Exelon Generation.

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TMI-16-084

10 CFR 50.54(f)

October 28, 2016

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

Three Mile Island Nuclear Station, Unit 1
Renewed Facility Operating License No. DPR-50
NRC Docket No. 50-289

Subject: 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 Review of Insights from the Fukushima Dai-ichi Accident

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 (ML12053A340)
2. NRC Letter, Electric Power Research Institute Report 3002000704, "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 (ML13106A331)
3. NEI Letter, Final Draft of Industry Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic (EPRI 1025287), dated November 27, 2012 (ML12333A168 and ML12333A170)
4. NRC Letter, Endorsement of Electric Power Research Institute Final Draft Report 1025287, "Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic", dated February 15, 2013 (ML12319A074)
5. Exelon Generation Company, LLC letter to NRC, Three Mile Island, Unit 1 - Seismic Hazard and Screening Report (CEUS Sites), Response to NRC Request for Information Pursuant to 10CFR50.54(f) Regarding Recommendation 2.1 of Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, dated March 31, 2014 (RS-14-073) (ML14090A271)

6. 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 (ML14111A147)
7. NRC Memorandum, Support Document for Screening and Prioritization Results Regarding Seismic Hazard Re-Evaluation for Operating Reactors in the Central and Eastern United States, dated May 21, 2014 (ML14136A126)
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 (ML15223A100/ML15223A102)
9. NRC Letter to NEI: Endorsement of Electric Power Research Institute Final Draft Report 3002004396: "High Frequency Program: Application Guidance for Functional Confirmation and Fragility," dated September 17, 2015 (ML15218A569)
10. 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 (ML15194A015)

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued a Request for Information per 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 NRC letter dated May 7, 2013 (Reference 2), the date to submit the report was extended to March 31, 2014.

By letter dated May 9, 2014 (Reference 6), the NRC transmitted the results of the screening and prioritization review of the seismic hazards reevaluation report for Three Mile Island Nuclear Station, Unit 1 submitted on March 31, 2014 (Reference 5). In accordance with the screening, prioritization, and implementation details report (SPID) (References 3 and 4), 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 (IHS) to determine if a plant is required to perform a high frequency confirmation evaluation. As noted in the May 9, 2014 letter from the NRC (Reference 6) on page 3 of Enclosure 2, Three Mile Island Nuclear Station, Unit 1 is to conduct a limited scope High Frequency Evaluation (Confirmation).

Within the May 9, 2014 letter (Reference 6), the NRC acknowledged that these limited scope evaluations will require additional development of the assessment process. By Reference 8, the Nuclear Energy Institute (NEI) submitted an Electric Power Research Institute (EPRI) report entitled, High Frequency Program: Application Guidance for Functional Confirmation and Fragility Evaluation (EPRI 3002004396) for NRC review and endorsement. NRC endorsement was provided by Reference 9. Reference 10 provided the NRC final seismic hazard evaluation

screening determination results and the associated schedules for submittal of the remaining seismic hazard evaluation activities.

The High Frequency Evaluation Confirmation Report for Three Mile Island Nuclear Station, Unit 1, provided in the enclosure to this letter, shows that all high frequency susceptible equipment evaluated within the scoping requirements and using evaluation criteria of Reference 8 for seismic demands and capacities, are acceptable. Therefore, no additional modifications or evaluations are necessary.

This letter closes Commitment Number 1 in Reference 5.

This letter contains no new regulatory commitments.

If you have any questions regarding this report, please contact Ronald Gaston at 630-657-3359.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 28th day of October 2016.

Respectfully submitted,

James Barstow
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: Three Mile Island Nuclear Station, Unit 1 - Seismic High Frequency Evaluation Confirmation Report

cc: NRC Regional Administrator - Region I
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Enclosure

Three Mile Island Nuclear Station, Unit 1

Seismic High Frequency Evaluation Confirmation Report

(49 pages)

HIGH FREQUENCY CONFIRMATION REPORT

IN RESPONSE TO NEAR TERM TASK FORCE (NTTF) 2.1 RECOMMENDATION

for the

THREE MILE ISLAND NUCLEAR STATION, UNIT 1
Middletown, PA 17057
Facility Operating License No. DPR-50
NRC Docket No. 50-289
Correspondence No.: RS-16-179, TMI-16-084

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Report Number: 15C4343-RPT-002, Rev. 0

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Document ID: 15C4343-RPT-002 Title: High Frequency Confirmation Report for Three Mile Island Nuclear Station, Unit 1 in Response to Near Term Task Force (NTTF) 2.1 Recommendation

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Project Name: Three Mile Island, Unit 1 High Frequency Confirmation
Job No.: 15C4343
Client: Exelon

This document has been prepared under the guidance of the S&A Quality Assurance Program Manual, Revision 18 and project requirements:

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S&A Stevenson & Associates	DOCUMENT APPROVAL SHEET Figure 2.8	PROJECT NO. 15C4343

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 [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 [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 Nuclear Regulatory Commission (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 [15] 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 [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" [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," [8] and was endorsed by the NRC in a letter dated September 17, 2015 [3]. Final screening identifying plants needing to perform a High Frequency Confirmation was provided by NRC in a letter dated October 27, 2015 [2].

This report describes the High Frequency Confirmation evaluation performed for Three Mile Island, Unit 1 (TMI-1). 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 [8] is used for the TMI-1 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 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 [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 [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 Nuclear Regulatory Commission (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 [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" [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 is 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," [8] and was endorsed by the NRC in a letter dated September 17, 2015 [3]. Final screening identifying plants needing to perform a High Frequency Confirmation was provided by NRC in a letter dated October 27, 2015 [2].

On March 31, 2014, TMI-1 submitted a reevaluated seismic hazard to the NRC as a part of the Seismic Hazard and Screening Report [4]. By letter dated October 27, 2015 [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 performed for TMI-1 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 [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 [8] is used for the TMI-1 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:

- TMI-1 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

TMI-1 submitted reevaluated seismic hazard information including GMRS and seismic hazard information to the NRC on March 31, 2014 [4]. In a letter dated August 14, 2015, the NRC staff concluded that the submitted GMRS adequately characterizes the reevaluated seismic hazard for the TMI-1 site [14].

The NRC final screening determination letter concluded [2] that the TMI-1 GMRS to SSE comparison resulted in a need to perform a High Frequency Confirmation in accordance with the screening criteria in the SPID [6].

1.5 Report Documentation

Section 2 describes the selection of devices. The identified devices are evaluated in Reference [17] for the seismic demand specified in Section 3 using the evaluation criteria discussed in Section 4. The overall conclusion is discussed in Section 5.

Table B-1 lists the devices identified in Section 2 and provides the results of the evaluations performed in accordance with Section 3 and Section 4.

2 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 FLEX/mitigating strategies 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. 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. 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.

The process/criteria for assessing potential reactor coolant leak path valves is to review all P&ID's attached to the Reactor Coolant System (RCS) and include all active isolation valves and any active second valve upstream or downstream that is assumed to be required to be closed during normal operation or close upon an initiating event (LOCA or Seismic). A table with the valves and associated P&ID is included in Table B-2 of this report.

Manual valves that are normally closed are assumed to remain closed and a second simple check valve is assumed to function and not be a Multiple Spurious Failure.

Active Function: A function that requires mechanical motion or a change of state (e.g., the closing of a valve or relay or the change in state of a transistor)

Simple Check Valve: A valve which closes upon reverse fluid flow only.

The Letdown and Purification System on PWRs is a normally in service system with the flowpath open and in operation. If an event isolated a downstream valve, there are pressure relief valves that would flow water out of the RC System. Letdown has auto isolation and abnormal operating procedure which isolate the flow. There are no auto open valves in this flowpath.

Table B-2 contains a list of valves analyzed and the resultant devices selected. Based on the analysis detailed in Table 2-1 below, there are no contact devices that meet the criteria for selection in this category.

