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First Energy Nuclear Operating Company

Davis-Besse Nuclear Power Station
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Mark B. Bezilla
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419-436-1340

August 2, 2017
L-17-233

10 CFR 50.54(f)

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

SUBJECT:
Davis-Besse Nuclear Power Station
Docket No. 50-346, License No. NPF-3
High Frequency Supplement to Seismic Hazard Screening Report, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-ichi Accident (CAC Nos. MF3728)

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued a Request for Information pursuant to 10 CFR 50.54(f) (Reference 1) to all power reactor licensees. The required response section of Enclosure 1 of Reference 1 indicated that licensees should provide a seismic hazard evaluation and screening report within 1.5 years from the date of the letter for central and eastern United States (CEUS) nuclear power plants. By letter dated May 7, 2013 (Reference 2), the NRC extended the date to submit the report to March 31, 2014.

By letter dated May 9, 2014 (Reference 3), the NRC transmitted the results of the screening and prioritization review of the seismic hazards reevaluation report for Davis-Besse Nuclear Power Station (DBNPS) submitted by letter dated March 31, 2014 (Reference 4). In accordance with the screening, prioritization, and implementation details report (SPID) (References 5, 6, and 7), and Augmented Approach guidance (Reference 2), the reevaluated seismic hazard is used to determine if additional seismic risk evaluations are warranted for a plant. Specifically, the reevaluated horizontal ground motion response spectrum (GMRS) at the control point elevation is compared to the existing safe shutdown earthquake (SSE) or Individual Plant Examination for External Events (IPEEE) High Confidence of Low Probability of Failure (HCLPF) Spectrum (HIS) to determine if a plant is required to perform a high frequency confirmation evaluation. As noted in Enclosure 2 of Reference 3, DBNPS is to conduct a limited scope high frequency evaluation (confirmation).

Within Reference 3, the NRC acknowledged that these limited scope evaluations will require additional development of the assessment process. The Nuclear Energy Institute (NEI) submitted an Electric Power Research Institute (EPRI) report titled, *High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation (EPRI 3002004396)* for NRC review and endorsement (References 8 and 9). NRC endorsement was provided by Reference 10. Reference 11 provided the NRC final seismic hazard evaluation screening determination results and the associated schedules for submittal of the remaining seismic hazard evaluation activities.

The enclosure to this letter provides the High Frequency Evaluation Confirmation Report for DBNPS that confirms that all high frequency susceptible equipment evaluated with the scoping requirements and criteria for seismic demand have adequate seismic capacity. Therefore, no additional modifications or evaluations are necessary. The enclosure provides the requested information in response to Reference 1 associated with NTTF Recommendation 2.1 Seismic evaluation criteria.

There are no new regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at 330-315-6810.

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 2, 2017.

Respectfully,

Mark B. Bezilla

Enclosure

Near-Term Task Force (NTTF) 2.1 High-Frequency Confirmation Submittal
Davis-Besse Nuclear Power Station

References:

1. NRC Letter, 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 12, 2012, Agencywide Documents Access and Management System (ADAMS) Accession Number ML12053A340.
2. NRC Letter, Electric Power Research Institute Report Final Draft Report XXXXXX, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic*, As An

Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations, dated May 7, 2013, ADAMS Accession Number ML13106A331.

3. NRC Letter, Screening and Prioritization Results Regarding Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Seismic Hazard Re-evaluations for Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated May 9, 2014, ADAMS Accession Number ML14111A147.
4. FENOC Letter, FirstEnergy Nuclear Operating Company (FENOC) Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-ichi Accident, dated March 31, 2014, ADAMS Accession Number ML14092A203.
5. NEI Letter, Final Draft of Industry Seismic Evaluation Guidance (EPRI 1025287), dated November 27, 2012, ADAMS Accession Numbers ML12333A168.
6. EPRI Report 1025287, *Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details [SPID] for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic*, November 2012, ADAMS Accession Number ML12333A170.
7. NRC Letter, Endorsement of Electric Power Research Institute Final Draft Report 1025287, *Seismic Evaluation Guidance*, dated February 15, 2013, ADAMS Accession Number ML12319A074.
8. NEI Letter, Request for NRC Endorsement of *High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation (EPRI 3002004396)*, dated July 30, 2015, ADAMS Accession Numbers ML15223A100.
9. EPRI Report 3002004396, *High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation*, July 2015, ADAMS Accession Number ML15223A102.
10. NRC Letter, Endorsement of Electric Power Research Institute Final Draft Report 3002004396, *High Frequency Program: Application Guidance for Functional Confirmation and Fragility*, dated September 17, 2015, ADAMS Accession Number ML15218A569.
11. NRC Letter, Final Determination of Licensee Seismic Probabilistic Risk Assessments Under the Request for Information Pursuant to Title 10 of the *Code of Federal Regulations* 50.54(f) Regarding Recommendation 2.1 "Seismic" of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated October 27, 2015, ADAMS Accession Number ML15194A015.

cc: Director, Office of Nuclear Reactor Regulation (NRR)
NRC Region III Administrator
NRC Resident Inspector
NRR Project Manager
Utility Radiological Safety Board

Enclosure
L-17-233

Near-Term Task Force (NTTF) 2.1
High-Frequency Confirmation Submittal
Davis-Besse Nuclear Power Station

(77 pages follow)

FIRST ENERGY NUCLEAR OPERATING COMPANY

Near-Term Task Force (NTTF) 2.1 High-Frequency Confirmation Submittal

Davis-Besse Nuclear Power Station

APPROVALS

Report Name:	Near-Term Task Force (NTTF) 2.1 High-Frequency Confirmation Submittal Davis-Besse Nuclear Power Station
Date:	June 12, 2017
Revision No.:	Revision 0

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*See comment review sheets for applicable sections reviewed

ABS Consulting

RIZZO ASSOCIATES

2734296-R-015
Revision 0

Near-Term Task Force (NTTF) 2.1 High-Frequency Confirmation Submittal Davis-Besse Nuclear Power Station

June 12, 2017

Prepared for:
FirstEnergy Nuclear Operating Company

ABSG Consulting Inc. • 300 Commerce Drive, Suite 200 • Irvine, California 92602

NEAR-TERM TASK FORCE (NTTF) 2.1 HIGH-FREQUENCY CONFIRMATION SUBMITTAL DAVIS-BESSE NUCLEAR POWER STATION

ABSG CONSULTING INC. REPORT NO. 2734296-R-015
REVISION 0
RIZZO REPORT NO. R12 12-4737
JUNE 12, 2017

ABSG CONSULTING INC.
RIZZO ASSOCIATES

ABS Consulting
RIZZO

APPROVALS

Report Name: Near-Term Task Force (NTTF) 2.1
High-Frequency Confirmation Submittal
Davis-Besse Nuclear Power Station

Date: June 12, 2017

Revision No.: 0

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CHANGE MANAGEMENT RECORD

REVISION No.	DATE	DESCRIPTIONS OF CHANGES/AFFECTED PAGES
0	June 12, 2017	Initial Submittal

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LIST OF ACRONYMS

ABS CONSULTING	ABSG CONSULTING INC.
AC	ALTERNATING CURRENT
AFW	AUXILIARY FEEDWATER
APRM	AVERAGE POWER RANGE MONITOR
AVV	ATMOSPHERIC VENT VALVE
CCW	COMPONENT COOLING WATER
CEUS	CENTRAL AND EASTERN UNITED STATES
DBNPS	DAVIS-BESSE NUCLEAR POWER STATION
DC	DIRECT CURRENT
DDFW	DIESEL-DRIVEN FEEDWATER SYSTEM
DGB	DIESEL GENERATOR BUILDING
EDG	EMERGENCY DIESEL GENERATOR
EFW	EMERGENCY FEEDWATER
EL	ELEVATION
EPRI	ELECTRIC POWER RESEARCH INSTITUTE
ESEP	EXPEDITED SEISMIC EVALUATION PROCESS
FENOC	FIRSTENERGY NUCLEAR OPERATING COMPANY
FIRS	FOUNDATION INPUT RESPONSE SPECTRA
ft	FEET
ft/s	FEET PER SECOND
g	ACCELERATION OF GRAVITY
GERS	GENERIC EQUIPMENT RUGGEDNESS SPECTRA
GMRS	GROUND MOTION RESPONSE SPECTRA
Hz	HERTZ
ISRS	IN-STRUCTURE RESPONSE SPECTRA
LOCA	LOSS OF COOLANT ACCIDENT
LOOP	LOSS OF OFFSITE POWER
m	METER

LIST OF ACRONYMS (CONTINUED)

MCC	MOTOR CONTROL CENTER
MOV	MOTOR-OPERATED VALVES
m/s	METER PER SECOND
NRC	UNITED STATES NUCLEAR REGULATORY COMMISSION
NSSS	NUCLEAR STEAM SUPPLY SYSTEM
NTTF	NEAR-TERM TASK FORCE
PGA	PEAK GROUND ACCELERATION
PORV	POWER-OPERATED RELIEF VALVE
PWR	PRESSURIZED WATER REACTOR
RB	REACTOR BUILDING
RCS	REACTOR COOLANT SYSTEM
RIZZO	RIZZO ASSOCIATES
SDFW	STEAM DRIVEN FEEDWATER SYSTEM
SFAS	SAFETY FEATURES ACTUATION SYSTEM
SFRCS	STEAM FEED RUPTURE CONTROL SYSTEM
SILO	SEAL-IN AND LOCK-OUT
SPID	SCREENING, PRIORITIZATION, AND IMPLEMENTATION DETAILS
SPRA	SEISMIC PROBABILISTIC RISK ASSESSMENT
SQURTS	SEISMIC QUALIFICATION REPORTING AND TESTING STANDARDIZATION
SSCs	STRUCTURES, SYSTEMS, AND COMPONENTS
SSE	SAFE SHUTDOWN EARTHQUAKE
SW	SERVICE WATER
UFSAR	UPDATED SAFETY ANALYSIS REPORT
UPS	UNINTERRUPTABLE POWER SUPPLY
WUS	WESTERN UNITED STATES
V/H	VERTICAL-TO-HORIZONTAL
V_S	SHEAR-WAVE VELOCITY

NEAR-TERM TASK FORCE (NTTF) 2.1
HIGH-FREQUENCY CONFIRMATION SUBMITTAL
DAVIS-BESSE NUCLEAR POWER STATION

EXECUTIVE SUMMARY

The purpose of this report is to provide information as requested by the Nuclear Regulatory Commission (NRC) in its March 12, 2012, letter issued to all power reactor licensees and holders of construction permits in active or deferred status (Reference 1). In particular, this report provides information requested to address the High-Frequency Confirmation requirements of Item (4), Enclosure 1, Recommendation 2.1: Seismic, of the March 12, 2012, letter (Reference 1).

Following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established a Near-Term Task Force (NTTF) to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 50.54(f) letter on March 12, 2012 (Reference 1), requesting information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter requests that licensees and holders of construction permits under 10 CFR Part 50 reevaluate the seismic hazards at their sites against present-day NRC requirements and guidance. Included in the 50.54(f) letter was a request that licensees perform a "confirmation, if necessary, that SSCs, which may be affected by high-frequency ground motion, will maintain their functions important to safety."

EPRI 1025287, "Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic" (Reference 6) provided screening, prioritization, and implementation details to the U.S. nuclear utility industry for responding to the NRC 50.54(f) letter. This report was developed with NRC participation and was subsequently endorsed by the NRC. The SPID included guidance for determining which plants should perform a High-Frequency Confirmation and identified the types of components that should be evaluated in the evaluation.

Subsequent guidance for performing a High-Frequency Confirmation was provided in EPRI 3002004396, "High Frequency Program, Application Guidance for Functional Confirmation and Fragility Evaluation," (Reference 8) and was endorsed by the NRC in a letter dated September 17, 2015 (Reference 3). Final screening identifying plants needing to perform a High-Frequency Confirmation was provided by NRC in a letter dated October 27, 2015 (Reference 2).

This report describes the High-Frequency Confirmation evaluation undertaken for the Davis-Besse Nuclear Power Station (DBNPS). The objective of this report is to provide summary information describing the High-Frequency Confirmation evaluations and results. The level of detail provided in the report is intended to enable NRC to understand the inputs used, the evaluations performed, and the decisions made as a result of the evaluations.

EPRI 3002004396 (Reference 8) is used for the DBNPS engineering evaluations described in this report. In accordance with Reference 8, the following topics are addressed in the subsequent sections of this report:

- Process of selecting components and a list of specific components for High-Frequency Confirmation
- Estimation of a vertical ground motion response spectrum (GMRS)
- Estimation of in-cabinet seismic demand for subject components
- Estimation of in-cabinet seismic capacity for subject components
- Summary of subject components' high-frequency evaluations

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to provide information as requested by the NRC in its March 12, 2012, 50.54(f) letter issued to all power reactor licensees and holders of construction permits in active or deferred status (Reference 1). In particular, this report provides requested information to address the High-Frequency Confirmation requirements of Item (4), Enclosure 1, Recommendation 2.1: Seismic, of the March 12, 2012 letter (Reference 1).

1.2 BACKGROUND

Following the accident at the Fukushima Dai-ichi nuclear power plant resulting from the March 11, 2011, Great Tohoku Earthquake and subsequent tsunami, the NRC established a NTTF to conduct a systematic review of NRC processes and regulations and to determine if the agency should make additional improvements to its regulatory system. The NTTF developed a set of recommendations intended to clarify and strengthen the regulatory framework for protection against natural phenomena. Subsequently, the NRC issued a 50.54(f) letter on March 12, 2012 (Reference 1), requesting information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter requests that licensees and holders of construction permits under 10 CFR Part 50 reevaluate the seismic hazards at their sites against present-day NRC requirements and guidance. Included in the 50.54(f) letter was a request that licensees perform a "confirmation, if necessary, that SSCs, which may be affected by high-frequency ground motion, will maintain their functions important to safety."

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Subsequent guidance for performing a High-Frequency Confirmation was provided in EPRI 3002004396, "High Frequency Program, Application Guidance for Functional Confirmation and Fragility Evaluation," (Reference 8) and was endorsed by the NRC in a letter dated September 17, 2015 (Reference 3). Final screening identifying plants needing to perform a High-Frequency Confirmation was provided by NRC in a letter dated October 27, 2015 (Reference 2).

On March 31, 2014, DBNPS submitted a reevaluated seismic hazard to the NRC as a part of the Seismic Hazard and Screening Report (Reference 4). By letter dated August 25, 2015, the NRC staff concluded that the GMRS that was submitted adequately characterizes the reevaluated seismic hazard for the DBNPS site (Reference 20). The seismic hazard was later reevaluated under the Expedited Seismic Evaluation Process (ESEP) and submitted to the NRC on December 19, 2014 (Reference 13). The ESEP was accepted by the NRC by letter dated October 19, 2015 (Reference 14). By letter dated October 27, 2015 (Reference 2), the NRC transmitted the results of the screening and prioritization review of the seismic hazards reevaluation.

This report describes the High-Frequency Confirmation evaluation undertaken for DBNPS using the methodologies in EPRI 3002004396, "High Frequency Program, Application Guidance for Functional Confirmation and Fragility Evaluation," as endorsed by the NRC in a letter dated September 17, 2015 (Reference 3).

The objective of this report is to provide summary information describing the High-Frequency Confirmation evaluations and results. The level of detail provided in the report is intended to enable NRC to understand the inputs used, the evaluations performed, and the decisions made as a result of the evaluations.

1.3 APPROACH

EPRI 3002004396 (Reference 8) is used for the DBNPS engineering evaluations described in this report. Section 4.1 of Reference 8 provided general steps to follow for the High-Frequency Confirmation component evaluation. Accordingly, the following topics are addressed in the subsequent sections of this report:

- DBNPS safe shutdown earthquake (SSE) and GMRS Information
- Selection of components and a list of specific components for High-Frequency Confirmation
- Estimation of seismic demand for subject components
- Estimation of seismic capacity for subject components
- Summary of subject components' high-frequency evaluations
- Summary of Results

1.4 PLANT SCREENING

The DBNPS submitted the Seismic Hazard and Screening Report in Response to the NRC Request for Information Pursuant to 10 CFR 50.54 (f) on March, 31 2014 (Reference 4). By letter dated August 25, 2015, the NRC staff concluded that the GMRS that was submitted adequately characterizes the reevaluated seismic hazard for the DBNPS site (Reference 20).

