Entergy Nuclear Northeast
Entergy Nuclear Operations, Inc.
James A. FitzPatrick NPP
P.O. Box 110
Lycoming, NY 13093
Tel 315-342-3840

Lawrence M. Coyle
Site Vice President – JAF

JAFP-14-0039
March 31, 2014

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Entergy Seismic Hazard and Screening Report (CEUS Sites), Response 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

James A. FitzPatrick Nuclear Power Plant
Docket No. 50-333
License No. DPR-059

Reference:

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
2. NEI Letter, Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations, dated April 9, 2013, ML13101A379
3. NRC Letter, Electric Power Research Institute 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, ML13106A331
4. 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, ML12333A170
5. NRC Letter, Endorsement of EPRI Final Draft Report 1025287, "Seismic Evaluation Guidance," dated February 15, 2013, ML12319A074
6. Entergy Letter, Entergy’s Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident, JAFP-13-0056, dated April 29, 2013

Dear Sir or Madam:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to all power reactor licensees and holders of construction permits in active or deferred status. Enclosure 1 of Reference 1 requested each addressee located in the Central and Eastern United States

(CEUS) to submit a Seismic Hazard Evaluation and Screening Report within 1.5 years from the date of Reference 1.

In Reference 2, the Nuclear Energy Institute (NEI) requested NRC agreement to delay submittal of the final CEUS Seismic Hazard Evaluation and Screening Reports so that an update to the Electric Power Research Institute (EPRI) ground motion attenuation model could be completed and used to develop that information. NEI proposed that descriptions of subsurface materials and properties and base case velocity profiles be submitted to the NRC by September 12, 2013, with the remaining seismic hazard and screening information submitted by March 31, 2014. NRC agreed with that proposed path forward in Reference 3.

Reference 4 contains industry guidance and detailed information to be included in the Seismic Hazard Evaluation and Screening Report submittals. NRC endorsed this industry guidance in Reference 5.

The attached Seismic Hazard Evaluation and Screening Report for James A. FitzPatrick Nuclear Power Plant (JAF) provides the information described in Section 4 of Reference 4 in accordance with the schedule identified in Reference 2 and committed to in Reference 6.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact Chris M. Adner, Regulatory Assurance Manager, at 315-349-6766.

I declare under penalty of perjury that the foregoing is true and correct. Executed on 31st day of March, 2014.

Sincerely,

Lawrence M. Coyle
Site Vice President

LMC/CMA/mh

Attachment: JAF Seismic Hazard and Screening Report

cc: NRC Regional Administrator
NRC Resident Inspector
Mr. Douglas Pickett, Senior Project Manager
Ms. Bridget Frymire, NYSPSC
Mr. Francis J. Murray Jr., President NYSERDA

JAFP-14-0039

Enclosure

JAF Seismic Hazard and Screening Report

(55 Pages)

Seismic Hazard and Screening Report for James A. FitzPatrick Nuclear Power Plant

Table of Contents

1.0 Introduction

Following the accident at the Fukushima Daiichi 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 (U.S. NRC, 2012) that requests information to assure that these recommendations are addressed by all U.S. nuclear power plants. The 50.54(f) letter (U.S. NRC, 2012) 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. Depending on the comparison between the reevaluated seismic hazard and the current design basis, the result is either no further risk evaluation or the performance of a seismic risk assessment. Risk assessment approaches acceptable to the staff include a seismic probabilistic risk assessment (SPRA), or a seismic margin assessment (SMA). Based upon the risk assessment results, the NRC staff will determine whether additional regulatory actions are necessary.

This report provides the information requested in items (1) through (7) of the "Requested Information" section and Attachment 1 of the 50.54(f) letter (U.S. NRC, 2012) pertaining to NTTF Recommendation 2.1 for the James A. FitzPatrick (JAF) plant, located in Oswego County, New York. In providing this information, Entergy followed the guidance provided in the *Seismic Evaluation Guidance: Screening, Prioritization, and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI,2013a). The *Augmented Approach, Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic* (EPRI, 2013c), has been developed as the process for evaluating critical plant equipment as an interim action to demonstrate additional plant safety margin prior to performing the complete plant seismic risk evaluations.

The original geologic investigations concluded that JAF is founded upon strong, competent bedrock well suited to the foundation of a nuclear plant. The regional study of seismicity and tectonics indicated that significant earthquake ground motion is not expected at the site during the design life of the plant. The historical records indicated that Seismic Class I structures, systems and components of the plant could be designed for an Operating Basis Earthquake (OBE) of 0.05g and a Design Basis Earthquake (DBE) of 0.10g horizontal ground acceleration. However, to be conservative, the OBE was assumed to be 0.08g and DBE to be 0.15g horizontal ground acceleration.

In response to the 50.54(f) letter (U.S. NRC, 2012) and following the guidance provided in the SPID (EPRI, 2013a), a seismic hazard reevaluation was performed. For screening purposes, a Ground Motion Response Spectrum (GMRS) was developed. Based on the results of the screening evaluation, JAF screens-in for a Spent Fuel Pool evaluation. Additionally, based on the results of the screening evaluation, JAF screens-out of a seismic risk evaluation and a High Frequency Confirmation.

2.0 Seismic Hazard Reevaluation

The James A. FitzPatrick Nuclear Power Plant is located approximately seven miles northeast of Oswego, New York, and is on Lake Ontario. The James A. FitzPatrick Nuclear Power Plant lies within the Erie-Ontario Lowland physiographic province. This province is bounded on the south by the Applachian Uplands, on the east by the Tug Hill Upland and Adirondack Highlands, and on the north by the Canadian Shield. Strata of the Erie-Ontario Lowland are Paleozoic sediments which are essentially undeformed. Regional dip is to the south or southwest at an average slope of less than 2 degrees. No folds or faults of any consequence are known in the general site area. (Entergy, 2013)

The regional study of seismicity and tectonics indicates that significant earthquake ground motion is not expected at the site during the design life of the plant. This historical record indicated that the Seismic Class I structures of the plant could be designed for a Safe Shutdown Earthquake of 0.10g horizontal ground acceleration as all structures are founded on or within competent bedrock. The underlying rock structure is among the most structurally stable in the United States. However, to be conservative, the Safe Shutdown Earthquake is assumed to have a horizontal ground acceleration of 0.15g. (Entergy, 2013)

2.1 Regional and Local Geology

The James A. FitzPatrick Nuclear Power Plant site is generally level with very minor irregularities in surface. The surface material consists of a very shallow thickness of ablation till underlain by a shallow thickness of basal till. The tills consist of mixtures of silts, sands, gravels, cobbles and some clay material. Total thickness of the till layer varies from about 0 to as much as 10 or 12 ft. The area is poorly drained because of its very low relief and there are a number of small swampy areas in the shallow depressions left in the till surface. The till layer lies directly on top of the Oswego sandstone. This is a hard, thin to medium bedded fine grained sandstone with laminations and lenticular beds of dark grey shale. The shale content increases with depth, and at approximately 130 ft below surface, the Oswego sandstones grade into the underlying Lorraine group, which is predominantly shale with some sandstone members. The sandstones are a hard, competent material, well suited to the foundations of the plant. The Oswego sandstone is moderately jointed, the joints being the most common in the upper 5 to 10 ft. Below that depth, the joints are much more widely spaced and are tight. Master joint sets strike north 70 to 80 degrees east, with a secondary set striking north 40 to 50 degrees east. Joints basically are moderately to widely spaced. The shale members are well cemented, durable shales which show no slaking when exposed to the weather over a period of several years. They also are sound, competent foundation materials for the plant. (Entergy, 2013)

All structures of the plant are founded directly upon the sandstone bedrock. (Entergy, 2013)

The sandstone in this area is almost flat lying, showing a general regional dip to the south to southwest of about 1.5 degrees. It shows no evidence of disturbance or orogenic activity. It is of mid-Paleozoic Age. Regionally, the area is known to be very quiet seismically. The nearest fault known prior to the start of the work on this project was approximately 40 miles southeast near Syracuse where it was exposed in a quarry. This is a minor, local fault striking north 75 degrees west. The nearest significant fault is the Clarendon-Linden Fault, which is located 90 miles west and which has a north-south trend tangent to the site. Displacement on this fault is approximately 100 ft. (Entergy, 2013)

During the course of the excavation of the plant, two minor geologic features were disclosed. The first is a compression buckle or teepee fold which was found crossing the axis of the turbine-generator. This fold has a strike of north 78 degrees west. The axis of the fold dips to the north at about 70 degrees. A detailed investigation was made of it and it was found that the feature was not a fault and not affected by seismic activity and therefore has no effect on project safety, on seismic design requirements or on structural design. (Entergy, 2013)

The second geologic feature which was disclosed was a minor normal (tension) fault which was found crossing the intake and discharge tunnels at a point approximately 1,000 ft north of the center line of the reactor. This minor fault strikes north 78 degrees west and dips approximately 60 to 64 degrees to the south. It is a very small fault. Total displacement is approximately 17 in. ± 1 in. The gouge zone associated with it varies from approximately 0.5 in. in sandstone members to possibly 3 or 4 in. in shale members. In addition, there is some subsidiary jointing of the rock adjacent to it which extends through a width of a foot or two on either side. The fault was projected up to the surface and then along a strike to the southeast to intercept the shoreline approximately at the barge slip some 1,500 ft east of the plant. A detailed examination was made where it crosses the barge slip and in a test trench at a point approximately 300 ft further east. At both locations, the fault could not be definitely established. There is no evidence of offsetting of any of the beds. There were, however, at the theoretical location of the fault, or very close to it, several minor joints which trended in a north 75 to 78 degrees west direction. It is noted that this joint direction is anomalous to the normal jointing of the area. This indicates that in the short distance of approximately 1,500 ft, the fault motion has died out and resolved itself simply into a set of joints. The joints show no displacement where the bedding is exposed in the cut for the barge slip. A detailed examination of the fault was made of material obtained from the shale adjoining the fault and of the fault gouge itself. These showed essentially identical clay materials present consisting primarily of chlorites and illites, and some alpha quartz. The absence of montmorillonite or halloysite strongly indicates there has been no hydrothermal alteration as would be expected if the fault were associated with deep seated tectonic activity. There is some secondary calcite deposited in joints immediately along the fault, and probably associated with it, which indicates the fault is relatively old. (Entergy, 2013)

It is concluded that the fault is a minor local feature that has most probably developed from differential loading by overlying material at some time in the geologic history of the area, and that it is not associated with orogenic movements nor regional tectonics. The conditions which created the fault no longer exist and, therefore, renewed motion on this small fault is not a

matter of concern. It does not affect the safety or design of the plant. Corrective measures were taken by drainage and guniting of the surface of the fault zone in each tunnel after cleaning it out a shallow distance, in accordance with good engineering practice. (Entergy, 2013)
Some bedrocks which were concealed before, were subsequently exposed along the shoreline, east of the barge slip, and a small normal fault was encountered in these shoreline out crops in 1977. The fault was striking about north 73 degrees west and dipping 68 degrees southwest and occurred about 70 ft north of the surface projection of the tunnel fault described above. Because of the close proximity to the projected trace of the tunnel fault and of similarity in strike, dip and the amount of apparent offset (15 in ±) it was believed that the barge slip structure might be a continuation of the tunnel fault. (Entergy, 2013)

A detailed investigation was performed by excavating and mapping two trenches, excavating two rock pits perpendicular to fault traces in the bottom of the trenches and mapping the shoreline exposure near the barge slip. The investigation revealed that (Entergy, 2013):

1. Individual faults within the zone are quite short and not related to regional tectonics. No buckling or reverse shear was noted in the trenching investigation or in the outcrop at the barge slip.
2. The last movement along the normal faults occurred before the last advance of the Wisconsin ice sheet or before about 22,000 B.P.
3. Fluid inclusion analysis reveals that the normal faulting is Early to Middle Paleozoic in age and is due to minor adjustments within the sedimentary basin.
4. The faults are minor geologic features - old and inactive and may not be called capable fault as defined by Appendix A (10 CFR 100).
5. These faults do not constitute any geologic, seismic or engineering safety hazard to the plant.

In summary, the plant is founded upon strong, competent bedrock of mid-Paleozoic Age, the Oswego formation. The rock is well suited to the foundations of a nuclear power plant. The minor geologic features which were found during construction and also after construction have no effect on the design or safety of the plant. (Entergy, 2013)

2.2 Probabilistic Seismic Hazard Analysis

2.2.1 Probabilistic Seismic Hazard Analysis Results

In accordance with the 50.54(f) letter (U.S. NRC, 2012) and following the guidance in the SPID (EPRI, 2013a), a probabilistic seismic hazard analysis (PSHA) was completed using the recently developed Central and Eastern United States Seismic Source Characterization (CEUS-SSC) for Nuclear Facilities (CEUS-SSC, 2012) together with the updated Electric Power Research Institute (EPRI) Ground-Motion Model (GMM) for the Central and Eastern United States (CEUS) (EPRI, 2013b). For the PSHA, a lower-bound moment magnitude of 5.0 was used, as specified in the 50.54(f) letter (U.S. NRC, 2012). (EPRI, 2014)

For the PSHA, the CEUS-SSC background seismic sources out to a distance of 400 miles (640 km) around JAF were included. This distance exceeds the 200 mile (320 km) recommendation contained in Reg. Guide 1.208 (U.S. NRC, 2007) and was chosen for completeness. Background sources included in this site analysis are the following (EPRI, 2014):

1. Atlantic Highly Extended Crust (AHEX)
2. Extended Continental Crust—Atlantic Margin (ECC_AM)
3. Great Meteor Hotspot (GMH)
4. Mesozoic and younger extended prior – narrow (MESE-N)
5. Mesozoic and younger extended prior – wide (MESE-W)
6. Midcontinent-Craton alternative A (MIDC_A)
7. Midcontinent-Craton alternative B (MIDC_B)
8. Midcontinent-Craton alternative C (MIDC_C)
9. Midcontinent-Craton alternative D (MIDC_D)
10. Northern Appalachians (NAP)
11. Non-Mesozoic and younger extended prior – narrow (NMESE-N)
12. Non-Mesozoic and younger extended prior – wide (NMESE-W)
13. Paleozoic Extended Crust narrow (PEZ_N)
14. Paleozoic Extended Crust wide (PEZ_W)
15. St. Lawrence Rift, including the Ottawa and Saguenay grabens (SLR)
16. Study region (STUDY_R)

For sources of large magnitude earthquakes, designated Repeated Large Magnitude Earthquake (RLME) sources in NUREG-2115 (CEUS-SSC, 2012) modeled for the CEUS-SSE, the following sources lie within 1,000 km of the site and were included in the analysis (EPRI, 2014):

1. Charlevoix
2. Wabash Valley

For each of the above background and RLME sources, the mid-continent version of the updated CEUS EPRI GMM was used. (EPRI, 2014)

2.2.2 Base Rock Seismic Hazard Curves

Consistent with the SPID (EPRI, 2013a), base rock seismic hazard curves are not provided as the site amplification approach referred to as Method 3 has been used. Seismic hazard curves are shown below in Section 2.3 at the Safe Shutdown Earthquake (SSE) control point elevation. (EPRI, 2014)

2.3 Site Response Evaluation

Following the guidance contained in Seismic Enclosure 1 of the 3/12/2012 50.54(f) Request for Information (U.S. NRC, 2012) and in the SPID (EPRI, 2013a) for nuclear power plant sites that are not founded on hard rock (defined as 2.83 km/sec), a site response analysis was performed for JAF. (EPRI, 2014)

2.3.1 Description of Subsurface Material

The JAF plant is located in the Erie-Ontario Lowland Physiographic Province of New York. The general site conditions consist of about 12 ft (3.7m) of till overlying Ordovician Oswego sandstone with hard rock at a depth of about 1,700 ft beneath the site (Entergy, 2013). The JAF consists of a single unit with the reactor building supported on continuous rock of the Oswego formation. Table 2.3.1-1 shows the geotechnical properties for the site. (EPRI, 2014)

Table 2.3.1-1. (modified from Entergy, 2013) Summary of Geotechnical Profile Data for JAF (EPRI, 2014)

Depth Range (ft)	Soil/Rock Description	Density (pcf)	Shear Wave Velocity (fps)	Compressional Wave Velocity (fps)	Poisson's Ratio
0 – 12 (1)	Basal till consisting of silt, sand, gravel, cobbles and some clay (1)				
12 – 130 (1)	Ordovician Oswego sandstone (3)		7,000 – 8,000 (2)	13,000 – 15,000 (2)	0.29 – 0.32 (2)
> 130 (1)	Lorraine group – predominantly shale with some sandstone (1)		≥ 9,300 (2)		
~ 845 (2)	Trenton limestone and sandstone strata of Ordovician and Cambrian age (2)		≥ 9,300 (2)		
> 1700 (3)	Precambrian rock consisting of schists, gneiss, and granite (3)				

A geophysical survey for JAF – 1968 (Ref. J.O. 02268.5036 Rev. 0, Procedures and Criteria for Generation of In-Structure Response Spectra – James A. FitzPatrick Nuclear Power Plant)

- Compressional wave velocities range from 11,046 to 15,093 ft/sec
- Shear wave velocities range from 5,559 to 8,020 ft/sec
- Young's Modulus, shear modulus and Poisson's ratio calculated from these values. Average value of Young's modulus is 4.2 x 10^6. Average value of shear modulus is 1.6 x 10^6.

