's and Licensee's Base Case Shear-Wave Velocity Profiles for the Davis-Besse site

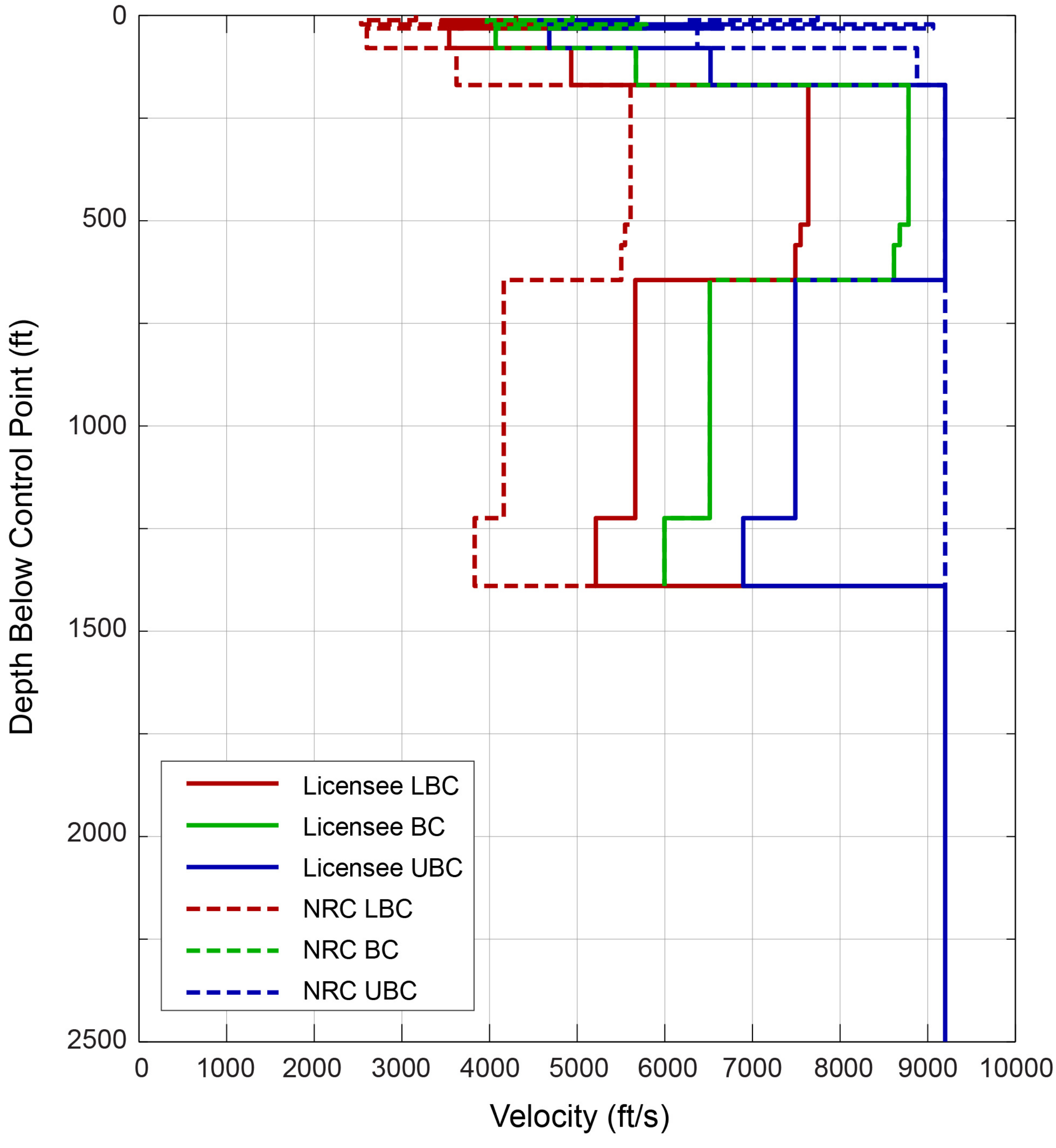


Figure 3.3- 2 Plot Comparing the Staff's and the License's Median Amplification Functions and Uncertainties for two input loading levels for the Davis-Besse site