The NRC final screening determination letter concluded (Reference 2) that the GMRS to SSE comparison at the DBNPS resulted in a need to perform a High-Frequency Confirmation in accordance with the screening criteria in the SPID (Reference 6).

Subsequent to the March 31, 2014 submittal, the seismic hazard was updated considering site specific damping in rock. The updated seismic hazard is the basis for the ESEP Reports submitted by FirstEnergy Nuclear Operating Company (FENOC) on December 19, 2014 (Reference 13), and also used in the SPRA. The ESEP was accepted by the NRC by letter dated October 19, 2015 (Reference 14).

Table 1-1, Table 1-2 and Figure 1-1 present the spectral accelerations characterizing the updated GMRSs and SSE at the DBNPS. *Figure 1-1* presents the comparison of SSE, ESEP

GMRS (Reference 13) and the GMRS reported in the DBNPS March 2014 submittal (Reference 4). The difference in the GMRS results is attributed to the material damping used for the rock material over the upper 500 feet (ft). While the GMRS reported in the March 2014 submittal is based on the low strain damping of approximately 3.2 percent over a depth of 500 ft below the Reactor Building (RB) foundation, the GMRS used in the ESEP limits this damping value to the upper 100 ft where the rock is considered as weathered or fractured. Below this depth, a low strain damping of 1.0 percent is used based on the unweathered shale dynamic properties from Stokoe et al. (Reference 19).

TABLE 1-1
GMRS AT THE DBNPS, EL 540 FT

FREQUENCY (Hz)	GMRS (g) [ESEP, DECEMBER 2014 SUBMITTAL]	GMRS (g) [MARCH 2014 SUBMITTAL]
0.10	0.0032	0.0032
0.13	0.0047	0.0046
0.16	0.0067	0.0067
0.20	0.0097	0.0097
0.26	0.0140	0.0141
0.33	0.0205	0.0206
0.42	0.0307	0.0308
0.50	0.0422	0.0425
0.53	0.0443	0.0446
0.67	0.0545	0.0549
0.85	0.0665	0.0666
1.00	0.0719	0.0718
1.08	0.0766	0.0764
1.37	0.0840	0.0834
1.74	0.0826	0.0816
2.21	0.0880	0.0869
2.50	0.0953	0.094
2.81	0.1114	0.1094
3.56	0.1666	0.1609
4.52	0.2470	0.2317
5.00	0.2951	0.275
5.74	0.3744	0.3385
7.28	0.4665	0.4216
9.24	0.5305	0.4751
10.00	0.5444	0.4889
11.72	0.5362	0.4751
14.87	0.4896	0.4308
18.87	0.4708	0.4013
23.95	0.4239	0.3455
25.00	0.4110	0.335
30.39	0.3913	0.3115
38.57	0.3877	0.3022
48.94	0.3572	0.2752
62.10	0.2878	0.2237
78.80	0.2200	0.1787
100.00	0.1993	0.1676

TABLE 1-2
SSE AT THE DBNPS

FREQUENCY (Hz)	SSE [g]
0.10	0.004
0.37	0.06
2.31	0.374
8.00	0.374
33.00	0.15
100.00	0.15

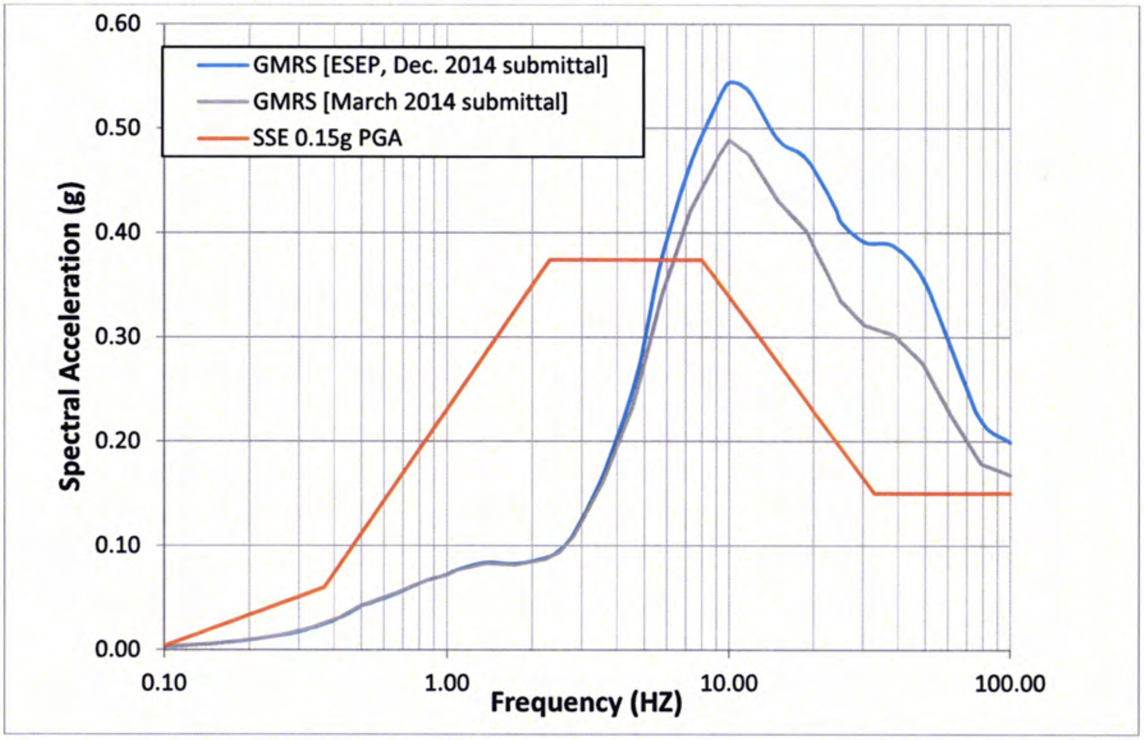


FIGURE 1-1
COMPARISON OF GMRS AND SSE AT THE DBNPS CONTROL POINT ELEVATION (EL 540 FT)

2.0 SELECTION OF COMPONENTS FOR HIGH-FREQUENCY SCREENING

The fundamental objective of the High-Frequency Confirmation review is to determine whether the occurrence of a seismic event could cause credited equipment to fail to perform as necessary. An optimized evaluation process is applied that focuses on achieving a safe and stable plant state following a seismic event. As described in Reference 8, this state is achieved by confirming that key plant safety functions critical to immediate plant safety are preserved (reactor trip, reactor vessel inventory and pressure control, and core cooling) and that the plant operators have the necessary power available to achieve and maintain this state immediately following the seismic event (AC/DC power support systems).

Within the applicable functions, the components that would need a High-Frequency Confirmation are contact control devices subject to intermittent states in seal-in or lockout circuits. Circuits that require two simultaneous relay chatters in order to reposition or lock-out a component are deemed improbable. However, if one set of contacts may seal-in, the second set of contacts were still analyzed. Control switches and local pushbuttons are not subject to high-frequency chatter and thus are not considered. This analysis is based on the plant operating at 100% power and all normal equipment is available and in the normal configuration; i.e., no equipment is out of service, e.g., for maintenance or testing.

Accordingly, the objective of the review as stated in Section 4.2.1 of Reference 8 is to determine if seismic induced high-frequency relay chatter would prevent the completion of the following key functions.

2.1 REACTOR TRIP/SCRAM

The reactor trip/SCRAM function is identified as a key function in Reference 8 to be considered in the High-Frequency Confirmation. The same report also states that the design requirements preclude the application of seal-in or lockout circuits that prevent reactor trip/SCRAM functions and that no high-frequency review of the reactor trip/SCRAM systems is necessary.

2.2 REACTOR VESSEL INVENTORY CONTROL

The reactor coolant system/reactor vessel inventory control systems were reviewed for contact control devices in seal-in and lockout (SILO) circuits that would create a Loss of Coolant Accident (LOCA). The focus of the review was contact control devices that could lead to a significant leak path (valves opening or the inability to close the valves). Check valves in series with active valves would prevent significant leaks due to misoperation of the active valve; therefore, SILO circuit reviews were not required for those active valves.
Reactor coolant system/reactor vessel inventory control system reviews were performed for valves associated with the following functions:

- Pressurizer Safety Valves (PORV, Sample Lines, High Point Vents)
- Letdown Line Valves
- Low Pressure Injection / Core Flood Tank Line Valves
- High Pressure Injection Line Valves
- Reactor Coolant Pump Seal Return Isolation Valves

Pressurizer Safety Valves (PORV, Sample Lines, High Point Vents)

Power-Operated Relief Valve (RC2A [PORV])

The PORV is a solenoid-operated pilot valve controlled via relays, which are controlled by reactor coolant system (RCS) pressure relays. The RCS pressure relays are solid state and do not seal-in, thus there is no seal-in or lockout relays in this logic which would cause a loss of RCS inventory out of the PORV.

RCS Sample Line Valves (RC239A, RC239B, RC240A, RC240B, RC200, and RC4632)

These are normally-closed motor-operated valves (MOVs) and solenoid valve (RC4632). In order to lose RCS inventory through the sample line, two to three valves would need to open. The MOVs' open circuitry are controlled by hand switches which are not susceptible to chatter, while the closed circuit can be controlled by the hand switch or (for RC240A and RC240B) a Safety Features Actuation System (SFAS) signal. Relay chatter of the MOV contactor (42/O) is possible and could lead to a potential of a very small leak path of the RCS to the Quench Tank or the Sampling System through the opening of these valves; therefore, these relays were included for evaluation. The relays evaluated include BE1181/42 (RC240A), BF1285/42 (RC200), BF1126/42 (RC239A), BF1127/42 (RC239B), and BF1128/42 (RC240B). Solenoid Valve RC4632 has a relay (SV4632/4) whose contacts could chatter, seal-in, and open the valve; therefore, that relay was included for evaluation.

High Point Vent Valves (RC4608A, RC4608B, RC4610A, and RC4610B)

RC4608A, RC4608B, RC4610A, and RC4610B are all normally-closed solenoid valves. They are controlled by control switches in the control room, which are not susceptible to chatter. There are no seal-in contacts to cause the valves to open. Therefore, there are no SILO devices susceptible to chatter.

Letdown Line Valves

Letdown Line Valves (MU2B, MU1A, MU1B, MU2A, and MU3)

MU2B, MU2A, MU1A, and MU1B are normally-open MOVs. MU3 is a normally-open air-operated valve. To isolate letdown either MU2B, MU2A, or MU3, or the combination of MU1A and MU1B need to close.

Letdown Isolation Valve MU2B can be closed by the hand switch. Additionally, the valve will automatically close if there is high pressure at the Reactor Coolant Letdown Cooler Component Cooling Outlet Valve or high temperature on the Letdown Line Delay Coil. The closing coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is closed, releasing the seal-in. Additionally, for this purpose closing the valve is beneficial and these contacts can be screened. The open portion of the MU2B circuit is controlled by a hand switch only. Since the valve is normally open, chatter of the 42/O contacts could only re-open the valve after the valve had started to close. The open coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is open (returned to its normal position), releasing the seal-in. Control of the valve is returned to its hand switch and the automatic interlocks; therefore, this relay was not evaluated.

Letdown Coolers Outlet Valve MU2A can be closed by the hand switch. Additionally, if there is a SFAS Level 2 signal (RCS pressure below 1600 PSI or Containment Pressure greater than 18.7 PSI), the SFAS contacts will close to energize the 42/C coil. The closing coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is closed, releasing the seal-in. Additionally, for this purpose, closing the valve is beneficial so these contacts can be screened. The open portion of the MU2A circuit is controlled by the hand switch only. Since the valve is normally open, chatter of the 42/O contacts could only re-open the valve after the valve had started to close or is closed. The open coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is open (returned to its normal position), releasing the seal-in. Control of the valve is returned to its hand switch; therefore, this relay was not evaluated.

Letdown Cooler Inlet Valves MU1A and MU1B can be closed by the hand switch. Additionally, if there is high pressure at the associated Reactor Coolant Letdown Cooler Component Cooling Outlet Valve or high temperature on the Letdown Line Delay Coil, the valve will automatically close. The closing coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is closed, releasing the seal-in. Additionally, for this purpose, closing the valve is beneficial so these contacts can be screened. The open portion of the MU1A and MU1B circuit is controlled by position of the Component Cooling Water to the Decay Heat Exchanger Valve (CC1409, CC1410). If CC1409 (CC1410) is fully open, then MU1A (MU1B) will receive an open signal since the 33/ao contacts would close. The 42/O open coil for MU1A (MU1B) does have seal-in contacts, but the limit switch contacts and torque switch contacts open with the valve is open (returned to its normal position), releasing the seal-in. Because the position switch contacts in this circuit are open when the valve is in the open position, chatter of the CC1409/CC1410 33/ao contacts or the MU1A/MU1B 42a/O contacts could only open MU1A (MU1B) after the valve had started to close. Therefore, the MU1A/MU1B 42/O relay was not evaluated.

Due to the interlock between CC1409/CC1410 and MU1A/MU1B, the circuits for CC1409/CC1410 were also reviewed. These valves are normally-open MOVs that can be closed using the hand switch for MU1A/MU1B through time delay relay contacts in the MU1A/MU1B closing circuit. The time delay relay contacts do not seal-in so they can be screened. The CC1409/CC1410 closing coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is closed, releasing the seal-in. If CC1409/CC1410 is closed, letdown temperature will increase and TSH3745A contacts will close resulting in a closure of MU1A/MU1B. Closure of CC1409/CC1410 does not prevent MU1A/MU1B from closing and therefore has no impact on letdown isolation. Therefore, the CC1409/CC1410 42/C relay contacts can be screened. The open portion of the CC1409/CC1410 circuit is controlled by the MU1A/MU1B hand switch only. Since the valve is normally open, chatter of the CC1409/CC1410 42/O contacts could only re-open the valve after the valve had started to close. The open coil does have seal-in contacts, but the limit switch contacts and torque switch contacts open when the valve is open (returned to its normal position), releasing the seal-in. Control of the valve is returned to the hand switch; therefore, this relay was not evaluated.

Pneumatically operated MU3 is normally open; when the solenoid is de-energized the valve will close. Power will be removed via SFAS Level 2 signal should a signal be generated, resulting in opening of contacts causing the valve to close. The valve can also be de-energized if the accumulator has low pressure causing the pressure switch contacts to open. Chatter of either the SFAS contact or the pressure switch can result in closure of the valve, which is a beneficial result for this analysis. Therefore, there are no seal-in or lock-out relays present that would prevent MU3 from closing.

Low Pressure Injection/Core Flood Line Valves

Check Valves

There are two core flood tank to reactor coolant system check valves (CF30/CF31) inside containment preventing flow from the RCS into the Low Pressure Injection/ Core Flood line. The check valves are not chatter sensitive and can be credited to remain closed; thus, these valves do not need to be analyzed.

DH11 and DH12

The two RCS to decay heat system MOVs DH11 and DH12 are normally-closed MOVs in series. If both were to unexpectedly open, it could result in an Inter-System Loss of Coolant Accident (ISLOCA). Therefore, these valves were reviewed for SILO devices. DH11 and DH12 have control power removed during plant heat up and power operations by opening a set of contacts (control room switch) preventing power from passing to the rest of the circuit; thus, chatter of downstream contacts cannot cause the valves to reposition. Additionally, a high pressure switch in the open circuitry would have open contacts while at power. DH11 and DH12 were found to not have any relays that could seal-in and cause the valve to reposition open without simultaneous chatter from the control power contacts and the pressure switch contacts. With DH11 and DH12 remaining closed, an ISLOCA would be avoided and no relays were evaluated for these valves.

High Pressure Injection Valves

Check Valves

In each of the four High Pressure Injection lines into the reactor coolant system, there are two check valves in series inside containment (HP48/HP50, HP49/HP51, HP56/HP58, and HP57/HP59) preventing flow from the RCS into the High Pressure Injection line. The check valves are not chatter sensitive and can be credited to remain closed; thus, these valves do not need to be analyzed.

