Response to

Request for Additional Information No.35, Supplement 1, Revision 0

8/01/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 02.05.02 - Vibratory Ground Motion
SRP Section: 02.05.04 - Stability of Subsurface Materials and Foundations
Application Section: FSAR Ch. 2
RGS1 Branch

Question 02.05.02-3:

In FSAR Tier 2 Section 2.5.2.6 “Ground Motion Response Spectrum,” you state, in guideline step 8, that comparison of structural seismic responses of the CSDRS with detailed site-specific SSI analyses will be made at some key locations as defined in Section 3.7.2. Please verify the control point elevation for the fuel building (FB) as defined in Section 2.5.2.6 compared with that described in Section 3.7.2.

Response to Question 02.05.02-3:

When it is necessary to perform detailed site-specific soil-structure interaction (SSI) analyses as discussed in U.S. EPR FSAR Tier 2, Section 2.5.2.6, guideline step 8; site-specific in-structure response spectra (ISRS) must be compared with U.S. EPR ISRS for the key locations identified by U.S. EPR FSAR Tier 2, Section 3.7.2.

The Fuel Building control point elevation is at +12 ft, 1-2/3 in. as specified in U.S. EPR FSAR Tier 2, Section 2.5.2.6, guideline step 8, item F.

U.S. EPR FSAR Tier 2, Section 3.7.2, will be revised to include U.S. EPR Fuel Building ISRS text and figures for elevation +12 ft, 1-2/3 in.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.7.2.5 will be revised as described in the response and as indicated on the enclosed markup.

U.S. EPR FSAR Tier 2, Figure 3.7.2-110, Figure 3.7.2-111, and Figure 3.7.2-112 will be added as described in the response and indicated on the enclosed markup.

Question 02.05.04-2:

FSAR Tier 2 Section 2.5.4.10.1, states that "the maximum bearing pressure under static loading conditions for the foundation basemat beneath the NI Common Basemat Structures is 22,000 lb/ft^2," and "the maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is 25,000 lb/ft^2." Please explain how the maximum dynamic/seismic bearing pressure was determined and justify this value with comparing maximum static bearing pressure. Please also explain why there is no maximum dynamic/seismic bearing pressure related parameter in the Tier I document.

Response to Question 02.05.04-2:

Maximum dynamic bearing pressure value under safe shutdown earthquake (SSE) loads was calculated using a nonlinear time history analysis with explicit representations of soil properties, Nuclear Island (NI) foundation mat and superstructure.

Maximum dynamic bearing pressure under SSE loads combined with other loads, as calculated by the method described in the preceding paragraph, is 34,560 lb/ft^2. The currently stated value of 25,000 lb/ft^2 shown in U.S. EPR FSAR Tier 2, Section 2.5.4.10.1, Section 3.8.5.5.1, and Table 3.8-16 will be revised to indicate 34,560 lb/ft^2.

U.S. EPR FSAR Tier 2, Table 2.1-1 under the Soil Section, will be revised to include the minimum soil dynamic bearing capacity value.

U.S. EPR FSAR Tier 1, Table 5.0-1 under Soil Parameters, will be revised to include the minimum soil dynamic bearing capacity value.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 2.5.4.10.1, Section 3.8.5.5.1 and Table 3.8-16 will be revised as described in the response and as indicated on the enclosed markup.

U.S. EPR FSAR Tier 2, Table 2.1-1 will be revised as described in the response and as indicated on the enclosed markup.

U.S. EPR FSAR Tier 1, Table 5.0-1 will be revised as described in the response and as indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

Table 5.0-1—Site Parameters for the U.S. EPR Design (5 Sheets)

Soil	
Parameter	**Value(s)**
Soil properties:	
(mMinimum shear wave velocity,	Minimum shear wave velocity (low strain best estimate average value at bottom of basemat) of 1000 feet per second.
mMinimum static bearing capacity (static),	Minimum static bearing capacity (static) of 22ksf,000 lb/ft² in localized areas at the bottom of the Nuclear Island basemat and 15ksf,000 lb/ft² on average across the total area of the bottom of the Nuclear Island basemat.
02.05.04-2 Minimum dynamic bearing capacity	Minimum dynamic bearing capacity of 34,560 lb/ft² at the bottom of the Nuclear Island basemat.
(Liquefaction potential)	No potential for liquefaction.
Maximum ground water level	Maximum ground water level is 3.3 ft below grade.
Maximum Differential Settlement (across the basemat)	1/2 inch in 50 ft in any direction
Slope Failure Potential	No slope failure potential is considered in the design of safety-related SSC for U.S. EPR design certification.