Table 2-1: RCS Valve Control Device Screening

Valve ID	Description	Reference	Comment
RC-V-42	Reactor Head Vent	209-780 [21]	Solenoid controlled by hand switch only
RC-V-43	Reactor Head Vent	209-780 [21]	Solenoid controlled by hand switch only
DH-V-1	1C-ESV Unit 3A RC to DH Rem Block Valve	208-452 [22] 209-503 [23] 208-413 [24] 302-640 [25]	Opening contactor may seal-in and open valve however RCS coolant loss is prevented by normally closed and depowered DH-V-2 and normally closed and non-vulnerable DH-V-3, which are in-line with DH-V-1.
DH-V-2	1C-ESV Unit 3B RC to DH Rem Block Valve	208-453 [26] 209-603 [27] 208-413 [24]	This valve is closed and depowered [28, pp. 3-31] and as such contact chatter has no effect on the position of the valve.
DH-V-3	1C-ESV Unit 4B RC Outlet to DH System	208-454 [29]	Motor contactors controlled by hand switches only with no seal-in of opening contactor and no permissive in closing circuit
RC-V-40A	RC Vent Valve	209-779 [30]	Solenoid controlled by hand switch only
RC-V-41A	RC Vent Valve	209-779 [30]	Solenoid controlled by hand switch only
RC-V-40B	RC Vent Valve	209-780 [21]	Solenoid controlled by hand switch only
RC-V-41B	RC Vent Valve	209-780 [21]	Solenoid controlled by hand switch only
RC-V-2	1C-ESV Unit 5C Pressurizer Relief Block Valve	208-426 Sh. 1 [31] 208-750 [32]	Motor contactors controlled by hand switches only; Valve is normally open and in this condition limit switches prevent seal-in of opening contactor; No permissive in closing circuit
RC-RV-2	Pressurizer Electromatic Relief Valve	209-034 [33] 209-069 [34]	Solenoid controlled by 63X/RC-3PS8; No Seal-in or Lockout would prevent normal operation
RC-V-44	RC Vent Valve	209-780 [21]	Solenoid controlled by hand switch only
RC-V-28	1B-ES Unit 10C Pressurizer Vent Valve	208-430 [35]	Motor contactors controlled by hand switches only with no seal-in of opening contactor and no permissive in closing circuit

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."

2.4 CORE COOLING

The core cooling systems were reviewed for contact control devices in seal-in and lockout circuits that would prevent at least a single train of non-AC power driven decay heat removal from functioning. TMI-1 credits their Turbine Driven Emergency Feedwater Pump to provide feedwater to the Steam Generators to maintain core decay-heat cooling.

The selection of contact devices for the Turbine Driven Emergency Feedwater Pump was performed in TMI-1 ESEL. For more information on the ESEL selection process and the complete ESEL refer to Ref. [19].

2.5 AC/DC POWER SUPPORT SYSTEMS

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

- Emergency Diesel Generators,
- Battery Chargers,
- 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 Emergency Diesel Generators and their ancillary support systems. EPRI 3002004396 [8] 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 was spurious due to contact chatter or in response to an actual system fault. The actions taken to diagnose the fault condition could substantially delay the restoration of emergency power.

In order to ensure contact chatter cannot compromise the emergency power system, control circuits were analyzed for the Emergency Diesel Generators (EDG), Battery Chargers, Vital AC Inverters, and Switchgear/Load Centers/MCCs as necessary for power supply from EDGs to 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 TMI's UFSAR [36]. TMI has two (2) DGs which provide emergency power for their two (2) divisions of Class 1E loads, with one DG for each division [37]. Four (4) battery chargers provide DC power and battery recharging functions [38]. (The output disconnect switches of the 1E and 1F chargers are normally open and for this reason these chargers were not considered in this analysis.)

The analysis necessary to identify contact devices in this category relies on conservative worse-case initial conditions and presumptions regarding event progression. The analysis considers the reactor is operating at power with no equipment failures or LOCA prior to the seismic event. The Emergency Diesel Generators 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 undervoltage 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 which 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 all divisions.

Emergency Diesel Generators

The analysis of the Emergency Diesel Generators, 1A and 1B, is divided into two sections, generator protective relaying and diesel engine control. General descriptions of these systems and controls appear in the UFSAR [36, pp. 8.2-17].

Generator Protective Relaying

The control circuits for the DG1A circuit breakers [39] include Generator Lockout Relay 86G/1D2 and Bus Lockout Relay 86B/1D. If any of these lockout relays are tripped the EDG breaker will not close automatically during the LOOP. Chatter in the generator protective relaying during the period of strong shaking may trip the DG1A circuit breaker. These relays are 46G Negative Phase Sequence (Phase-to-Phase Fault), 76FX Field Overload, 64G Neutral Ground, 32 Reverse Power, K1 Exciter Shutdown, and 40X Loss of Excitation. The 86G/1D2 Generator Lockout may be tripped by chatter in Differential Relay 87M/1D2 on the EDG breaker [40]. The 86B/1D Bus Lockout Relay may be tripped by chatter in Phase Overcurrent Relays 51B/1D/A, 51B/1D/B, and 51B/1D/C; and Neutral Overcurrent Protective Relay 51B/1D/N [41].

The control circuit for the DG1B circuit breaker is identical in design and sensitive to chatter in its equivalent devices: 86G/1E3, 87M/1E3, 86B/1E, 46G, 76FX, 64G, 32, K1, 40X, 51B/1E/A, 51B/1E/B, 51B/1E/C, and 51B/1E/N [40, 41, 42].

Diesel Engine Control

Chatter analysis for the diesel engine control was performed on the start and shutdown circuits of each EDG [43, 44]. The SILO devices which may block EDG Emergency Start in response to a LOOP are the Generator Lockout Relay 86G (already covered), and Shutdown Relay SDR. Chatter in any other device in the start control circuit would only have a transient effect, delaying start by, at most, the period of strong shaking.

The devices which could trip and seal-in the Shutdown Relay are the Lube Oil Pressure Low at Idle Relay OPL; Start Failure Relay SFR; Lube Oil Pressure Low Relays OP1, OP2, and OP3; Crankcase Pressure High Relays CC1, CC2, and CC3; and Engine Overspeed Relay EOR. When the engine is not operating the oil pressure is low and the oil pressure switches are closed. To

prevent tripping the Shutdown Relay timers T3A, T3B, and T3C block the oil pressure switches. In this state, chatter in the contacts of these timers could lead to an engine trip. Chatter in the contacts of Cranking Timers T2A and T2B could energize the Start Failure Relay lead to engine shutdown. Similarly, Chatter in the Engine Overspeed Switch EOS could energize the Engine Overspeed Relay and lead to engine shutdown.

The control circuit for the DG1B Engine Control is identical in design and sensitive to chatter in its identically-named devices.

Battery Chargers

Chatter analysis of the battery chargers was performed using the vendor schematic diagrams [45, 46, p. 32] as well as an As-Built Walkdown described in Attachment 9.2 of Reference [18]. Each battery charger has a High Voltage Shutdown (HVSD) circuit which is intended to protect the batteries and DC loads from overvoltage due to charger failure. The high voltage shutdown circuit has a latching output relay K which, upon detection of an output overvoltage, disconnects the auxiliary voltage transformers via the High Voltage Shutdown Relay (HVSDR), shutting the charger down. Chatter in the contacts of the HVSD output relay K or the HVSDR will only have a temporary effect on the charger during the period of strong shaking. The operate coil of HVSD output relay K is controlled by a non-vulnerable solid-state circuit [46, p. 32]. No other vulnerable contact device affects the availability of the battery chargers.

Inverters

Chatter analysis of the inverters was performed using schematic diagrams contained in the vendor manual [47]. Chatter in the contacts of the time delay relay K1 could energize the shunt trip coil of the DC input circuit breaker CB1. The 10 second time delay associated with K1 masks any chatter in the contacts of the relays in the K1's coil circuit.

EDG Ancillary Systems

In order to start and operate the Emergency Diesel Generators require a number of components and systems. For the purpose of identifying electrical contact devices, only systems and components which are electrically controlled are analyzed. Information in the UFSAR [36] 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 active components in this system required to operate are the air start solenoids [36, pp. 8.2-18], which are covered under the EDG engine control analysis in section 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 utilize engine-driven mechanical lubrication oil pumps which do not rely on electrical control.

Fuel Oil

The Diesel Generators utilize engine-driven mechanical 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 transfer pumps [48, 49] concluded they do not include SILO devices. The mechanical pumps do not rely on electrical control.

Cooling Water

The Diesel Generator Jacket Water System is described in the UFSAR [36, pp. 8.2-18], *"The jacket coolant system is designed to dissipate excess heat from the engine and lube oil to the atmosphere through heat exchangers (radiators) which employ a fan driven directly from the engine."* This cooling system is purely mechanical and thus no chatter analysis is necessary.

Ventilation

The Diesel Generator Building Ventilation System is described in Section 9.8.7 of the UFSAR [36, pp. 9.8-21]. Ventilation for each Diesel Generator is provided via an air handling unit which is operated manually from the control room. The UFSAR discusses the loss of ventilation to the Diesel Generator Building and states manual actions are required within one hour. This time frame is deemed adequate to reset any SILO device which may inhibit the ventilation system, and thus chatter analysis of this system 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 Air Handlers) was traced to identify any SILO devices which could lead to a circuit breaker trip and interruption in power [38, 50, 51]. This effort excluded the EDG circuit breakers, which are covered in section 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 circuit breakers in 4160V Busses and 480V Switchgear which are supplying power to loads identified in this section have been selected for evaluation [50, 51]. 480V Control Centers use Molded-Case Circuit Breakers, which are seismically rugged; and DC power distribution is via non-vulnerable disconnect switches [38]. The only circuit breakers affected by contact devices (not already covered) were those that distribute power from the 4160V ESF Busses to the 4160/480V step-down transformers. A chatter analysis of the control circuits for these circuit breakers [52, 53] indicates the transformer primary phase overcurrent relays 50-51/A, 50-51/B, and 50-51/C; and the Ground Overcurrent Relay 50/G all could trip the transformer primary circuit breaker following the seismic event. The 480V Switchgear breakers do not use separate protective relaying and control of these breakers is via rugged devices [54, 55, 56, 57, 58, 59, 60]

2.6 SUMMARY OF SELECTED COMPONENTS

The investigation of high-frequency contact devices as described above was performed in Ref. [18]. A list of the contact devices requiring a high frequency confirmation is provided in Appendix B, Table B-1. The identified devices are evaluated in Ref. [17] per the methodology/description of Section 3 and 4. Results are presented in Section 5 and Table B-1.