(1) Values from JAF FSAR, Section 2.5
(2) Values from EPRI Hazard Results Using the USGS 2008 Seismic Source Model, October 2011
(3) Values from JAF PSAR, Section 2.5

The following description of the general geology at the site is taken from site specific information (Entergy, 2013):

> Surficial deposits at the site consist of a thin layer of ablation till underlain by basal till. The till consists of mixtures of silt, sand, gravel, cobbles and some clay material. The total thickness ranges from 0 to 12 ft (0 to 3.7 m). These deposits lie directly on the Ordovician Oswego Sandstone. This formation is a fine-grained sandstone with laminations and lenticular shale beds. The sandstones are hard and moderately jointed; joints are most common in the upper 5 to 10 ft (1.5 to 3 m). The shale content of the Oswego increases with depth. The Oswego Sandstone is almost flat lying with a regional dip to the south-southwest of about 1.5º.
>
> At approximately 130 ft (40 m) below surface, this formation grades into the underlying Lorraine Group, which is composed of predominately shale with some sandstone members. This formation is about 715 ft (220 m) thick. Below the Lorraine Group are the Trenton limestone and sandstone strata of Ordovician and Cambrian age. Precambrian basement is at a depth of 1,700 ft (520 m) below the site.
>
> All plant structures are founded directly upon Oswego Sandstone. The reactor building has an embedment of 49.5 ft (15 m) below the surrounding yard grade. The ground water table is shallow since a few swamps and bogs are present on other parts of the site.

2.3.2 Development of Base Case Profiles and Nonlinear Material Properties

Table 2.3.1-1 shows the recommended shear-wave velocities versus depth for the best estimate profile (P1) listed in Table 2.3.2-2. Since profile densities were not available they were taken from Table B-2 of the SPID (EPRI, 2013a). Based on Table 2.3.1-1 and the adopted location of the SSE at a depth of 12 ft (3.65 m), the profile consists of about 1,700 ft (520 m) of firm rock overlying hard Precambrian basement rock. (EPRI, 2014)

Geophysical investigations including seismic refraction surveys, a borehole geophysical survey and microtremor measurements were conducted at the site before 1970 (Entergy, 2013). For the Oswego Sandstone a shear-wave velocity of 7,000 to 8,000 ft/sec (2,133 to 2,438 m/sec) is given in Table 2.3.1-1 with a range from 5,559 to 8,020 ft/sec. These measurements are in the top 130 ft (40 m). For the deeper strata (Lorraine and Trenton) estimates of shear-wave velocity are greater than or equal to 9,300 ft /sec (2,830 m/sec), the velocity of hard rock. These values were probably derived from compressional-wave measurements and an assumed Poisson's ratio. (EPRI, 2014)

Based on the specified shear-wave velocities, measured in only the top 130 ft, the range in shear-wave velocities shown below Table 2.3.1-1 and the early time frame for the measurements, a scale factor of 1.57 was adopted to reflect upper and lower range base-cases. The scale factor of 1.57 reflect a σ_{ln} of about 0.35 respectively, based on the SPID (EPRI, 2013a) 10^{th} and 90^{th} fractiles which implies a 1.28 scale factor on σ_{μ}. (EPRI, 2014)

Using the shear-wave velocities specified in Table 2.3.1-1, three base-profiles were developed using the scale factor of 1.57. The specified shear-wave velocities were taken as the mean or best estimate base-case profile (P1) with lower and upper range base-cases profiles P2 and P3 respectively. The three base-case profiles P1, P2, and P3, have a mean depth below the SSE of 1,700 ft (518 m) to hard reference rock, randomized ±510 ft (±156 m). The base-case profiles (P1, P2, and P3) are shown in Figure 2.3.2-1 and listed in Table 2.3.2-1. The depth randomization reflects ±30% of the depth and was included to provide a realistic broadening of the fundamental resonance rather than reflect actual random variations to basement shear-wave velocities across a footprint. (EPRI, 2014)

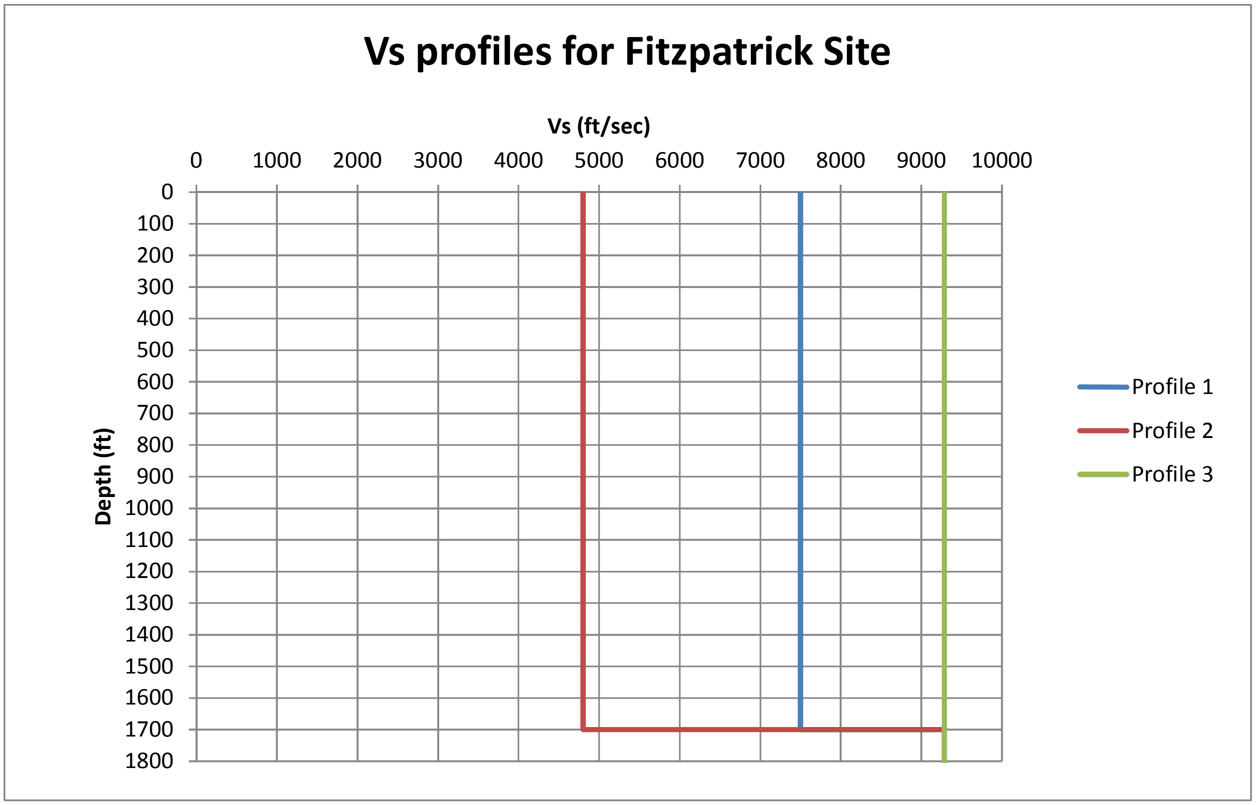

Figure 2.3.2-1. Shear-wave velocity profiles for the JAF site. (EPRI, 2014)

Table 2.3.2-1. Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, the JAF site. (EPRI, 2014)

Profile 1			Profile 2			Profile 3		
thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)
	0	7500		0	4800		0	9285
6.0	6.0	7500	6.0	6.0	4800	6.0	6.0	9285
6.0	12.0	7500	6.0	12.0	4800	6.0	12.0	9285
8.0	20.0	7500	8.0	20.0	4800	8.0	20.0	9285
10.9	30.9	7500	10.9	30.9	4800	10.9	30.9	9285
18.9	49.8	7500	18.9	49.8	4800	18.9	49.8	9285
18.9	68.7	7500	18.9	68.7	4800	18.9	68.7	9285
18.9	87.6	7500	18.9	87.6	4800	18.9	87.6	9285
18.9	106.5	7500	18.9	106.5	4800	18.9	106.5	9285
13.5	120.0	7500	13.5	120.0	4800	13.5	120.0	9285
24.3	144.3	7500	24.3	144.3	4800	24.3	144.3	9285
18.9	163.2	7500	18.9	163.2	4800	18.9	163.2	9285
18.9	182.1	7500	18.9	182.1	4800	18.9	182.1	9285
18.9	201.0	7500	18.9	201.0	4800	18.9	201.0	9285
18.9	219.9	7500	18.9	219.9	4800	18.9	219.9	9285
18.9	238.8	7500	18.9	238.8	4800	18.9	238.8	9285
11.2	250.0	7500	11.2	250.0	4800	11.2	250.0	9285
26.8	276.8	7500	26.8	276.8	4800	26.8	276.8	9285
18.9	295.7	7500	18.9	295.7	4800	18.9	295.7	9285
18.9	314.6	7500	18.9	314.6	4800	18.9	314.6	9285
18.9	333.5	7500	18.9	333.5	4800	18.9	333.5	9285
18.9	352.4	7500	18.9	352.4	4800	18.9	352.4	9285
18.9	371.3	7500	18.9	371.3	4800	18.9	371.3	9285
18.9	390.2	7500	18.9	390.2	4800	18.9	390.2	9285
18.9	409.1	7500	18.9	409.1	4800	18.9	409.1	9285
18.9	428.0	7500	18.9	428.0	4800	18.9	428.0	9285
18.9	446.9	7500	18.9	446.9	4800	18.9	446.9	9285
18.9	465.8	7500	18.9	465.8	4800	18.9	465.8	9285
18.9	484.7	7500	18.9	484.7	4800	18.9	484.7	9285
15.3	500.0	7500	15.3	500.0	4800	15.3	500.0	9285
22.5	522.5	7500	22.5	522.5	4800	22.5	522.5	9285
56.7	579.2	7500	56.7	579.2	4800	56.7	579.2	9285
56.7	635.9	7500	56.7	635.9	4800	56.7	635.9	9285
56.7	692.6	7500	56.7	692.6	4800	56.7	692.6	9285
56.7	749.2	7500	56.7	749.2	4800	56.7	749.2	9285
56.7	805.9	7500	56.7	805.9	4800	56.7	805.9	9285
56.7	862.6	7500	56.7	862.6	4800	56.7	862.6	9285

Table 2.3.2-1. Layer thicknesses, depths, and shear-wave velocities (Vs) for 3 profiles, the JAF site. (EPRI, 2014)

Profile 1			Profile 2			Profile 3		
thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)	thickness (ft)	depth (ft)	Vs (ft/s)
56.7	919.3	7500	56.7	919.3	4800	56.7	919.3	9285
56.7	976.0	7500	56.7	976.0	4800	56.7	976.0	9285
56.7	1032.7	7500	56.7	1032.7	4800	56.7	1032.7	9285
56.7	1089.4	7500	56.7	1089.4	4800	56.7	1089.4	9285
56.7	1146.1	7500	56.7	1146.1	4800	56.7	1146.1	9285
56.7	1202.8	7500	56.7	1202.8	4800	56.7	1202.8	9285
56.7	1259.5	7500	56.7	1259.5	4800	56.7	1259.5	9285
56.7	1316.2	7500	56.7	1316.2	4800	56.7	1316.2	9285
56.7	1372.9	7500	56.7	1372.9	4800	56.7	1372.9	9285
56.7	1429.6	7500	56.7	1429.6	4800	56.7	1429.6	9285
56.7	1486.3	7500	56.7	1486.3	4800	56.7	1486.3	9285
56.7	1542.9	7500	56.7	1542.9	4800	56.7	1542.9	9285
56.7	1599.6	7500	56.7	1599.6	4800	56.7	1599.6	9285
56.7	1656.3	7500	56.7	1656.3	4800	56.7	1656.3	9285
43.6	1699.9	7500	43.6	1699.9	4800	43.6	1699.9	9285
3280.8	4980.8	9285	3280.8	4980.8	9285	3280.8	4980.8	9285

2.3.2.1 Shear Modulus and Damping Curves

No site-specific nonlinear dynamic material properties were determined for the firm rock materials in the initial siting of JAF. The rock material over the upper 500 ft (152 m) was assumed to have behavior that could be modeled as either linear or non-linear. To represent this potential for either case in the upper 500 ft of firm rock at JAF site, two sets of shear modulus reduction and hysteretic damping curves were used. Consistent with the SPID (EPRI, 2013a), the EPRI rock curves (model M1) were considered to be appropriate to represent the upper range nonlinearity likely in the materials at this site and linear analyses (model M2) was assumed to represent an equally plausible alternative rock response across loading level. For the linear analyses, the low strain damping from the EPRI rock curves were used as the constant damping values in the upper 500 ft. (EPRI, 2014)

2.3.2.2 Kappa

For JAF profile of about 1700 ft (518 m) of firm rock over hard reference rock, the kappa value of 0.006 s for hard rock (EPRI, 2013a) was combined with the low strain damping in the hysteretic damping curves to give the values listed in Table 2.3.2-2. The low strain kappa values range from 0.006 s for the stiffest profile (P3, hard rock) to 0.019 s for the softest profile (P2) combined with EPRI rock curves (Table 2.3.2-2). The full epistemic uncertainty in overall profile damping has contributions from kappa at low strain in the firm rock but also the wide range in hysteretic damping curves at higher loading levels of significance to design. (EPRI, 2014)

Table 2.3.2-2. Kappa Values and Weights Used for Site Response Analyses. (EPRI, 2014)

Velocity Profile	Kappa(s)
P1	0.014
P2	0.019
P3	0.006
Velocity Profile	Weights
P1	0.4
P2	0.3
P3	0.3
G/G_{max} and Hysteretic Damping Curves	
M1	0.5
M2	0.5