Table 2.1-1—U.S. EPR Site Design Envelope
Sheet 1 of 7

U.S. EPR Site Design Envelope	
Precipitation (Refer to Section 2.4)	
Rainfall	≤19.4 in/hr
Snow (design: extreme live load, including 48-hour probable maximum winter precipitation)	≤100 psf
Seismology (Refer to Sections 2.5 & 3.7)	
Horizontal SSE Acceleration	0.3g Peak (CSDRS shapes – See Section 3.7.)
Vertical SSE Acceleration	0.3g Peak (CSDRS shapes – See Section 3.7.)
Fault Displacement Potential	No fault displacement is considered for safety-related SSCs in U.S. EPR design certification.
Soil (Refer to Section 2.5)	
Minimum Static Bearing Capacity ~~(Static)~~	22 ksf in localized areas at the bottom of the Nuclear Island basemat and 15 ksf on average across the total area of the bottom of the Nuclear Island basemat.
Minimum Dynamic Bearing Capacity	34.56 ksf at the bottom of the Nuclear Island basemat.
Minimum Shear Wave Velocity (Low strain best estimate average value at bottom of basemat)	1000 fps
Liquefaction	None

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2.5.4.7 Response of Soil and Rock to Dynamic Loading

Section 2.5.2 notes that the design of the U.S. EPR is based on the assumption that the shear wave velocities assumed for the 10 generic soil profiles described in Section 3.7.1.3 are strain-compatible properties. For SSI analysis for the U.S. EPR, assumed relationships to depict the strain-dependent modulus-reduction and hysteretic damping properties are not explicitly considered. The COL applicant will address site-specific response of soil and rock to dynamic loading, including the determination of strain-dependent modulus-reduction and hysteretic damping properties.

2.5.4.8 Liquefaction Potential

The design of the U.S. EPR assumes that the plant is not founded on liquefiable materials (GDC 2).

The COL applicant will address site-specific liquefaction potential. As stated in ~~Section 2.5.2~~Section 3.7.1, the evaluation of liquefaction is performed for the seismic level of the site-specific SSE.

2.5.4.9 Earthquake Site Characteristics

Section 3.7.1 describes the seismic design basis for the U.S. EPR. Section 2.5.2 presents a brief summary of the seismic design basis.

Site-specific earthquake site characteristics will be described by the COL applicant.

2.5.4.10 Static Stability

Static stability pertaining to bearing capacity and settlement for the U.S. EPR is described in the following section. Additional information is provided in Section 3.8.5 for the foundations of Seismic Category I structures.

2.5.4.10.1 Bearing Capacity

The maximum bearing pressure under static loading conditions for the foundation basemat beneath the NI Common Basemat Structures is 22,000 lb/ft^2, which includes the dead weight of the structure and components and 25 percent of the live load. The maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is ~~25,000~~34,560 lb/ft^2. Refer to Appendix 3E for details of these bearing pressures under the basemat (GDC 2). 02.05.04-2

A COL applicant that references the U.S. EPR design certification will verify that site-specific foundation soils beneath the foundation basemats of Seismic Category I structures have the capacity to support the bearing pressure with a factor of safety of 3.0 under static conditions.

Acceptance criteria for settlement for Seismic Category I foundations are addressed in Section 2.5.

Additional acceptance criteria for critical areas of these structures are described in Appendix 3E.

A COL applicant that references the U.S. EPR design certification will evaluate site-specific methods for shear transfer between the foundation basemats and underlying soil for soil parameters that are not within the envelope specified in Section 2.5.4.2.

3.8.5.5.1 Nuclear Island Common Basemat Structure Foundation Basemat

Appendix 3E provides details of the design of the NI Common Basemat Structure foundation basemat critical areas.

Maximum soil bearing pressures under the NI Common Basemat Structure foundation basemat are 22,000 pounds per square foot for static loading conditions, and ~~25,000~~34,560 pounds per square foot for dynamic loading conditions.