3 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 TMI-1 horizontal ground motion response spectrum (GMRS), which was generated as part of the TMI-1 Seismic Hazard and Screening Report [4] submitted to the NRC on March 31, 2014, and accepted by the NRC on January 22, 2016 [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 Ref. [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 applicable buildings at TMI-1 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. [4], Table 2.3.2-1 and reproduced below in Table 3-1.

Table 3-1: Soil Mean Shear Wave Velocity Vs. Depth Profile

Layer	Depth (ft)	Depth (m)	Thickness, d_i (ft)	Vs_i (ft/sec)	d_i / Vs_i	$\Sigma [d_i / Vs_i]$	Vs30 (ft/s)
1	3.048	10	10	5,002	2.00E-03	2.00E-03	4,944
2	6.096	20	10	5,007	2.00E-03	4.00E-03	
3	9.144	30	10	5,012	2.00E-03	5.99E-03	
4	12.192	40	10	5,017	1.99E-03	7.98E-03	
5	15.24	50	10	5,022	1.99E-03	9.98E-03	
6	18.288	60	10	5,027	1.99E-03	1.20E-02	
7	21.336	70	10	5,032	1.99E-03	1.40E-02	
8	24.384	80	10	5,037	1.99E-03	1.59E-02	
9	27.432	90	10	5,042	1.98E-03	1.79E-02	
10	30.48	100	10	5,047	1.98E-03	1.99E-02	

Using the shear wave velocity vs. depth profile, the velocity of a shear wave traveling from a depth of 30m (98.43ft) 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)/$\Sigma[d_i/Vs_i]$.
- Note: The shear wave velocity is calculated based on time it takes for the shear wave to travel 30.4m (99.8ft) instead of 30m (98.43ft). This small change in travel distance will have no impact on identifying soil class type.

The site's soil class is determined by using the site's shear wave velocity (Vs30) and the peak ground acceleration (PGA) of the GMRS and comparing them to the values within Reference [8], Table 3-1. Based on the PGA of 0.227g and the shear wave velocity of 4944ft/s, the site soil class is B-Hard.

Once a site soil class is determined, the mean vertical vs. horizontal GMRS ratios (V/H) at each frequency are determined by using the site soil class and its associated V/H values in Reference [8], Table 3-2.

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. It is noted that Reference [8], Table 3-2 values are constant between 0.1Hz and 15Hz.

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 TMI-1.

Table 3-2: Horizontal and Vertical Ground Motions Response Spectra

Frequency (Hz)	HGMRS (g)	V/H Ratio	VGMRS (g)
100	0.227	0.8	0.182
90	0.228	0.82	0.187
80	0.230	0.87	0.200
70	0.234	0.91	0.213
60	0.246	0.92	0.226
50	0.279	0.9	0.251
45	0.302	0.89	0.268
40	0.324	0.86	0.279
35	0.348	0.81	0.282
30	0.378	0.75	0.284
25	0.404	0.7	0.283
20	0.430	0.68	0.292
15	0.457	0.68	0.311
12.5	0.465	0.68	0.316
10	0.463	0.68	0.315
9	0.449	0.68	0.305
8	0.430	0.68	0.292
7	0.405	0.68	0.275
6	0.373	0.68	0.254
5	0.335	0.68	0.228
4	0.276	0.68	0.188
3.5	0.242	0.68	0.165
3	0.202	0.68	0.137
2.5	0.165	0.68	0.112
2	0.145	0.68	0.099
1.5	0.116	0.68	0.079
1.25	0.097	0.68	0.066
1	0.079	0.68	0.054
0.9	0.074	0.68	0.050
0.8	0.066	0.68	0.045
0.7	0.058	0.68	0.040
0.6	0.049	0.68	0.033
0.5	0.040	0.68	0.027
0.4	0.032	0.68	0.022
0.35	0.028	0.68	0.019
0.3	0.024	0.68	0.016
0.25	0.020	0.68	0.014
0.2	0.016	0.68	0.011
0.15	0.012	0.68	0.008
0.125	0.010	0.68	0.007
0.1	0.008	0.68	0.005

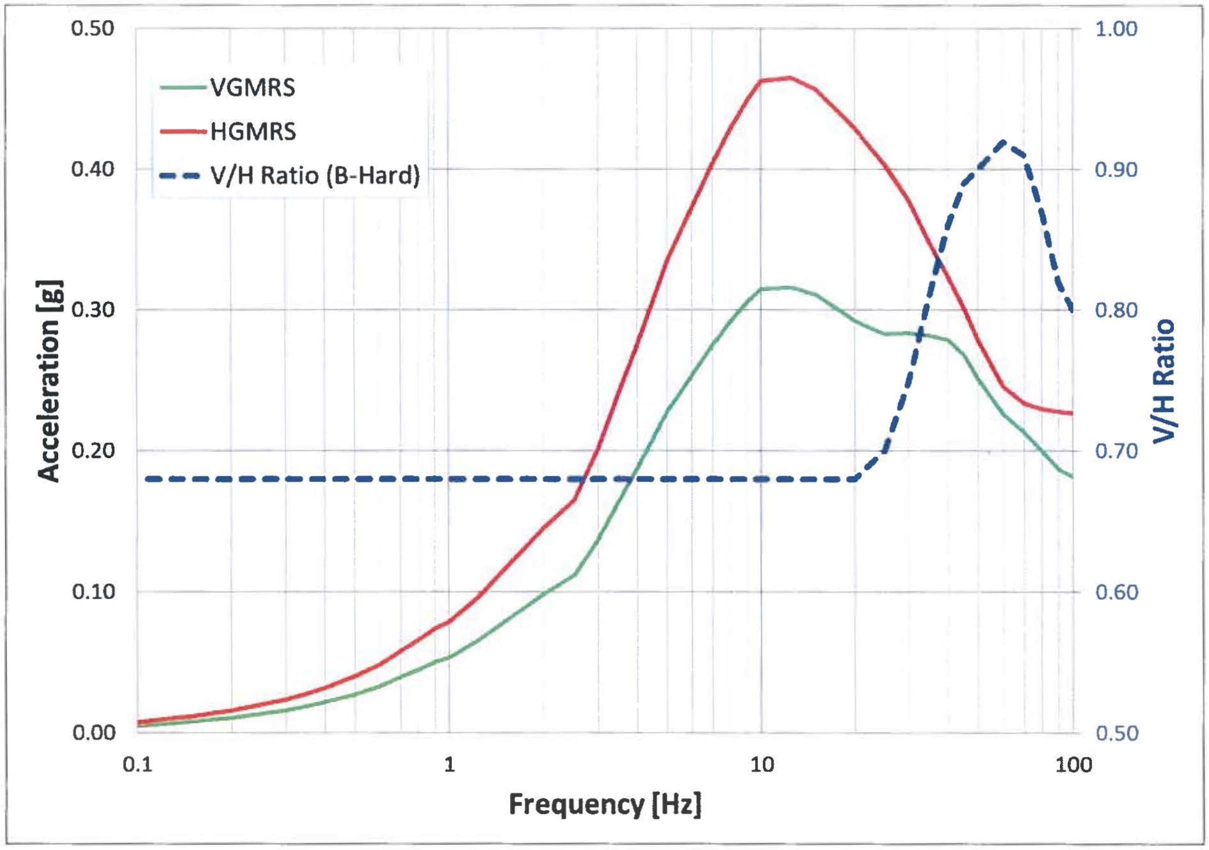

Figure 3-1 Plot of the Horizontal and Vertical Ground Motions Response Spectra and V/H Ratios

3.3 Component Horizontal Seismic Demand

Per Reference [8] the peak horizontal acceleration is amplified using the following two factors to determine the horizontal in-cabinet response spectrum:

- Horizontal in-structure amplification factor AF_{SH} to account for seismic amplification at floor elevations above the host building's foundation
- Horizontal in-cabinet amplification factor AF_c to account for seismic amplification within the host equipment (cabinet, switchgear, motor control center, etc.)