2.3.3 Randomization of Base Case Profiles

To account for the aleatory variability in dynamic material properties that is expected to occur across a site at the scale of a typical nuclear facility, variability in the assumed shear-wave velocity profiles has been incorporated in the site response calculations. For JAF site, random shear wave velocity profiles were developed from the base case profiles shown in Figure 2.3.2-1. Consistent with the discussion in Appendix B of the SPID (EPRI, 2013a), the velocity randomization procedure made use of random field models which describe the statistical correlation between layering and shear wave velocity. The default randomization parameters developed (Toro, 1997) for United States Geological Survey (USGS) “A” site conditions were used for this site. Thirty random velocity profiles were generated for each base case profile. These random velocity profiles were generated using a natural log standard deviation of 0.25 over the upper 50 ft and 0.15 below that depth. As specified in the SPID (EPRI, 2013a), correlation of shear wave velocity between layers was modeled using the footprint correlation model. In the correlation model, a limit of ±2 standard deviations about the median value in each layer was assumed for the limits on random velocity fluctuations. (EPRI, 2014)

2.3.4 Input Spectra

Consistent with the guidance in Appendix B of the SPID (EPRI, 2013a), input Fourier amplitude spectra were defined for a single representative earthquake magnitude (**M** 6.5) using two different assumptions regarding the shape of the seismic source spectrum (single-corner and double-corner). A range of 11 different input amplitudes (median peak ground accelerations (PGA) ranging from 0.01 to 1.5g) were used in the site response analyses. The characteristics of the seismic source and upper crustal attenuation properties assumed for the analysis of JAF site were the same as those identified in Tables B-4, B-5, B-6 and B-7 of the SPID (EPRI, 2013a) as appropriate for typical CEUS sites. (EPRI, 2014)

2.3.5 Methodology

To perform the site response analyses for JAF site, a random vibration theory (RVT) approach was employed. This process utilizes a simple, efficient approach for computing site-specific amplification functions and is consistent with existing NRC guidance and the SPID (EPRI, 2013a). The guidance contained in Appendix B of the SPID (EPRI, 2013a) on incorporating epistemic uncertainty in shear-wave velocities, kappa, non-linear dynamic properties and source spectra for plants with limited at-site information was followed for JAF site. (EPRI, 2014)

2.3.6 Amplification Functions

The results of the site response analysis consist of amplification factors (5% damped pseudo absolute response spectra) which describe the amplification (or de-amplification) of hard reference rock motion as a function of frequency and input reference rock amplitude. The amplification factors are represented in terms of a median amplification value and an associated standard deviation (sigma) for each oscillator frequency and input rock amplitude. Consistent with the SPID (EPRI, 2013a) a minimum median amplification value of 0.5 was employed in the present analysis. Figure 2.3.6-1 illustrates the median and ±1 standard deviation in the predicted amplification factors developed for the eleven loading levels parameterized by the median reference (hard rock) peak acceleration (0.01g to 1.50g) for profile P1 and (EPRI, 2013a) rock G/G_{max} and hysteretic damping curves. The variability in the amplification factors results from variability in shear-wave velocity, depth to hard rock, and modulus reduction and hysteretic damping curves. To illustrate the effects of nonlinearity at JAF firm rock site, Figure 2.3.6-2 shows the corresponding amplification factors developed with linear site response analyses (model M2). Between the linear and nonlinear (equivalent-linear) analyses, Figures 2.3.6-1 and Figure 2.3.6-2 respectively show only a minor difference across structural frequency as well as loading level. (EPRI, 2014)

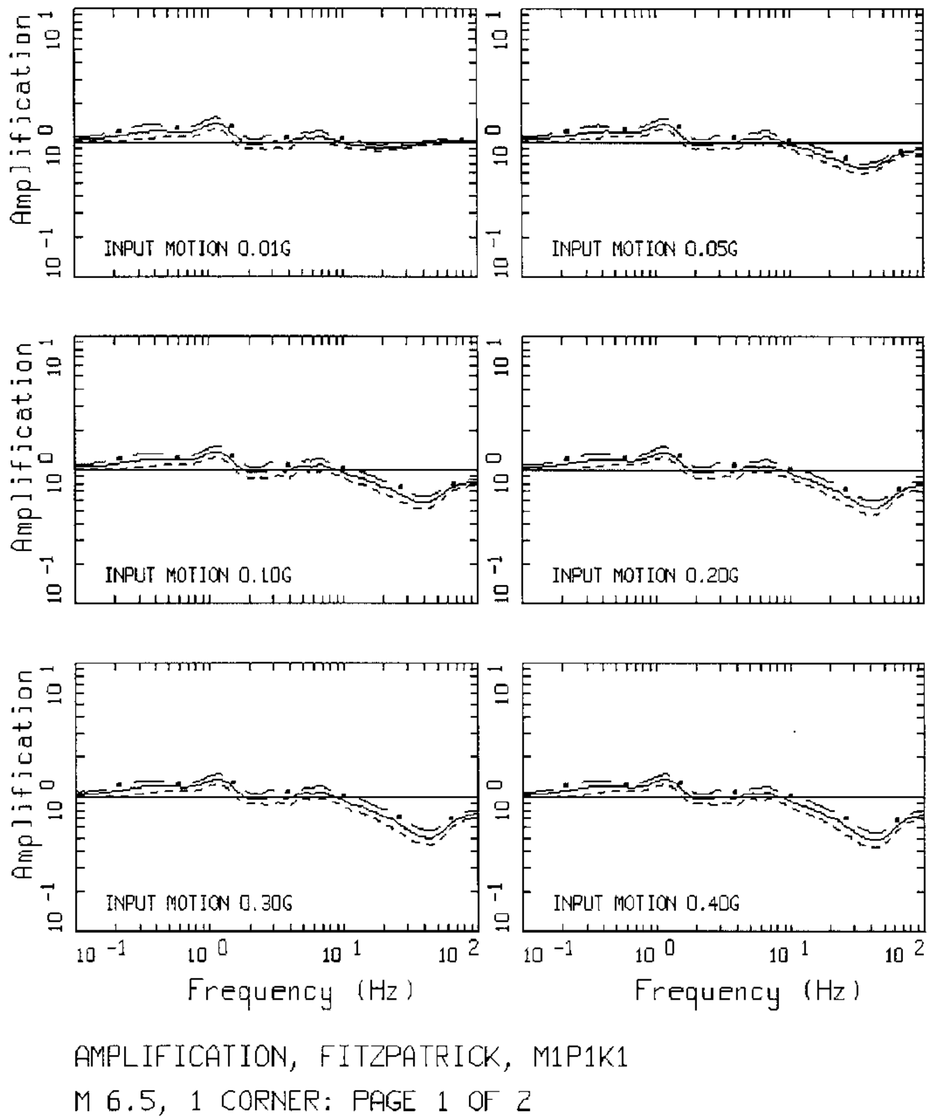

Figure 2.3.6-1. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), EPRI rock modulus reduction and hysteretic damping curves (model M1), and base-case kappa at eleven loading levels of hard-rock median peak acceleration values from 0.01g to 1.50g. **M** 6.5 and single-corner source model (EPRI, 2013a).

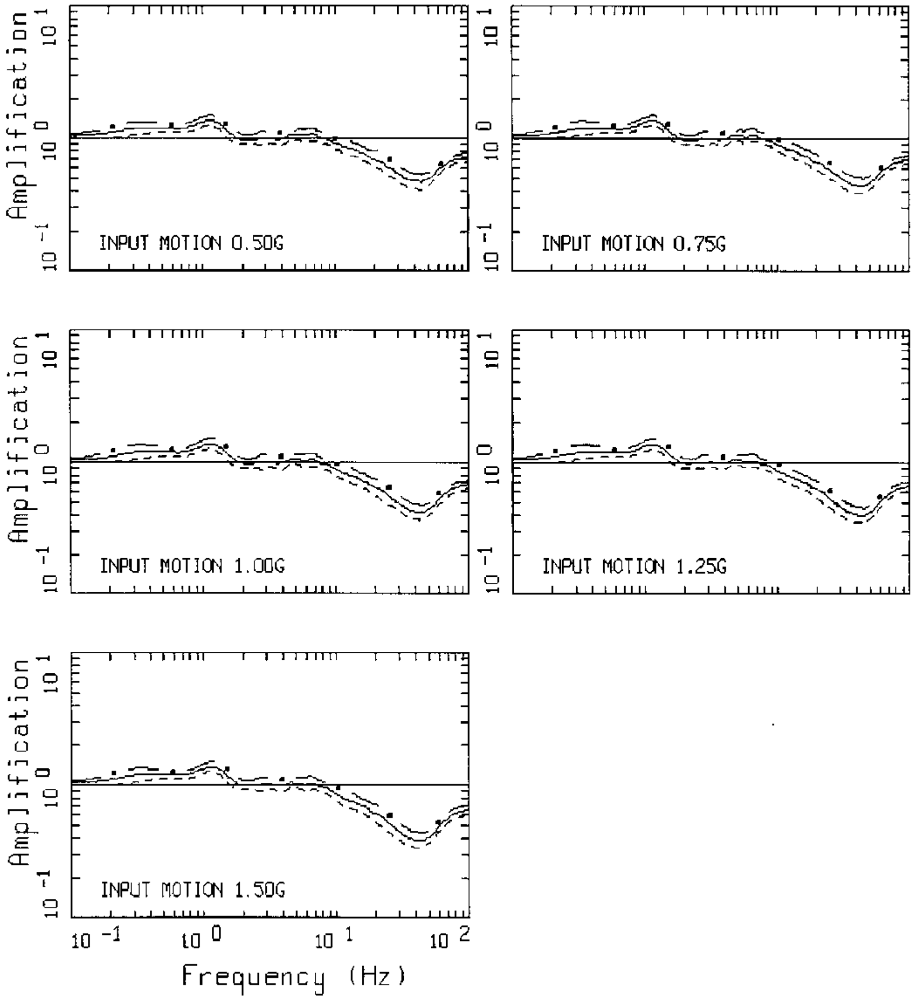

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Figure 2.3.6-1.(cont.)

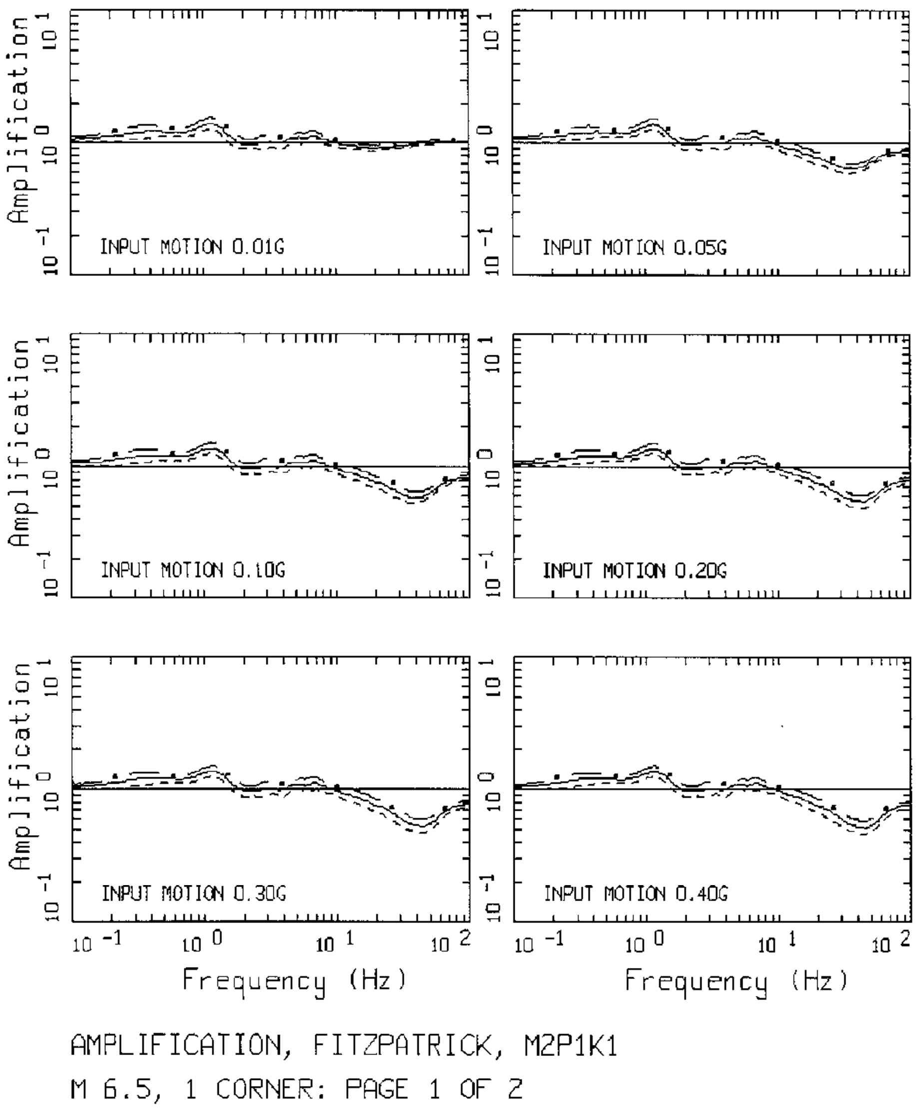

Figure 2.3.6-2. Example suite of amplification factors (5% damping pseudo absolute acceleration spectra) developed for the mean base-case profile (P1), linear site response (model M2), and base-case kappa at eleven loading levels of hard-rock median peak acceleration values from 0.01g to 1.50g. **M** 6.5 and single-corner source model (EPRI, 2013a).

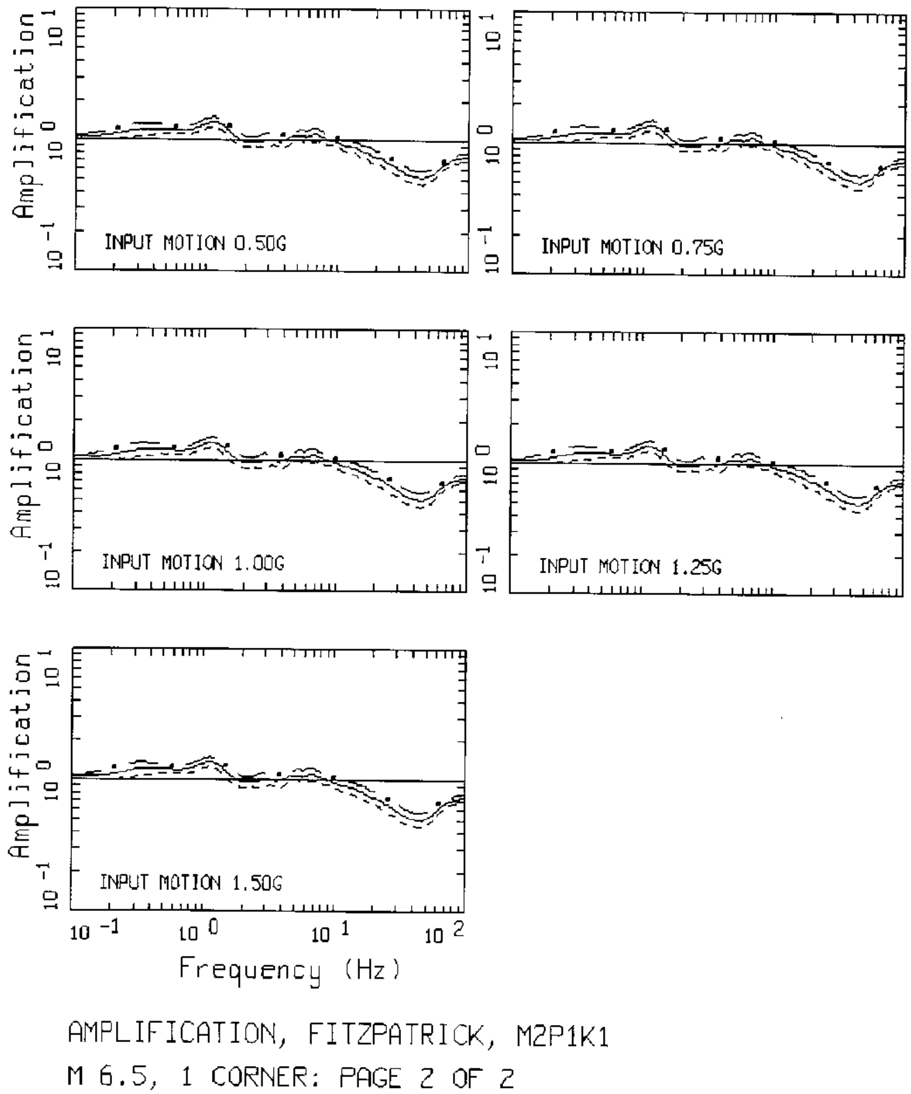

Figure 2.3.6-2.(cont.)