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The NI Common Basemat Structure foundation basemat for the U.S. EPR plant design can accommodate tilt settlements up to 0.5 inches in 50 feet in any direction across the basemat, as described in Section 2.5.4.10.2. Differential settlements and local settlements within the perimeter of the foundation, are not likely to affect the structure, systems, or components due to the extremely thick foundation stiffened by numerous shear walls. The combined stiffness allows the NI Common Basemat Structure foundation basemat to bridge potential foundation irregularities.

For worst-case loading combinations on the NI Common Basemat Structure foundation basemat, the conservative methodology used to calculate sliding and uplift due to seismic loadings is described in Section 3.8.5.4.2. The calculated values, as provided in Table 3.8-16, are sufficiently small that they can be considered inconsequential with respect to sliding and overturning.

For worst-case loading combinations on the RB internal structures basemat above the containment liner, the minimum safety factor against sliding is 0.16 occurring for soil case 2sn4u, based solely on friction between the liner and the supporting concrete. Because friction will not prevent sliding, the surrounding concrete haunch wall is designed with sufficient capacity to resist the total base shear force. The minimum safety factor against overturning is 1.22 occurring for soil case 2sn4u.

3.8.5.5.2 Emergency Power Generating Buildings Foundation Basemats

Appendix 3E provides details of the design of the EPGB foundation basemats critical sections.

Table 3.8-16—Dynamic Analysis Results

Soil Case Name	Maximum Bearing Pressure		Maximum Sliding-X		Maximum Sliding-Y		Maximum Uplift-Z	
	Bearing Pressure	Time	Sliding -X~~-~~ East-West	Time	Sliding -Y~~-~~ North-South	Time	Uplift -Z	Time
	(ksf)	(s)	(inch)	(s)	(inch)	(s)	(inch)	(s)
5a	~~18~~27.42	~~7.64~~ 7.5150	~~0.0011~~0.0020	~~4.82~~ 6.9075	~~0.0011~~0.0027	~~5.975~~ 9.9125	0.0133 ~~-0.0004~~	~~4.18~~5.1125
4u	~~22~~33.84	~~9.035~~ 4.8950	~~0.0201~~0.3165	~~12.055~~ 6.7850	~~0.0189~~0.2298	~~4.85~~ 9.2325	~~0.0497~~ 0.2371	~~1.775~~ 1.8050
2u	~~19~~20.22	~~11.59~~ 6.2250	~~0.0174~~0.0175	~~7.7~~ 6.9750	~~0.0118~~0.0124	~~5.83~~ 4.4175	~~0.0175~~ 0.1056	~~4.325~~ 4.3425
2n3u	~~23~~28.57	~~4.935~~ 9.5575	~~0.0314~~0.0292	~~12.92~~ 12.9350	~~0.0195~~0.0294	~~7.665~~ 9.5200	~~0.1992~~ 0.4180	~~9.14~~ 7.7525
2sn4u	~~25~~34.56	~~1.84~~ 9.8225	~~0.0586~~0.2381	~~5.32~~ 7.1875	~~0.0390~~0.1600	~~5.385~~ 7.6825	~~0.2191~~ 0.6604	~~1.815~~ 5.2850
1u	~~16~~17.25	10.4500	~~0.0073~~0.0071	~~9.75~~ 9.7575	~~0.0057~~0.0056	~~7.03~~ 12.8100	-0.0031~~0~~	2.4800

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Next File

Figure 3.7.2-110—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 inches (3.7 m) 2%, 3%, 4%, 5%, 7% and 10% Damping X-Direction