Reactor Coolant Pump Seal Return Valves

Valves MU59A, MU59B, MU59C, and MU59D

To isolate Seal Return, all MU59A-D valves need to close. MU59A-D are all normally-open valves that need to reposition closed. MU59A-D uses a similar control diagram such that a momentary chatter of the 42/C contacts would result in a closure of the valve. For this purpose closing the valve is beneficial and the 42/C contacts can be screened. There are limit switches that do not close unless the valve is some percentage closed or is closed, thus preventing the valve from opening due to a chatter of the 42/O contacts. Therefore, open position switches in the opening circuit prevent seal-in of the opening contactor auxiliary contact and no other contacts prevent valve closure via the control switch. Thus, these valves are not affected by seal-in or lock-out.

2.3 REACTOR VESSEL PRESSURE CONTROL

The reactor vessel pressure control function is identified as a key function in Reference 8 to be considered in the High-Frequency Confirmation. The same report also states that "required post event pressure control is typically provided by passive devices" and that "no specific high-frequency component chatter review is required for this function." As confirmation, the pressure control function at Davis-Besse was reviewed.

The DBNPS RCS pressure control is provided by essential Pressurizer Heaters, the Power-Operated Relief Valve (PORV), and the Pressurizer Safety Valves (PSVs).

A review of the essential Pressurizer Heater control circuits found no relays that could seal-in or lock-out and prevent control room use of the heaters.

The PORV (RC2A) is a solenoid-operated pilot valve controlled via relays, which are controlled by RCS pressure relays. The RCS pressure relays are solid state and do not seal-in, thus there is no seal-in or lockout relays in this logic which would cause a loss of RCS inventory out of the PORV (and a reduction in pressure).

The PSVs are spring-operated valves that open when the RCS pressure exceeds the lift set point. There are no relays that would seal-in or lock-out and cause the PSVs to open. Therefore, there are no relays that could impact RCS pressure control.

2.4 CORE COOLING

The core cooling systems were reviewed for contact control devices in SILO circuits that would prevent at least a single train of non-AC power driven decay heat removal from functioning.

The initial need for decay heat removal and the related scope of consideration varies based on the plant's nuclear steam supply system (NSSS). The relay chatter impacts that could affect this function would be those that would cause the flow control valves to close and remain closed.

For Pressurized Water Reactor (PWR) plants, it is expected that the availability of an AC-independent (steam or diesel-driven) alternate/emergency feedwater pump to supply water to at least one steam generator will be sufficient to satisfy the immediate decay heat removal needs. Therefore, for this evaluation, the following function needs to be checked: circuitry to detect and isolate flow to a faulted steam generator and MOVs relied upon for feeding the steam generator.

The selection of contact devices for the Steam Driven Feedwater System ([SDFW] – Auxiliary Feedwater [AFW] at Davis-Besse) and Diesel-Driven Feedwater System ([DDFW] – Emergency Feedwater [EFW] at Davis-Besse) were based on the premise that AFW/EFW operation is desired; thus, any SILO which would lead to AFW/EFW operation is beneficial and thus does not meet the criteria for selection. Only contact devices which could render the AFW/EFW system inoperable were considered. A review of the AFW system was broken down into the steam side and the flow side.

The steam side included a review of the valves required to allow steam to pass from the steam generator to the Auxiliary Feed Pump Turbine (AFPT). The valves reviewed include MOVs MS106, MS106A, MS107, and MS107A, and air-operated valves (AOVs) MS5889A, and MS5889B. For the MOVs, there are contactors with potential to seal-in and prevent the Main Steam valves from going to their desired position (open); however, a torque switch would open once the valve has gone fully closed and clear the seal-in. After that point, the Steam and Feedwater Rupture Control System (SFRCS) would reposition the valve to the desired position. The AOVs (MS5889A, MS5889B) fail open on loss of power to the associated solenoid valves. SFRCS deenergizes the solenoids. There are no relays in the circuit which could chatter, seal-in, and prevent SFRCS from de-energizing the solenoid valves to allow the valves to open. Therefore, there are no contact devices in the steam line valves to the AFPTs identified for evaluation. Additionally, if an air-operated Main Steam Isolation Valve (MS100, MS101) fails to close during a seismic event, the open pathway could depressurize the associated steam generator and divert steam from the AFPT. Therefore, the circuits for MS100 and MS101 were reviewed. The spring-loaded AOVs fail closed on loss of power to the associated solenoid valves or on low air pressure. SFRCS deenergizes the solenoids to close the valves. There are no relays in the circuits which could chatter, seal-in, and prevent SFRCS from de-energizing the solenoid valves to cause the valves to close. Therefore, those valves were screened.

The flow side included a review of the valves required to move water from the safety-related feedwater source (service water) to the SGs. The Condensate Storage Tank is not seismically qualified and therefore is not credited during the seismic event. The valves reviewed include MOVs AF599, AF608, AF3869, AF3870, AF3871, AF3872, SW1382, and SW1383, and solenoid valves FV6451 and FV6452. Additionally, the Service Water (SW) Pump circuits were reviewed. From review of the MOVs required to allow flow from the Auxiliary Feed Pumps to the Steam Generators there are some contactors with potential to seal-in and prevent the AFW flow to the SGs; however, a torque or limit switch would open once the valve has gone fully closed and clear the seal-in. At that point, either SFRCS would reposition the valve to the desired position, or the SW valve would open when low suction pressure is sensed. Solenoid valves FV6451 and FV6452 automatically throttle flow based on steam generator water level and the valves fail open on loss of power. A review of their circuits confirmed there are no relays whose contacts could chatter, seal-in, and prevent the valves from allowing the flow of water to the SGs.

A chatter analysis of the SW pump circuit breaker control circuits indicates the bus lockout, phase overcurrent, and ground fault relays all could prevent automatic breaker closure following the seismic event and were identified for evaluation.

Since the diesel-driven EFW system is manually started and manually terminated by hand switch operation only, there are no contact devices in the pump circuit that meet the selection criteria. The flow path was also reviewed and found to contain no contact devices that would seal-in or lock-out thus preventing flow to the Steam Generators. Steam relief from the SGs to the atmosphere will be done through local operator action of the Atmosphere Vent Valves (AVVs) using installed remote controllers, therefore relay chatter from the AVVs is irrelevant. In addition, there are no high-frequency sensitive devices within the control circuitry of the AVVs that would seal-in or lock-out and prevent manual operation of the AVVs.

2.5 AC/DC POWER SUPPORT SYSTEMS

The AC and DC power support systems were reviewed for contact control devices in SILO circuits that prevent the availability of DC and AC power sources. The following AC and DC power support systems were reviewed:

- Emergency Diesel Generators (EDGs),
- Battery Chargers and Inverters,
- EDG Ancillary Systems, and
- Switchgear, Load Centers, and MCCs.

Electrical power, especially DC, is necessary to support achieving and maintaining a stable plant condition following a seismic event. DC power relies on the availability of AC power to recharge the batteries. The availability of AC power is dependent upon the EDGs and their ancillary support systems. EPRI 3002004396 requires confirmation that the supply of emergency power is not challenged by a SILO device. The tripping of lockout devices or circuit breakers is expected to require some level of diagnosis to determine if the trip diagnose of the faulted condition could delay the restoration of emergency power.

In order to ensure contact chatter cannot compromise the emergency power system, control circuits were analyzed for the EDGs, Battery Chargers, Vital AC Inverters, and Switchgear/Load Centers/MCCs as necessary to distribute power from the EDGs to the Battery Chargers and EDG Ancillary Systems. General information on the arrangement of safety-related AC and DC systems, as well as operation of the EDGs, was obtained from the DBNPS UFSAR. The DBNPS EDGs provide emergency power to the safety-related busses. The DBNPS contains two trains of Class 1E loads with one EDG for each train.

The analysis considers the reactor is operating at power with no equipment failures or LOCA prior to the seismic event. The EDGs are not operating but are available. The seismic event is presumed to cause a Loss of Offsite Power (LOOP) and a normal reactor SCRAM.

In response to bus under-voltage relaying detecting the LOOP, the Class 1E control systems must automatically shed loads, start the EDGs, and sequentially load the Diesel Generators as designed. Ancillary systems required for EDG operation as well as Class 1E battery chargers and inverters must function as necessary. The goal of this analysis is to identify any vulnerable contact devices that could chatter during the seismic event, seal-in or lock-out, and prevent these systems from performing their intended safety-related function of supplying electrical power during the LOOP.

The following sections contain a description of the analysis for each element of the AC/DC Support Systems. Contact devices are identified by description in this narrative and apply to both trains.

Emergency Diesel Generators

The analysis of the EDGs is broken down into the generator protective relaying and diesel engine control. General descriptions of these systems and controls appear in the UFSAR.

Generator Protective Relaying

The control circuits for the EDG circuit breakers include bus lockout, EDG lockout, and phase over-current protective relays. Chatter in any of the bus lockout or EDG lockout relays may prevent closure of the EDG circuit breaker.

The bus lockout relay could actuate due to relay chatter, resulting in closure of contacts that would cause the EDG output breaker from closing and the EDG would not re-power the bus. When the bus lockout relay is tripped, it prevents closure of the EDG, CCW pump, SW pump, and load center transformer circuit breakers.

The relays that could lead to a bus lockout include:

- Relays AC103/51-1, AC103/51GS-1, AC103/51-2, AC103/51-1X, AC103/51-2, AC103/51-3, AC103/51GS, and AC110/51X can cause the bus lockout relay to actuate and prevent EDG 1 from loading the 4160 bus C1_41.
- Relays AD103/51-1, AD103/51GS-1, AD103/51-2, AD103/51-1X, AD103/51-2, AD103/51-3, AD103/51GS, and AD110/51X can cause the bus lockout relay to actuate and prevent EDG 2 from loading the 4160 bus D1_EA.

The EDG output breaker can be prevented from closing due to actuation of the over-current relay. The over-current relays AC101/51V2DG or AD101/51V2DG contacts could chatter and seal-in resulting in an energization of the EDG output breaker trip coil.

The EDG lockout relays are not actuated until after the EDG has started and reached at least 200 RPM. The current is stopped by the open contacts SS2X and K1X; thus, if there were chatter of any of the EDG protection circuits (ground over current, phase over current, differential, or engine auto shutdown) the lockout relays would not energize and seal-in. If chatter of the protection relays were to occur after the EDG was started due to under voltage and has reached 200 RPM, the R3 contacts would open and prevent the 86-1 coil from being energized. Only chatter of the shutdown relay contacts (SDRX or SDRX1) could result in energizing the 86-2 coil and seal-in causing the EDG to shut down under those conditions.

The SFAS interlock can also cause the output breaker trip coil to energize. Chatter of the 94-1 relay or chatter of R3X1 can cause the 94-1 coil to energize thus causing the EDG trip coil to energize.

Diesel Engine Control

Chatter analysis for the diesel engine control was performed on the start and shutdown circuits of each EDG. The start circuit is blocked by seal-in of the engine trouble SDRX1 shutdown or start failure relays. Chatter of the seal-in contacts of these relays or other relay contacts that actuate the shutdown relay (SDR) may prevent EDG start.

The start failure relay (TD1) is actuated if the cooling water output pressure is less than 20 PSI, or Diesel Speed does not reach 200 RPM after 7 seconds following a start signal. If either of those conditions is not reached within 7 seconds, the fail to start coil (TD1) actuates causing the TD1 contacts to close and energize the R2 contact resulting in passing current to the shutdown coils that seal-in and cause the generator to reduce speed. Chatter in the contacts of the R2 relay may also energize the shutdown relay (SDRX) and seal-in.

The EDG is emergency started by an under-voltage signal that closes 27Z-3 contacts 1-2. Once closed the R3X coil is energized, closing the R3X contacts starting the redundant fuel pump, and energizing the R1X coil. The R1X coil then closes the R1X contacts, energizing the AV1A and AV2A coils which opens the air start solenoid valves and the engine starts to pick up in speed. Once the engine reaches 40 RPM the SS1A contacts close, and the SS1X coils energize. As the EDG increases in speed, the SS2A contacts close energizing the SS2X coil at 200 RPM, the SS3A contacts close energizing the SS3 coil at 400 RPM, and the SS4A contacts close energizing the SS4 coil at 800 RPM.

As the engine comes up in speed, at 400 RPM, the field flash occurs from closure of the SS3 contacts, and the generator starts developing an output voltage. Once the field flash occurs, and voltage raises the CR3X coil is energized by a solid-state "V" relay (electro-mechanical relay output contacts), causing the EDG output breaker to close. If the SS3 contacts would chatter and the EDG did not receive its start signal, the field flash could potentially burn itself out such that when called upon during emergency actuation, the field would not flash and voltage would not be developed and the CR3X coil would not energize thus the EDG output breaker would not close.

Chatter of the SDR R7 contacts could energize the EDG output breaker trip coil and is therefore included for evaluation.

Chatter of the 86-2 DG relay contacts could lead to seal-in of the SDR. Chatter of the overspeed trip relay (OTR) contacts themselves can also lead to seal-in of the SDR. The emergency stop control switch is non-vulnerable. Chatter from the relays for the low lube oil pressure and high jacket water temperature switches could lead to seal-in of the SDR.

Chatter of the switches controlling low lube oil pressure or high jacket water temperature are not susceptible to chatter, thus they would not lead to seal-in of the SDR.

Note that during Diesel Generator emergency operation, the Safety Features Actuation start, Under-voltage start, and control room manual start, contacts block the low lube oil pressure and high jacket water temperature chatter; however, this feature is not operating before the start signal is given and thus will not prevent the seal-in of the engine trouble SDR should coincident chatter occur in these circuits prior to DG start.

EDG Ancillary Systems

A number of components and systems are required to start and operate the EDGs. For identifying electrical contact devices, only systems and components which are electrically controlled are analyzed. Information in the UFSAR was used as appropriate for this analysis.

Starting Air

Based on Diesel Generator availability as an initial condition, the passive air reservoirs are presumed pressurized and the only electrically active components in this system required to operate are the air start solenoids, which are covered under the EDG engine control analysis above.

Combustion Air Intake and Exhaust

The combustion air intake and exhaust for the Diesel Generators are passive systems which do not rely on electrical control.

Lube Oil

The Diesel Generators use engine-driven mechanical lubrication oil pumps which do not rely on electrical control. The lube oil system also contains AC Turbo Oil pumps which circulate the lube oil. These pumps do not contain seal-in or lockout relays. These pumps would stop if there is a thermal overload condition. In addition, there are DC Turbo Oil pumps which circulate the lube oil and start on low lube oil pressure and stop after lube oil pressure has been raised. The DC oil pumps do not contain seal-in or lockout relays and will function as required in a seismic event.

Fuel Oil

The Diesel Generators use engine-driven mechanical pumps and DC-powered auxiliary pumps to supply fuel oil to the engines from the day tanks. The day tanks are re-supplied using AC-powered Diesel Oil Transfer Pumps. Chatter analysis of the control circuits for the electrically-powered auxiliary and transfer pumps concluded they do not include SILO devices. The mechanical pumps do not rely on electrical control and therefore there is no impact due to relay chatter.

Cooling Water

This system consists of jacket water and an aftercooler. The aftercooler is cooled by jacket water and the jacket water is cooled by Component Cooling Water (CCW). The CCW is then cooled by SW. Engine-driven pumps operating in the cooling loops are credited when the engine is operating. These mechanical pumps do not rely on electrical control. The electric jacket water pump is only used during shutdown periods and is thus not included in this analysis.

Three CCW and SW pumps provide cooling water to the heat exchangers associated with the two EDGs. In automatic mode these pumps are started via closure of the EDG Output breaker.

If there were chatter of the SAX/13 such that it opens and recloses itself (i.e., it does not seal-in) could result in an increase in delay to start the CCW and SW pumps. This momentary chatter does not result in an extensive delay and is therefore not evaluated in this analysis. A chatter analysis of the CCW and SW pump circuit breaker control circuits indicates the bus lockout, phase overcurrent, and ground fault relays all could prevent automatic (sequential) breaker closure following the seismic event. These breakers are AC113 (CCW Pump 1), AD113 (CCW Pump 2), AC108/AD108 (Swing CCW Pump 3), AC107 (SW Pump 1), AD107 (SW Pump 2), and AC109/AD109 (Swing SW Pump 3).