2.3.7 Control Point Seismic Hazard Curves

The procedure to develop probabilistic site-specific control point hazard curves used in the present analysis follows the methodology described in Section B-6.0 of the SPID (EPRI, 2013a). This procedure (referred to as Method 3) computes a site-specific control point hazard curve for a broad range of spectral accelerations given the site-specific bedrock hazard curve and site-specific estimates of soil or soft-rock response and associated uncertainties. This process is repeated for each of the seven spectral frequencies for which ground motion equations are available. The dynamic response of the materials below the control point was represented by the frequency- and amplitude-dependent amplification functions (median values and standard deviations) developed and described in the previous section. The resulting control point mean hazard curves for JAF are shown in Figure 2.3.7-1 for the seven spectral frequencies for which the GMM is defined. Tabulated values of the control point hazard curves are provided in Appendix A. (EPRI, 2014)

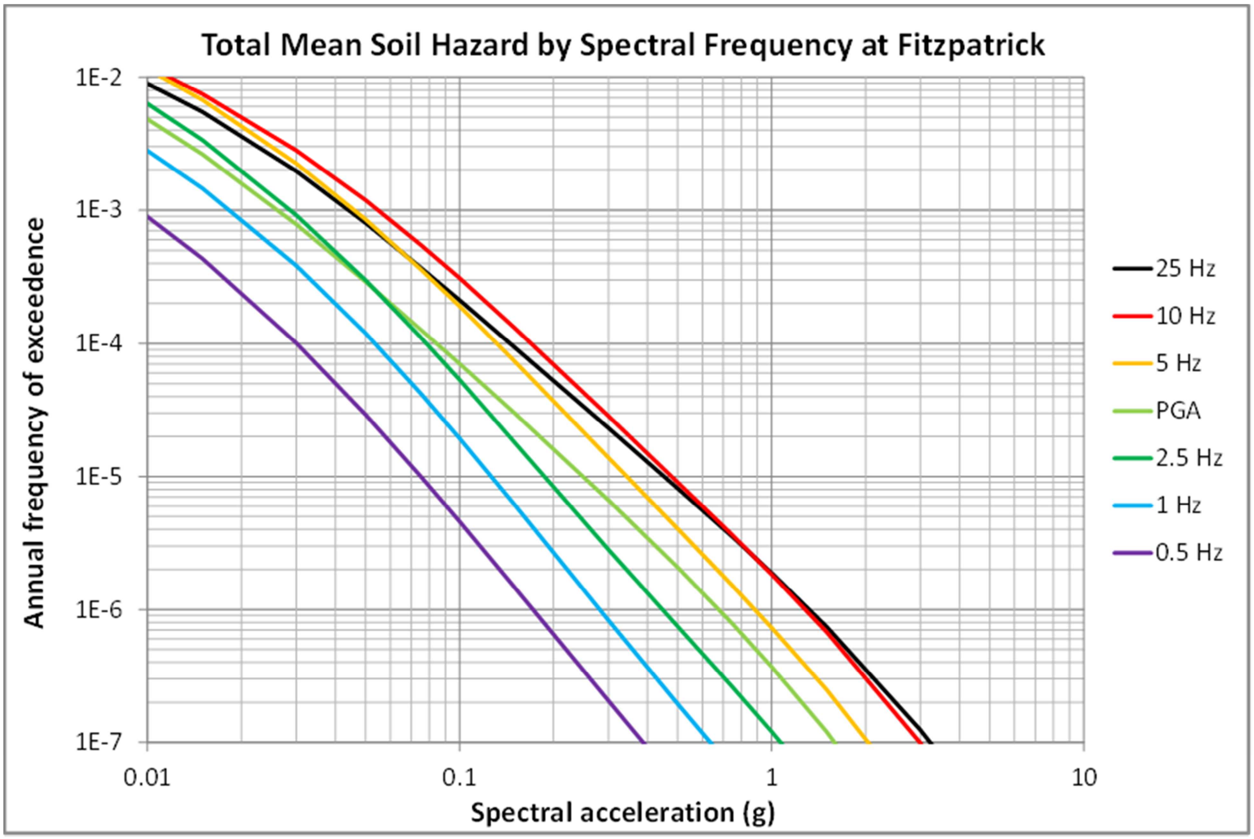

Figure 2.3.7-1. Control point mean hazard curves for spectral frequencies of 0.5, 1.0, 2.5, 5.0, 10, 25 and PGA (100) Hz at JAF. (EPRI, 2014)

2.4 Control Point Response Spectrum

The control point hazard curves described above have been used to develop uniform hazard response spectra (UHRS) and the GMRS. The UHRS were obtained through linear interpolation in log-log space to estimate the spectral acceleration at each spectral frequency for the 10^{-4} and 10^{-5} per year hazard levels. Table 2.4-1 shows the UHRS and GMRS for a range of spectral frequencies. (EPRI, 2014)

Table 2.4-1. UHRS for 10^{-4} and 10^{-5} and GMRS at Control Point for JAF. (EPRI, 2014)

Freq. (Hz)	10^{-4} UHRS (g)	10^{-5} UHRS (g)	GMRS (g)
100	8.45E-02	2.49E-01	1.20E-01
90	8.44E-02	2.49E-01	1.20E-01
80	8.48E-02	2.52E-01	1.22E-01
70	8.62E-02	2.59E-01	1.25E-01
60	9.06E-02	2.78E-01	1.33E-01
50	1.02E-01	3.26E-01	1.55E-01
40	1.22E-01	3.94E-01	1.87E-01
35	1.30E-01	4.20E-01	1.99E-01
30	1.38E-01	4.39E-01	2.09E-01
25	1.45E-01	4.53E-01	2.16E-01
20	1.58E-01	4.80E-01	2.31E-01
15	1.70E-01	4.99E-01	2.41E-01
12.5	1.71E-01	4.92E-01	2.39E-01
10	1.70E-01	4.78E-01	2.33E-01
9	1.66E-01	4.62E-01	2.26E-01
8	1.60E-01	4.39E-01	2.15E-01
7	1.54E-01	4.15E-01	2.04E-01
6	1.43E-01	3.80E-01	1.88E-01
5	1.32E-01	3.44E-01	1.70E-01
4	1.14E-01	2.90E-01	1.44E-01
3.5	1.02E-01	2.55E-01	1.27E-01
3	9.31E-02	2.27E-01	1.14E-01
2.5	7.84E-02	1.87E-01	9.44E-02
2	7.04E-02	1.68E-01	8.47E-02
1.5	6.24E-02	1.49E-01	7.50E-02
1.25	5.96E-02	1.41E-01	7.13E-02
1	5.36E-02	1.26E-01	6.38E-02
0.9	5.04E-02	1.20E-01	6.05E-02
0.8	4.67E-02	1.12E-01	5.66E-02
0.7	4.19E-02	1.02E-01	5.11E-02
0.6	3.62E-02	8.91E-02	4.47E-02
0.5	3.01E-02	7.52E-02	3.76E-02
0.4	2.41E-02	6.01E-02	3.00E-02
0.35	2.11E-02	5.26E-02	2.63E-02
0.3	1.81E-02	4.51E-02	2.25E-02
0.25	1.51E-02	3.76E-02	1.88E-02
0.2	1.20E-02	3.01E-02	1.50E-02
0.15	9.03E-03	2.26E-02	1.13E-02
0.125	7.53E-03	1.88E-02	9.39E-03
0.1	6.02E-03	1.50E-02	7.51E-03

The 10^{-4} and 10^{-5} UHRS are used to compute the GMRS at the control point and are shown in Figure 2.4-1. (EPRI, 2014)

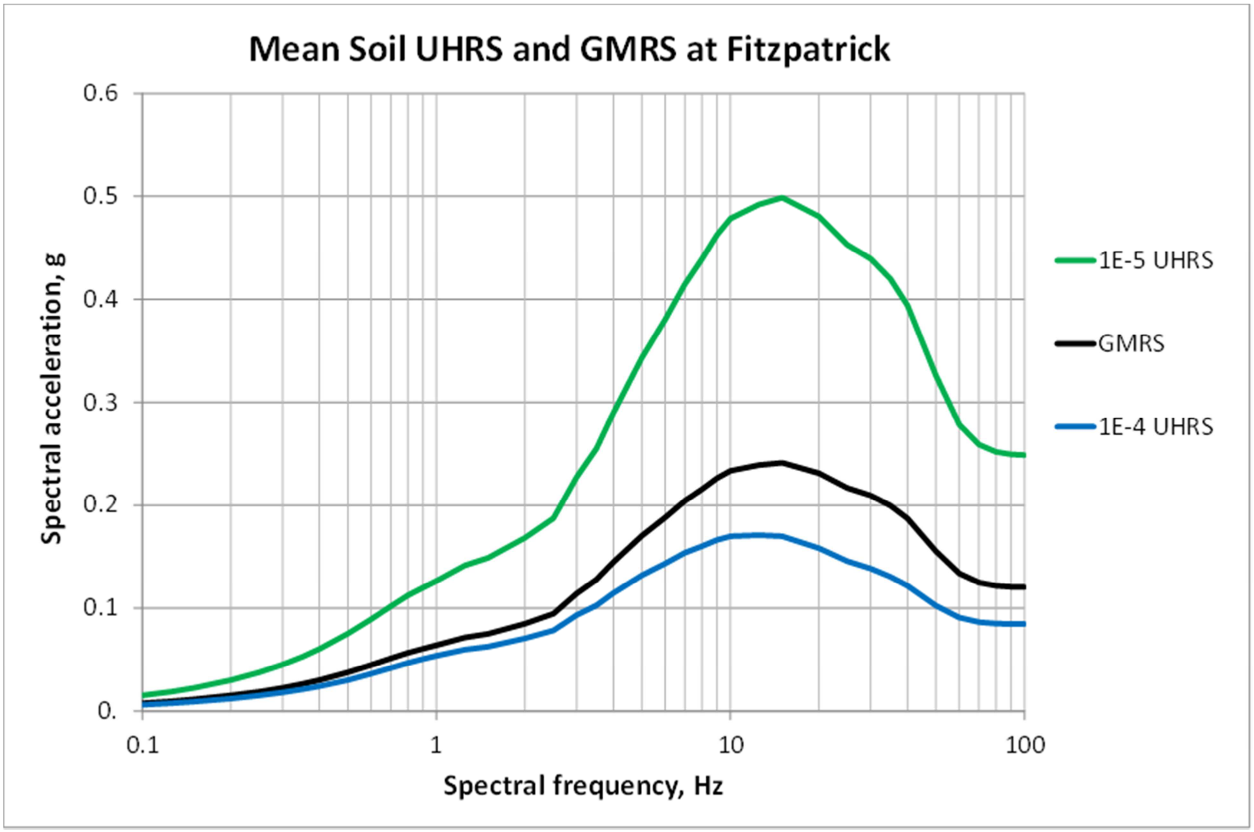

Figure 2.4-1. UHRS for 10^{-4} and 10^{-5} and GMRS at control point for JAF (5%-damped response spectra). (EPRI, 2014)

3.0 Plant Design Basis and Beyond Design Basis Evaluation Ground Motion

The design basis for JAF is identified in the Updated Final Safety Analysis Report (Entergy, 2013) and other pertinent documents.

An evaluation for beyond design basis (BDB) ground motions was performed in the Individual Plant Examination of External Events (IPEEE). The IPEEE capacity response spectrum is included in Section 3.3 for screening purposes.

3.1 Description of Spectral Shape

The SSE for JAF was developed through an evaluation of the maximum earthquake potential for the region surrounding the site. The Safe Shutdown Earthquake is conservative and corresponds to a horizontal ground acceleration of 0.15g.

The SSE is defined in terms of a PGA and a design response spectrum. Table 3.1-1 shows the spectral acceleration (SA) values as a function of frequency for the 5% damped horizontal SSE. (EPRI, 2014)

Table 3.1-1. SSE for JAF (Entergy, 2013).

Freq. (Hz)	100	25	10	5	2.5	1	0.5
SA (g)	0.15	0.15	0.15	0.21	0.22	0.13	0.064

3.2 Control Point Elevation

The SSE control point elevation is defined at depth 12 ft, which is the top of the Oswego sandstone where all plant structures are founded (Entergy, 2013).

3.3 IPEEE Description and Capacity Response Spectrum

A focused-scope seismic margin assessment (SMA) was performed to support the IPEEE for JAF. The results of the IPEEE were submitted to the NRC (Entergy, 1996). Results of the NRC review are documented in reference (U.S. NRC, 2000).

The James A. FitzPatrick Nuclear Power Plant Seismic IPEEE was performed using NRC methodology with seismic capacities evaluated in accordance with EPRI NP-6041 (EPRI, 1991). With this method, a seismic margin earthquake (SME) was postulated and the items needed for safe shutdown were then evaluated for the SME demand. Components and structures that were determined to have sufficient capacity to survive the SME without loss of function were screened out. Items that did not screen were subjected to a more detailed evaluation, including calculation of a high-confidence-low-probability of failure (HCLPF) peak ground acceleration (PGA) for that item. A 0.30 PGA earthquake level and the NUREG/CR-0098 (U.S. NRC, 1978) median response spectra shape were used.

The IPEEE was reviewed for adequacy utilizing the guidance provided in Section 3.3 of the SPID (EPRI, 2013a). A detailed description of the results of the IPEEE adequacy review is provided in Appendix B.

The results of the review have shown, in accordance with the criteria established in SPID (EPRI, 2013a) Section 3.3, that the IPEEE is adequate to support screening of the updated seismic hazard for JAF. The review also concluded that the risk insights obtained from the IPEEE are still valid under the current plant configuration.

The full scope detailed review of relay chatter required in SPID (EPRI, 2013a) Section 3.3.1 has not been completed. The results of the review will be provided in a future submittal.

The NUREG/CR-0098 (U.S. NRC, 1978) horizontal IPEEE HCLPF Spectrum (IHS) spectral acceleration anchored at 0.22 g for JAF is provided in Table 3.3-1. The SSE and IHS are shown in Figure 3.3-1.