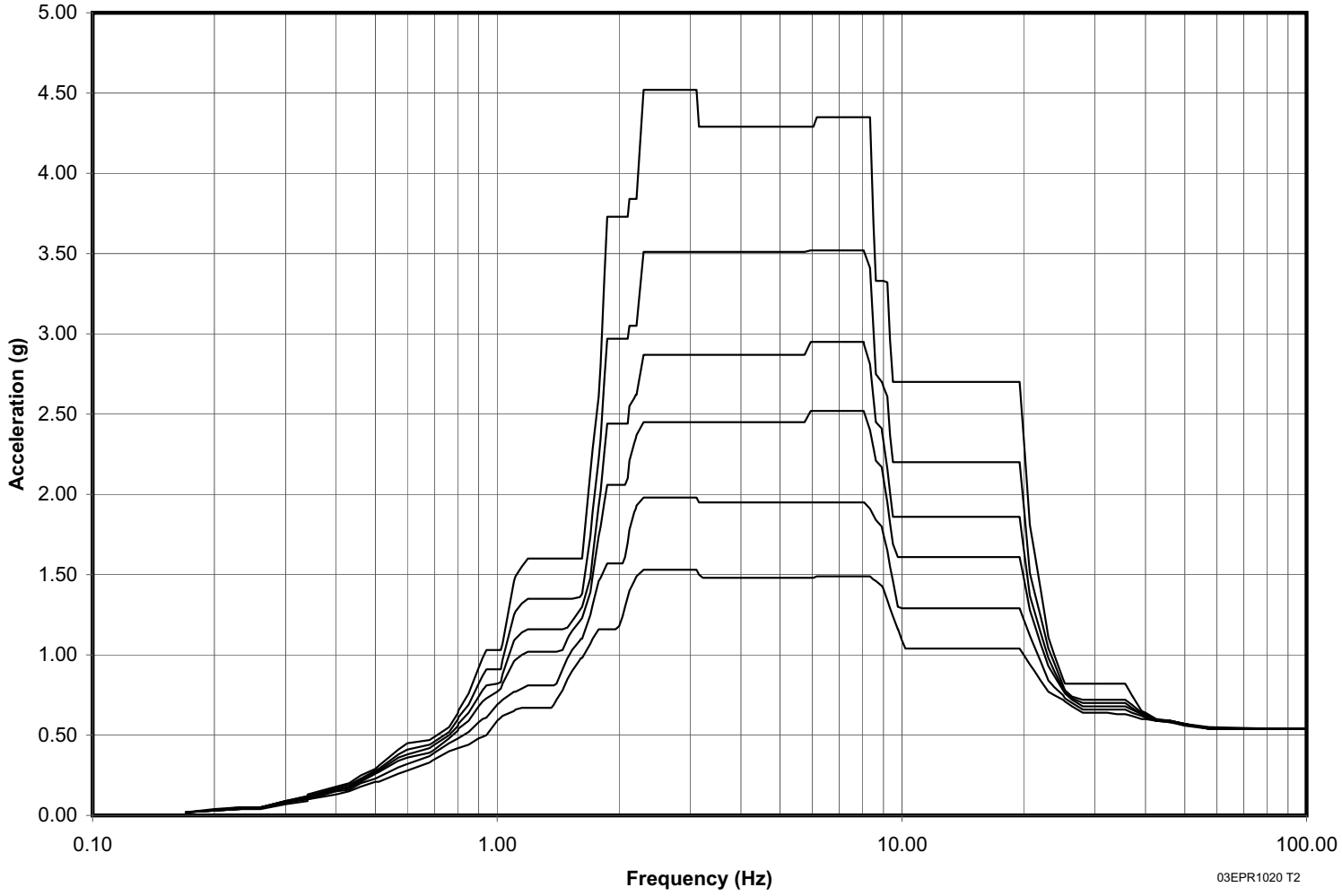

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Figure 3.7.2-111—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 inches (3.7 m) 2%, 3%, 4%, 5%, 7% and 10% Damping Y-Direction