The in-structure amplification factor AF_{SH} is derived from Figure 4-3 in Reference [8]. The in-cabinet horizontal 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 [13] assuming 5% in-cabinet response spectrum damping. EPRI NP-7148 [13] 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:

- TMI-1 Motor Control Centers 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.
- TMI-1 Switchgear cabinets 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 1.5 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.
- TMI-1 Control cabinets are in a lineup of several interconnected sections with moderate width. Each section consists of structures with height-to-depth ratios of about 3 which results in moderate frame stresses and damping. The response levels are mid-range between MCCs and switchgear and therefore these cabinets 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 VGMRS between 15 Hz and 40 Hz and amplifying it using the following two factors:

- Vertical in-structure amplification factor AF_{SV} to account for seismic amplification at floor elevations above the host building's foundation
- Vertical in-cabinet amplification factor AF_c to account for seismic amplification within the host equipment (cabinet, switchgear, motor control center, etc.)

The in-structure amplification factor AF_{SV} is derived from Figure 4-4 in Reference [8]. The in-cabinet vertical amplification factor, AF_c is derived in Reference [8] and is 4.7 for all cabinet types.

4 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 [7], then the component seismic capacity from this program is used.

(2) If a contact device was not tested as part of [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 Seismic Qualification Reporting and Testing Standardization (SQURTS) testing program).

(b) Generic Equipment Ruggedness Spectra (GERS) capacities per [9], [10], [11], and [12].

(c) Assembly (e.g. electrical cabinet) tests where the component functional performance was monitored.

(3) The existing station procedure is used for contact devices where operator action can resolve any inadvertent actuation of the essential components.

The high-frequency capacity of each device was evaluated in Ref. [17] with the component mounting point demand from Section 3 using the criteria in Section 4.5 of Reference [8].

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

5 Conclusions

5.1 General Conclusions

TMI-1 has performed a High Frequency Confirmation evaluation in response to the NRC's 50.54(f) letter [1] using the methods in EPRI report 3002004396 [8].

The evaluation identified a total of 82 components that required seismic high frequency evaluation. As summarized in Table B-1 in Appendix B, 64 of the devices have adequate seismic capacity. The remaining 18 devices are adequate despite their seismic capacities' being unknown or less than seismic demand because any chatter in these 18 devices can be resolved by TMI-1 operator actions.

5.2 Identification of Follow-up Actions

No follow-up actions were identified.

6 References

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16 NEI 12-06, Rev. 2. "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide"

17 15C4343-CAL-001, Rev. 1, "High Frequency Functional Confirmation and Fragility Evaluation of Relays."

18 15C4343-RPT-001, Rev. 1, "Selection of Relays and Switches for High Frequency Seismic Evaluation."

19 Three Mile Island Nuclear Station, Unit 1, "Expedited Seismic Evaluation Process (ESEP) Report" December 17, 2014, ADAMS Accession Number ML14353A194

20 Not Used

21 TMI Drawing 209-780 Rev. 8, *Electric Elementary Diagram Reactor Coolant Vent System Channel B*

22 TMI Drawing 208-452 Rev. 9, *Electrical Elementary Diagram 480V Control Center 1C-ESV Unit 3A RC to DH Remote Block Valve DH-V-1*

23 TMI Drawing 209-503 Rev. 4, *Electrical Elementary Wiring Diagram Engineered Safeguard Actuation A Low Pressure Injection Actuation*

24 TMI Drawing 208-413 Rev. 3, *Electrical Elementary Diagram Selector Switch Developments*

25 TMI Drawing 302-640 Rev. 84, *Decay Heat Removal Flow Diagram*

26 TMI Drawing 208-453 Rev. 10, *Electrical Elementary Diagram 480V Control Center 1C-ESV - Unit 3B RC to DH Remote Block Valve DH-V-2*

27 TMI Drawing 209-603 Rev. 4, *Electrical Elementary Wiring Diagram Engineered Safeguard Actuation B Low Pressure Injection Actuation*

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33 TMI Drawing 209-034 Rev. 4, *Electrical Elementary Diagram DC and Miscellaneous Pressurizer Electromatic Relief Valve RC-RV2*

34 TMI Drawing 209-069 Rev. 10, *Electrical Elementary Diagram DC and Miscellaneous RC Pressurizer Switch RC3-PS8*

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40 TMI Drawing 208-218 Rev. 6, *Electrical Elementary Diagram 4160V Switchgear ES Diesel Generator 1A and 1B Differential Relay Connections*

41 TMI Drawing 208-172 Rev. 7, *Electrical Elementary Diagram 4160V Switchgear ES Bus Back-Up*

42 TMI Drawing 208-164 Rev. 28, *Electrical Elementary Diagram 4160V Switchgear (1E3) G11-02 Diesel Generator 1B Breaker*

43 TMI Drawing 11865841 Sheet 1A Rev. 29, *Electrical Schematic Diesel Engine Control*

44 TMI Drawing 11865841 Sheet 1B Rev. 8, *Electrical Schematic Diesel Engine Control*

45 C&D Batteries Drawing NBC-404ME Rev. 4, *Schematic Diagram Three Phase Model Arrangement*

46 TMI Vendor Manual VM-TM-0160 Rev. 13, "C&D Batteries Autoreg Battery Charger"

47 TMI Vendor Manual VM-TM-2999 Rev. 5, "Ametek Solidstate Controls 15KVA Inverter and Weschler Bargraph Tricolor Digital Meter"

48 TMI Drawing 11865841 Sheet 3A Rev. 30, *Electrical Schematic AC Auxiliary and Generator*

49 TMI Drawing 11865841 Sheet 3B Rev. 19, *Electrical Schematic AC Auxiliary and Generator*

50 TMI Drawing 206-022 Rev. 21, *Electrical One Line and Relay Diagram 4160V Engineered Safeguards Switchgear*

51 TMI Drawing 206-032 Rev. 18, *One-Line and Relay Diagram, Engineered Safeguards Screen House, Reactor Building, Heating and Ventilation 480V Switchgear*

52 TMI Drawing 208-159 Rev. 4, *Electrical Elementary Diagrams 4160V Switchgear ES (1D5) P1-02 Transformer*

53 TMI Drawing 208-161 Rev. 5, *Electrical Elementary Diagram 4160V Switchgear ES (1E6) S1-02 Transformer.*

54 TMI Drawing 208-287 Rev. 3, *Electrical Elementary Diagram 480V Switchgear ES (1P-1B) 1P-02 ES Bus Feeder Breaker*

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56 TMI Drawing 208-263 Rev. 1, *Electrical Elementary Diagram 480V Switchgear ES (1P-1B) Typical Incoming Supply Breaker (E.S.)*

57 TMI Drawing 208-255 Rev. 6, *Electrical Elementary Diagram 480V Switchgear Control Switch Developments*

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59 TMI Drawing 208-291 Rev. 5, *Electrical Elementary Diagram 480V Switchgear ES (1S-1B) 1S-02 ES Bus Feeder Breaker*

60 TMI Drawing 208-296 Rev. 5, *Electrical Elementary Diagram 480V Switchgear ES (1S-1C) 1B ES Control Center Feeder Breaker*

A Representative Sample Component Evaluations

The following sample calculation is extracted from Reference [17].

Notes:

1. Reference citations within the sample calculation are per the Ref. [17] reference section shown on the following page.
2. This sample calculation contains evaluations of sample high-frequency-sensitive components per the methodologies of both the EPRI high-frequency guidance [8] and the flexible coping strategies guidance document NEI 12-06 [16].

6 REFERENCES

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   - 1.2. EPRI 3002002997. "High Frequency Program: High Frequency Testing Summary." September 2014.
   - 1.3. EPRI NP-6041-SL. "A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)." August 1991.
   - 1.4. NEI 12-06, Appendix H, Rev. 2, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide."
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3. Station Documents
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   - 3.2. RC-5536, "Seismic Qualification Report 87M 3ϕ Differential Relay.", March 23, 1977.
   - 3.3. Not Used
   - 3.4. C-1101-900-5320-025, Rev. 1, "SQUG/USI A-46 Seismic Evaluation of Relays for TMI Unit 1."
   - 3.5. TDR 1185, "Relay Report for Three Mile Island.", February 28, 1996.
   - 3.6. Drawing 208-163, Rev. 24, "4160V SWGR – ES (1D2) Electrical Elementary Diagram G1-02 Diesel Generator 1A Breaker."
   - 3.7. Drawing 208-164, Rev. 28, "Electrical 4160V Switchgear (1E3) G11-02 Diesel Generator Breaker."
   - 3.8. Drawing 11865841, Sheet 1A, Rev. 29, "Electrical Schematic Diesel Engine Control."
   - 3.9. Drawing 11865841, Sheet 1B, Rev. 8, "Electrical Schematic Diesel Engine Control."
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   - 3.11. Seismic Qualification No. SQ-T1-EG-Y-0001A, Rev. 2, "EG-Y-0001A."
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5.2. Trentec, Inc. Report No. 2T238.1, Rev. 0, "Seismic Qualification Report for ABB Relays." (See Attachment E for select pages)
5.3. QualTech NP Report No. S1214.0, Rev. 1, "Seismic Test Report for a QualTech NP Differential Pressure Alarm System, Omron Relays, Joslyn Clark Relay, and Ashcroft Vacuum and Pressure Gauges." (See Attachment F for select pages)

8 ANALYSIS

A detailed example analysis of two relays is provided within this section. This example is intended to illustrate each step of the high frequency analysis methodology given in Section 2. A complete analysis of all subject relays is shown in tabular form in Attachment A.