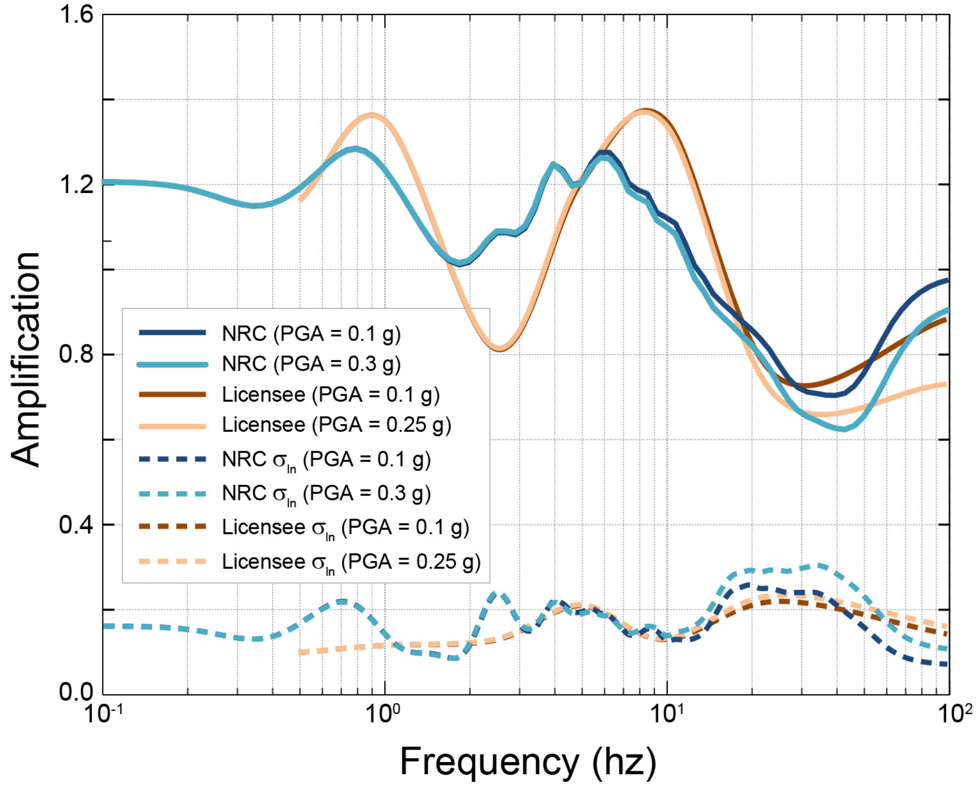


Figure 3.3-3 Plot Comparing the Staff's and the Licensee's Mean Control Point Hazard Curves at a Variety of Frequencies for the Davis-Besse site