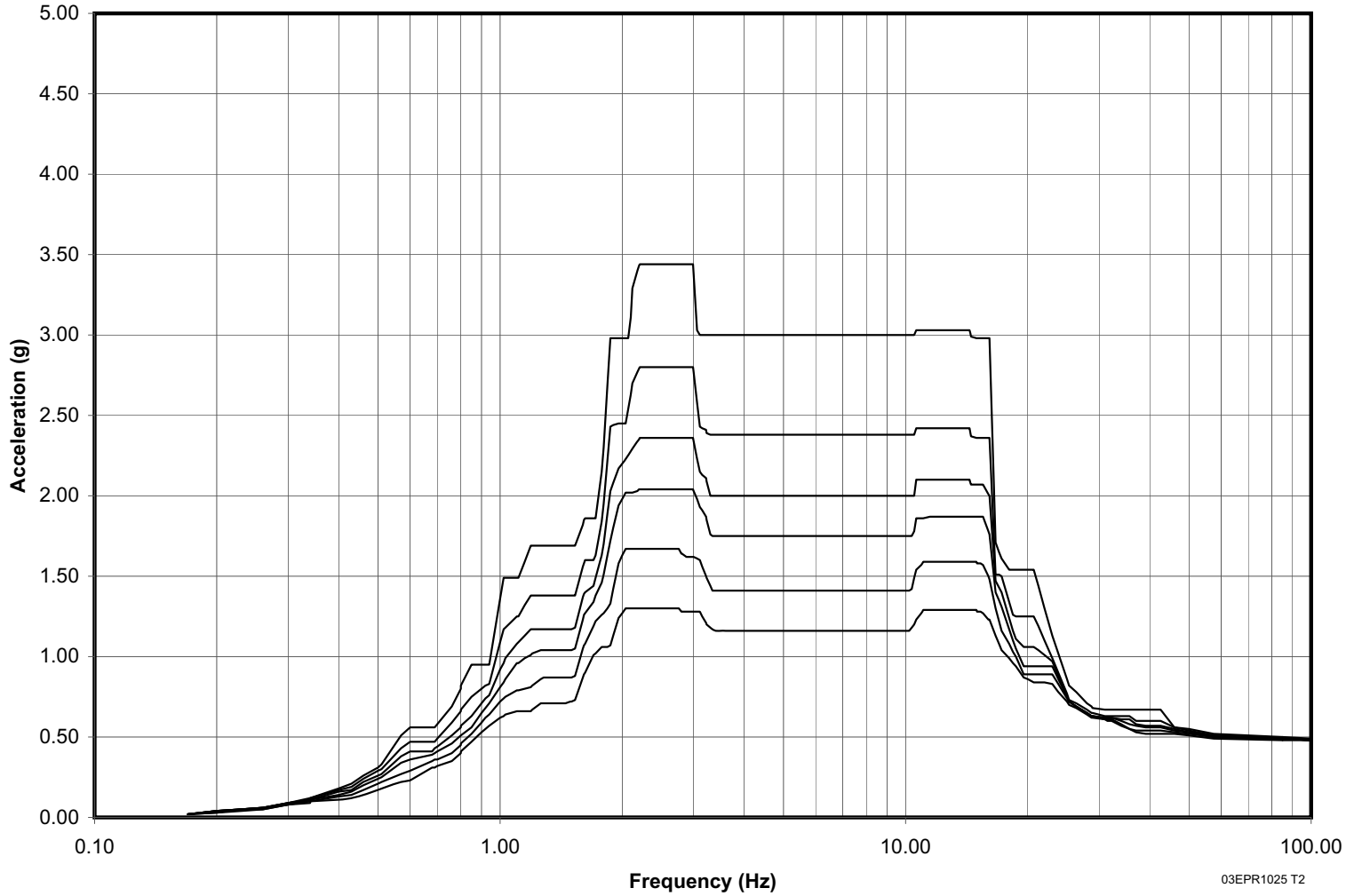

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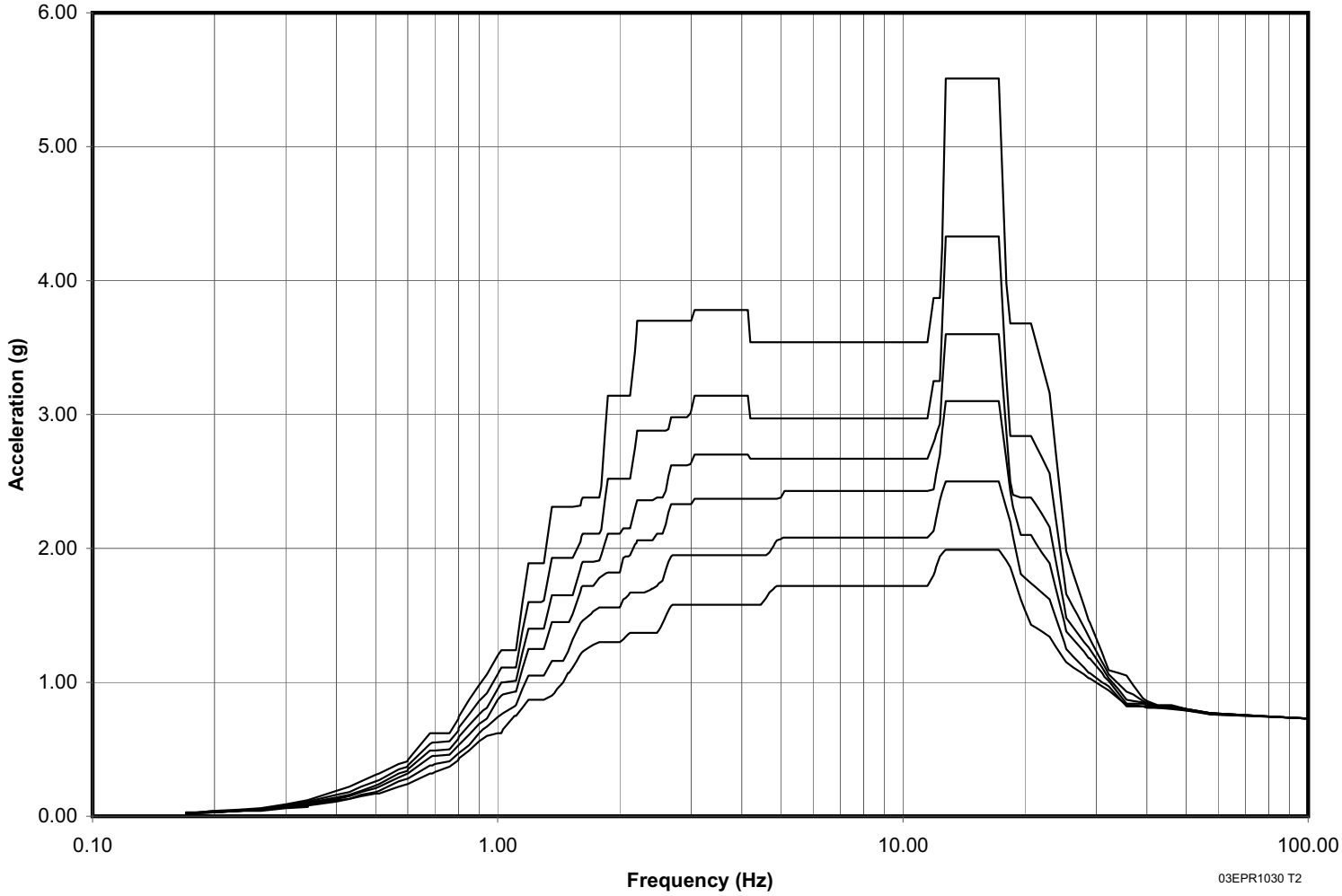
Figure 3.7.2-112—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 inches (3.7 m) 2%, 3%, 4%, 5%, 7% and 10% Damping Z-Direction



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- Elevation +26 ft, 7 inches. See Figure 3.7.2-86 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +26 ft, 7 inches (+8.10m) 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-87 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +26 ft, 7 inches (+8.10m) 2%, 3%, 4%, 5%, 7% and 10% Damping, and Figure 3.7.2-88 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +26 ft, 7 inches (+8.10m) 2%, 3%, 4%, 5%, 7% and 10% Damping.

- Elevation +50 ft, 6-1/4 inches. See Figure 3.7.2-89 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +50 ft, 6-1/4 inches (+15.40m) 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-90 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +50 ft, 6-1/4 inches (+15.40m) 2%, 3%, 4%, 5%, 7% and 10% Damping, and Figure 3.7.2-91 — Spectrum Envelope of Safeguard Building 2&3 - Elev. +50 ft, 6-1/4 inches (+15.40m) 2%, 3%, 4%, 5%, 7% and 10% Damping.

- SB 4

  - Elevation +68 ft, 10-3/4 inches. See Figure 3.7.2-92 — Spectrum Envelope of Safeguard Building 4 - Elev. +68 ft, 10-3/4 inches (+21.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-93 — Spectrum Envelope of Safeguard Building 4 - Elev. +68 ft, 10-3/4 inches (+21.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping, and Figure 3.7.2-94 — Spectrum Envelope of Safeguard Building 4 - Elev. +68 ft, 10-3/4 inches (+21.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping.