Table 3.3-1. IHS Anchored at 0.22g PGA for JAF. Entergy (2013)

Freq. (Hz)	IHS
0.5	0.11
1.0	0.21
2.2	0.47
8.0	0.47
10	0.41
25	0.26
33	0.22
100	0.22

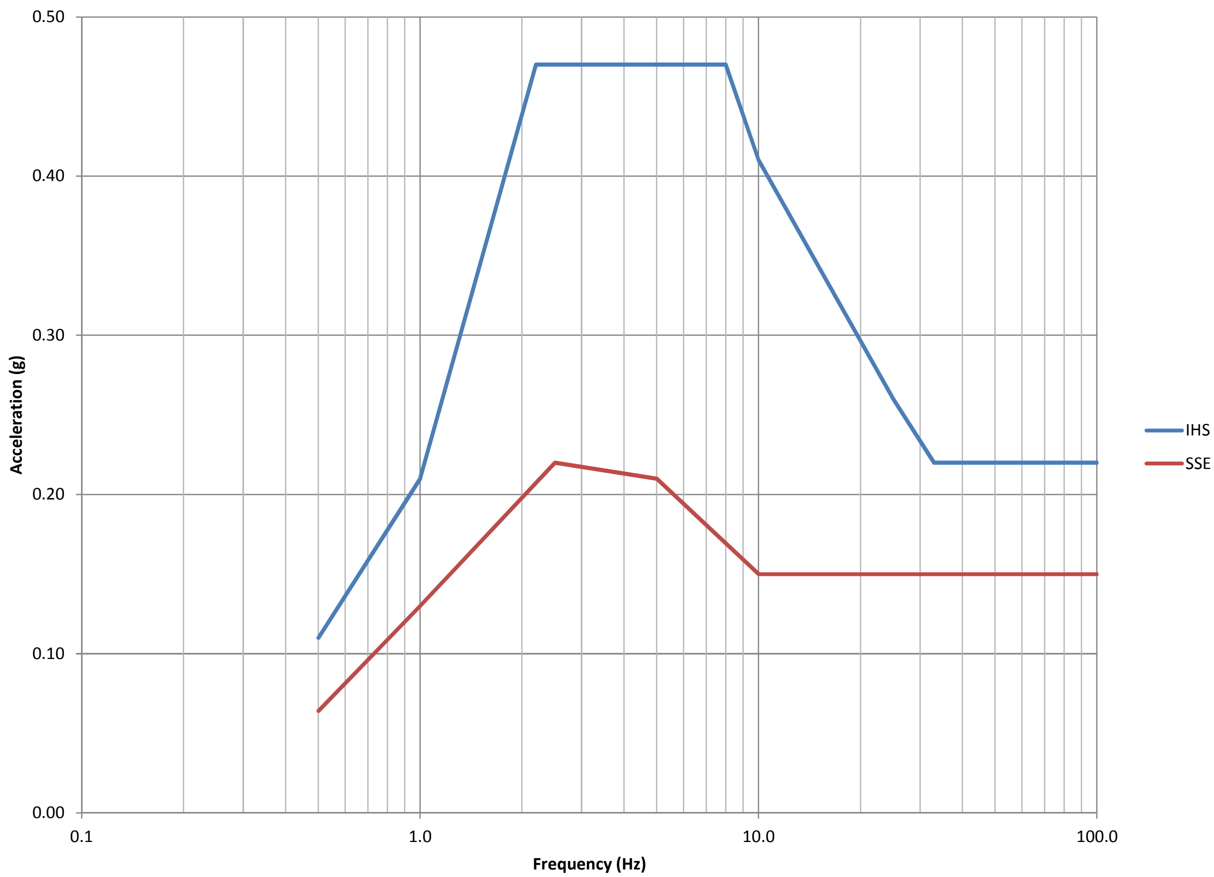

Figure 3.3-1. SSE and IHS Response Spectra for JAF.

4.0 Screening Evaluation

In accordance with SPID (EPRI, 2013a) Section 3, a screening evaluation was performed as described below.

4.1 Risk Evaluation Screening (1 to 10 Hz)

In the 1 to 10 Hz part of the response spectrum, the IHS exceeds the GMRS. Based on this comparison, a risk evaluation will not be performed.

4.2 High Frequency Screening (> 10 Hz)

Above 10 Hz, the IHS exceeds the GMRS. Therefore, a High Frequency Confirmation will not be performed.

4.3 Spent Fuel Pool Evaluation Screening (1 to 10 Hz)

In the 1 to 10 Hz part of the response spectrum, the GMRS exceeds the SSE. Therefore, JAF screens-in for a Spent Fuel Pool evaluation.

5.0 Interim Actions

Based on the screening evaluation, the expedited seismic evaluation described in EPRI 3002000704 (EPRI, 2013c) will be performed as proposed in a letter to the NRC (ML13101A379) dated April 9, 2013 (NEI, 2013) and agreed to by the NRC (ML13106A331) in a letter dated May 7, 2013 (U.S. NRC, 2013)

Consistent with NRC letter (ML14030A046) dated February 20, 2014 (U.S. NRC, 2014), the seismic hazard reevaluations presented herein are distinct from the current design and licensing bases of JAF. Therefore, the results do not call into question the operability or functionality of SSCs and are not reportable pursuant to 10 CFR 50.72, "Immediate notification requirements for operating nuclear power reactors," and 10 CFR 50.73, "Licensee event report system".

The NRC letter also requests that licensees provide an interim evaluation or actions to demonstrate that the plant can cope with the reevaluated hazard while the expedited approach and risk evaluations are conducted. In response to that request, NEI letter dated March 12, 2014 (NEI, 2014), provides seismic core damage risk estimates using the updated seismic hazards for the operating nuclear plants in the Central and Eastern United States. These risk estimates continue to support the following conclusions of the NRC GI-199 Safety/Risk Assessment (U.S. NRC, 2010):

> Overall seismic core damage risk estimates are consistent with the Commission's Safety Goal Policy Statement because they are within the subsidiary objective of 10^{-4}/year for core damage frequency. The GI-199 Safety/Risk Assessment, based in part on information from the U.S. Nuclear Regulatory Commission's (NRC's) Individual Plant Examination of External Events (IPEEE) program, indicates that no concern exists regarding adequate protection and that the current seismic design of operating reactors provides a safety margin to withstand potential earthquakes exceeding the original design basis.

JAF is included in the March 12, 2014 risk estimates (NEI, 2014). Using the methodology described in the NEI letter, all plants were shown to be below 10^{-4}/year; thus, the above conclusions apply.

In accordance with the Near-Term Task Force Recommendation 2.3, JAF performed seismic walkdowns using the guidance in EPRI Report 1025286 (EPRI, 2012). The seismic walkdowns were completed and captured in Fukushima Seismic Walkdown Report (Entergy, 2012). The goal of the walkdowns was to verify current plant configuration with the existing licensing basis, to verify the current maintenance plans, and to identify any vulnerabilities. The walkdown also verified that any vulnerabilities identified in the IPEEE (Entergy, 1996) were adequately addressed. The results of the walkdown, including any identified corrective actions, confirm that JAF can adequately respond to a seismic event.

6.0 Conclusions

In accordance with the 50.54(f) request for information (U.S. NRC, 2012), a seismic hazard and screening evaluation was performed for the James A. FitzPatrick Nuclear Power Plant. A GMRS was developed solely for the purpose of screening for additional evaluations in accordance with the SPID (EPRI, 2013a). Based on the results of the screening evaluation, JAF screens-in for a Spent Fuel Pool evaluation. Additionally, based on the results of the screening evaluation, JAF screens-out of a seismic risk evaluation and a High Frequency Confirmation.

7.0 References

10 CFR Part 50. Title 10, Code of Federal Regulations, Part 50, “Domestic Licensing of Production and Utilization Facilities,” U.S. Nuclear Regulatory Commission, Washington DC.

10 CFR Part 100. Title 10, Code of Federal Regulations, Part 100, “Reactor Site Criteria,” U.S. Nuclear Regulatory Commission, Washington DC.

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Appendix A

Tabulated Data

Table A-1a. Mean and Fractile Seismic Hazard Curves for 100 Hz (PGA) at JAF. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	5.57E-02	3.09E-02	4.31E-02	5.58E-02	6.93E-02	7.77E-02
0.001	4.15E-02	1.92E-02	3.05E-02	4.13E-02	5.35E-02	6.36E-02
0.005	1.14E-02	3.42E-03	6.17E-03	1.01E-02	1.62E-02	2.46E-02
0.01	4.83E-03	1.21E-03	2.07E-03	3.84E-03	6.83E-03	1.32E-02
0.015	2.63E-03	5.91E-04	9.65E-04	1.92E-03	3.68E-03	8.35E-03
0.03	7.84E-04	1.29E-04	2.04E-04	4.43E-04	1.07E-03	3.14E-03
0.05	2.91E-04	3.52E-05	5.75E-05	1.32E-04	3.84E-04	1.31E-03
0.075	1.28E-04	1.25E-05	2.16E-05	5.27E-05	1.67E-04	5.91E-04
0.1	7.04E-05	6.45E-06	1.16E-05	2.88E-05	9.11E-05	3.19E-04
0.15	2.99E-05	2.72E-06	5.27E-06	1.32E-05	3.90E-05	1.25E-04
0.3	6.65E-06	5.66E-07	1.29E-06	3.52E-06	9.37E-06	2.29E-05
0.5	2.07E-06	1.38E-07	3.68E-07	1.15E-06	3.23E-06	6.83E-06
0.75	7.77E-07	3.42E-08	1.10E-07	4.13E-07	1.29E-06	2.64E-06
1.	3.70E-07	1.08E-08	4.07E-08	1.82E-07	6.26E-07	1.31E-06
1.5	1.20E-07	1.69E-09	8.23E-09	4.98E-08	2.07E-07	4.63E-07
3.	1.31E-08	9.79E-11	3.33E-10	3.19E-09	2.04E-08	5.75E-08
5.	1.92E-09	4.19E-11	9.11E-11	3.14E-10	2.57E-09	8.85E-09
7.5	3.36E-10	3.52E-11	4.77E-11	9.24E-11	4.25E-10	1.62E-09
10.	8.68E-11	3.01E-11	4.01E-11	9.11E-11	1.38E-10	4.63E-10

Table A-1b. Mean and Fractile Seismic Hazard Curves for 25 Hz at JAF.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	6.03E-02	4.01E-02	4.90E-02	6.00E-02	7.23E-02	8.12E-02
0.001	4.81E-02	2.76E-02	3.73E-02	4.77E-02	6.00E-02	6.93E-02
0.005	1.76E-02	6.83E-03	1.11E-02	1.60E-02	2.39E-02	3.33E-02
0.01	8.94E-03	2.84E-03	4.83E-03	7.66E-03	1.25E-02	2.01E-02
0.015	5.47E-03	1.57E-03	2.64E-03	4.50E-03	7.77E-03	1.36E-02
0.03	1.96E-03	4.56E-04	7.34E-04	1.44E-03	2.84E-03	5.75E-03
0.05	8.04E-04	1.49E-04	2.42E-04	5.20E-04	1.18E-03	2.60E-03
0.075	3.72E-04	5.42E-05	9.37E-05	2.19E-04	5.50E-04	1.29E-03
0.1	2.11E-04	2.64E-05	4.77E-05	1.16E-04	3.14E-04	7.45E-04
0.15	9.38E-05	1.04E-05	1.95E-05	4.98E-05	1.38E-04	3.33E-04
0.3	2.31E-05	2.57E-06	5.05E-06	1.29E-05	3.37E-05	7.55E-05
0.5	8.17E-06	8.72E-07	1.92E-06	4.98E-06	1.27E-05	2.49E-05
0.75	3.51E-06	3.47E-07	8.12E-07	2.22E-06	5.66E-06	1.04E-05
1.	1.88E-06	1.69E-07	4.13E-07	1.21E-06	3.09E-06	5.66E-06
1.5	7.42E-07	5.27E-08	1.44E-07	4.63E-07	1.27E-06	2.35E-06
3.	1.24E-07	4.83E-09	1.60E-08	6.45E-08	2.22E-07	4.43E-07
5.	2.69E-08	6.09E-10	2.19E-09	1.10E-08	4.77E-08	1.04E-07
7.5	6.84E-09	1.40E-10	4.07E-10	2.22E-09	1.15E-08	2.84E-08
10.	2.37E-09	9.11E-11	1.44E-10	6.45E-10	3.84E-09	1.02E-08

Table A-1c. Mean and Fractile Seismic Hazard Curves for 10 Hz at JAF.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	6.69E-02	5.12E-02	5.58E-02	6.54E-02	7.89E-02	8.72E-02
0.001	5.67E-02	3.90E-02	4.56E-02	5.58E-02	6.83E-02	7.66E-02
0.005	2.32E-02	1.07E-02	1.55E-02	2.19E-02	3.09E-02	3.84E-02
0.01	1.20E-02	4.63E-03	7.03E-03	1.08E-02	1.69E-02	2.19E-02
0.015	7.48E-03	2.64E-03	4.01E-03	6.54E-03	1.08E-02	1.46E-02
0.03	2.81E-03	8.60E-04	1.29E-03	2.32E-03	4.19E-03	6.36E-03
0.05	1.19E-03	3.23E-04	4.90E-04	9.24E-04	1.79E-03	3.01E-03
0.075	5.53E-04	1.34E-04	2.10E-04	4.07E-04	8.23E-04	1.53E-03
0.1	3.10E-04	6.93E-05	1.08E-04	2.19E-04	4.56E-04	8.98E-04
0.15	1.31E-04	2.53E-05	4.13E-05	8.72E-05	1.95E-04	4.01E-04
0.3	2.84E-05	4.56E-06	8.00E-06	1.87E-05	4.31E-05	8.85E-05
0.5	9.06E-06	1.32E-06	2.57E-06	6.17E-06	1.42E-05	2.64E-05
0.75	3.60E-06	4.83E-07	1.02E-06	2.53E-06	5.83E-06	1.01E-05
1.	1.84E-06	2.22E-07	5.05E-07	1.31E-06	3.01E-06	5.20E-06
1.5	6.75E-07	6.64E-08	1.67E-07	4.70E-07	1.13E-06	1.98E-06
3.	9.89E-08	5.27E-09	1.62E-08	5.83E-08	1.72E-07	3.33E-07
5.	1.92E-08	5.66E-10	1.95E-09	9.24E-09	3.33E-08	7.34E-08
7.5	4.49E-09	1.23E-10	3.23E-10	1.69E-09	7.55E-09	1.87E-08
10.	1.46E-09	9.11E-11	1.20E-10	4.83E-10	2.35E-09	6.45E-09