8.1 Equipment Scope

The list of essential relays at Three Mile Island are per Ref. 4.1 and can be found in Attachment A, Table A-1 of this calculation.

8 ANALYSIS (cont'd)

8.2 High-Frequency Seismic Demand

Calculate the high-frequency seismic demand on the relays per the methodology from Ref. 1.1.

A sample calculation for the high-frequency seismic demand of relay components and MU-V-003\20X and MU-V-026\20X is presented below. A table that calculates the high-frequency seismic demand for all of the subject relays listed in Attachment A, Table A-1 of this calculation is provided in Attachment A, Table A-2 of this calculation.

8.2.1 Horizontal Seismic Demand

The horizontal site-specific GMRS for Three Mile Island is per Ref. 2.1. GMRS data can be found in Attachment B of this calculation.

Determine the peak acceleration of the horizontal GMRS between 15 Hz and 40 Hz.

Peak acceleration of horizontal GMRS between 15 Hz and 40 Hz (Ref. 2.1; see Attachment B of this calculation): $SA_{GMRS} := 0.457g$ (at 15 Hz)

Calculate the horizontal in-structure amplification factor based on the distance between the subject foundation elevation and the subject floor elevation.

Foundation Elevation (Control Building): (Ref. 3.2) $El_{found} := 278ft$

Relay floor elevation (Ref. 4.2): $EL_{relay} := 338.5ft$

Relay components MU-V-003\20X and MU-V-026\20X are both located in the Control Building at elevation 338'-6" per Ref. 4.2.

Distance between relay floor and foundation: $h_{relay} := EL_{relay} - El_{found} = 60.50 \cdot ft$

8 ANALYSIS (cont'd)

8.2 High-Frequency Seismic Demand (cont'd)

8.2.1 Horizontal Seismic Demand (cont'd)

Work the distance between the relay floor and foundation with Ref. 1.1, Fig. 4-3 to calculate the horizontal in-structure amplification factor.

Slope of amplification factor line, $0ft < h_{relay} < 40ft$ $\quad m_h := \frac{2.1 - 1.2}{40ft - 0ft} = 0.0225 \cdot \frac{1}{ft}$

Intercept of amplification factor line, $0ft < h_{relay} < 40ft$ $\quad b_h := 1.2$

Horizontal in-structure amplification factor:

$$AF_{SH}(h_{relay}) := \begin{vmatrix} (m_h \cdot h_{relay} + b_h) & \text{if } h_{relay} \le 40ft \\ 2.1 & \text{otherwise} \end{vmatrix}$$

$$AF_{SH}(h_{relay}) = 2.10$$

Calculate the horizontal in-cabinet amplification factor based on the type of cabinet that contains the subject relay.

Type of cabinet (per Ref. 4.1) (enter "MCC", "Switchgear", "Control Cabinet", or "Rigid"): $\quad cab :=$ "Control Cabinet"

Horizontal in-cabinet amplification factor (Ref. 1.1, p. 4-13):

$$AF_{c.h}(cab) := \begin{vmatrix} 3.6 & \text{if } cab = \text{"MCC"} \\ 7.2 & \text{if } cab = \text{"Switchgear"} \\ 4.5 & \text{if } cab = \text{"Control Cabinet"} \\ 1.0 & \text{if } cab = \text{"Rigid"} \end{vmatrix}$$

$$AF_{c.h}(cab) = 4.5$$

Multiply the peak horizontal GMRS acceleration by the horizontal in-structure and in-cabinet amplification factors to determine the in-cabinet response spectrum demand on the relays.

Horizontal in-cabinet response spectrum (Ref. 1.1, p. 4-12, Eq. 4-1a):

$$ICRS_{c.h} := AF_{SH}(h_{relay}) \cdot AF_{c.h}(cab) \cdot SA_{GMRS} = 4.319 \cdot g$$

Note that the horizontal seismic demand is same for both relay components MU-V-003\20X and MU-V-026\20X.

8 ANALYSIS (cont'd)

8.2 High-Frequency Seismic Demand (cont'd)

8.2.2 Vertical Seismic Demand

Determine the peak acceleration of the horizontal GMRS between 15 Hz and 40 Hz.

Peak acceleration of horizontal GMRS between 15 Hz and 40 Hz (see Sect. 8.2.1 of this calculation)

$SA_{GMRS} = 0.457 \cdot g$ (at 15 Hz)

Obtain the peak ground acceleration (PGA) of the horizontal GMRS from Ref. 2.1 (see Attachment B of this calculation).

Peak Ground Acceleration of Horizontal GMRS: (Note that this is the acceleration at zero period)

$PGA_{GMRS} := 0.227g$

Calculate the shear wave velocity traveling from a depth of 30m to the surface of the site (V_{s30}) from Ref. 1.1 and Attachment C.

Shear Wave Velocity:

$$V_{s30} = \frac{(30m)}{\Sigma\left(\frac{d_i}{V_{si}}\right)}$$

where,
d_i: Thickness of the layer (ft)
V_{si}: Shear wave velocity of the layer (ft/s)

Per Attachment C, the sum of thickness of the layer over shear wave velocity of the layer is 0.0199 sec.

Shear Wave Velocity:

$$V_{s30} := \frac{30m}{0.0199sec} = 4946 \cdot \frac{ft}{sec}$$

8 ANALYSIS (cont'd)

8.2 High-Frequency Seismic Demand (cont'd)

8.2.2 Vertical Seismic Demand (cont'd)

Work the PGA and shear wave velocity with Ref. 1.1, Table 3-1 to determine the soil class of the site. Based on the PGA of 0.227g and shear wave velocity of 4946ft/sec at Three Mile Island, the site soil class is B-Hard.

Work the site soil class with Ref. 1.1, Table 3-2 to determine the mean vertical vs. horizontal GMRS ratios (V/H) at each spectral frequency. Multiply the V/H ratio at each frequency between 15Hz and 40Hz by the corresponding horizontal GMRS acceleration at each frequency between 15Hz and 40Hz to calculate the vertical GMRS.

See Attachment B for a table that calculates the vertical GMRS (equal to (V/H) x horizontal GMRS) between 15Hz and 40Hz.

Determine the peak acceleration of the vertical GMRS (SA_{VGMRS}) between frequencies of 15Hz and 40Hz. (By inspection of Attachment B, the SA_{VGMRS} occurs at 15Hz.)

V/H ratio at 15Hz
(See Attachment B of this calculation): $VH := 0.68$

Horizontal GMRS at frequency of peak vertical GMRS (at 15Hz)
(See Attachment B of this calculation): $HGMRS := 0.457g$

Peak acceleration of vertical GMRS between 15 Hz and 40 Hz: $SA_{VGMRS} := VH \cdot HGMRS = 0.311 \cdot g$ (at 15 Hz)

A plot of horizontal and vertical GMRS is provided in Attachment B of this calculation.

8 ANALYSIS (cont'd)

8.2 High-Frequency Seismic Demand (cont'd)

8.2.2 Vertical Seismic Demand (cont'd)

Calculate the vertical in-structure amplification factor based on the distance between the plant foundation elevation and the subject floor elevation.

Distance between relay floor and foundation (see Sect. 8.2.1 of this calculation): $h_{relay} = 60.50 \cdot ft$

Work the distance between the relay floor and foundation with Ref. 1.1, Fig. 4-4 to calculate the vertical in-structure amplification factor.

Slope of amplification factor line: $m_V := \frac{2.7 - 1.0}{100ft - 0ft} = 0.017 \cdot \frac{1}{ft}$

Intercept of amplification factor line: $b_V := 1.0$

Vertical in-structure amplification factor:

$$AF_{SV}(h_{relay}) := \begin{cases} (m_V \cdot h_{relay} + b_V) & \text{if } h_{relay} \leq 100ft \\ 2.7 & \text{otherwise} \end{cases}$$

$$AF_{SV}(h_{relay}) = 2.03$$

Per Ref. 1.1, the vertical in-cabinet amplification factor is 4.7 regardless of cabinet type.

Vertical in-cabinet amplification factor: $AF_{c.v} := 4.7$

Multiply the peak vertical GMRS acceleration between by the vertical in-structure and in-cabinet amplification factors to determine the in-cabinet response spectrum demand on the relay.