Ventilation

Ventilation for each Diesel Generator Enclosure is provided via two supply fans. In automatic mode these fans are started when the EDG reaches 40 RPM. This permissive does not prevent the ventilation fans from running and does not contain a SILO device. Successful ventilation also requires proper damper alignment. No SILO devices were found to prevent the dampers from opening as required.

Battery Chargers

Chatter analysis on the battery chargers was performed using information from the UFSAR as well as vendor schematic diagrams. Each battery charger has an under-voltage relay on the input side set to alarm when battery charge input voltage drops below the design capability of the batteries, and one under-voltage alarm relay on the output side. Contacts 1-3 of Relay K301 can operate the trip coil of the battery charger 480VAC input breaker only if the Low AC Voltage Disconnect Switch is enabled, which is done by taking the switch to Test. On the in-service battery charger, this switch is never in TEST, so the K301 contacts cannot energize the trip coil. The operate coil of this relay is controlled by a non-vulnerable solid-state circuit. The Master Control Board does not have any relays installed; therefore, no further review is required. Contacts shown on the Battery Charger Schematic Drawings were determined to have no adverse effect on the capability of a battery charger to provide an output voltage. No other vulnerable contact device affects the availability of the battery chargers.

Inverters

Analysis of schematics for the Static Inverters, and the Average Power Range Monitor (APRM) Uninterruptable Power Supply (UPS) Inverters revealed no vulnerable contact devices and thus chatter analysis is unnecessary.

Switchgear, Load Centers, and MCCs

Power distribution from the EDGs to the necessary electrical loads (Battery Chargers, Inverters, Fuel Oil Pumps, and EDG Ventilation Fans) was traced to identify any SILO devices which could lead to a circuit breaker trip and interruption in power. This effort excluded the EDG circuit breakers and the CCW/SW pump breakers which are covered in above, as well as component-specific contactors and their control devices, which are covered in the analysis of each component above. The medium- and low-voltage power circuit breakers in switchgear and load centers supplying power to loads identified in this section are included in this evaluation. The Molded-Case Circuit Breakers used in the motor control centers are seismically rugged; and DC power distribution is via non-vulnerable disconnect switches. The only circuit breakers affected by contact devices (not already covered) were those that distribute power from the essential busses to the load centers. A chatter analysis of the control circuits for these circuit breakers indicates the bus lockout, overcurrent, and ground fault relays all could prevent automatic (sequential) breaker closure following the seismic event. The relays listed above are included for evaluation and reported in ***Table B-1*** in ***Appendix B***.

2.6 SUMMARY OF SELECTED COMPONENTS

A list of the contact devices requiring a High-Frequency Confirmation is provided in *Appendix B*.

3.0 SEISMIC EVALUATION

3.1 HORIZONTAL SEISMIC DEMAND

Per Reference 8, Sect. 4.3, the basis for calculating high-frequency seismic demand on the subject components in the horizontal direction is the DBNPS horizontal GMRS, which was generated as part of the DBNPS ESEP report (Reference 13) submitted to the NRC on December 19, 2014 and accepted by the NRC on October 19, 2015 (Reference 14).

It is noted in Reference 8 that a Foundation Input Response Spectrum (FIRS) may be necessary to evaluate buildings whose foundations are supported at elevations different than the Control Point elevation. However, for sites founded on rock, per Reference 8, "The Control Point GMRS developed for these rock sites are typically appropriate for all rock-founded structures and additional FIRS estimates are not deemed necessary for the High-Frequency Confirmation effort." For sites founded on soil, the soil layers will shift the frequency range of seismic input towards the lower frequency range of the response spectrum by engineering judgment. Therefore, for purposes of high-frequency evaluations in this report, the GMRS is an adequate substitute for the FIRS for sites founded on soil.

The DBNPS site bedrock occurs at elevation (EL) 555 ft and consists of massive and bedded dolomite layers. The deepest foundation elevation of these structures is EL 540 ft and is associated with the RB. Therefore, the GMRS, Control Point elevation is taken to be the base of the RB foundation, EL 540 ft. The bedrock immediately underlying the bottom of the RB foundation (EL 540 ft) is characterized by shear-wave velocities (Vs) of about 5,200 feet per second (ft/s).

The applicable buildings at DBNPS are founded on rock; therefore, the Control Point GMRS is representative of the input at the building foundation.

The horizontal GMRS values are provided in ***Table 3-2.***

3.2 VERTICAL SEISMIC DEMAND

As described in Section 3.2 of Reference 8, the horizontal GMRS and site soil conditions are used to calculate the vertical GMRS (VGMRS), which is the basis for calculating high-frequency seismic demand on the subject components in the vertical direction. The site's soil mean shear-wave velocity vs. depth profile is provided in Reference 15, Table 5-3 and reproduced below in ***Table 3-1.***

TABLE 3-1
SOIL MEAN SHEAR-WAVE VELOCITY VS. DEPTH PROFILE FOR THE FIRST 100 FT

PROFILE ELEVATION [ft]	LAYER	LAYER END DEPTH [ft]	LAYER END DEPTH [m]	LAYER THICKNESS d_i [ft]	Vs_i [ft/s]	d_i / Vs_i	$\Sigma [d_i / Vs_i]$	Vs30 [ft/s]
540	1	12	3.7	12	4948	0.00243	0.00243	4548
528	2	22	6.7	10	3970	0.00252	0.00494	
518	3	32	9.8	10	5790	0.00173	0.00667	
508	4	80	24.4	48	4071	0.01179	0.01846	
460	5	100	30.5	20	5672	0.00353	0.02199	

Using the shear-wave velocity vs. depth profile, the velocity of a shear wave traveling from a depth of 30m (98.4 ft) to the surface of the site (Vs30) is calculated per the methodology of Reference 8, Section 3.5.

- The time for a shear wave to travel through each soil layer is calculated by dividing the layer depth (d_i) by the shear-wave velocity of the layer (Vs_i).
- The total time for a wave to travel from a depth of 30m to the surface is calculated by adding the travel time through each layer from depths of 0m to 30m ($\Sigma[d_i/Vs_i]$).
- The velocity of a shear wave traveling from a depth of 30m to the surface is therefore the total distance (30m) divided by the total time; i.e., $Vs30 = (30m)/\Sigma[d_i/Vs_i]$.

The vertical FIRS is derived using the Vertical-to-Horizontal (V/H) spectral ratio for rock sites in Western United States (WUS) and Central and Eastern United States (CEUS) from NUREG/CR-6728 (McGuire et al., 2001) (Reference 16). The average Vs in the upper 30 meters (m) (100 ft) is used to weight the WUS and CEUS V/H values. The average Vs in the upper 30 meters (Vs30) for EL 540 ft is 4548 ft/sec (1386 meters per second [m/s]). The Vs30 for WUS and CEUS rock sites are 520 m/s and 2800 m/s, respectively (Reference 16). The V/H ratios at EL 540 ft use a weight of (2800-1386)/(2800-520)=0.62 for WUS V/H ratios and (1386-520)/(2800-520)=0.38 for CEUS V/H ratios.

The V/H ratios from Reference 16 are also dependent on peak ground acceleration (PGA). The spectral ordinate of horizontal FIRS at 100 Hertz (Hz) is used as the PGA to determine the V/H ratios. For EL 540 ft, the 100-Hz SA for the horizontal FIRS is 0.1993g. Because this value is at the boundary between two PGA-level bins (i.e., ≤ 0.2g and 0.2 – 0.5g) corresponding to different V/H spectral ratios in Reference 16, the arithmetic average of the V/H spectral ratio for the two bins is used.

The vertical GMRS is then calculated by multiplying the mean V/H ratio at each frequency by the horizontal GMRS acceleration at the corresponding frequency.

The V/H ratios and VGMRS values are provided in ***Table 3-2*** of this report.

Figure 3-1 below provides a plot of the horizontal GMRS, V/H ratios, and vertical GMRS for DBNPS.

TABLE 3-2
HORIZONTAL AND VERTICAL GROUND MOTIONS RESPONSE SPECTRA

Frequency (Hz)	HGMRS (g)	V/H Ratio	VGMRS (g)
0.10	0.0032	0.5938	0.0019
0.13	0.0047	0.5957	0.0028
0.16	0.0067	0.5970	0.0040
0.20	0.0097	0.5979	0.0058
0.26	0.0140	0.6000	0.0084
0.33	0.0205	0.6000	0.0123
0.42	0.0307	0.5863	0.0180
0.50	0.0422	0.5711	0.0241
0.53	0.0443	0.5688	0.0252
0.67	0.0545	0.5651	0.0308
0.85	0.0665	0.5564	0.0370
1.00	0.0719	0.5494	0.0395
1.08	0.0766	0.5470	0.0419
1.37	0.0840	0.5429	0.0456
1.74	0.0826	0.5387	0.0445
2.21	0.0880	0.5398	0.0475
2.50	0.0953	0.5467	0.0521
2.81	0.1114	0.5557	0.0619
3.56	0.1666	0.5774	0.0962
4.52	0.2470	0.6134	0.1515
5.00	0.2951	0.6306	0.1861
5.74	0.3744	0.6584	0.2465
7.28	0.4665	0.7226	0.3371
9.24	0.5305	0.8026	0.4258
10.00	0.5444	0.8297	0.4517
11.72	0.5362	0.8790	0.4713
14.87	0.4896	0.9079	0.4445
18.87	0.4708	0.9150	0.4308
23.95	0.4239	0.8846	0.3750
25.00	0.4110	0.8779	0.3608
30.39	0.3913	0.8515	0.3332
38.57	0.3877	0.8463	0.3281
48.94	0.3572	0.8583	0.3066
62.10	0.2878	0.8687	0.2500
78.80	0.2200	0.8591	0.1890
100.00	0.1993	0.8194	0.1633

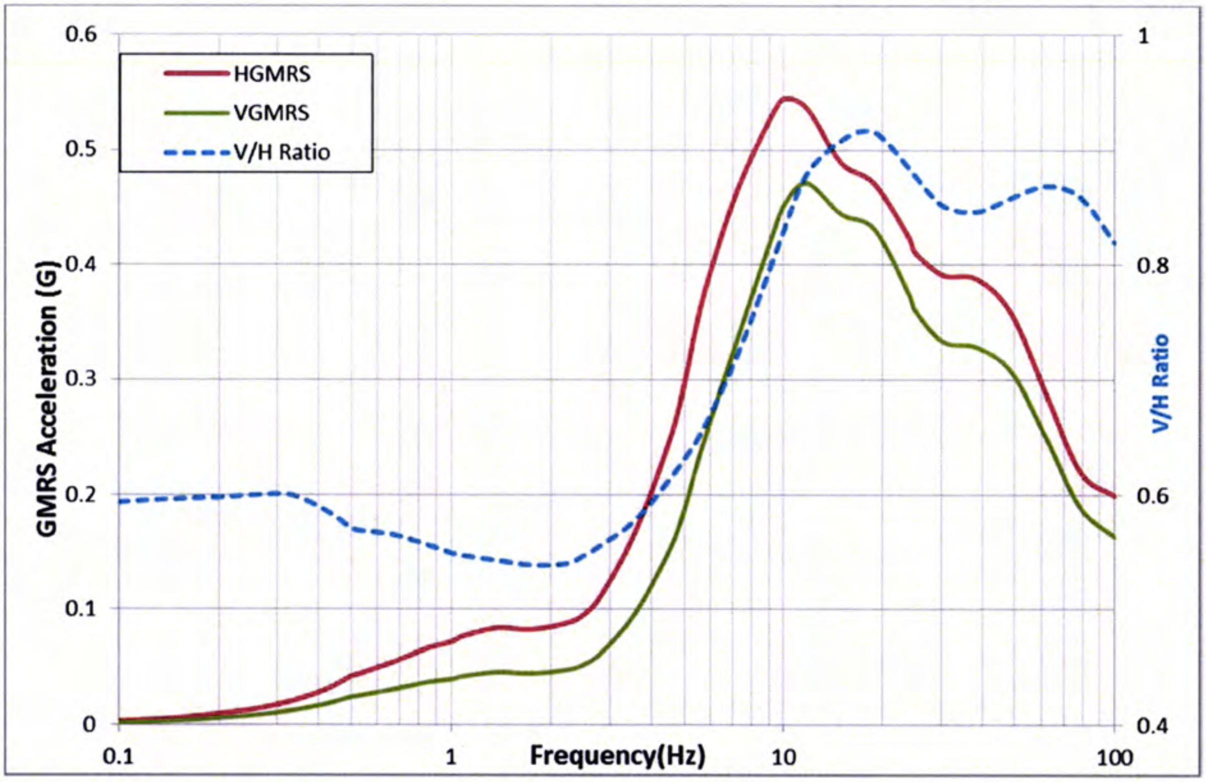


FIGURE 3-1
PLOT OF THE HORIZONTAL AND VERTICAL GROUND MOTIONS RESPONSE SPECTRA AND V/H RATIOS

3.3 COMPONENT HORIZONTAL SEISMIC DEMAND

The horizontal seismic demand to be used in this evaluation are the in-structure response spectra at the base of the equipment, amplified by amplification factors suggested in Reference 8 for the specific type of equipment. The required 5% in-structure response spectra ISRS are obtained from Reference 17 which is developed as part of the Seismic Probabilistic Risk Assessment (SPRA) program at DBNPS Unit 1. If there are sharp peak(s) in the ISRS in the frequency range of interest, these peaks are clipped in accordance with the guidelines in EPRI NP-6041-SL (Reference 18).

Per Reference 8, the peak horizontal acceleration is amplified using the horizontal in-cabinet amplification factor AFc to account for seismic amplification within the host equipment (cabinet, switchgear, motor control center, etc.)

The in-cabinet amplification factor, AF_c is associated with a given type of cabinet construction. The three general cabinet types are identified in Reference 8 and Appendix I of EPRI NP-7148 (Reference 11) assuming 5% in-cabinet response spectrum damping. EPRI NP-7148 (Reference 11) classified the cabinet types as high amplification structures such as switchgear panels and other similar large flexible panels, medium amplification structures such as control panels and control room benchboard panels and low amplification structures such as motor control centers.

All of the electrical cabinets containing the components subject to High-Frequency Confirmation (see ***Table B-1*** in ***Appendix B***) can be categorized into one of the in-cabinet amplification categories in Reference 8 as follows:

- MCCs F12A, F11A, and E11B are typical motor control center cabinets consisting of a lineup of several interconnected sections. Each section is a relatively narrow cabinet structure with height-to-depth ratios of about 4.5 that allow the cabinet framing to be efficiently used in flexure for the dynamic response loading, primarily in the front-to-back direction. This results in higher frame stresses and hence more damping which lowers the cabinet response. In addition, the subject components are not located on large unstiffened panels that could exhibit high local amplifications. These cabinets qualify as low amplification cabinets.
- Switchgear cabinets C1 and D1 are large cabinets consisting of a lineup of several interconnected sections typical of the high amplification cabinet category. Each section is a wide box-type structure with height-to-depth ratios of about 0.87 and may include wide stiffened panels. This results in lower stresses and hence less damping which increases the enclosure response. Components can be mounted on the wide panels, which results in the higher in-cabinet amplification factors.
- Relay panels C3615, C3616, C3617 and C3618 are in lineups of three interconnected sections with moderate width. Each section consists of structures with height-to-depth ratios of about 1.8 which results in moderate frame stresses and damping. Relay panels C3621 and C3622 are slender panels mounted on the EDGs and braced slightly above their mid-heights. Relay panel RC4607 is a small and lightweight panel attached to a stiffened floor-mounted rack. The response levels are mid-range between motor control centers and switchgear and; therefore, these panels can be considered in the medium amplification category.

3.4 COMPONENT VERTICAL SEISMIC DEMAND

The component vertical demand is determined using the peak acceleration of the 5% damped vertical ISRS from Reference 17 between 15 Hz and 40 Hz and amplifying it using the vertical in-cabinet amplification factor AF_c to account for seismic amplification within the host equipment; e.g., switchgear, motor control center, or relay panel. The in-cabinet amplification factor, AF_c, is derived in Reference 8 and is 4.7 for all cabinet types. If there are sharp peak(s) in the ISRS in the frequency range of interest, these peaks are clipped in accordance with the guidelines in EPRI NP-6041-SL (Reference 18).