- RCB

  - Elevation +123 ft, 4-1/4 inches. See Figure 3.7.2-95 — Spectrum Envelope of Containment Building - Elev. +123 ft, 4-1/4 inches (+37.60m) 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-96 — Spectrum Envelope of Containment Building - Elev. +123 ft, 4-1/4 inches (+37.60m) 2%, 3%, 4%, 5%, 7% and 10% Damping. and Figure 3.7.2-97 — Spectrum Envelope of Containment Building - Elev. +123 ft, 4-1/4 inches (+37.60m) 2%, 3%, 4%, 5%, 7% and 10% Damping.

  - Elevation +190 ft, 3-1/2 inches. See Figure 3.7.2-98 — Spectrum Envelope of Containment Building - Elev. +190 ft, 3-1/2 inches (+58.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-99 — Spectrum Envelope of Containment Building - Elev. +190 ft, 3-1/2 inches (+58.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping. and Figure 3.7.2-100 — Spectrum Envelope of Containment Building - Elev. +190 ft, 3-1/2 inches (+58.00m) 2%, 3%, 4%, 5%, 7% and 10% Damping).

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- FB

  - Elevation +12 ft, 1-2/3 inches. See Figure 3.7.2-110 — Spectrum Envelope of Fuel Building - Elev. +12 ft, 1-2/3 inches (+3.70 m) 2%, 3%, 4%, 5%, 7% and 10% Damping X-Direction, Figure 3.7.2-111 — Spectrum Envelope of Fuel Building - Elev. +12 ft, 1-2/3 inches (+3.70 m) 2%, 3%, 4%, 5%, 7% and 10% Damping Y-Direction, and Figure 3.7.2-112 — Spectrum Envelope of Fuel

Building - Elev. +12 ft, 1-2/3 inches (+3.70 m) 2%, 3%, 4%, 5%, 7% and 10% Damping Z-Direction

(2) EPGB and ESWB

Figure 3.7.2-101— Spectrum Envelope of EPGB at Elev. +0 ft, 0 inches at Node 1172 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-102 — Spectrum Envelope of EPGB at Elev. +0 ft, 0 inches at Node 1172 2%, 3%, 4%, 5%, 7% and 10% Damping, and Figure 3.7.2-103 — Spectrum Envelope of EPGB at Elev. +0 ft, 0 inches at Node 1172 2%, 3%, 4%, 5%, 7% and 10% Damping, show the peak-broadened and smoothed ISRS envelopes at Node 1172 on elevation +0 ft, 0 inches of the EPGB.

Figure 3.7.2-104 — Spectrum Envelope of ESWB at Elev +63 ft, 0 inches at Node 12733 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-105 — Spectrum Envelope of ESWB at Elev +63 ft, 0 inches at Node 12733 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-106 — Spectrum Envelope of ESWB at Elev +63 ft, 0 inches at Node 12733 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-107 — Spectrum Envelope of ESWB at Elev +14 ft, 0 inches at Node 10385 2%, 3%, 4%, 5%, 7% and 10% Damping, Figure 3.7.2-108 — Spectrum Envelope of ESWB at Elev +14 ft, 0 inches at Node 10385 2%, 3%, 4%, 5%, 7% and 10% Damping, and Figure 3.7.2-109 — Spectrum Envelope of ESWB at Elev +14 ft, 0 inches at Node 10385 2%, 3%, 4%, 5%, 7% and 10% Damping, show the peak-broadened and smoothed ISRS envelopes at Node 12733 on elevation +63 ft, 0 inches and Node 10385 on elevation +14 ft, 0 inches of the ESWB.

As discussed in Section 3.8.4.4.3 and Section 3.8.4.4.4, subsequent analyses will incorporate certain design details for the EPGBs and ESWBs that are not reflected in the existing respective SASSI models used for the SSI analyses described in Section 3.7.2. The subsequent analyses will determine the impact of these design details on the seismic responses and ISRS presented in Section 3.7.2.

3.7.2.6 Three Components of Earthquake Motion

(1) NI Common Basemat Structures and NAB

As previously stated in Section 3.7.2.4.6, the floor acceleration time history in a given direction is obtained by algebraically combining the three corresponding time histories due to the three earthquake components. Therefore, both the floor ZPA and the ISRS for the floor acceleration time history properly account for the contributions from the three components of earthquake motion. For member forces and moments in the stick models, the STRESS module of SASSI code outputs the maximum member force/moment in the stick model due to each earthquake motion component. The maximum member forces/moments due to the three earthquake motion components are then combined by the SRSS rule to obtain the maximum total member force/