Vertical in-cabinet response spectrum (Ref. 1.1, p. 4-12, Eq. 4-1b):

$$ICRS_{c.v} := AF_{SV}(h_{relay}) \cdot AF_{c.v} \cdot SA_{VGMRS} = 2.96 \cdot g$$

Note that the vertical seismic demand is same for both relay components MU-V-003\20X and MU-V-026\20X.

8 ANALYSIS (cont'd)

8.3 High-Frequency Seismic Capacity

A sample calculation for the high-frequency seismic capacity of MU-V-003\20X and MU-V-026\20X relay components are presented here. A table that calculates the high-frequency seismic capacities for all of the subject relays listed in Section 1, Table 1-1 of this calculation is provided in Attachment A of this calculation.

8.3.1 Seismic Test Capacity

The high frequency seismic capacity of a relay can be determined from the EPRI High Frequency Testing Program (Ref. 1.2) or other broad banded low frequency capacity data such as the Generic Equipment Ruggedness Spectra (GERS) or other qualification reports.

The relay model for component MU-V-003\20X, a Telemecanique J13PA20 relay per Table A-1, was not tested as part of the Ref. 1.2 high-frequency testing program. GERS spectral accelerations from Ref. 1.5 is used as the seismic test capacity. The seismic test capacity for J13PA20 relay mode is 14.2g per Ref. 5.1, Table 3-1.

The relay model for component MU-V-026\20X is a Joslyn Clark Control 4U4-2 relay per Table A-1, was not tested as part of the Ref. 1.2 high-frequency testing program. Seismic capacity is derived from the 4U4-2 relay model test response spectra (TRS) within SQURT Test Report 50090.8 (Ref. 5.1). Per Ref. 5.1, pg. 25, the 4U4-2 relay is qualified without chatter in the de-energized state to the fragility level of test #14. Pg. 336 to 341 of Ref. 5.1, provides TRS for test #14.

Per Ref. 1.1, Section 4.5.2, a conservative estimate of the high-frequency (i.e., 20Hz to 40Hz) capacity can be made by extending the low frequency qualification report capacity into the high frequency range to a roll off frequency of about 40Hz. Page 339 of Ref. 5.1 provides a peak low frequency capacity of 5.59g at 7.9Hz, which is extended out to 40Hz to serve as the high frequency capacity.

Seismic test capacity (SA*):

$$SA' := \begin{pmatrix} 14.20 \\ 5.59 \end{pmatrix} g \qquad \begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$$

8.3.2 Effective Spectral Test Capacity

GERS spectral acceleration and qualification test report for the relay components MU-V-003\20X and MU-V-026\20X are used as the seismic test capacity, respectively. Therefore, there are no spectral acceleration increase and the effective spectral test capacity is equal to the seismic test capacity.

Effective spectral test capacity (Ref. 1.1, p. 4-16):

$$SA_T := \begin{pmatrix} SA'_1 \\ SA'_2 \end{pmatrix} = \begin{pmatrix} 14.20 \\ 5.59 \end{pmatrix} \cdot g \qquad \begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$$

8 ANALYSIS (cont'd)

8.3 High-Frequency Seismic Capacity (cont'd)

8.3.3 Seismic Capacity Knockdown Factor

Determine the seismic capacity knockdown factor for the subject relay based on the type of testing used to determine the seismic capacity of the relay.

Using table Table 4-2 of Ref. 1.1 and the capacity sources from Section 8.3.1 above, the knockdown factors are chosen as:

Seismic capacity knockdown factor: $F_k := \begin{pmatrix} 1.50 \\ 1.20 \end{pmatrix}$ $\begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$

8.3.4 Seismic Testing Single-Axis Correction Factor

Determine the seismic testing single-axis correction factor of the subject relay, which is based on whether the equipment housing to which the relay is mounted has well-separated horizontal and vertical motion or not.

Per Ref. 1.1, pp. 4-17 to 4-18, relays mounted within cabinets that are braced, bolted together in a row, mounted to both floor and wall, etc. will have a correction factor of 1.00. Relays mounted within cabinets that are bolted only to the floor or otherwise not well-braced will have a correction factor of 1.2.

Per Ref. 1.1, pp. 4-18, conservatively take the F_{MS} value as 1.0.

Single-axis correction factor (Ref. 1.1, pp. 4-17 to 4-18): $F_{MS} := 1.0$

8 ANALYSIS (cont'd)

8.3 High-Frequency Seismic Capacity for Ref. 1.1 Relays (cont'd)

8.3.5 Effective Wide-Band Component Capacity Acceleration

Calculate the effective wide-band component capacity acceleration per Ref. 1.1, Eq. 4-5.

Effective wide-band component capacity acceleration (Ref. 1.1, Eq. 4-5)

$$TRS := \left(\frac{SA_T}{F_k}\right) \cdot F_{MS} = \begin{pmatrix} 9.467 \\ 4.658 \end{pmatrix} \cdot g \qquad \begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$$

8.4 High-Frequency Seismic Capacity for Ref. 1.4, Appendix H Relays

8.4.1 Effective Wide-Band Component Capacity Acceleration

Per a review of the capacity generation methodologies of Ref. 1.1 and Ref. 1.4, App. H, Section H.5, the capacity of a Ref. 1.4 relay is equal to the Ref. 1.1 effective wide-band component capacity multiplied by a factor accounting for the difference between a 1% probability of failure ($C_{1\%}$, Ref. 1.1) and a 10% probability of failure ($C_{10\%}$, Ref. 1.4).

Per Ref. 1.4, App. H, Table H.1, use the $C_{10\%}$ vs. $C_{1\%}$ ratio from the Realistic Lower Bound Case for relays.

$C_{10\%}$ vs. $C_{1\%}$ ratio

$$C_{10} := 1.36$$

Effective wide-band component capacity acceleration (Ref. 1.4, App. H, Sect. H.5)

$$TRS_{1.4} := TRS \cdot C_{10} = \begin{pmatrix} 12.875 \\ 6.335 \end{pmatrix} \cdot g \qquad \begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$$

8 ANALYSIS (cont'd)

8.5 Relay (Ref. 1.1) High-Frequency Margin

Calculate the high-frequency seismic margin for relays per Ref. 1.1, Eq. 4-6.

A sample calculation for the high-frequency seismic demand of relay components MU-V-003\20X and MU-V-026\20X is presented here. A table that calculates the high-frequency seismic margin for all of the subject relays listed in Section 1, Table 1-1 of this calculation is provided in Attachment A of this calculation.

Horizontal seismic margin (Ref. 1.1, Eq. 4-6): $\frac{TRS}{ICRS_{c.h}} = \begin{pmatrix} 2.192 \\ 1.079 \end{pmatrix}$ **> 1.0, O.K.** **> 1.0, O.K.** $\begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026.`.20X} \end{pmatrix}$

Vertical seismic margin (Ref. 1.1, Eq. 4-6): $\frac{TRS}{ICRS_{c.v}} = \begin{pmatrix} 3.195 \\ 1.572 \end{pmatrix}$ **> 1.0, O.K.** **> 1.0, O.K.** $\begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026.`.20X} \end{pmatrix}$

Both the horizontal and vertical seismic margins for MU-V-003\20X and MU-V-026\20X are greater than 1.00; therefore, these components are adequate for high frequency seismic spectral ground motion for their Ref. 1.1 functions.

8.6 Relay (Ref. 1.4) High-Frequency Margin

Calculate the high-frequency seismic margin for Ref. 1.4 relays.

A sample calculation for the high-frequency seismic demand of relay components MU-V-003\20X and MU-V-026\20X is presented here. A table that calculates the high-frequency seismic margin for all of the subject relays listed in Section 1, Table 1-1 of this calculation is provided in Attachment A of this calculation.

Horizontal seismic margin (Ref 1.4): $\frac{TRS_{1.4}}{ICRS_{c.h}} = \begin{pmatrix} 2.981 \\ 1.467 \end{pmatrix}$ **> 1.0, O.K.** **> 1.0, O.K.** $\begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$

Vertical seismic margin (Ref 1.4): $\frac{TRS_{1.4}}{ICRS_{c.v}} = \begin{pmatrix} 4.345 \\ 2.138 \end{pmatrix}$ **> 1.0, O.K.** **> 1.0, O.K.** $\begin{pmatrix} \text{MU-V-003\textbackslash 20X} \\ \text{MU-V-026\textbackslash 20X} \end{pmatrix}$

Both the horizontal and vertical seismic margins for MU-V-003\20X and MU-V-026\20X are greater than 1.00; therefore, these components are adequate for high-frequency seismic spectral ground motion for their Ref. 1.4 functions.