4.0 CONTACT DEVICE EVALUATIONS

Per Reference 8, seismic capacities (the highest seismic test level reached by the contact device without chatter or other malfunction) for each subject contact device are determined by the following procedures:

1. If a contact device was tested as part of the EPRI High-Frequency Testing program (Reference 7), then the component seismic capacity from this program is used.
2. If a contact device was not tested as part of Reference 7, then one or more of the following means to determine the component capacity were used:
   a) Device-specific seismic test reports (either from the station or from the SQURTS testing program.
   b) Generic Equipment Ruggedness Spectra (GERS) capacities per Reference 9 and Reference 10.
   c) Assembly (e.g., electrical cabinet) tests where the component functional performance was monitored.

The high-frequency capacity of each device was evaluated with the component mounting point demand from ***Section 3.0*** using the criteria in Section 4.5 of Reference 8. A total of 80 components are identified that required High-Frequency Confirmation evaluation. The 80 components are grouped into 16 main groups based on device type and capacity and enclosure dynamic characteristics and location.

A summary of the high-frequency evaluation conclusions is provided in ***Table B-1*** in ***Appendix B***.

5.0 CONCLUSIONS

5.1 GENERAL CONCLUSIONS

DBNPS has performed a High-Frequency Confirmation evaluation in response to the NRC's 50.54(f) letter (Reference 1) using the methods in EPRI Report 3002004396 (Reference 8).

The evaluation identified a total of 80 components that required High-Frequency Confirmation evaluation. The 80 components identified are grouped into 16 main groups based on device type and capacity and enclosure dynamic characteristics and location. The high-frequency evaluation is performed for the 16 main groups and the results are summarized in ***Table B-1*** in ***Appendix B***.

As shown in ***Appendix B***, ***Table B-1***, 11 components out of a total of 80 components have capacity less than demand when evaluated in accordance with Reference 8 guidance. These components were then reevaluated through mitigation strategies included in Appendix H of Reference 5 and shown to be adequate (i.e., $HCLPF_{C10\%} > PGA_{GMRS}$) and do not impact the credited path for mitigation strategies.

5.2 IDENTIFICATION OF FOLLOW-UP ACTIONS

For DBNPS, all the identified 80 components have adequate seismic capacity and no follow-up actions were identified.

6.0 REFERENCES

1. NRC (E. Leeds and M. Johnson) Letter to All Power Reactor Licensees et al., "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," March 12, 2012, ADAMS Accession Number ML12053A340.

2. NRC (W. Dean) Letter to the Power Reactor Licensees on the Enclosed List. "Final Determination of Licensee Seismic Probabilistic Risk Assessments Under the Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendation 2.1 'Seismic' of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," October 27, 2015, ADAMS Accession Number ML15194A015.

3. NRC (J. Davis) Letter to Nuclear Energy Institute (A. Mauer), "Endorsement of Electric Power Research Institute Final Draft Report 3002004396, 'High Frequency Program: Application Guidance for Functional Confirmation and Fragility," September 17, 2015, ADAMS Accession Number ML15218A569.

4. FirstEnergy Nuclear Operating Company (FENOC) seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-ichi Accident: Enclosure C-NTTF 2.1 Seismic Hazard and Screening Report for Davis-Besse Nuclear Power Station dated March 31, 2014, ADAMS Accession Number ML14092A203.

5. NEI 12-06, Revision 2, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, December 2015, ADAMS Accession Number ML16005A625.

6. EPRI 1025287, "Seismic Evaluation Guidance: Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," February 2013.

7. EPRI 3002002997, “High Frequency Program: High Frequency Testing Summary.” September 2014.

8. EPRI 3002004396, “High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation,” July 2015.

9. EPRI NP-7147-SL, “Seismic Ruggedness of Relays,” August 1991.

10. EPRI NP-7147 SQUG Advisory 2004-02, “Relay GERS Corrections,” September 10, 2004.

11. EPRI NP-7148-SL, “Procedure for Evaluating Nuclear Power Plant Relay Seismic Functionality,” December 1990.

12. Not used.

13. FirstEnergy Nuclear Operating Company (FENOC) Expedited Seismic Evaluation Process (ESEP) Reports, Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dai-ichi Accident: Enclosure C-Expedited Seismic Evaluation Process (ESEP) Report for Davis-Besse Nuclear Power Station dated December 19, 2014, ADAMS Accession Number ML14353A059.

14. NRC Letter, Davis-Besse Nuclear Power Station, Unit 1 – Staff Review of Interim Evaluation Associated with Reevaluated Seismic Hazard Implementing Near-Term Task Force Recommendation 2.1, dated October 19, 2015, ADAMS Accession Number ML15273A237.

15. ABS Consulting/RIZZO Associates, “Probabilistic Seismic Hazard Analysis and Ground Motion Response Spectra, Davis-Besse Nuclear Power Station, Seismic PRA Project,” 2734296-R-003, Revision 1, 2014.

16. McGuire, R. K, Silva, W. J., and Costantino, C. J., 2001, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines," NUREG/CR-6728, U.S. Nuclear Regulatory Commission, October 2001.

17. ABS Consulting/RIZZO Associates, "Building Seismic Analysis of Davis-Besse Nuclear Power Station: Seismic PRA Project," Revision 1, ABS Consulting Report 2734296-R-005, 2014.

18. EPRI NP-6041-SL, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," Revision 1, Electric Power Research Institute, June 1994.

19. Stokoe, K. H., W. K. Choi, and F-Y Menq, 2003, "Summary Report: Dynamic Laboratory Tests: Unweathered and Weathered Shale Proposed Site of Building 9720-82 Y-12 National Security Complex, Oak Ridge, Tennessee," Department of Civil Engineering, The University of Texas at Austin, Austin, Texas, 2003.

20. NRC Letter, 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, dated August 25, 2015, ADAMS Accession Number ML15230A289.

APPENDIX A

REPRESENTATIVE SAMPLE COMPONENT EVALUATIONS

A Representative Sample Component Evaluations

A1. Purpose

The purpose of this calculation is to show two examples of High Frequency Confirmation evaluation for sensitive components that required evaluation at Davis Besse Nuclear Power Station. This calculation is in support of plant response to NRC Near-Term Task Force recommendation 2.1 for performing high frequency confirmation.

A2.0 Scope

The complete list of the components selected for High Frequency confirmation evaluation are listed in ***Table B-1***. The two components selected for sample calculation are presented in ***Table A-1***. These example calculations show the detailed procedure for the High Frequency confirmation evaluation.

Table A-1: Components selected for sample High Frequency Confirmation Evaluation

Relay/Contactor Model	Relay Manufacturer	Cabinet/Panel/ Bus which Houses Relay/Breaker	Bldg.	Elev. (ft)	RRS Point	State
Electro-Mechanical Contactor A201K1C	Cutler Hammer	F11A	Aux. 7	603	2	De-Energized
		E11B	Aux. 8	585	1	De-Energized
		F12A	Aux. 6	603	2	De-Energized
HFA51A42H	G.E.	C3615, C3616	Aux. 6	585	3	De-Energized (NO)

A3.0 Methodology

The methodology in Reference A1 will be used to calculate Capacity to Demand ratios for the subject relays, and contactors in the High Frequency range of 15-40 Hz. The capacity is obtained from either EPRI HF Test program (Ref. A2), or from GERS (Refs. A8, A9 & A10), or other shake table tests (Refs. A5, A6, A7) if the EPRI Program did not include the specific relay model. The EPRI HF Test Program reports a representative average spectral acceleration (SA) in the high frequency range. While the capacities in References A5 thru A10 are for the Low Frequency region (i.e., 4.5-16 Hz), according to the conclusions in References A1 and A2, the Low Frequency capacities are always lower than the High Frequency capacities and therefore could be used conservatively in the HF confirmation program.

The seismic Demand to be used in this evaluation are the in-structure response spectra at the base of the equipment, amplified by amplification factors suggested in Reference A1 for the specific type of equipment. Reference A3 provides the required 5% ISRS, which were developed as part of the Seismic PRA program at Davis Besse Nuclear Power Station Unit 1. If there are sharp peak(s) in the ISRS in the frequency range of interest (15 Hz to 40 Hz), these peaks are clipped in accordance with the guidelines in Reference A4.

While not required for HF confirmation task, the C10% capacities are calculated and also reported here for each relay or contactor using guidance in Reference A11.

A4.0 References

A1. EPRI Technical Report No. 3002004396, "High Frequency Program - Application Guidance for Functional Confirmation and Fragility Evaluation," Final Report, July 2015.

A2. EPRI Technical Report No. 3002002997, "High Frequency Program - High Frequency Testing Summary," Final Report, September 2014.

A3. ABS Consulting/Rizzo Associates, "Building Seismic Analysis of Davis Besse Nuclear Power Station: Seismic PRA Project," Rev.1. ABS Report 2734296-R-005 (Rizzo Report R7-12-4737).

A4. EPRI NP-6041-SL, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," Rev.1, Electric Power Research Institute, June 1994.

A5. Anco Test Report 1633.03, "Relay and Switch Tests," Rev.1.0, September 1996.

A6. FirstEnergy Calculation No. C-CSS-100.00-155, "Seismic Evaluation for Revised ABB Relay Seismic Testing ZPA Values," Rev.0, 6/13/2003.

A7. FirstEnergy Calculation No. C-CSS-004.01-014, "Seismic Evaluation for 4.16 kV Switchgear 50/51 Phase A & Phase C Relay Replacement with ABB COM-5 Model," Rev.2, Dated 5/26/2011.

A8. EPRI TR-105988-V1, "GERS Formulated Using Data from the SQURTS Program," April 1996, and SQUG Advisory 2004-02, "Relay GERS Corrections," September 7, 2004.

A9. EPRI NP-7147-SL, "Seismic Ruggedness of Relays," August 1991.

A10. EPRI NP-7147-SL, Vol.2, Addendum 2, "Seismic Ruggedness of Relays," April 1995.

A11. NEI 12-06, Appendix H, December 1, 2015.

A5.0 High Frequency Confirmation Evaluations

The HF confirmation of the relays and contactors identified in ***Section A2.0*** above is performed in the following Sections. These evaluations use the methodology cited in Reference A1, as described in ***Section A3.0*** above.

A5.1 HF Evaluation for Cutler Hammer Contactor A201K1C

Manufacturer	Host Panel(s)	Bldg.	Elev. (ft)	RRS Point	Equipment Class
Cutler Hammer	F11A	Aux. 7	603	2	1. MCC
	E11B	Aux. 8	585	3	1. MCC
	F12A	Aux. 6	603	2	1. MCC

A5.1.1 Capacity

$SA := 19.0g$	HF seismic capacity of Cutler Hammer Electro Mechanical Contactor A201K1C in De-Energized state from Reference A2, Table 5-6
$SA_T := SA + 0.625g = 19.63 \cdot g$	Effective spectral test capacity per Ref. A1

A5.1.2 Demand

The 5% damped in-structure response spectra at the locations of the MCCs that house the contactors (located at Point 2 in Aux. 6, El. 603', Point 2 in Aux. 7, El. 603' & Point 1 in Aux. 8, El. 585') in both horizontal and vertical directions are shown below and the HF demand in the 15Hz to 40 Hz.

$SA_{H\_Aux6\_603\_2} := \max(0.24g, 0.32g)$

$SA_{H\_Aux6\_603\_2} = 0.32 \cdot g$

Maximum horizontal acceleration (X or Y direction) in the 15Hz to 40Hz range corresponding to Pt. 2, AUX6, El.603' (no clipping required)

$SA_{V\_Aux6\_603\_2} := 1.03g$

Maximum vertical acceleration in Z-direction in the 15Hz to 40Hz range corresponding to Pt.2, AUX6, El.603' (no clipping required)

$SA_{H\_Aux7\_603\_2} := \max(0.64g, 1.37g)$

$SA_{H\_Aux7\_603\_2} = 1.37 \cdot g$

Maximum horizontal acceleration (X or Y direction) in the 15Hz to 40Hz range corresponding to Pt. 2, AUX7, El.603' (see clippings on the following sections)

$SA_{V\_Aux7\_603\_2} := 0.92g$

Maximum vertical acceleration in Z-direction in the 15Hz to 40Hz range corresponding to Pt.2, AUX7, El.603' (see clipping on the following sections)

$SA_{H\_Aux8\_585\_3} := \max(0.78g, 0.73g)$

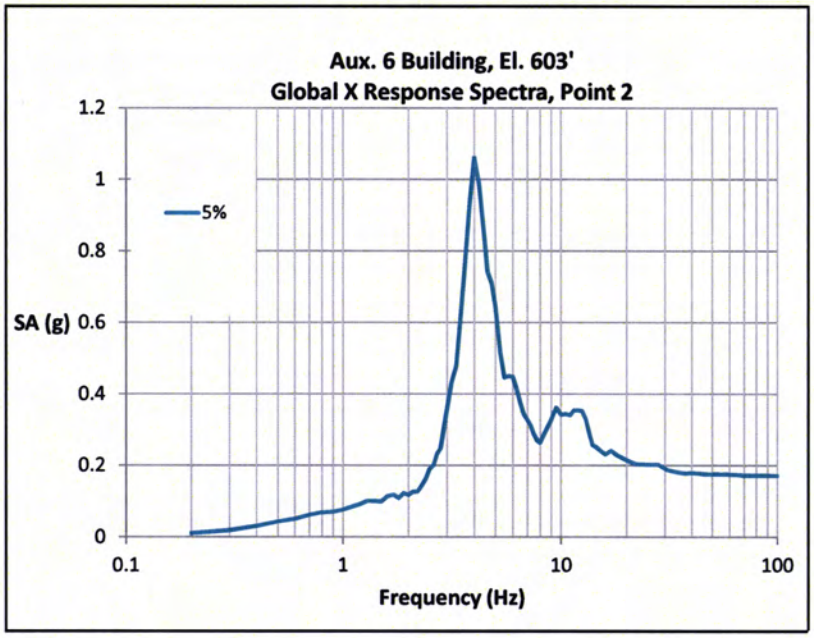
$SA_{H\_Aux8\_585\_3} = 0.78 \cdot g$

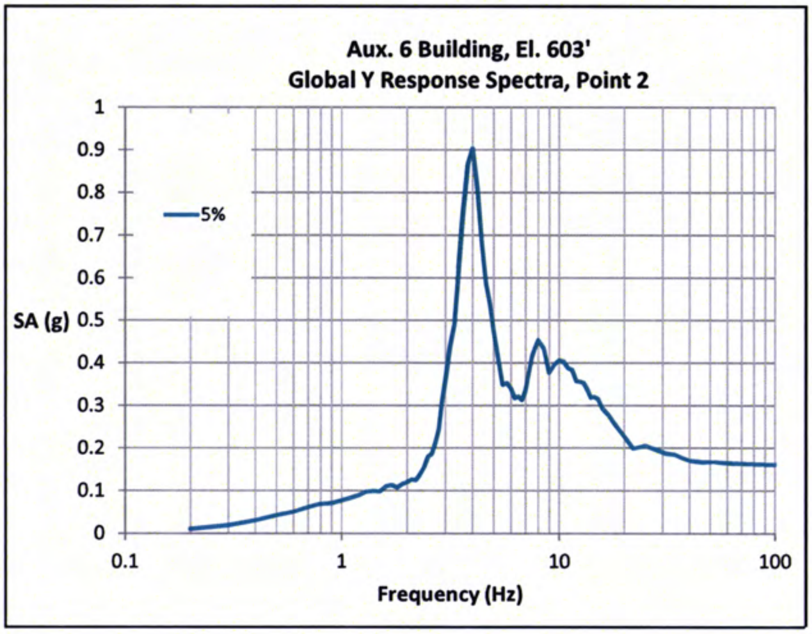
Maximum horizontal acceleration (X or Y direction) in the 15Hz to 40Hz range corresponding to Pt.3, AUX8, El.585' (see clippings on the following sections)