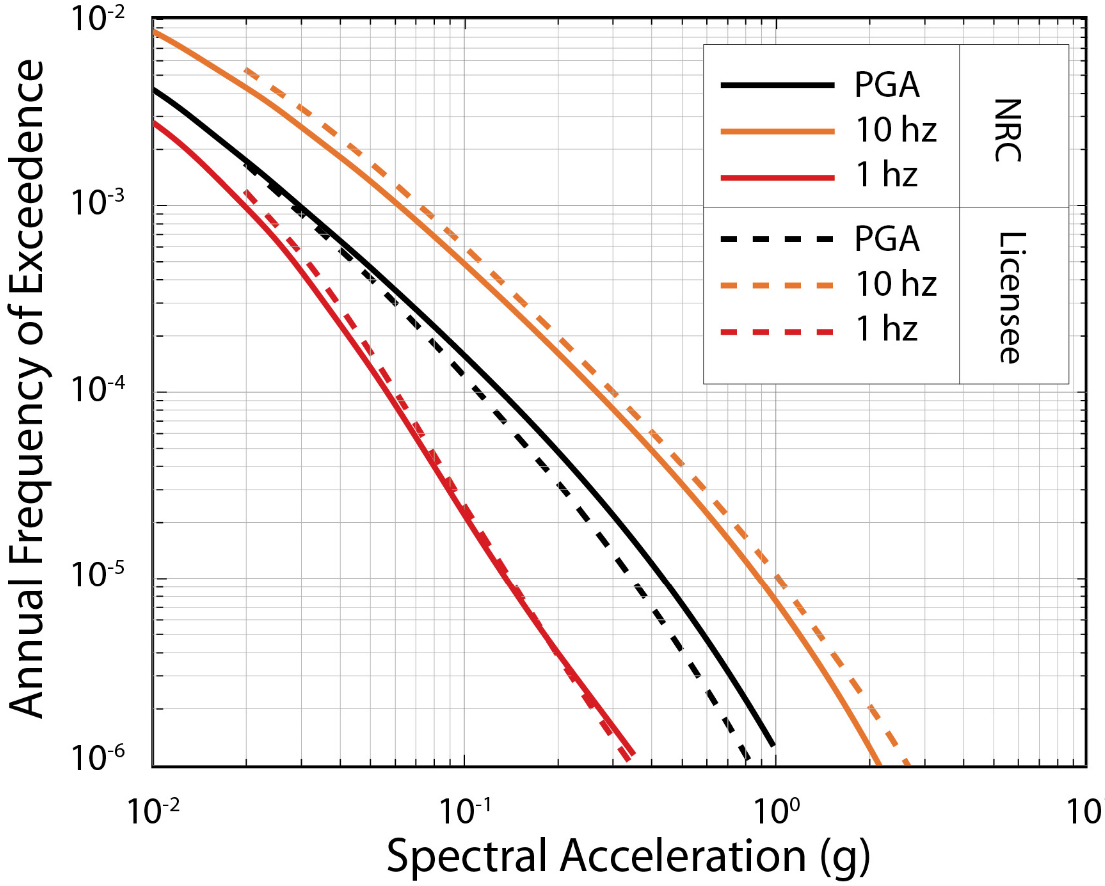
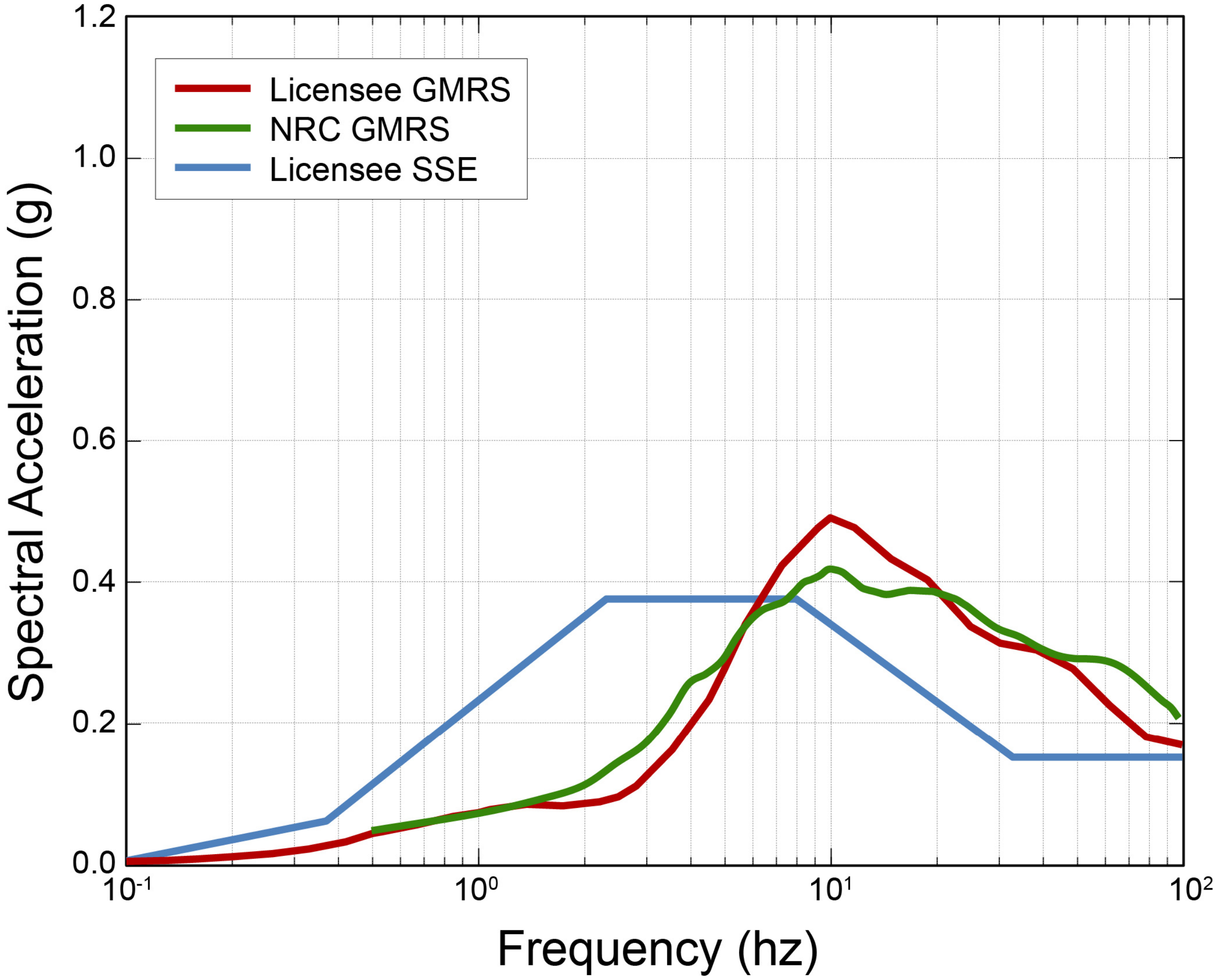


Figure 3.4-1 Comparison of the Staff's GMRS with Licensee's GMRS and the SSE for the Davis-Besse site



If you have any questions, please contact me at (301) 415-1617 or at Frankie.Vega@nrc.gov.

Sincerely,

/RA/

Frankie G. Vega, Project Manager
Hazards Management Branch
Japan Lessons-Learned Division
Office of Nuclear Reactor Regulation

Docket No. 50-346

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Hazard Evaluation and Screening Report

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