B Components Identified for High Frequency Confirmation

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
1	1	MU-TS-1	Process Switch	Core Cooling	Close MU-V-3 if temperature greater than 145° F	Barksdale	MT1H-M154S-12-A	N/A	Control Cabinet	Auxiliary Building	281	EPRI HF Test	Cap > Dem
2	1	MU-V-026\20X	Control Relay	Core Cooling	Hold MU-V-26 solenoid in energized state to keep valve closed	Joslyn Clark Control	4U4-2	XCL	Control Cabinet	Control Building	338.5	SQURTS Report	Cap > Dem
3	1	MS-V-004AB-AR23	Control Relay	Core Cooling	Transfer control of MS-V-4A/B to BU Loaders	Struthers Dunn	219BBXP 33	NNI ICS Cabinet	Control Cabinet	Control Building	338.5	GERS	Cap > Dem
4	1	MU-V-003\20X	Control Relay	Core Cooling	Hold MU-V-3 solenoid in energized state to keep valve closed	Telemecanique	J13PA20	RSTSP-A	Control Cabinet	Control Building	338.5	GERS	Cap > Dem
5	1	DG-1A/T3A	Control Relay	AC/DC Power Support Systems	DG-1A Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
6	1	DG-1A/T3B	Control Relay	AC/DC Power Support Systems	DG-1A Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
7	1	DG-1A/T3C	Control Relay	AC/DC Power Support Systems	DG-1A Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
8	1	DG-1B/T3A	Control Relay	AC/DC Power Support Systems	DG-1B Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
9	1	DG-1B/T3B	Control Relay	AC/DC Power Support Systems	DG-1B Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
10	1	DG-1B/T3C	Control Relay	AC/DC Power Support Systems	DG-1B Alarm Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
11	1	DG-1B/T2A	Control Relay	AC/DC Power Support Systems	DG-1B Cranking Time Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
12	1	DG-1B/T2B	Control Relay	AC/DC Power Support Systems	DG-1B Cranking Time Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
13	1	DG-1A/T2A	Control Relay	AC/DC Power Support Systems	DG-1A Cranking Time Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
14	1	DG-1A/T2B	Control Relay	AC/DC Power Support Systems	DG-1A Cranking Time Delay Relay	Amerace	E7012PD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	EPRI HF Test	Cap > Dem
15	1	86B/1D	Control Relay	AC/DC Power Support Systems	BUS 1D Lockout Relay	GE	12HEA61C	1D1	Switchgear	Control Building	338.5	GERS	Cap > Dem
16	1	86B/1E	Control Relay	AC/DC Power Support Systems	BUS 1E Lockout Relay	GE	12HEA61C	1E1	Switchgear	Control Building	338.5	GERS	Cap > Dem
17	1	86G/1D2	Control Relay	AC/DC Power Support Systems	DG-1A Lockout Relay	GE	12HEA61C	1D2	Switchgear	Control Building	338.5	GERS	Cap > Dem
18	1	86G/1E3	Control Relay	AC/DC Power Support Systems	DG-1B Lockout Relay	GE	12HEA61C	1E3	Switchgear	Control Building	338.5	GERS	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
19	1	87M/1D2	Protective Relay	AC/DC Power Support Systems	DG-1A Differential Relay	Brown Boveri (ABB)	87M	1D2	Switchgear	Control Building	338.5	TMI Report	Cap > Dem
20	1	87M/1E3	Protective Relay	AC/DC Power Support Systems	DG-1B Differential Relay	Brown Boveri (ABB)	87M	1E3	Switchgear	Control Building	338.5	TMI Report	Cap > Dem
21	1	DG-1A/EOS	Process Switch	AC/DC Power Support Systems	DG-1A Overspeed Switch	N/A	N/A	DG 1A Skid Mounted	N/A	Diesel Generator Building	305	GERS	Cap > Dem
22	1	DG-1B/EOS	Process Switch	AC/DC Power Support Systems	DG-1B Overspeed Switch	N/A	N/A	DG 1B Skid Mounted	N/A	Diesel Generator Building	305	GERS	Cap > Dem
23	1	DG-1A/CC1	Control Relay	AC/DC Power Support Systems	DG-1A High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
24	1	DG-1A/CC2	Control Relay	AC/DC Power Support Systems	DG-1A High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
25	1	DG-1A/CC3	Control Relay	AC/DC Power Support Systems	DG-1A High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
26	1	DG-1A/EOR	Control Relay	AC/DC Power Support Systems	DG-1A Overspeed Shutdown Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
27	1	DG-1B/EOR	Control Relay	AC/DC Power Support Systems	DG-1B Overspeed Shutdown Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
28	1	DG-1A/OP1	Control Relay	AC/DC Power Support Systems	DG-1A Lube Oil Pressure Low Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
29	1	DG-1A/OP2	Control Relay	AC/DC Power Support Systems	DG-1A Lube Oil Pressure Low Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
30	1	DG-1A/OP3	Control Relay	AC/DC Power Support Systems	DG-1A Lube Oil Pressure Low Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
31	1	DG-1B/CC1	Control Relay	AC/DC Power Support Systems	DG-1B High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
32	1	DG-1B/CC2	Control Relay	AC/DC Power Support Systems	DG-1B High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
33	1	DG-1B/CC3	Control Relay	AC/DC Power Support Systems	DG-1B High Crankcase Pressure Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
34	1	DG-1B/OP1	Control Relay	AC/DC Power Support Systems	DG-1B Lube Oil Pressure Low Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
35	1	DG-1B/OP2	Control Relay	AC/DC Power Support Systems	DG-1B Lube Oil Pressure Low Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
36	1	DG-1B/OP3	Control Relay	AC/DC Power Support Systems	DG-1B Lube Oil Pressure Low Relay	Westinghouse	BFD	EMRP B (1B DG CNPL)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
37	1	DG-1A/SDR	Control Relay	AC/DC Power Support Systems	DG-1A Shutdown Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
38	1	DG-1B/SDR	Control Relay	AC/DC Power Support Systems	DG-1B Shutdown Relay	Westinghouse	BFD	EMRP B (1B DG CNPL)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
39	1	DG-1B/OPL	Control Relay	AC/DC Power Support Systems	DG-1B Lube Oil Pressure Low at Idle Relay	Westinghouse	BFD	Engine Mounted Relay Panel B	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
40	1	DG-1A/OPL	Control Relay	AC/DC Power Support Systems	DG-1A Lube Oil Pressure Low at Idle Relay	Westinghouse	BFD	Engine Mounted Relay Panel A	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
41	1	50/G	Protective Relay	AC/DC Power Support Systems	1D5 Ground Overcurrent Relay	Westinghouse	CO-8	1E6	Switchgear	Control Building	338.5	GERS	Operator Action
42	1	50-51/ICS/A	Protective Relay	AC/DC Power Support Systems	1D5 A Phase Overcurrent Relay	Westinghouse	CO-8	1D5	Switchgear	Control Building	338.5	GERS	Operator Action
43	1	50-51/ICS/A	Protective Relay	AC/DC Power Support Systems	1E6 A Phase Overcurrent Relay	Westinghouse	CO-8	1E6	Switchgear	Control Building	338.5	GERS	Operator Action
44	1	50-51/ICS/B	Protective Relay	AC/DC Power Support Systems	1D5 B Phase Overcurrent Relay	Westinghouse	CO-8	1D5	Switchgear	Control Building	338.5	GERS	Operator Action
45	1	50-51/ICS/B	Protective Relay	AC/DC Power Support Systems	1E6 B Phase Overcurrent Relay	Westinghouse	CO-8	1E6	Switchgear	Control Building	338.5	GERS	Operator Action
46	1	50-51/ICS/C	Protective Relay	AC/DC Power Support Systems	1D5 C Phase Overcurrent Relay	Westinghouse	CO-8	1D5	Switchgear	Control Building	338.5	GERS	Operator Action
47	1	50-51/ICS/C	Protective Relay	AC/DC Power Support Systems	1E6 C Phase Overcurrent Relay	Westinghouse	CO-8	1E6	Switchgear	Control Building	338.5	GERS	Operator Action
48	1	51B/1D/A	Protective Relay	AC/DC Power Support Systems	BUS 1D A Phase Overcurrent Relay	Westinghouse	CO-8	1D1	Switchgear	Control Building	338.5	GERS	Operator Action
49	1	51B/1D/B	Protective Relay	AC/DC Power Support Systems	BUS 1D B Phase Overcurrent Relay	Westinghouse	CO-8	1D1	Switchgear	Control Building	338.5	GERS	Operator Action