Table A-1d. Mean and Fractile Seismic Hazard Curves for 5.0 Hz at JAF.
(EPRI 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	6.83E-02	5.12E-02	5.75E-02	6.73E-02	8.00E-02	8.85E-02
0.001	5.88E-02	3.90E-02	4.63E-02	5.83E-02	7.13E-02	8.00E-02
0.005	2.36E-02	1.02E-02	1.51E-02	2.32E-02	3.23E-02	3.90E-02
0.01	1.15E-02	4.13E-03	6.64E-03	1.08E-02	1.64E-02	2.10E-02
0.015	6.74E-03	2.22E-03	3.63E-03	6.17E-03	9.93E-03	1.31E-02
0.03	2.24E-03	6.54E-04	1.07E-03	1.92E-03	3.42E-03	4.83E-03
0.05	8.51E-04	2.29E-04	3.73E-04	6.83E-04	1.34E-03	1.98E-03
0.075	3.63E-04	8.85E-05	1.44E-04	2.80E-04	5.75E-04	9.11E-04
0.1	1.91E-04	4.31E-05	7.13E-05	1.42E-04	3.01E-04	4.98E-04
0.15	7.38E-05	1.49E-05	2.49E-05	5.35E-05	1.16E-04	2.04E-04
0.3	1.39E-05	2.29E-06	4.19E-06	9.79E-06	2.19E-05	3.95E-05
0.5	4.05E-06	5.66E-07	1.16E-06	2.84E-06	6.45E-06	1.13E-05
0.75	1.51E-06	1.77E-07	4.01E-07	1.05E-06	2.46E-06	4.31E-06
1.	7.31E-07	7.13E-08	1.77E-07	5.05E-07	1.21E-06	2.16E-06
1.5	2.49E-07	1.77E-08	4.98E-08	1.60E-07	4.25E-07	7.89E-07
3.	3.18E-08	1.10E-09	3.68E-09	1.62E-08	5.50E-08	1.16E-07
5.	5.53E-09	1.51E-10	4.19E-10	2.16E-09	9.11E-09	2.25E-08
7.5	1.18E-09	9.11E-11	1.08E-10	3.84E-10	1.82E-09	5.20E-09
10.	3.59E-10	4.01E-11	9.11E-11	1.34E-10	5.42E-10	1.64E-09

Table A-1e. Mean and Fractile Seismic Hazard Curves for 2.5 Hz at JAF. (EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	6.36E-02	4.50E-02	5.12E-02	6.26E-02	7.66E-02	8.47E-02
0.001	5.08E-02	3.09E-02	3.73E-02	5.05E-02	6.45E-02	7.34E-02
0.005	1.53E-02	6.17E-03	8.85E-03	1.44E-02	2.19E-02	2.76E-02
0.01	6.33E-03	2.13E-03	3.23E-03	5.66E-03	9.51E-03	1.27E-02
0.015	3.35E-03	1.01E-03	1.60E-03	2.92E-03	5.20E-03	7.13E-03
0.03	9.20E-04	2.22E-04	3.68E-04	7.45E-04	1.49E-03	2.19E-03
0.05	2.99E-04	6.09E-05	1.05E-04	2.25E-04	4.90E-04	7.89E-04
0.075	1.12E-04	1.95E-05	3.47E-05	8.00E-05	1.84E-04	3.14E-04
0.1	5.34E-05	8.47E-06	1.53E-05	3.68E-05	8.85E-05	1.55E-04
0.15	1.81E-05	2.49E-06	4.77E-06	1.18E-05	2.96E-05	5.50E-05
0.3	2.82E-06	2.80E-07	6.17E-07	1.74E-06	4.63E-06	8.98E-06
0.5	7.46E-07	4.83E-08	1.29E-07	4.31E-07	1.25E-06	2.49E-06
0.75	2.60E-07	1.05E-08	3.37E-08	1.36E-07	4.50E-07	9.24E-07
1.	1.21E-07	3.28E-09	1.18E-08	5.66E-08	2.10E-07	4.50E-07
1.5	3.87E-08	5.83E-10	2.42E-09	1.51E-08	6.64E-08	1.55E-07
3.	4.40E-09	9.11E-11	1.62E-10	1.08E-09	6.83E-09	1.95E-08
5.	6.96E-10	4.01E-11	9.11E-11	1.53E-10	9.37E-10	3.19E-09
7.5	1.37E-10	3.14E-11	4.01E-11	9.11E-11	1.95E-10	6.54E-10
10.	3.93E-11	3.01E-11	4.01E-11	9.11E-11	9.79E-11	2.13E-10

Table A-1f. Mean and Fractile Seismic Hazard Curves for 1.0 Hz at JAF.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	4.70E-02	2.39E-02	3.23E-02	4.70E-02	6.09E-02	7.03E-02
0.001	3.17E-02	1.31E-02	1.95E-02	3.09E-02	4.37E-02	5.27E-02
0.005	7.09E-03	1.92E-03	3.42E-03	6.36E-03	1.07E-02	1.46E-02
0.01	2.80E-03	5.75E-04	1.11E-03	2.35E-03	4.50E-03	6.54E-03
0.015	1.46E-03	2.46E-04	4.98E-04	1.16E-03	2.42E-03	3.68E-03
0.03	3.84E-04	4.31E-05	9.51E-05	2.68E-04	6.64E-04	1.13E-03
0.05	1.19E-04	9.79E-06	2.29E-05	7.23E-05	2.07E-04	3.90E-04
0.075	4.23E-05	2.76E-06	6.54E-06	2.25E-05	7.23E-05	1.49E-04
0.1	1.94E-05	1.08E-06	2.60E-06	9.37E-06	3.28E-05	7.03E-05
0.15	6.14E-06	2.76E-07	6.83E-07	2.57E-06	9.93E-06	2.32E-05
0.3	8.27E-07	2.16E-08	6.45E-08	2.84E-07	1.23E-06	3.28E-06
0.5	1.95E-07	2.64E-09	1.01E-08	5.58E-08	2.80E-07	8.12E-07
0.75	6.35E-08	4.56E-10	2.01E-09	1.49E-08	8.98E-08	2.80E-07
1.	2.85E-08	1.60E-10	6.17E-10	5.35E-09	3.84E-08	1.31E-07
1.5	8.93E-09	9.11E-11	1.49E-10	1.21E-09	1.10E-08	4.13E-08
3.	1.04E-09	4.01E-11	9.11E-11	1.18E-10	9.51E-10	4.63E-09
5.	1.77E-10	3.01E-11	4.01E-11	9.11E-11	1.60E-10	7.23E-10
7.5	3.78E-11	3.01E-11	4.01E-11	9.11E-11	9.11E-11	1.72E-10
10.	1.17E-11	3.01E-11	4.01E-11	9.11E-11	9.11E-11	9.65E-11

Table A-1g. Mean and Fractile Seismic Hazard Curves for 0.5 Hz at JAF.
(EPRI, 2014)

AMPS(g)	MEAN	0.05	0.16	0.50	0.84	0.95
0.0005	2.41E-02	1.13E-02	1.62E-02	2.32E-02	3.19E-02	3.95E-02
0.001	1.39E-02	5.58E-03	8.60E-03	1.29E-02	1.92E-02	2.49E-02
0.005	2.52E-03	5.20E-04	1.04E-03	2.10E-03	4.01E-03	6.00E-03
0.01	8.94E-04	1.13E-04	2.60E-04	6.64E-04	1.53E-03	2.49E-03
0.015	4.33E-04	3.90E-05	9.79E-05	2.88E-04	7.66E-04	1.32E-03
0.03	1.01E-04	4.83E-06	1.34E-05	5.12E-05	1.82E-04	3.68E-04
0.05	2.92E-05	8.85E-07	2.53E-06	1.13E-05	5.05E-05	1.18E-04
0.075	1.01E-05	2.16E-07	6.17E-07	3.01E-06	1.62E-05	4.25E-05
0.1	4.58E-06	7.66E-08	2.25E-07	1.13E-06	6.83E-06	1.98E-05
0.15	1.47E-06	1.62E-08	5.27E-08	2.80E-07	1.92E-06	6.64E-06
0.3	2.06E-07	8.23E-10	3.63E-09	2.60E-08	2.13E-07	9.51E-07
0.5	4.90E-08	1.23E-10	4.37E-10	4.25E-09	4.31E-08	2.35E-07
0.75	1.58E-08	9.11E-11	1.18E-10	9.37E-10	1.18E-08	7.45E-08
1.	6.99E-09	5.83E-11	9.11E-11	3.23E-10	4.50E-09	3.23E-08
1.5	2.16E-09	4.01E-11	7.55E-11	1.05E-10	1.08E-09	9.24E-09
3.	2.50E-10	3.01E-11	4.01E-11	9.11E-11	1.18E-10	8.60E-10
5.	4.27E-11	3.01E-11	4.01E-11	9.11E-11	9.11E-11	1.53E-10
7.5	9.19E-12	3.01E-11	4.01E-11	9.11E-11	9.11E-11	9.11E-11
10.	2.85E-12	3.01E-11	4.01E-11	9.11E-11	9.11E-11	9.11E-11

Table A-2. Amplification Functions for JAF. (EPRI, 2014)

PGA	Median AF	Sigma ln(AF)	25 Hz	Median AF	Sigma ln(AF)	10 Hz	Median AF	Sigma ln(AF)	5 Hz	Median AF	Sigma ln(AF)
1.00E-02	1.03E+00	4.60E-02	1.30E-02	9.26E-01	6.33E-02	1.90E-02	1.00E+00	8.81E-02	2.09E-02	1.10E+00	9.33E-02
4.95E-02	9.05E-01	6.20E-02	1.02E-01	7.54E-01	1.29E-01	9.99E-02	9.83E-01	1.01E-01	8.24E-02	1.09E+00	9.62E-02
9.64E-02	8.61E-01	6.86E-02	2.13E-01	7.27E-01	1.43E-01	1.85E-01	9.76E-01	1.03E-01	1.44E-01	1.09E+00	9.65E-02
1.94E-01	8.27E-01	7.39E-02	4.43E-01	7.08E-01	1.50E-01	3.56E-01	9.67E-01	1.04E-01	2.65E-01	1.09E+00	9.68E-02
2.92E-01	8.10E-01	7.66E-02	6.76E-01	6.98E-01	1.54E-01	5.23E-01	9.61E-01	1.05E-01	3.84E-01	1.08E+00	9.71E-02
3.91E-01	7.99E-01	7.84E-02	9.09E-01	6.90E-01	1.56E-01	6.90E-01	9.55E-01	1.06E-01	5.02E-01	1.08E+00	9.74E-02
4.93E-01	7.90E-01	7.96E-02	1.15E+00	6.83E-01	1.57E-01	8.61E-01	9.50E-01	1.07E-01	6.22E-01	1.08E+00	9.76E-02
7.41E-01	7.76E-01	8.11E-02	1.73E+00	6.71E-01	1.59E-01	1.27E+00	9.40E-01	1.08E-01	9.13E-01	1.07E+00	9.76E-02
1.01E+00	7.65E-01	8.20E-02	2.36E+00	6.61E-01	1.60E-01	1.72E+00	9.31E-01	1.09E-01	1.22E+00	1.07E+00	9.76E-02
1.28E+00	7.57E-01	8.24E-02	3.01E+00	6.52E-01	1.61E-01	2.17E+00	9.22E-01	1.11E-01	1.54E+00	1.06E+00	9.74E-02
1.55E+00	7.50E-01	8.26E-02	3.63E+00	6.44E-01	1.61E-01	2.61E+00	9.14E-01	1.12E-01	1.85E+00	1.06E+00	9.80E-02
2.5 Hz	**Median AF**	**Sigma ln(AF)**	**1 Hz**	**Median AF**	**Sigma ln(AF)**	**0.5 Hz**	**Median AF**	**Sigma ln(AF)**			
2.18E-02	1.01E+00	1.25E-01	1.27E-02	1.30E+00	1.67E-01	8.25E-03	1.27E+00	1.18E-01			
7.05E-02	1.00E+00	1.24E-01	3.43E-02	1.29E+00	1.63E-01	1.96E-02	1.26E+00	1.13E-01			
1.18E-01	9.98E-01	1.23E-01	5.51E-02	1.29E+00	1.61E-01	3.02E-02	1.26E+00	1.12E-01			
2.12E-01	9.97E-01	1.21E-01	9.63E-02	1.28E+00	1.59E-01	5.11E-02	1.26E+00	1.11E-01			
3.04E-01	9.96E-01	1.20E-01	1.36E-01	1.28E+00	1.58E-01	7.10E-02	1.26E+00	1.10E-01			
3.94E-01	9.96E-01	1.19E-01	1.75E-01	1.28E+00	1.58E-01	9.06E-02	1.26E+00	1.10E-01			
4.86E-01	9.96E-01	1.19E-01	2.14E-01	1.28E+00	1.58E-01	1.10E-01	1.26E+00	1.10E-01			
7.09E-01	9.97E-01	1.18E-01	3.10E-01	1.28E+00	1.57E-01	1.58E-01	1.26E+00	1.10E-01			
9.47E-01	9.97E-01	1.17E-01	4.12E-01	1.28E+00	1.57E-01	2.09E-01	1.26E+00	1.10E-01			
1.19E+00	9.98E-01	1.17E-01	5.18E-01	1.29E+00	1.56E-01	2.62E-01	1.26E+00	1.10E-01			
1.43E+00	9.98E-01	1.18E-01	6.19E-01	1.29E+00	1.56E-01	3.12E-01	1.26E+00	1.10E-01			

Tables A-3a and A-3b are tabular versions of the typical amplification factors provided in Figures 2.3.6-1 and 2.3.6-2. Values are provided for two input motion levels at approximately 10^{-4} and 10^{-5} mean annual frequency of exceedance. These factors are unverified and are provided for information only. The figures should be considered the governing information.

Table A-3a. Median AFs and sigmas for Model 1, Profile 1, for 2 PGA levels.
(For Information Only)

M1P1K1	Rock PGA=0.0964			M1P1K1	PGA=0.292		
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.079	0.823	0.056	100.0	0.220	0.753	0.065
87.1	0.080	0.812	0.057	87.1	0.222	0.738	0.066
75.9	0.081	0.793	0.058	75.9	0.225	0.713	0.069
66.1	0.083	0.756	0.061	66.1	0.231	0.665	0.073
57.5	0.086	0.692	0.069	57.5	0.243	0.591	0.084
50.1	0.092	0.630	0.084	50.1	0.266	0.534	0.104
43.7	0.101	0.586	0.099	43.7	0.296	0.503	0.123
38.0	0.111	0.581	0.102	38.0	0.330	0.512	0.123
33.1	0.122	0.593	0.111	33.1	0.363	0.536	0.128
28.8	0.133	0.640	0.112	28.8	0.396	0.588	0.125
25.1	0.145	0.680	0.135	25.1	0.429	0.634	0.147
21.9	0.152	0.738	0.130	21.9	0.446	0.697	0.143
19.1	0.157	0.762	0.110	19.1	0.457	0.728	0.119
16.6	0.163	0.814	0.106	16.6	0.469	0.782	0.112
14.5	0.167	0.861	0.107	14.5	0.473	0.829	0.114
12.6	0.171	0.895	0.106	12.6	0.479	0.867	0.115
11.0	0.175	0.928	0.093	11.0	0.485	0.903	0.101
9.5	0.180	0.990	0.091	9.5	0.494	0.967	0.095
8.3	0.175	1.034	0.095	8.3	0.476	1.014	0.096
7.2	0.173	1.081	0.091	7.2	0.466	1.061	0.092
6.3	0.165	1.091	0.111	6.3	0.442	1.075	0.112
5.5	0.156	1.075	0.095	5.5	0.415	1.061	0.095
4.8	0.154	1.073	0.076	4.8	0.406	1.063	0.074
4.2	0.144	1.028	0.118	4.2	0.378	1.022	0.116
3.6	0.135	0.986	0.109	3.6	0.353	0.982	0.109
3.2	0.130	1.006	0.097	3.2	0.338	1.003	0.095
2.8	0.123	0.993	0.126	2.8	0.317	0.992	0.125
2.4	0.111	0.971	0.083	2.4	0.286	0.971	0.082
2.1	0.101	0.966	0.082	2.1	0.258	0.967	0.081
1.8	0.094	1.003	0.108	1.8	0.239	1.003	0.107
1.6	0.091	1.111	0.117	1.6	0.229	1.110	0.115
1.4	0.089	1.260	0.109	1.4	0.223	1.256	0.107
1.2	0.085	1.362	0.094	1.2	0.211	1.357	0.093
1.0	0.077	1.356	0.089	1.0	0.189	1.350	0.088
0.91	0.067	1.282	0.085	0.91	0.163	1.278	0.084
0.79	0.058	1.216	0.079	0.79	0.139	1.213	0.077
0.69	0.050	1.184	0.070	0.69	0.121	1.182	0.069
0.60	0.044	1.184	0.066	0.60	0.105	1.181	0.065
0.52	0.038	1.197	0.071	0.52	0.090	1.194	0.070
0.46	0.032	1.208	0.085	0.46	0.076	1.205	0.083
0.10	0.001	1.070	0.035	0.10	0.003	1.064	0.034