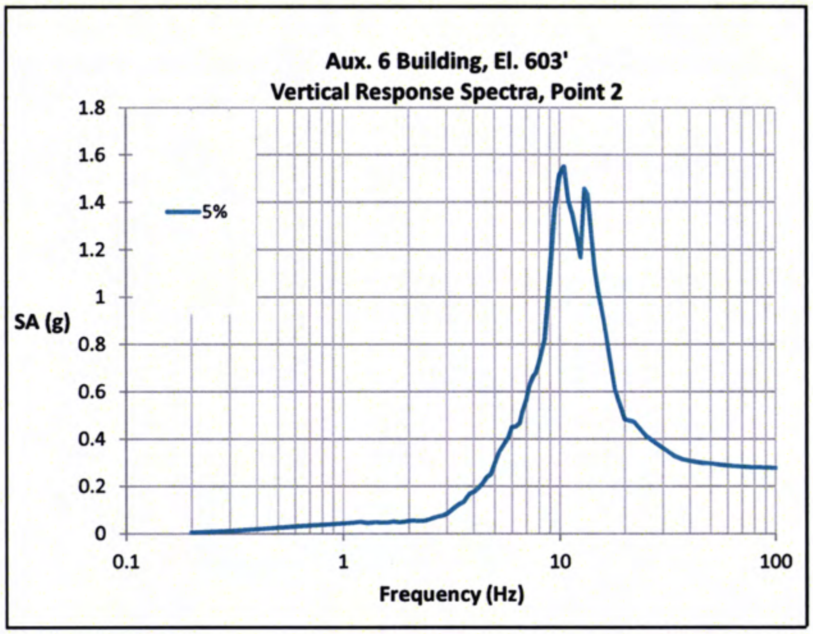
$SA_{V\_Aux8\_585\_3} := 0.61g$

Maximum vertical acceleration in Z-direction in the 15Hz to 40Hz range corresponding to Pt.3, AUX8, El.585' (see clipping on the following sections)

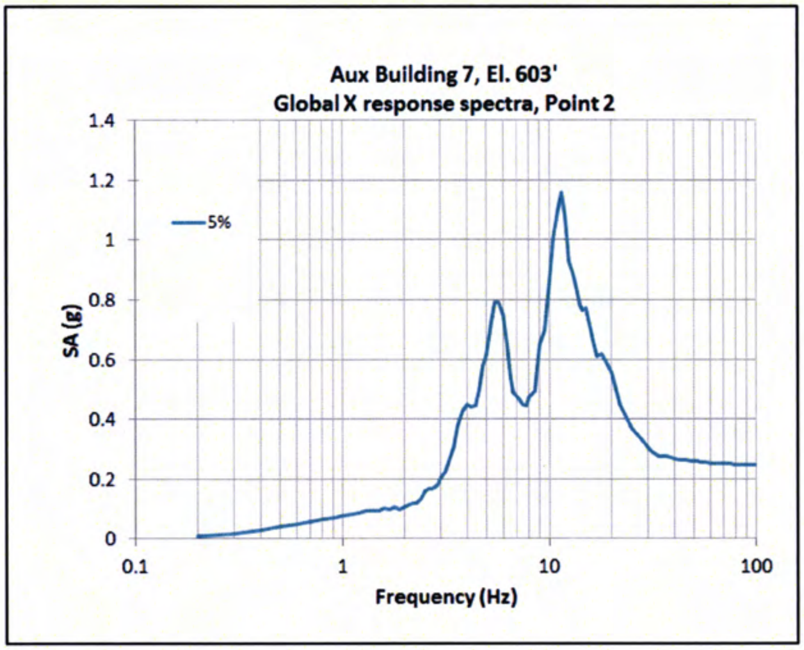
- ***ISRS at Auxiliary Bldg. 6, Elevation 603', Point 2:***






Aux. 6 Building, El. 603'
Vertical Response Spectra, Point 2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
SA (g)
5%
0.1
1
10
100
Frequency (Hz)

- ***ISRS at Auxiliary Bldg. 7, Elevation 603', Point 2:***



Clip RRS_x at fc=11.5Hz

$f_c := 11.5\text{Hz}$

$S_{a\_peak} := 1.16\text{g}$

$S_{a\_peak} \cdot 80\% = 0.93 \cdot \text{g}$

$f_{1\_1} := 10.25\text{Hz}$ $\quad f_{2\_1} := 12.5\text{Hz}$

$\Delta f_{0.8} := f_{2\_1} - f_{1\_1} = 2.25 \cdot \text{Hz}$

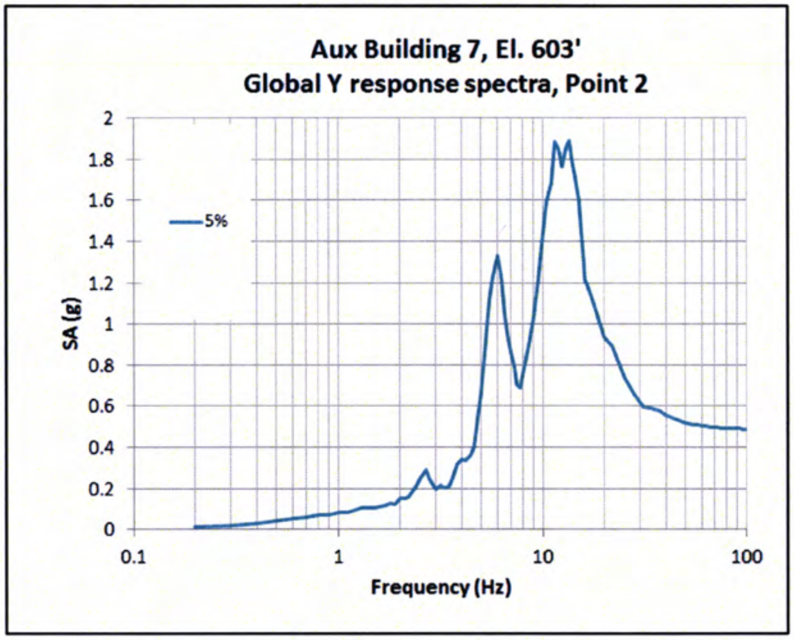
$$B := \frac{\Delta f_{0.8}}{f_c} = 0.20$$

$$C_C := \begin{array}{|l} 0.55 \ \text{ if } \ B \le 0.2 \\ 0.4 + 0.75 \cdot B \ \text{ if } \ 0.2 \le B \le 0.8 \\ 1.0 \ \text{ if } \ B > 0.8 \end{array}$$

$C_C = 0.55$

$S_{a\_clip\_x\_Aux7\_603\_2\_5\%} := C_C \cdot S_{a\_peak} = 0.64 \cdot \text{g}$

Clipped horizontal X acceleration at Aux. 7, EL.603', Point 2, 5% damping in the frequency range of 15Hz to 40Hz



Clip RRS_y at fc=11.5Hz

$f_c := 11.5Hz$

$S_{a\_peak} := 1.89g$

$S_{a\_peak} \cdot 80\% = 1.51 \cdot g$

$f_{1\_1} := 10.25Hz$ $\quad f_{2\_1} := 15.25Hz$

$\Delta f_{0.8} := f_{2\_1} - f_{1\_1} = 5.00 \cdot Hz$

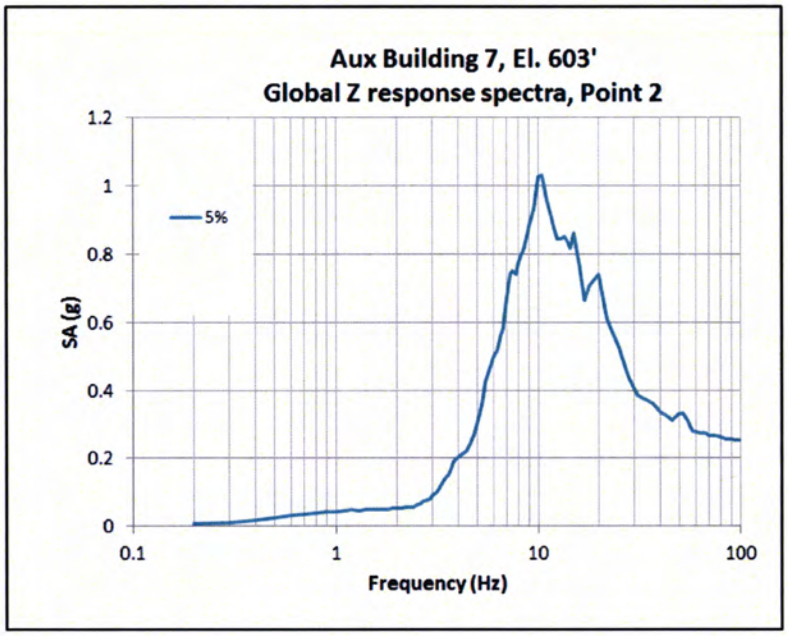
$$B := \frac{\Delta f_{0.8}}{f_c} = 0.43$$

$$C_C := \left| \begin{array}{l} 0.55 \text{ if } B \le 0.2 \\ 0.4 + 0.75 \cdot B \text{ if } 0.2 \le B \le 0.8 \\ 1.0 \text{ if } B > 0.8 \end{array} \right.$$

$C_C = 0.73$

$S_{a\_clip\_y\_Aux7\_603\_2\_5\%} := C_C \cdot S_{a\_peak} = 1.37 \cdot g$

Clipped horizontal Y acceleration at Aux. 7, EL.603', Point 2, 5% damping in the frequency range of 15Hz to 40Hz



Clip RRS_z at fc=10.5Hz

$f_c := 10.5\text{Hz}$

$S_{a\_peak} := 1.03\text{g}$

$S_{a\_peak} \cdot 80\% = 0.82 \cdot \text{g}$

$f_{1\_1} := 8.5\text{Hz}$ $f_{2\_1} := 15.4\text{Hz}$

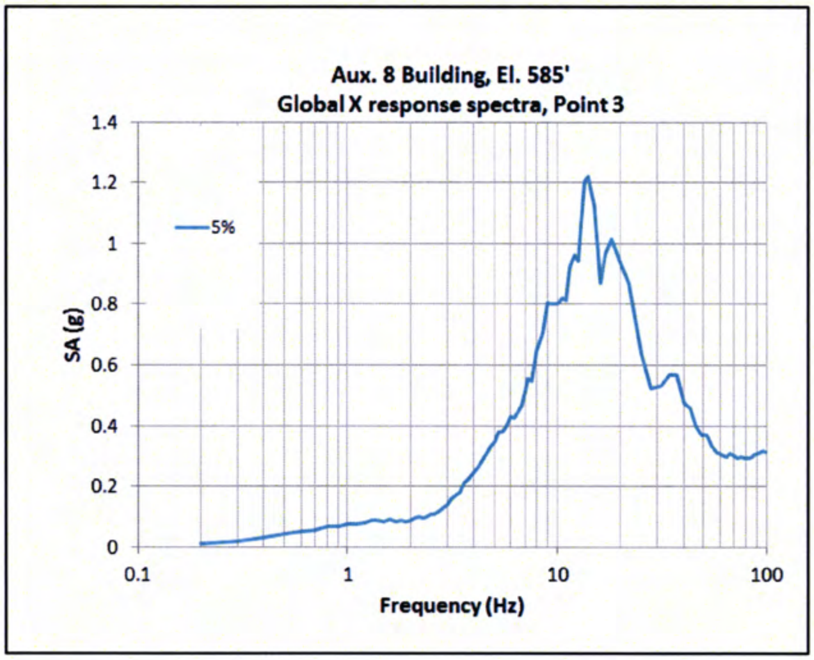
$\Delta f_{0.8} := f_{2\_1} - f_{1\_1} = 6.90 \cdot \text{Hz}$

$$B := \frac{\Delta f_{0.8}}{f_c} = 0.66$$

$$C_C := \begin{vmatrix} 0.55 \text{ if } B \le 0.2 \\ 0.4 + 0.75 \cdot B \text{ if } 0.2 \le B \le 0.8 \\ 1.0 \text{ if } B > 0.8 \end{vmatrix} \qquad C_C = 0.89$$

$S_{a\_clip\_z\_Aux7\_603\_2\_5\%} := C_C \cdot S_{a\_peak} = 0.92 \cdot \text{g}$ Clipped vertical Z acceleration at Aux. 7, EL.603', Point 2, 5% damping in the frequency range of 15Hz to 40Hz

- ***ISRS at Auxiliary Bldg. 8, Elevation 585', Point 3:***



Clip RRS_x at fc=13.5Hz

$f_c := 13.5\text{Hz}$

$S_{a\_peak} := 1.205g$

$S_{a\_peak} \cdot 80\% = 0.96 \cdot g$

$f_{1\_1} := 12.6\text{Hz}$ $\quad f_{2\_1} := 17\text{Hz}$

$\Delta f_{0.8} := f_{2\_1} - f_{1\_1} = 4.40 \cdot \text{Hz}$

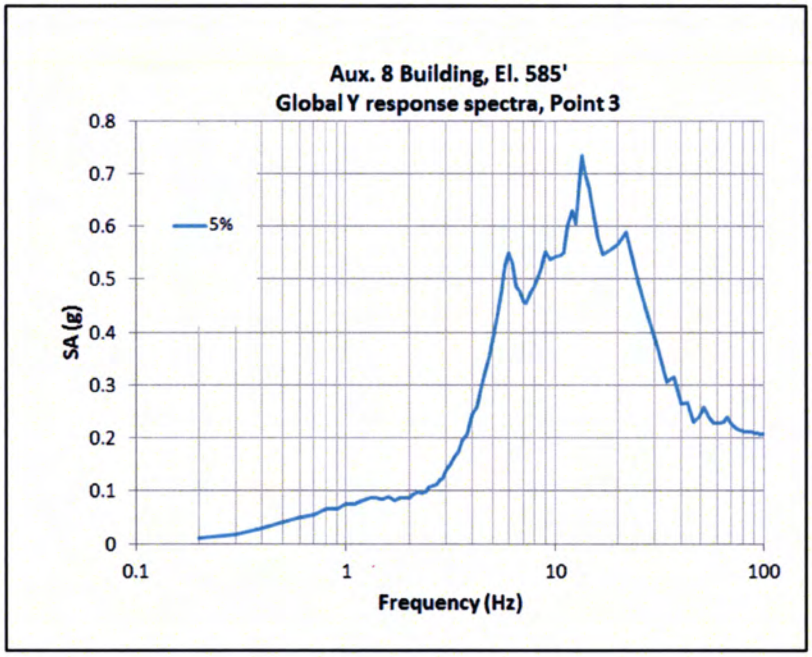
$$B := \frac{\Delta f_{0.8}}{f_c} = 0.33$$

$$C_C := \begin{array}{|l} 0.55 \text{ if } B \le 0.2 \\ 0.4 + 0.75 \cdot B \text{ if } 0.2 \le B \le 0.8 \\ 1.0 \text{ if } B > 0.8 \end{array}$$

$C_C = 0.64$

$S_{a\_clip\_x\_Aux8\_585\_3\_5\%} := C_C \cdot S_{a\_peak} = 0.78 \cdot g$

Clipped horizontal X acceleration at Aux. 8, EL.585', Point 3, 5% damping in the frequency range of 15Hz to 40Hz