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
50	1	51B/1D/C	Protective Relay	AC/DC Power Support Systems	BUS 1D C Phase Overcurrent Relay	Westinghouse	CO-8	1D1	Switchgear	Control Building	338 5	GERS	Operator Action
51	1	51BN/1D	Protective Relay	AC/DC Power Support Systems	BUS 1D Neutral Overcurrent Relay	Westinghouse	CO-8	1D1	Switchgear	Control Building	338.5	GERS	Operator Action
52	1	51B/1E/A	Protective Relay	AC/DC Power Support Systems	BUS 1E A Phase Overcurrent Relay	Westinghouse	CO-8	1E1	Switchgear	Control Building	338.5	GERS	Operator Action
53	1	51B/1E/B	Protective Relay	AC/DC Power Support Systems	BUS 1E B Phase Overcurrent Relay	Westinghouse	CO-8	1E1	Switchgear	Control Building	338.5	GERS	Operator Action
54	1	51B/1E/C	Protective Relay	AC/DC Power Support Systems	BUS 1E C Phase Overcurrent Relay	Westinghouse	CO-8	1E1	Switchgear	Control Building	338.5	GERS	Operator Action
55	1	51BN/1E	Protective Relay	AC/DC Power Support Systems	BUS 1E Neutral Overcurrent Relay	Westinghouse	CO-8	1E1	Switchgear	Control Building	338.5	GERS	Operator Action
56	1	50/G	Protective Relay	AC/DC Power Support Systems	1D5 Ground Overcurrent Relay	Westinghouse	ITH	1D5	Switchgear	Control Building	338.5	GERS	Operator Action
57	1	DG-1A/46G	Protective Relay	AC/DC Power Support Systems	Negative Phase Sequence (Phase-to-Phase Fault) Relay	Westinghouse	COQ	1D2	Switchgear	Control Building	338.5	SQURTS Report	Cap > Dem
58	1	DG-1B/46G	Protective Relay	AC/DC Power Support Systems	Negative Phase Sequence (Phase-to-Phase Fault) Relay	Westinghouse	COQ	1E3	Switchgear	Control Building	338.5	SQURTS Report	Cap > Dem
59	1	DG-1A/76FX	Protective Relay	AC/DC Power Support Systems	Field Overload Relay	Joslyn Clark	714UPA	ALM/CNPL (1P-DC)	Control Cabinet	Diesel Generator Building	305	SQURTS Report	Cap > Dem
60	1	DG-1B/76FX	Protective Relay	AC/DC Power Support Systems	Field Overload Relay	Joslyn Clark	714UPA	ALM/CNPL (1Q-DC)	Control Cabinet	Diesel Generator Building	305	SQURTS Report	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
61	1	DG-1A/64G	Protective Relay	AC/DC Power Support Systems	Neutral Ground Relay	Westinghouse	CO-6	ALM/CNPL (1P-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
62	1	DG-1B/64G	Protective Relay	AC/DC Power Support Systems	Neutral Ground Relay	Westinghouse	CO-6	ALM/CNPL (1Q-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
63	1	DG-1A/32	Protective Relay	AC/DC Power Support Systems	Reverse Power Relay	Westinghouse	CRN-1	ALM/CNPL (1P-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
64	1	DG-1B/32	Protective Relay	AC/DC Power Support Systems	Reverse Power Relay	Westinghouse	CRN-1	ALM/CNPL (1Q-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
65	1	DG-1A/K1	Protective Relay	AC/DC Power Support Systems	Exciter Shutdown Relay	Westinghouse	MD101	ALM/CNPL (1P-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
66	1	DG-1B/K1	Protective Relay	AC/DC Power Support Systems	Exciter Shutdown Relay	Westinghouse	MD101	ALM/CNPL (1Q-DC)	Control Cabinet	Diesel Generator Building	305	GERS	Cap > Dem
67	1	DG-1A/40X	Protective Relay	AC/DC Power Support Systems	Loss of Excitation Relay	Westinghouse	KLF-1	ALM/CNPL (1P-DC)	Control Cabinet	Diesel Generator Building	305	SQURTS Report	Operator Action
68	1	DG-1B/40X	Protective Relay	AC/DC Power Support Systems	Loss of Excitation Relay	Westinghouse	KLF-1	ALM/CNPL (1Q-DC)	Control Cabinet	Diesel Generator Building	305	SQURTS Report	Operator Action
69	1	G1-02	Medium Voltage Circuit Breaker	AC/DC Power Support Systems	DG-1A Circuit Breaker	Wyle	5-3AH-DPR350-1200-78	1D2	Switchgear	Control Building	338.5	GERS	Cap > Dem
70	1	G11-02	Medium Voltage Circuit Breaker	AC/DC Power Support Systems	DG-1B Circuit Breaker	Wyle	5-3AH-DPR350-1200-78	1E3	Switchgear	Control Building	338.5	GERS	Cap > Dem
71	1	P1-02	Medium Voltage Circuit Breaker	AC/DC Power Support Systems	1P Transformer Circuit Breaker	Westinghouse	50-DH-P350	1D5	Switchgear	Control Building	338.5	GERS	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
72	1	S1-02	Medium Voltage Circuit Breaker	AC/DC Power Support Systems	1S Transformer Circuit Breaker	Westinghouse	50-DH-P350	1E6	Switchgear	Control Building	338.5	GERS	Cap > Dem
73	1	1P-02	Low Voltage Circuit Breaker	AC/DC Power Support Systems	1P Switchgear Feeder Breaker	Westinghouse	DB-50	1P-1B	Switchgear	Control Building	322	GERS	Cap > Dem
74	1	1S-02	Low Voltage Circuit Breaker	AC/DC Power Support Systems	1S Switchgear Feeder Breaker	Westinghouse	DB-50	1S-1B	Switchgear	Control Building	322	GERS	Cap > Dem
75	1	EE-MCC-ES-1A-BK	Low Voltage Circuit Breaker	AC/DC Power Support Systems	1A Control Center Feeder Breaker	Westinghouse	DB-50	1P-1C	Switchgear	Control Building	322	GERS	Cap > Dem
76	1	EE-MCC-ES-1B-BK	Low Voltage Circuit Breaker	AC/DC Power Support Systems	1B Control Center Feeder Breaker	Westinghouse	DB-50	1S-1C	Switchgear	Control Building	322	GERS	Cap > Dem
77	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1A	Inverter	Control Building	322	GERS	Cap > Dem
78	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1C	Inverter	Control Building	322	GERS	Cap > Dem
79	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1E	Inverter	Control Building	322	GERS	Cap > Dem
80	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1B	Inverter	Control Building	322	GERS	Cap > Dem
81	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1D	Inverter	Control Building	322	GERS	Cap > Dem

Table B-1: Components Identified for High Frequency Confirmation

No.	Unit	Component						Enclosure		Building	Floor Elev. (ft)	Component Evaluation	
		ID	Type	System	Function	Manufacturer	Model No.	ID	Type			Basis for Capacity	Evaluation Result
82	1	K1	Protective Relay	AC/DC Power Support Systems	Fault Trip Time Delay Relay	N/A	N/A	EE-INV-1F	Inverter	Control Building	322	GERS	Cap > Dem

Table B-2: Reactor Coolant Leak Path Valve Identified for High Frequency Confirmation

VALVE	P&ID	SHEET	UNIT	NOTE
RC-V-42	302-650	1	1	Reactor Head Vent
RC-V-43	302-650	1	1	Reactor Head Vent
DH-V-1	302-640	1	1	1C-ESV Unit 3A RC to DH Rem Block Valve
DH-V-2	302-640	1	1	1C-ESV Unit 3B RC to DH Rem Block Valve
DH-V-3	302-640	1	1	1C-ESV Unit 4B RC Outlet to DH System
RC-V-40A	302-650	1	1	RC Vent Valve
RC-V-41A	302-650	1	1	RC Vent Valve
RC-V-40B	302-650	1	1	RC Vent Valve
RC-V-41B	302-650	1	1	RC Vent Valve
MU-V-88A	302-661	1	1	MU to RC Pump Seal Loop A Simple Check Valve (no need to be included)
MU-V-88B	302-661	1	1	MU to RC Pump Seal Loop B Simple Check Valve (no need to be included)
MU-V-88C	302-661	1	1	MU to RC Pump Seal Loop C Simple Check Valve (no need to be included)
MU-V-88D	302-661	1	1	MU to RC Pump Seal Loop D Simple Check Valve (no need to be included)
MU-V-86A	302-661	1	1	MU to Cold Leg Loop B Pump D Simple Check Valve (no need to be included)
MU-V-86B	302-661	1	1	MU to Cold Leg Loop B Pump C Simple Check Valve (no need to be included)

Table B-2: Reactor Coolant Leak Path Valve Identified for High Frequency Confirmation

VALVE	P&ID	SHEET	UNIT	NOTE
RC-V-2	302-650	1	1	1C-ESV Unit 5C Pressurizer Relief Block Valve
RC-RV-2	302-650	1	1	Pressurizer Electromatic Relief Valve
RC-V-44	302-650	1	1	RC Vent Valve
RC-V28	302-650	1	1	1B-ES Unit 10C Pressurizer Vent Valve
RC-V-1204	302-651	1	1	Manual Instrument Isolation Globe Valve (no need to be included)
RC-V-1208	302-651	1	1	Manual Instrument Isolation Globe Valve (no need to be included)
CF-V-5A	302-711	1	1	Core Flood Simple Check Valve (no need to be included)
CF-V-5B	302-711	1	1	Core Flood Simple Check Valve (no need to be included)