Table A-3b. Median AFs and sigmas for Model 2, Profile 1, for 2 PGA levels.
(For Information Only)

M2P1K1		PGA=0.0964		M2P1K1		PGA=0.292	
Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)	Freq. (Hz)	Soil_SA	med. AF	sigma ln(AF)
100.0	0.080	0.826	0.054	100.0	0.226	0.773	0.061
87.1	0.080	0.815	0.055	87.1	0.228	0.759	0.062
75.9	0.081	0.796	0.056	75.9	0.232	0.734	0.065
66.1	0.083	0.759	0.059	66.1	0.239	0.687	0.069
57.5	0.086	0.695	0.066	57.5	0.252	0.614	0.080
50.1	0.093	0.633	0.080	50.1	0.278	0.559	0.101
43.7	0.101	0.589	0.092	43.7	0.312	0.530	0.113
38.0	0.112	0.584	0.092	38.0	0.349	0.542	0.109
33.1	0.122	0.597	0.107	33.1	0.384	0.566	0.121
28.8	0.134	0.644	0.108	28.8	0.419	0.621	0.120
25.1	0.145	0.683	0.126	25.1	0.450	0.665	0.137
21.9	0.153	0.741	0.121	21.9	0.466	0.728	0.129
19.1	0.158	0.766	0.111	19.1	0.474	0.756	0.117
16.6	0.165	0.819	0.112	16.6	0.487	0.812	0.116
14.5	0.168	0.866	0.106	14.5	0.491	0.860	0.110
12.6	0.172	0.900	0.102	12.6	0.495	0.895	0.105
11.0	0.176	0.933	0.092	11.0	0.499	0.929	0.094
9.5	0.181	0.994	0.088	9.5	0.506	0.991	0.090
8.3	0.175	1.038	0.097	8.3	0.486	1.035	0.098
7.2	0.173	1.085	0.093	7.2	0.475	1.083	0.093
6.3	0.165	1.094	0.110	6.3	0.449	1.092	0.111
5.5	0.157	1.078	0.097	5.5	0.421	1.075	0.097
4.8	0.154	1.076	0.083	4.8	0.410	1.074	0.083
4.2	0.144	1.029	0.118	4.2	0.380	1.027	0.118
3.6	0.135	0.986	0.108	3.6	0.353	0.985	0.108
3.2	0.130	1.006	0.096	3.2	0.339	1.005	0.096
2.8	0.123	0.993	0.125	2.8	0.317	0.992	0.124
2.4	0.111	0.970	0.083	2.4	0.285	0.969	0.082
2.1	0.101	0.966	0.082	2.1	0.258	0.965	0.081
1.8	0.094	1.003	0.108	1.8	0.239	1.002	0.108
1.6	0.091	1.111	0.117	1.6	0.229	1.109	0.116
1.4	0.089	1.260	0.109	1.4	0.223	1.256	0.108
1.2	0.085	1.362	0.094	1.2	0.211	1.356	0.093
1.0	0.077	1.356	0.089	1.0	0.189	1.350	0.088
0.91	0.067	1.282	0.085	0.91	0.163	1.278	0.083
0.79	0.058	1.216	0.079	0.79	0.139	1.212	0.077
0.69	0.050	1.184	0.070	0.69	0.121	1.182	0.069
0.60	0.044	1.184	0.066	0.60	0.105	1.181	0.065
0.52	0.038	1.197	0.071	0.52	0.090	1.194	0.070
0.46	0.032	1.208	0.085	0.46	0.076	1.205	0.083
0.10	0.001	1.070	0.035	0.10	0.003	1.064	0.034

Appendix B

IPEEE Adequacy Review

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1.0 Background

The Nuclear Regulatory Commission (NRC) staff issued Generic Letter (GL) 88-20, Supplement 4 on June 28, 1991 (Reference 6.15) requesting that each licensee conduct an individual plant examination of external events (IPEEE) for severe accident vulnerabilities. Concurrently, NUREG-1407, “Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities” (Reference 6.2) was issued to provide utilities with detailed guidance for performance of the IPEEE.

A focused-scope seismic margin assessment (SMA) was performed for the seismic portion of the JAF IPEEE (Reference 6.1) using the NRC SMA methodology (Reference 6.3). A 0.3g focused scope SMA was performed utilizing a NUREG/CR-0098 (Reference 6.4) spectral shape for a rock site. The calculated plant-level high confidence of low probability of failure (HCLPF) for JAF resulting from performance of the IPEEE was 0.17g. This HCLPF value was based on failure of block walls separating diesel generators. These block walls were subsequently reinforced, resulting in a plant HCLPF value of 0.22g as described in section 3.0.

The NRC issued its Staff Evaluation Report (SER) on September 21, 2000 for the JAF IPEEE. The SER concluded that the JAF IPEEE process was capable of identifying the most likely severe accidents and severe accident vulnerabilities, meeting the intent of GL 88-20 (Reference 6.15).

Commitments made in the IPEEE were completed and verified in Reference 6.6 and Reference 6.7.

2.0 General Considerations

The plant licensing seismic design basis earthquake (DBE) is a Housner response spectrum with a peak ground acceleration (PGA) of 0.15g in the horizontal direction and 0.10g in the vertical direction.

The James A. Fitzpatrick IPEEE is a focused scope seismic margin assessment using the NRC SMA methodology using fault tree/event tree modeling. The IPEEE HCLPF Spectrum (IHS) is developed in accordance with NUREG/CR-0098 (Reference 6.4) rock spectrum anchored at the 0.3g. In this analysis, seismic capacity is expressed in terms of the PGA of the seismic margin earthquake (SME).

The IPEEE commitments and modifications that were required to achieve the plant level HCLPF have been completed. Verification of the completion of these commitments and modifications were provided in the JAF Response to 10CFR 50.54(f) Request for Information Recommendation 2.3 Seismic (Reference 6.6) and are further discussed below in Section 3.0.

The following sections summarize the results of the IPEEE adequacy evaluation according to the guidance of the SPID.

2.1 Relay Chatter

The JAF relay evaluation for IPEEE was consistent with the requirements of a focused-scope evaluation, as described in NUREG-1407 (Reference 6.2). The full scope detailed review of relay chatter required in SPID Section 3.3.1 has not been completed. As identified in the NEI letter to NRC dated October 3, 2013 [ML13281A308] (Reference 6.8), the relay chatter review will be completed on the same schedule as the High Frequency Confirmation as proposed in the NEI letter to NRC dated April 9, 2013 (Reference 6.19) and accepted in NRC's response dated May 7, 2013 (Reference 6.20).

2.2 Soil Failure Evaluation

The safety-related structures at JAF are founded on rock. Based on a geophysical survey that was done in 1968, the original shear wave velocity of the foundation material was estimated to be in excess of 5,500 ft/sec (Reference 6.1). Rock was previously defined as material with a shear-wave velocity greater than 3,500 ft/sec, therefore soil failure effects (such as liquefaction, slope stability and settlement) are considered negligible (Reference 6.16).

As stated in NUREG-1407, Section 3.2.1 (Reference 6.2), a plant in the full-scope category that is located on a rock site is not required to perform a soil failure evaluation.

3.0 Prerequisites

The following items have been addressed in order to use the IPEEE analysis for screening purposes and to demonstrate that the IPEEE results can be used for comparison with the ground motion response spectra (GMRS):

1.) Confirmation that commitments made under the IPEEE have been met.
2.) Confirmation that all of the modifications and other changes credited in the IPEEE analysis are in place.
3.) Confirmation that any identified deficiencies or weaknesses to NUREG-1407 in the JAF IPEEE NRC SER are properly justified to ensure that the IPEEE conclusions remain valid.
4.) Confirmation that major plant modifications since the completion of the IPEEE have not degraded/impacted the conclusion reached in the IPEEE.

Response:

<u>Item 1</u>

The JAF IPEEE commitments were completed. Verification of these commitments were completed and were provided in the JAF Response to 10CFR 50.54(f) Request for Information Recommendation 2.3 Seismic (Reference 6.6).

The principal insight from the seismic margins assessment was that the overall plant HCLPF was dominated by seismically induced station blackout events. The dominant seismically-induced station blackout sequences were controlled by the seismic failure of block walls EGB-272-6, -7, -9 and -10 (HCLPF = 0.17g).

In response to this finding, JAF committed to strengthen these block walls located in the emergency diesel generator building. This commitment was carried out as Modification D1-96-011 (see Reference 6.6).

A vulnerability to fire or explosion as a result of the seismic-induced failure of the hydrogen line in the turbine building was identified. Accordingly, procedure AOP-14, “Earthquake” (Reference 6.14), was modified by adding a note stating that the hydrogen piping in the Turbine Building is susceptible to failure during a seismic event and that the piping can be isolated by closing 89A-H2HAS-1, the hydrogen supply isolation valve.

The IPEEE report stated that “Although no ‘low ruggedness’ relays were found in the emergency diesel generator system, relays for which no seismic capacity documentation exists are present in that system. Should the relays be of low seismic capacity, there is the potential for the common-cause failure of all EDGs. This issue was resolved as part of the A-46 program, as verified in Reference 6.7.”

Item 2

No instances were found where the IPEEE analysis took credit for a plant modification that had not been implemented at the time of the IPEEE.

Item 3

The JAF NRC Staff Evaluation Report (Reference 6.5) on the seismic portion of the IPEEE concluded that the process, organization, and documentation are consistent with NUREG-1407 (Reference 6.2) and the study addressed all major issues relevant to the IPEEE program as requested for a 0.3g focused scope plants.

However, the following observations were noted during the review of the SER:

1. In a few areas related to structural fragility evaluation, the described analysis were considered to be inconsistent with the guidelines contained in EPRI-6041 (Reference 6.17). Specifically :

   A) Screening of Class II structure of the turbine building using the screening criteria for Class I structures.

   The entire turbine building complex is a reinforced concrete structure except for the turbine hall and the screenwell superstructure, neither of which house SMA components. The Class

I structures were designed for the 0.15g design basis earthquake and the Class II portions of the structure were designed for the 0.08g operating basis earthquake. The turbine building complex was assigned a seismic capacity of 0.3 PGA per Table 2-3 of EPRI NP-6041 (Reference 6.17). This is justified since the Class I structures is designed for 0.15g which exceeds the NP-6041 requirements of 0.10g. While the Class II design of 0.08g for OBE is less than the EPRI requirement of 0.10g SSE, the difference in accelerations is compensated by the lower values for damping and other constraints used in the OBE analysis.

B) Capacity estimation of block walls.

Although the methods described in EPRI NP-6041 (Reference 6.17) were not followed exactly, the block walls with a 0.17g HCLPF (which represents the plant HCLPF) were modified. This raised the plant HCLPF from 0.17g to 0.22g. These block wall failures were the dominant contributor to plant seismic-induced core damage, and therefore no IPEEE seismic insights were impacted.

2. HCLPFs obtained for unreinforced concrete block walls at Fitzpatrick are optimistic and should not be used as capacity estimates for these structures.

   As stated above, the block walls that were dominant contributors to core damage sequences were subsequently reinforced to achieve a plant HCLPF value of 0.22g.

3. There is no discussion in the submittal about possible fires resulting from electrical equipment.

   The independent review team concluded that the analysis of seismic-induced fires appears adequate, and the review was done adequately based on a thorough walkdown (Section 6.4.1.1 of the IPEEE, Reference 6.1). Therefore, the IPEEE conclusions regarding seismically induced fires remain valid.

4. Consequences of collapse of the screenwell superstructure are not well explained.

   The screenwell superstructure was screened out per EPRI NP-6041, as stated in section 3.1.4.1 of the IPEEE report (Reference 6.1).

Item 4

Since the issuance of IPEEE Report in 1996, all plant modification at JAF have been controlled by the current modification procedure EN-DC-115 (Reference 6.9) and its predecessors. All of these procedures have strict rules for seismic design, which means that all modifications have been evaluated for any potential adverse seismic effects. Based on these strict procedures, no major modifications were performed that would invalidate the results of the JAF IPEEE.

4.0 Adequacy Demonstration

4.1 Structural Models and Structural Response Analysis

Methodology used:

Structural Models

Pertinent resources, including IPEEE (Reference 6.1), SER (Reference 6.5), and calculations (References 6.11 to 6.14 and 6.22) were reviewed.

Major structures for the JAF site considered in the SMA are the Reactor Building and Turbine Building Complex. Structural models were developed in the '70s for the purposes of generating modal properties for dynamic analysis. The seismic margin earthquake is the NUREG/CR-0098 (Reference 6.4) spectrum anchored to a peak ground acceleration of 0.3g.

The dynamic models were developed such that they can accurately predict the building response, including in-structure response spectra, in the frequency range of interest. The JAF dynamic models of the structures are adequate to represent frequencies in excess of 20 Hz and, as such, are adequate for the assessments focused on the 1 Hz to 10 Hz range.

Basically the plant consists of two building complexes: (1) the reactor building housing the reactor pressure vessel, primary shield wall, drywell, and the suppression chamber and (2) the turbine building complex which includes the turbine building, administration building, radwaste building, screenwell pumphouse, and emergency diesel generator building. The structural models from the original design basis analyses were used in the IPEEE. These building structures were modeled as beam elements with the appropriate axial, shear and bending stiffnesses. The masses of walls, floors, and equipment were lumped discretely at floor elevations and other major structural discontinuities. The reactor and turbine building complexes have some torsional irregularities. However, the structural models are detailed enough to capture the overall structural responses for both the horizontal and vertical components of ground motion.

The bedrock was represented by translational springs, vertical and horizontal, calculated based on an equivalent circular base. Rocking flexibility was not considered, since the rocking stiffness was judged to be extremely rigid.

Compliance with NUREG-1407:

This methodology meets the guidance and requirements of EPRI NP-6041 (Reference 6.17) and the enhancements specified in NUREG-1407 (Reference 6.2).

Adequate for Screening:

The IPEEE methodology and structural modeling are in compliance with NUREG-1407 (Reference 6.2) and are adequate for screening purposes.

4.2 In-Structure Demands and ISRS

Methodology used:

For the JAF IPEEE, new in-structure response spectra (ISRS) were generated using a direct generation methodology. This is one of the two methods deemed acceptable in EPRI NP-6041 (Reference 6.17, pages 4-25) for development of floor response spectra; the other method is time history analysis. The seismic margin earthquake (SME) was converted to a power spectral density (PSD), and that PSD was applied to the existing design basis structural dynamic models. Random vibration analysis techniques were then used to obtain floor PSDs, and the floor PSDs were converted to ISRS.