Clip RRS_y at fc=13.5Hz

$f_c := 13.5Hz$

$S_{a\_peak} := 0.734g$

$S_{a\_peak} \cdot 80\% = 0.59 \cdot g$

$f_1 := 11.3Hz$ $f_2 := 22Hz$

$\Delta f_{0.8} := f_2 - f_1 = 10.70 \cdot Hz$

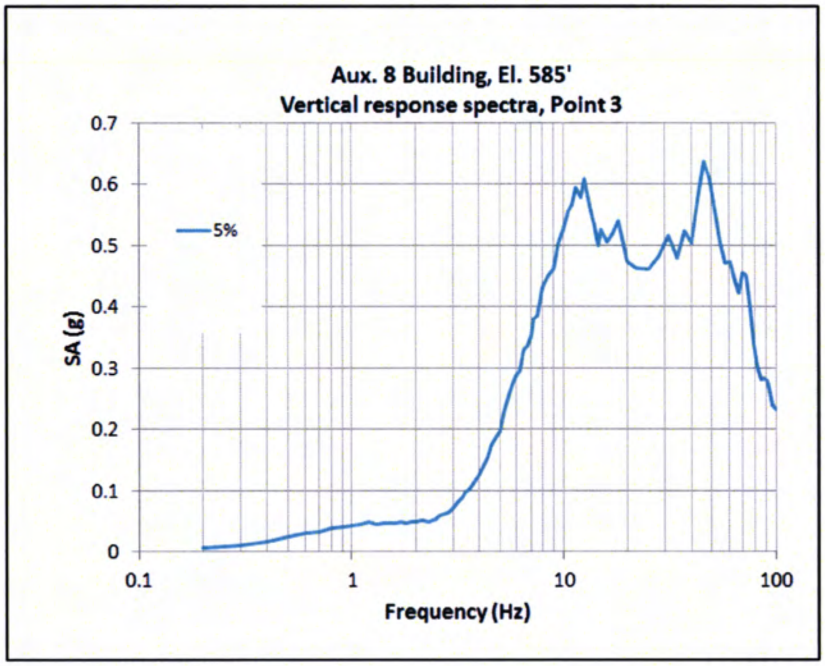
$$B := \frac{\Delta f_{0.8}}{f_c} = 0.79$$

$$C_C := \begin{vmatrix} 0.55 \quad \text{if} \quad B \le 0.2 \\ 0.4 + 0.75 \cdot B \quad \text{if} \quad 0.2 \le B \le 0.8 \\ 1.0 \quad \text{if} \quad B > 0.8 \end{vmatrix}$$

$C_C = 0.99$

$S_{a\_clip\_y\_Aux8\_585\_3\_5\%} := C_C \cdot S_{a\_peak} = 0.73 \cdot g$

Clipped horizontal Y acceleration at Aux. 8, EL.585', Point 3, 5% damping in the frequency range of 15Hz to 40Hz



Clip RRS_z at fc=12.5Hz

$f_c := 12.5\text{Hz}$

$S_{a\_peak} := 0.607\text{g}$

$S_{a\_peak} \cdot 80\% = 0.49 \cdot \text{g}$

$f_1 := 9.3\text{Hz}$ $\quad$ $f_2 := 19.5\text{Hz}$

$\Delta f_{0.8} := f_2 - f_1 = 10.20 \cdot \text{Hz}$

$$B := \frac{\Delta f_{0.8}}{f_c} = 0.82$$

$$C_C := \left| \begin{array}{l} 0.55 \quad \text{if} \quad B \le 0.2 \\ 0.4 + 0.75 \cdot B \quad \text{if} \quad 0.2 \le B \le 0.8 \\ 1.0 \quad \text{if} \quad B > 0.8 \end{array} \right.$$

$C_C = 1.00$

$S_{a\_clip\_z\_Aux8\_585\_3\_5\%} := C_C \cdot S_{a\_peak} = 0.61 \cdot g$

Clipped vertical Z acceleration at Aux. 8, EL.585', Point 3, 5% damping in the frequency range of 15Hz to 40Hz

$AF_{C\_H} := 3.6$	Maximum horizontal in-cabinet amplification factor for motor control centers per Ref. A1
$AF_{C\_V} := 4.7$	Maximum vertical in-cabinet amplification factor for motor control centers per Ref. A1
$ICRS_{H\_Aux6\_603} := SA_{H\_Aux6\_603\_2} \cdot AF_{C\_H} = 1.15 \cdot g$	Maximum Horizontal in-cabinet response spectra at Point 2, AUX6, El.603'
$ICRS_{V\_Aux6\_603} := SA_{V\_Aux6\_603\_2} \cdot AF_{C\_V} = 4.84 \cdot g$	Maximum vertical in-cabinet response spectra at Point 2, AUX6, El.603'
$ICRS_{H\_Aux7\_603} := SA_{H\_Aux7\_603\_2} \cdot AF_{C\_H} = 4.93 \cdot g$	Maximum Horizontal in-cabinet response spectra at Point 2, AUX7, El.603'
$ICRS_{V\_Aux7\_603} := SA_{V\_Aux7\_603\_2} \cdot AF_{C\_V} = 4.32 \cdot g$	Maximum vertical in-cabinet response spectra at Point 2, AUX7, El.603'
$ICRS_{H\_Aux8\_585} := SA_{H\_Aux8\_585\_3} \cdot AF_{C\_H} = 2.81 \cdot g$	Maximum Horizontal in-cabinet response spectra at Point 3, AUX8, El.585'
$ICRS_{V\_Aux8\_585} := SA_{V\_Aux8\_585\_3} \cdot AF_{C\_V} = 2.87 \cdot g$	Maximum vertical in-cabinet response spectra at Point 3, AUX8, El.585'

A5.1.3 Capacity-Demand Ratio

$F_k := 1.56$ CDFM Knockdown factor for fragility threshold from high frequency test program (Table 4-2 of Ref. A1)

$F_{MS} := 1.20$ Multi-axis to single-axis correction factor from Section 4.5.2 of Ref. A1

$TRS := \left(\frac{SA_T}{F_k}\right) \cdot (F_{MS}) = 15.1 \cdot g$ effective wide-band component capacity acceleration

$CDR_{H\_Aux6\_603} := \frac{TRS}{ICRS_{H\_Aux6\_603}}$ Capacity-Demand-Ratio in horizontal direction at Aux6, El.603', Point 2

$\boxed{CDR_{H\_Aux6\_603} = 13.10}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{V\_Aux6\_603} := \frac{TRS}{ICRS_{V\_Aux6\_603}}$ Capacity-Demand-Ratio in vertical direction at Aux6, El.603', Point 2

$\boxed{CDR_{V\_Aux6\_603} = 3.12}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{H\_Aux7\_603} := \frac{TRS}{ICRS_{H\_Aux7\_603}}$ Capacity-Demand-Ratio in horizontal direction at Aux7, El.603', Points 2

$\boxed{CDR_{H\_Aux7\_603} = 3.06}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{V\_Aux7\_603} := \frac{TRS}{ICRS_{V\_Aux7\_603}}$ Capacity-Demand-Ratio in vertical direction at Aux7, El.603', Point 2

$\boxed{CDR_{V\_Aux7\_603} = 3.49}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{H\_Aux8\_585} := \frac{TRS}{ICRS_{H\_Aux8\_585}}$ Capacity-Demand-Ratio in horizontal direction at Aux8, El.585', Point 1

$\boxed{CDR_{H\_Aux8\_585} = 5.38}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{V\_Aux8\_585} := \frac{TRS}{ICRS_{V\_Aux8\_585}}$ Capacity-Demand-Ratio in vertical direction at Aux8, El.585', Point 1

$\boxed{CDR_{V\_Aux8\_585} = 5.27}$ > 1.0 i.e., Capacity > Demand --> O.K.

A5.1.4 HCLPF Capacities ($C_{1\%}$ and $C_{10\%}$)

The PGA used in developing the Davis Besse in-structure response spectra is 0.20g.

$PGA := 0.20g$

β_c is the composite uncertainty for relays taken from Table H.1 of Reference A11. This composite uncertainty is considered to be Realistic Lower Bound Case according to Table H.1 of Reference A11, and it is suggested for use in calculating the median capacity.

$\beta_c := 0.30$

- ***Contactors in MCC F12A***

$HCLPF_{A201K\_Aux6\_603\_C1\%} := \min\left(CDR_{H\_Aux6\_603}, CDR_{V\_Aux6\_603}\right) \cdot PGA$

$\boxed{HCLPF_{A201K\_Aux6\_603\_C1\%} = 0.62 \cdot g}$

$A_{m\_A201K\_Aux6\_603\_C1\%} := HCLPF_{A201K\_Aux6\_603\_C1\%} \cdot e^{\left(2.33 \cdot \beta_c\right)}$

$\boxed{A_{m\_A201K\_Aux6\_603\_C1\%} = 1.25 \cdot g}$

$Ratio_{C10\%\_C1\%} := 1.36$ Ratio of $C_{10\%}/C_{1\%}$ from Table H.1 of Ref. A11

$HCLPF_{A201K\_Aux6\_603\_C10\%} := Ratio_{C10\%\_C1\%} \cdot HCLPF_{A201K\_Aux6\_603\_C1\%}$

$\boxed{HCLPF_{A201K\_Aux6\_603\_C10\%} = 0.85 \cdot g}$

- ***Contactors in MCC F11A***

$HCLPF_{A201K\_Aux7\_603\_C1\%} := \min\left(CDR_{H\_Aux7\_603}, CDR_{V\_Aux7\_603}\right) \cdot PGA$

$\boxed{HCLPF_{A201K\_Aux7\_603\_C1\%} = 0.61 \cdot g}$

$A_{m\_A201K\_Aux7\_603\_C1\%} := HCLPF_{A201K\_Aux7\_603\_C1\%} \cdot e^{\left(2.33 \cdot \beta_c\right)}$

$\boxed{A_{m\_A201K\_Aux7\_603\_C1\%} = 1.23 \cdot g}$

$Ratio_{C10\%\_C1\%} := 1.36$ Ratio of $C_{10\%}/C_{1\%}$ from Table H.1 of Ref. A11

$HCLPF_{A201K\_Aux7\_603\_C10\%} := Ratio_{C10\%\_C1\%} \cdot HCLPF_{A201K\_Aux7\_603\_C1\%}$

$\boxed{HCLPF_{A201K\_Aux7\_603\_C10\%} = 0.83 \cdot g}$

- ***Contactors in MCC F11B***

$$HCLPF_{A201K\_AUX8\_585\_C1\%} := \min\left(CDR_{H\_Aux8\_585}, CDR_{V\_Aux8\_585}\right) \cdot PGA$$

$$\boxed{HCLPF_{A201K\_AUX8\_585\_C1\%} = 1.05 \cdot g}$$

$$A_{m\_A201K\_AUX8\_585\_C1\%} := HCLPF_{A201K\_AUX8\_585\_C1\%} \cdot e^{\left(2.33 \cdot \beta_c\right)}$$

$$\boxed{A_{m\_A201K\_AUX8\_585\_C1\%} = 2.12 \cdot g}$$

$Ratio_{C10\%\_C1\%} := 1.36$ Ratio of $C_{10\%}/C_{1\%}$ from Table H.1 of Ref. A11

$$HCLPF_{A201K\_AUX8\_585\_C10\%} := Ratio_{C10\%\_C1\%} \cdot HCLPF_{A201K\_AUX8\_585\_C1\%}$$

$$\boxed{HCLPF_{A201K\_AUX8\_585\_C10\%} = 1.43 \cdot g}$$

A5.2 HF Evaluation for General Electric Relay HFA51A42H

Relay Model	Relay Manufacturer	Host Panel(s)	Building	Elev.	RRS Point	EPRI Equip. Class
HFA51A42H	GE	C3615, C3616	Aux. 6	585	3	20. Dist Panel

A5.2.1 Capacity

$TRS_x := 10.0g$

$TRS_y := 10.0g$ GERS Capacity from Ref. A10 for Non-Operate, Normally Open state

$TRS_z := 10.0g$

$SA := \left(TRS_x \cdot TRS_y \cdot TRS_z\right)^{\frac{1}{3}} = 10.0 \cdot g$ HF seismic capacity of GE HFA51A42H relays in De-Energized/NO state

$SA_T := SA = 10.0 \cdot g$ Effective spectral test capacity per Ref. A1

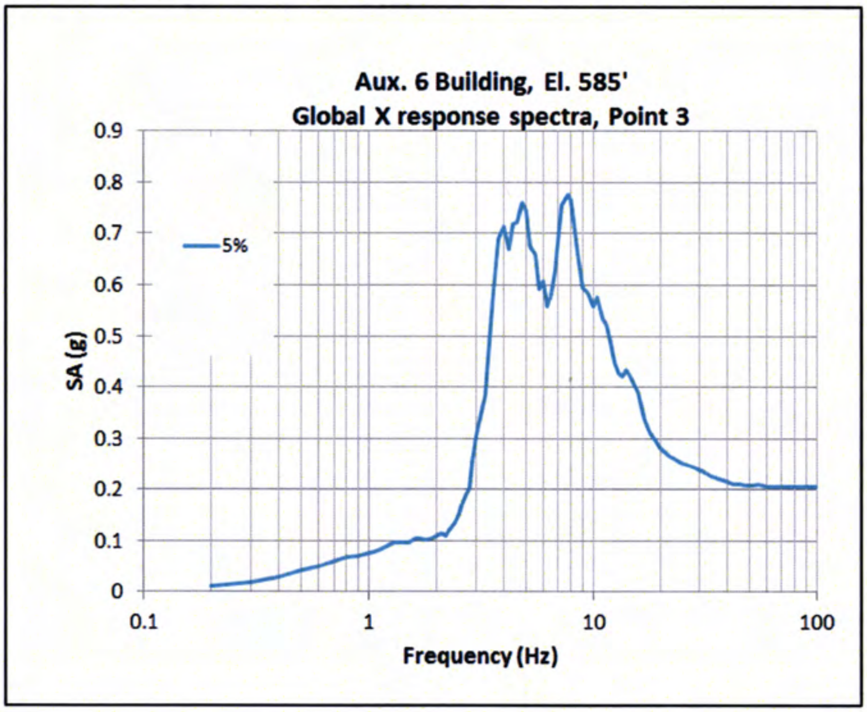
A5.2.2 Demand

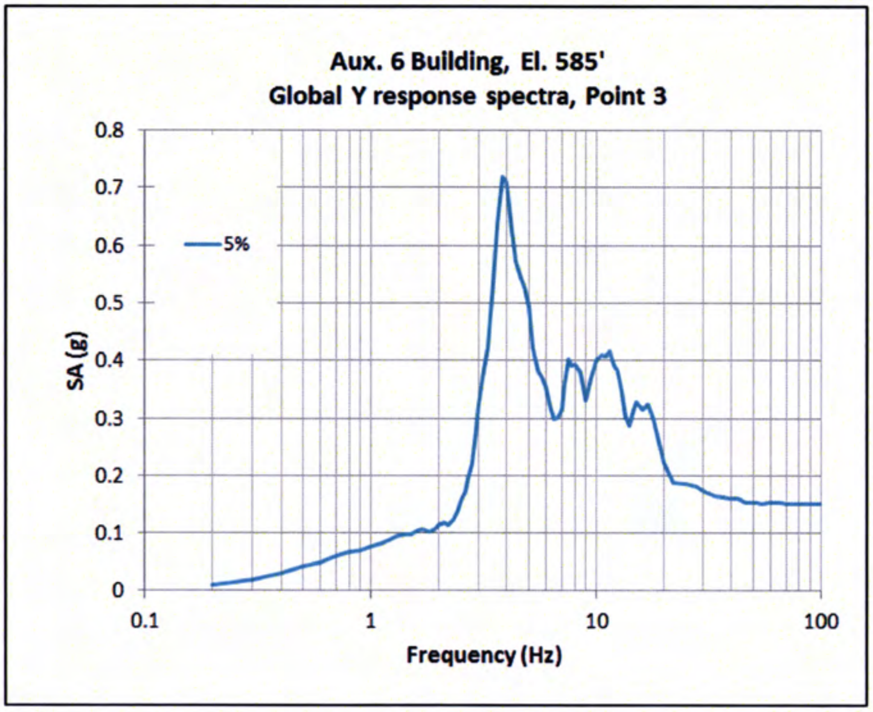
The 5% damped in-structure response spectra at the locations of the relay panels (located at Points 3 in Aux. 6, El. 585') in both horizontal and vertical directions are shown below. The HF demand in the 15Hz to 40 Hz are:

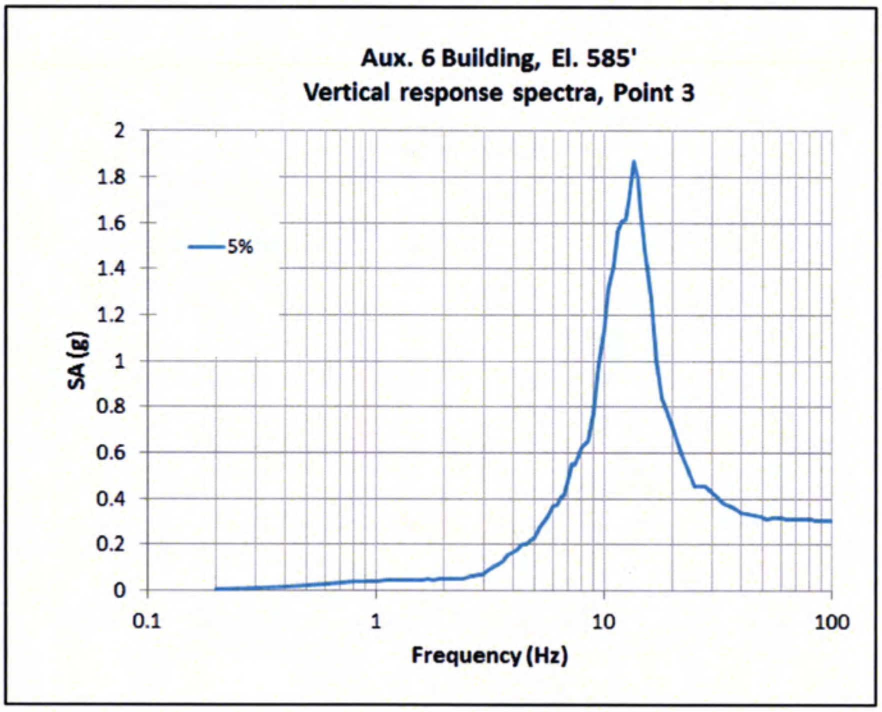
$SA_{H\_Aux6\_585\_3} := \max(0.41g, 0.33g) = 0.41 \cdot g$ Maximum horizontal acceleration (X or Y direction) in the 15Hz to 40Hz range corresponding to Pt.3, AUX6, El.585' (no clipping required)

$SA_{V\_Aux6\_585\_3} := 1.14g$ Maximum vertical acceleration (Z direction) in the 15Hz to 40Hz range corresponding to Pt.3, AUX6, El.585' (see below for clipping of vertical spectra)

- ***ISRS at Auxiliary Bldg. 6, Elevation 585', Point 3:***







Clip RRS_z at fc=13.5Hz

$f_c := 13.5\text{Hz}$

$S_{a\_peak} := 1.87g$ $\qquad S_{a\_peak} \cdot 80\% = 1.50 \cdot g$

$f_1 := 11.26\text{Hz}$ $\qquad f_2 := 15.0\text{Hz}$

$\Delta f_{0.8} := f_2 - f_1 = 3.74 \cdot \text{Hz}$

$$B := \frac{\Delta f_{0.8}}{f_c} = 0.28$$

$$C_C := \left| \begin{array}{l} 0.55 \ \text{ if } \ B \le 0.2 \\ 0.4 + 0.75 \cdot B \ \text{ if } \ 0.2 \le B \le 0.8 \\ 1.0 \ \text{ if } \ B > 0.8 \end{array} \right. = 0.61$$

$S_{a\_clip} := C_C \cdot S_{a\_peak} = 1.14 \cdot g$

$S_{a\_peak\_z\_AUX6\_585\_3\_5} := S_{a\_clip} = 1.14 \cdot g$

Clipped vertical Z acceleration
at Aux. 6, EL.585', Point 3,
5% damping in the frequency
range of 15Hz to 40Hz

$AF_{C\_H} := 4.5$	Maximum horizontal in-cabinet amplification factor for Control Cabinets per Ref. A1
$AF_{C\_V} := 4.7$	Maximum vertical in-cabinet amplification factor for Control Cabinets per Ref. A1
$ICRS_{H\_Aux6\_585\_3} := SA_{H\_Aux6\_585\_3} \cdot AF_{C\_H} = 1.85 \cdot g$	Maximum Horizontal in-cabinet response spectra at Point 3, AUX6, El.585'
$ICRS_{V\_Aux6\_585\_3} := SA_{V\_Aux6\_585\_3} \cdot AF_{C\_V} = 5.36 \cdot g$	Maximum vertical in-cabinet response spectra at Point 3, AUX6, El.585'

A5.2.3 Capacity-Demand Ratio

$F_k := 1.50$	CDFM Knockdown factor for GERS qualification test from Table 4-2 of Ref. A1
$F_{MS} := 1.20$	Multi-axis to single-axis correction factor from Section 4.5.2 of Ref. A1
$TRS_D := \left(\frac{SA_T}{F_k}\right) \cdot \left(F_{MS}\right) = 8.00 \cdot g$	effective wide-band component capacity acceleration
$CDR_{H\_Aux6\_585} := \frac{TRS_D}{ICRS_{H\_Aux6\_585\_3}}$	Capacity-Demand-Ratio in horizontal direction at Aux6, El.585', Point 3

$\boxed{CDR_{H\_Aux6\_585} = 4.34}$ > 1.0 i.e., Capacity > Demand --> O.K.

$CDR_{V\_Aux6\_585} := \frac{TRS_D}{ICRS_{V\_Aux6\_585\_3}}$	Capacity-Demand-Ratio in vertical direction at Aux6, El.585', Point 3

$\boxed{CDR_{V\_Aux6\_585} = 1.49}$ > 1.0 i.e., Capacity > Demand --> O.K.

A5.2.4 HCLPF Capacities ($C_{1\%}$ and $C_{10\%}$)

The PGA used in developing the Davis Besse in-structure response spectra is 0.20g.

$PGA := 0.20g$

β_c is the composite uncertainty for relays taken from Table H.1 of Reference A11. This composite uncertainty is considered to be Realistic Lower Bound Case according to Table H.1 of Reference A11, and it is suggested for use in calculating the median capacity.

$\beta_c := 0.30$

$HCLPF_{HFA51A\_C1\%} := \min(CDR_{H\_Aux6\_585}, CDR_{V\_Aux6\_585}) \cdot PGA$

$\boxed{HCLPF_{HFA51A\_C1\%} = 0.30 \cdot g}$

$A_{m\_HFA51A\_C1\%} := HCLPF_{HFA51A\_C1\%} \cdot e^{(2.33 \cdot \beta_c)}$

$\boxed{A_{m\_HFA51A\_C1\%} = 0.60 \cdot g}$

$Ratio_{C10\%\_C1\%} := 1.36$ Ratio of $C_{10\%}/C_{1\%}$ from Table H.1 of Ref. A11

$HCLPF_{HFA51A\_C10\%} := Ratio_{C10\%\_C1\%} \cdot HCLPF_{HFA51A\_C1\%}$

$\boxed{HCLPF_{HFA51A\_C10\%} = 0.41 \cdot g}$ > PGA=0.20g ——> O.K.

APPENDIX B

COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION

TABLE B-1
COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION

No.	Unit	Component					Enclosure		Bldg.	Elev. (ft)	Component Evaluation			C1%$^{(3)}$ (g)	C10%$^{(3)}$ (g)
		ID	Type	System Function	Manufacturer	Relay/ Contactor/ Breaker Model No.	ID	Type			Basis for Capacity	C/D Ratio$^{(1)}$	Evaluation Result		
1	1	AC103/86-1/C1 AC103/86-2/C1 AD103/86-1/D1 AD103/86-2/D2	Protective Relay	AC/DC Power Support System, Actuates Bus Lockout	G.E.	HFA53K91F	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	1.61	Capacity > Demand	0.32	0.44
	1	AC103/51-1X AC103/51-1 AC103/51-2 AC103/51-3 AD103/51-1X AD103/51-1 AD103/51-2 AD103/51-3		AC/DC Power Support System, Over Current Protection											
2	1	AC110/51-4 AD110/51-4	Protective Relay	AC/DC Power Support System, Over Current Protection	Westinghouse	CO-2	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	1.93	Capacity > Demand	0.39	0.53
3	1	AC110/51-5 AD110/51-5	Protective Relay	AC/DC Power Support System, Over Current Protection	Westinghouse	CO-5	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	2.90	Capacity > Demand	0.58	0.79
4	1	AC110/51GS-3 AC1CE11-50/51 AC1CE12-50/51 AD110/51GS-3 AD1DF11-50/51 AD1DF12-50/51	Protective Relay	AC/DC Power Support System, Over Current Protection	Westinghouse	CO-11	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	4.51	Capacity > Demand	0.90	1.23
5	1	AC107-50/51 AC108-50/51 AC109-50/51 AC113-50/51 AD107-50/51 AD108-50/51 AD109-50/51 AD113-50/51	Protective Relay	AC/DC Power Support System, Over Current Protection	ABB	COM-5	C1, D1	Switchgear	AUX. 6	585	IEEE/ANSI C37-98 test	2.90	Capacity > Demand	0.58	0.79

TABLE B-1
COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION (CONTINUED)

No.	Unit	Component					Enclosure		Bldg.	Elev. (ft)	Component Evaluation			C1%(3) (g)	C10%(3) (g)
		ID	Type	System Function	Manufacturer	Relay/ Contactor/ Breaker Model No.	ID	Type			Basis for Capacity	C/D Ratio(1)	Evaluation Result		
6	1	AC107/50GS AC113/50GS AC1CE11/50GS AD107/50GS AD1DF12/50GS	Protective Relay	AC/DC Power Support System, Ground Sensing Relay	ABB	ITE Type 50D	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	5.00	Capacity > Demand	1.00	1.36
7	1	AC103/51GS-1 AC103/51GS-2 AD103/51GS-1 AD103/51GS-2		AC/DC Power Support System, Over Current Protection											
8	1	AC110/51X AD110/51X	Protective Relay	AC/DC Power Support System, Over Current Protection	G.E.	HGA17C61	C1, D1	Switchgear	Aux. 6	585	GERS	1.55	Capacity > Demand	0.31	0.42
9	1	AC101/51V2DG AD101/51V2DG	Protective Relay	AC/DC Power Support System; Back Up OC Trip of AC101	ABB	COV-9	C1, D1	Switchgear	Aux. 6	585	IEEE/ANSI C37-98 test	4.51	Capacity > Demand	0.90	1.23
10	1	BF1285/42	Control Relay	RCS Inventory Control; Control of Valve RC200; Drain valve to RCS Quench Tank	Cutler Hammer	Electro-Mechanical Contactor A201K1C	F12A	MCC	Aux. 6	603	EPRI HF Test	3.12	Capacity > Demand	0.62	0.85
	1	BF1126/42	Control Relay	RCS Inventory Control; Control of Valve RC239A; RCS Sample Isolation Valve			F11A		Aux. 7	603		3.06	Capacity > Demand	0.61	0.83

TABLE B-1
COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION
(CONTINUED)

No.	Unit	Component					Enclosure		Bldg.	Elev. (ft)	Component Evaluation			C1%$^{(3)}$ (g)	C10%$^{(3)}$ (g)
		ID	Type	System Function	Manufacturer	Relay/ Contactor/ Breaker Model No.	ID	Type			Basis for Capacity	C/D Ratio$^{(1)}$	Evaluation Result		
10	1	BF1127/42	Control Relay	RCS Inventory Control; Control of Valve RC239B; RCS Sample Isolation Valve	Cutler Hammer	Electro-Mechanical Contactor A201K1C	F11A	MCC	Aux. 7	603	EPRI HF Test	3.06	Capacity > Demand	0.61	0.83
	1	BF1128/42	Control Relay	RCS Inventory Control; Control of Valve RC240B; RCS Sample Isolation Valve											
	1	BE1181/42	Control Relay	RCS Inventory Control; Control of Valve RC240A; RCS Sample Isolation Valve			E11B		Aux. 8	585		5.27	Capacity > Demand	1.05	1.43
11	1	R7_1	Control Relay	EDG1 Shutdown Relay	Square D	8501KPD13V63	C3621	Relay Panel	Aux 6	585	IEEE/ANSI C37-98 test	3.06	Capacity > Demand	0.61	0.83
		R7_2		EDG2 Shutdown Relay			C3622								
		OTR_1		EMER DSL GEN 1-1 OVERSPEED TRIP RELAY			C3621								
		OTR_2		EMER DSL GEN 1-2 OVERSPEED TRIP RELAY			C3622								
		R2_1		EMER DSL GEN 1-1 FAIL TO START RELAY			C3621								
		R2_2		EMER DSL GEN 1-2 FAIL TO START RELAY			C3622								

TABLE B-1
COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION (CONTINUED)

No.	**Unit**	**Component**					**Enclosure**		**Bldg.**	**Elev. (ft)**	**Component Evaluation**			**C1%(3) (g)**	**C10%(3) (g)**
		ID	**Type**	**System Function**	**Manufacturer**	**Relay/ Contactor/ Breaker Model No.**	**ID**	**Type**			**Basis for Capacity**	**C/D Ratio(1)**	**Evaluation Result**		
11	1	SDRX1_1		EMER DSL GEN 1-1 SHUTDOWN/LOCKOUT RELAY	Square D	8501KPD13V63	C3621	Relay Panel	Aux 6	585	IEEE/ANSI C37-98 test	3.06	Capacity > Demand	0.61	0.83
		SDRX1_2		EMER DSL GEN 1-2 SHUTDOWN/LOCKOUT RELAY			C3622								
		SDRX_1		EMER DSL GEN 1-1 SHUTDOWN/LOCKOUT RELAY			C3621								
		SDRX_2		EMER DSL GEN 1-2 SHUTDOWN/LOCKOUT RELAY			C3622								
		R3X1_1		EMER DSL GEN 1-1 AUTO/EMER START RELAY			C3617								
		R3X1_2		EMER DSL GEN 1-2 AUTO/EMER START RELAY			C3618								
		SS3_1		EMER DSL GEN 1-1 ENGINE SPEED RELAY 400R			C3621								
		SS3_2		EMER DSL GEN 1-2 ENGINE SPEED RELAY 400R			C3622								
		SS4_1		EMER DSL GEN 1-1 ENGINE SPEED RELAY 800R			C3621								
		SS4_2		EMER DSL GEN 1-2 ENGINE SPEED RELAY 800R			C3622								
12	1	TD1_1	Protective Relay	EDG 1 Start Failure	Agastat	E7012PC0004	C3621	Relay Panel	Aux 6	585	IEEE/ANSI C37-98 test	2.43	Capacity > Demand	0.49	0.66
		TD1_2		EDG 2 Start Failure			C3622								

TABLE B-1
COMPONENTS IDENTIFIED FOR HIGH-FREQUENCY CONFIRMATION (CONTINUED)

No.	Unit	Component					Enclosure		Bldg.	Elev. (ft)	Component Evaluation			C1%[3] (g)	C10%[3] (g)
		ID	Type	System Function	Manufacturer	Relay/ Contactor/ Breaker Model No.	ID	Type			Basis for Capacity	C/D Ratio[1]	Evaluation Result		
13	1	AC108/50GS AC109/50GS AC1CE12/50GS AD109/50GS AD113/50GS AD108/50GS AD1DF11/50GS	Protective Relay	AC/DC Power Support System, Ground Sensing Relay	Westinghouse	ITH	C1, D1	Switchgear	Aux. 6	585	GERS	0.77	Capacity < Demand[2]	0.15	0.21
14	1	86-1/DG1 86-2/DG1 86-1/DG2 86-2/DG2	Protective Relay	EDG Lockout Relay	GE	HFA53K91H	C3615, C3616	Relay Panel	Aux 6	585	IEEE/ANSI C37-98 test	0.93	Capacity < Demand[2]	0.19	0.25
15	1	94-1/DG1 94-1/DG2	Protective Relay	EDG Lockout Relay	GE	HFA51A42H	C3615, C3616	Relay Panel	Aux 6	585	GERS	1.49	Capacity > Demand	0.30	0.41
16	1	SV4632/4	Control Relay	RCS Inventory Control; Valve RC4632	Agastat	EGPD	RC4607	Relay Panel	Aux 7	603	EPRI HF Test	2.69	Capacity > Demand	0.54	0.73

Notes:

(1) C/D Ratios are the minimum of horizontal or vertical C/D ratios.

(2) While the Capacity-Demand Ratio is shown to be less than 1.0, this relay meets the intent of HF confirmation by showing its C10% capacity exceeds the PGA of 0.20g consistent with NEI 12-06 guidance.

(3) While not required for the NTTF 2.1 HF confirmation task, the C1% and C10% capacities are calculated and reported. This information is utilized to demonstrate compliance with the NEI 12-06 Appendix H requirements that C10% exceeds the GMRS. The reported values are representative of the 15 Hz to 40 Hz frequency range.

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