Compliance with NUREG-1407:

This methodology meets the guidance and requirements of EPRI NP-6041 (Reference 6.17) and the enhancements specified in NUREG-1407 (Reference 6.2).

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2) and the IPEEE in-structure demands and ISRS results are adequate for screening purposes.

4.3 Selection of Seismic Equipment List (SEL)/Safe Shutdown Equipment List (SSEL)

Methodology

The initial component list was developed from the JAF A-46 safe shutdown equipment list (SSEL) and the JAF IPE database. The JAF A-46 SSEL was developed using the methodology presented in the Generic Implementation Procedure (GIP) (Reference 6.10). The initial component list was developed from the Individual Plant Examination (IPE) component database. Balance of plant components and components dependent on offsite power were removed based on the assumption that offsite power will be lost in a seismic event. In addition, components not in the IPE database but included in the A-46 SSEL were added to the list of components. Components not included in the IPE due to low random failure probabilities (e.g., tanks, heat exchangers, etc.) were added to the seismic component list.

Event tree functional success paths were developed with the aid of the IPE event tree models. Support system requirements for the above functional success paths were identified. A list of components was developed for each system with an indication of the component location. The location of equipment was used to ensure that the list of structures was complete for seismic capability screening and analysis.

The type of components considered under the civil/structural review (passive components) were those required to remain intact and provide physical support for mechanical and electrical components.

The passive and active components included in the IPEEE scope are identified in Tables in the JAF IPEEE submittal (Reference 6.1).

Compliance with NUREG-1407:

This methodology meets the guidance and requirements of EPRI NP-6041 (Reference 6.17) and the enhancements specified in NUREG-1407 (Reference 6.2).

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2), and the IPEEE seismic equipment selection results are adequate for screening purposes.

4.4 Screening of Components

Methodology used:

Components were evaluated using the screening criteria summarized in Tables 2-3 and 2-4 of EPRI-6041 (Reference 6.17).

The JAF Seismic Review Team (SRT) screened from further margin review those structures and components for which the SRT could document a HCLPF calculated to exceed the seismic margin earthquake (SME) of 0.3g.

In addition, IPE components were screened if they were only subject to non-seismic failures with probabilities less than the following:

- 10^{-2} if the failure of the component leads to the loss of only one train in one system
- 10^{-3} if the failure of the component leads to the loss of all trains in one system
- 10^{-3} if the failure of the component leads to the loss of one train in multiple systems
- 10^{-4} if the failure of the component leads to the loss of multiple trains in multiple systems

Structures and equipment that could not be screened were further evaluated as documented in the IPEEE submittal and back up calculations/evaluations (Reference 6.1).

Screening evaluations included spatial interactions, such as assessment of the effects of seismic induced flooding, proximity to other structures or components, etc. (see walkdown methodology discussion below).

Compliance with NUREG-1407:

The above methodology meets the requirements of NUREG-1407, Section 3.2.4.4, “Screening Criteria” (Reference 6.2) which states that screening guidance given in the GIP may be used provided review/screening is performed at the appropriate seismic margin earthquake.

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2) and the IPEEE screening of component results are adequate for screening purposes.

4.5 Walkdowns

Methodology used:

Evaluation of electrical and mechanical equipment relied in part on the walkdowns conducted as part of the USI A-46 seismic evaluation. Additional walkdowns were performed as part of the IPEEE. If the IPEEE walkdown judged the equipment anchorage was not robust, the A-46 anchorage evaluation was scaled to obtain an anchorage seismic capacity. Masonry block walls were noted if adjacent to equipment. The final assigned seismic capacity was the minimum capacity of the equipment, anchorage capacity, or any adjacent block wall.

Particular attention was paid to proximity effects from equipment interaction, failure of overhead equipment, and flexibility of attached lines or cables.

The IPEEE walkdown team was comprised of the same members as the A-46 walkdown team.

Compliance with NUREG-1407:

Walkdowns were conducted and documented in accordance with EPRI NP-6041 (Reference 6.17) as required by Section 3.2.4.1 of NUREG-1407 (Reference 6.2).

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2) and the IPEEE walkdown results are adequate for screening purposes.

4.6 Fragility Evaluations

Methodology used:

For seismic IPEEE purposes, JAF is a 0.3g focused scope plant (Table 3.1 of NUREG-1407, Reference 6.2). As such, the objective of the seismic margin assessment was to rank structures, equipment, and distribution systems in terms of their seismic capacity. In this assessment, seismic capacity is expressed in terms of the peak ground acceleration of the seismic margin earthquake.

Components were evaluated using the screening criteria summarized in Tables 2-3 and 2-4 of EPRI NP-6041 (Reference 6.17). These criteria assign a seismic (HCLPF) capacity to a component based on three seismic levels, expressed in terms of 5% damped peak spectral acceleration: 0.8g, 0.8g to 1.2g, and >1.2g. In terms of peak ground acceleration (PGA), the common practice is to convert these levels to 0.3g, 0.3g to 0.5g and > 0.5g.

No attempt was made to assign a PGA greater than 0.5g to a component. Therefore, the criteria in the Tables 2-3 and 2-4 for the third earthquake level were not applied. If a component met the requirements for the second earthquake level, it was assigned a capacity of 0.5g. If a component could meet the requirements for the first level but not the second level, it was assigned a capacity of 0.3g. If a component could not meet the requirements for the first level, a capacity was calculated.

The evaluation of major structures was based primarily on a review of the design bases, augmented by a walkdown to identify any anomalous conditions. Seismic capacities were explicitly calculated for masonry block walls, either by scaling existing NRC IE Bulletin 80-11 (Reference 6.21) calculations or by specific calculation.

The evaluation of mechanical and electrical equipment relied heavily on the walkdowns conducted for the USI A-46 seismic evaluation. The seismic capacities of distribution systems, include piping, electrical raceways, and ductwork, were estimated. The seismic capacity of the raceways was based on the A-46 raceway evaluations. Piping and ductwork were evaluated from a review of the design bases, augmented by walkdowns.

Compliance with NUREG-1407:

James A. FitzPatrick calculated HCLPFs in accordance with the guidance of EPRI NP-6041 (Reference 6.17) and NUREG-1407, Section 3.2.5.7 (Reference 6.2). Block walls in the diesel generator building resulted in the limiting HCLPF value of 0.17g. In response to this finding, JAF committed to strengthen these block walls (located in the emergency diesel generator building). This commitment was carried out as Modification D1-96-011 (see Reference 6.6).

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2), and the IPEEE fragility evaluation results are adequate for screening purposes.

4.7 System Modeling

Methodology used:

The JAF SMA analysis used the NRC methodology incorporating seismic event trees and fault trees.

Seismic initiating events were based on the plant response to a 0.3 g review level earthquake (RLE). The first event tree to be solved was the Seismic Event Tree. This event tree is composed of top events addressing the following areas:

- Reactivity control (ATWS)
- Structural integrity
- AC power (offsite power and EDGs)
- Primary system integrity.

The Seismic Event Tree sequences terminated in core damage, a Loss of Coolant Accident (LOCA) event (Small Loss of Coolant Accident (SLOCA), Medium Loss of Coolant Accident (MLOCA) or Large Loss of Coolant Accident (LLOCA)), a seismic transient, or a small seismic event (not further analyzed). The transient seismic, SLOCA, MLOCA, and LLOCA end states transferred each to a separate event tree for further analysis. Seismic sequence success was defined as maintaining a hot shutdown state for 72 hours.

Support systems required for frontline systems were modeled and included in the fault tree analysis.

Human actions defined in the IPE were evaluated for seismic events. Latent human failure probabilities prior to the seismic event were unchanged from the IPE values. Also, human failure probabilities following a seismic event less severe than the DBE (0.15g) were assumed to be the same as the IPE values. Human failure probabilities for seismic events between 0.15g and 0.5g were assumed to be twice their IPE values. For seismic events exceeding 0.5g, human failure probabilities were assumed to be 0.1 for actions inside the control room, and 1.0 for actions outside the main control room. Because of the high uncertainty of post-seismic-event human actions, human actions were analyzed qualitatively but not quantitatively.

The evaluation of non-seismic failures and human actions was considered in the IPEEE evaluation of seismic risk. The systems and components in the success path with the highest non-seismic unreliability were identified, and the impact on risk was evaluated and documented in the IPEEE.

Major structures and systems whose failure might lead to early containment failure were reviewed during walkdowns and evaluated by seismic capacity calculations. Included in the evaluations were the seismic gaps between major structures. Major structures evaluated were the drywell, torus, and the primary coolant system. All these structures were concluded to have HCLPF values sufficient to justify screening from further analysis.

Compliance with NUREG-1407:

The fault tree/event tree modeling meets the requirements of NUREG-1407 (Reference 6.2) as detailed in NUREG-4482 (Reference 6.3) as endorsed in Reference 6.2. The treatment of non-seismic failures and human actions in the JAF IPEEE meets the requirements of Section 3.2.5.8 of NUREG-1407 (Reference 6.2).

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2), and the IPEEE system modeling results are adequate for screening purposes.

4.8 Containment Performance

Methodology used:

Major structures and systems whose failure might lead to early containment failure include the drywell, torus, reactor building, and the primary coolant system. All these structures were concluded to have HCLPF values sufficient to justify screening from further analysis.

Pathways that could significantly contribute to containment isolation were evaluated. The evaluation included the equipment required to isolate and to provide for the structural integrity of the penetration. The isolation valve list was derived from the JAF IPE. No isolation valves required instrument air or nitrogen for actuation, and were not impacted by loss of offsite power. All containment isolation valves were screen with a HCLPF of 0.5g.

Two isolation valves were identified that could remain open from relay chatter, but a normally closed isolation valve in series would maintain successful isolation. All containment penetrations were found to be seismically rugged.

Other findings related to seismically induced containment failure were:

- No seismic vulnerabilities were identified for isolation valves whose failure could lead to an ISLOCA event.
- Seismic failure of the reactor building (HCLPF = 0.3g) would lead to core damage and containment bypass.
- Drywell personnel and equipment hatches were determined to be rugged with no seismic vulnerabilities.

No unique seismic-related decay heat removal vulnerabilities were found. The plant HCLPF capacity for decay heat removal was estimated to be 0.3g.

Compliance with NUREG-1407:

The review of containment meets the requirements of Section 3.2.6 of NUREG-1407 (Reference 6.2) to evaluate the containment integrity, isolation, bypass and suppression functions to identify vulnerabilities that involve early failure of the containment functions.

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2), and the IPEEE containment performance results are adequate for screening purposes.

4.9 Peer Review

Methodology used:

Methodology, data results, and conclusions of the seismic IPEEE were reviewed at several levels:

- NYPA Systems analysis Group staff and the consultants reviewed each other's work at each stage of the process.
- NYPA staff from various areas, including licensing, engineering, technical services and training reviewed data and conclusions.

A formal, independent, peer review was performed on the IPEEE final draft report. The peer review team addressing the seismic IPEEE consisted of:

- Mr. Robert J. Budnitz, President, Future Resources Associates, INC
  Mr. Budnitz was chairman of the expert panel that developed the NRC SMA methodology and was the principal outside systems consultant to the NRC on the enhancement guidance in NUREG-1407.
- Dr. John D. Stevenson, Structural Mechanical Consulting Engineer.
  Dr. Stevenson is a recognized expert in structural analysis.

Key comments and resolutions are summarized in the IPEEE (Reference 6.1).

Compliance with NUREG-1407:

The above review process, using a combination of IPEEE Team Members, an Independent In-house Review Team, and an external consultant for seismic review, meets the requirements of Section 7 of NUREG-1407 (Reference 6.2) for peer review.

Adequate for Screening:

The methodology used is in compliance with NUREG-1407 (Reference 6.2), and the IPEEE peer review results are adequate for screening purposes.

5.0 Conclusion

The JAF IPEEE was a focused-scope seismic margin analysis. A soil failure analysis is not necessary since the structures are founded on bedrock. A relay evaluation consistent with a full-scope IPEEE, as described in NUREG-1407 (Reference 6.2), will be performed according to the schedule provided in NEI letter to NRC dated October 3, 2013 (Reference 6.8).

Based on the IPEEE adequacy review performed consistent with the guidance contained in EPRI 1025287 (Reference 6.16) and documented herein, with the exception of the completion of the detailed relay chatter review, the JAF IPEEE results are considered adequate for screening and the risk insights gained from the IPEEE remain valid under the current plant configuration.

Information used in determining the IPEEE adequacy is contained in the JAF record management system and is available for onsite audit by the NRC.

6.0 References

6.1 JAF-RPT-MISC-02211, "James A. Fitzpatrick Nuclear Power Plant Individual Plant Examination of External Events," Rev. 0, June 1996.

6.2 NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," June 1991.

6.3 NUREG/CR-4482, "Recommendations to the Nuclear Regulatory Commission on Trial Guidelines for the Seismic Margins Reviews of Nuclear Power Plants," March 1986.

6.4 NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," May 1978.

6.5 Nuclear Regulatory Letter to Power Authority of the State of New York, "James A. Fitzpatrick Nuclear Power Plant – Review of Fitzpatrick Individual Plant Examination of External Events (IPEEE)," TAC NO. M83622, September 21, 2000.

6.6 Entergy JAF-12-0134, Letter – "Seismic Walkdown Report – Entergy's Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Seismic Aspects of Recommendation 2.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," James A, Fitzpatrick Nuclear Power Plant, Docket No. 50-333, License No. DPR-59.

6.7 Entergy JAF Corrective Action, WT-WTHQN-2011-01114, "Verify that the actions described in the IPEEE associated documents have been completed as committed," closed 5/8/2012.

6.8 NEI Letter, Kimberly A. Keithline to David L. Skeen, NRC, "Relay Chatter Reviews for Seismic Hazard Screening," dated October 3, 2013.

6.9 Entergy Procedure EN-DC-115, “Engineering Change Process,” Revision 16, 11/21/2013.

6.10 SQUG, “Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment”, Revision 2, Corrected, February 14, 1992.

6.11 Entergy PASNY Calculation 16-0-39, “Final Dynamic Analysis,” June 1972.

6.12 Entergy NYPA File No. 02268.5036-1A, “Procedures and Criteria for Generation of In-Structure Response Spectra,” September 1992.

6.13 Entergy S Stevenson & Associates Calculation 93C2803-C008, Revision 0, “Development of Review Level Earthquake Floor Response Spectra.”

6.14 Entergy JAF Procedure AOP-14, Revision 14, “Earthquake.”

6.15 United States Nuclear Regulatory Commission, “Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities - 10CFR 50.54(f) (Generic Letter No. 88-20, Supplement 4),” June 28, 1991.

6.16 Electric Power Research Institute, “Seismic Evaluation Guidance Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic,” Report 1025287, Feb. 2013.

6.17 “A Methodology for Assessment of Nuclear Power Plant Seismic Margin,” Revision 1, NP-6041-SLR1, Aug 1991.

6.18 United States Nuclear Regulatory Commission, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” NUREG-0800, July 1981.

6.19 NEI Letter to NRC, “Proposed Path Forward for NTTF Recommendation 2.1: Seismic Reevaluations,” April 9, 2013.

6.20 NRC Letter, Eric J. Leeds to Joseph E. Pollock, NEI “Electric Power Research Institute 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 Reevaluation,” dated May 7, 2013.

6.21 United States Nuclear Regulatory Commission, “Bulletin 80-11: Masonry Wall Design," May 8, 1980.

6.22 Entergy PASNY Calculation 11825-Book 2-1, Revision 0, “Turbine Building and Adjacent Buildings,” June 1971.