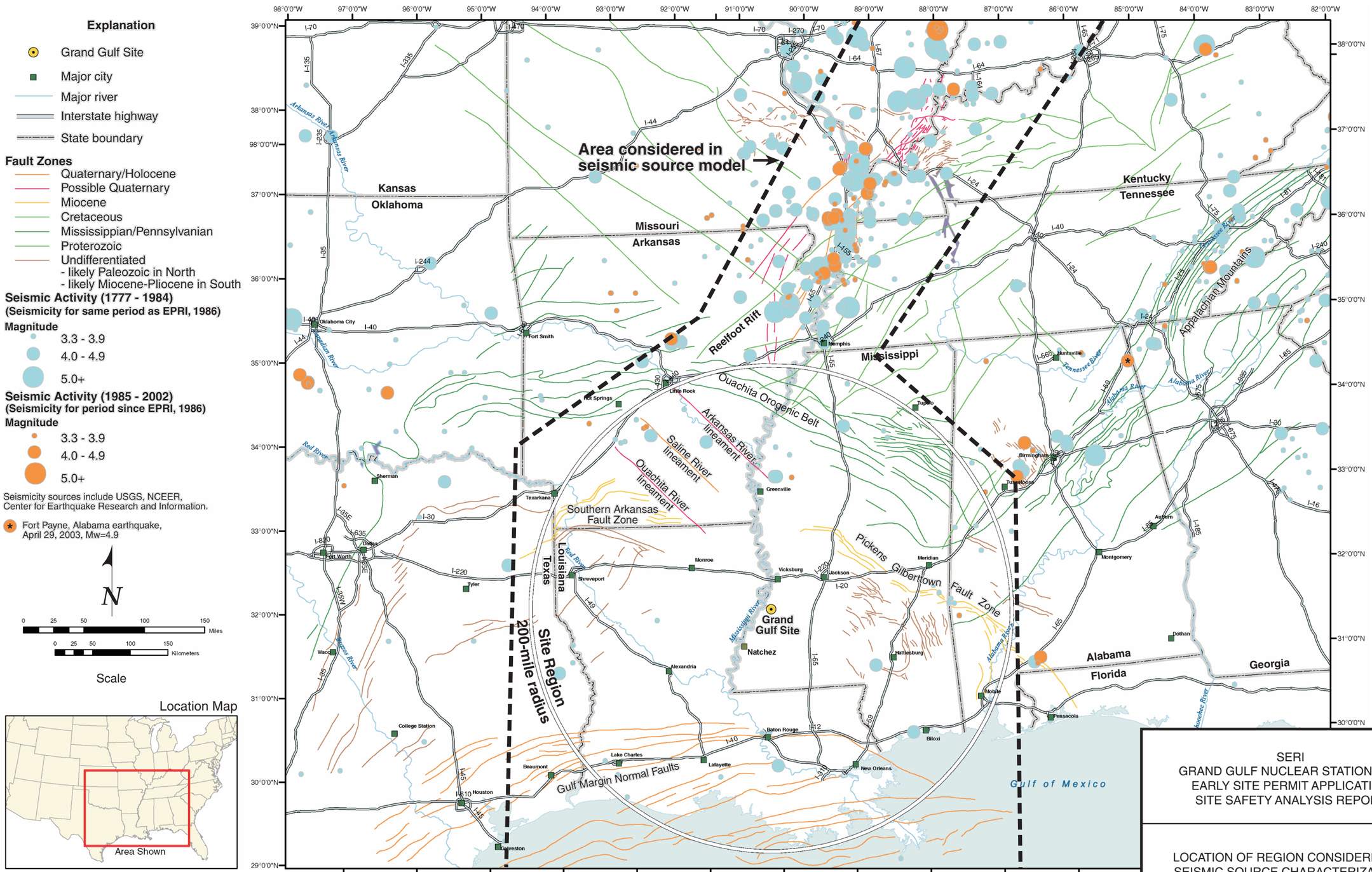

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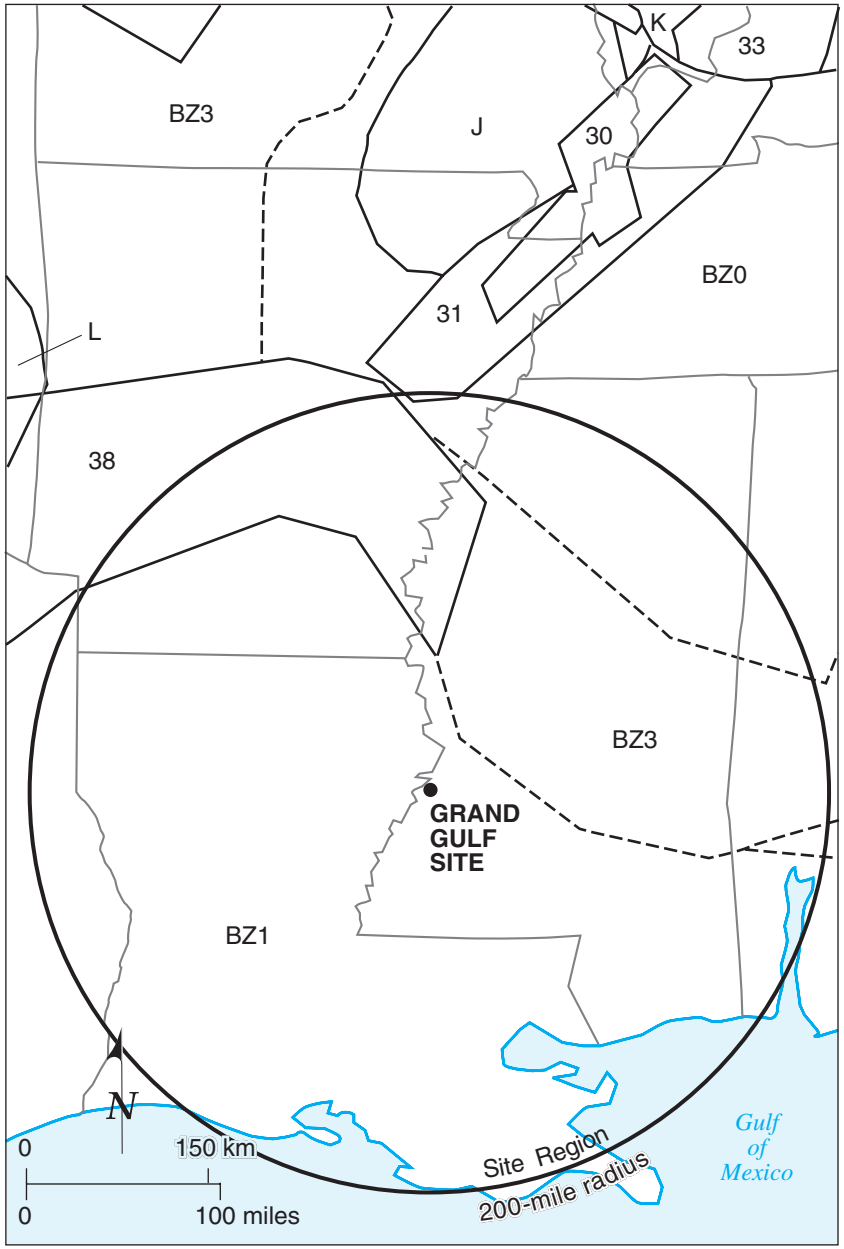
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

LOCATION OF REGION CONSIDERED IN SEISMIC SOURCE CHARACTERIZATION

FIGURE 2.5-38 REV. 0



Summary of Bechtel Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
BZ1	Gulf Coast Region Background	0	0	1.0	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
BZ3	Northern Plains Region Background	30	48	1.0	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
38	Ouachita	70	113	0.25	5.4 [0.10] 5.7 [0.40] 6.0 [0.40] 6.6 [0.10]
BZ0	New Madrid Region Background	140	225	1.0	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]
31	Reelfoot Rift	190	306	0.60	5.7 [0.10] 6.0 [0.40] 6.3 [0.40] 6.6 [0.10]
Selected sources beyond 200 mi (320 km)					
30	New Madrid Fault Zone	235	378	1.00	7.4 [0.10] 7.5 [0.90]

1 Closest distance between site and source measured from Bechtel seismic source map (Reference 9)
2 Pa = probability of activity; from Reference 10
3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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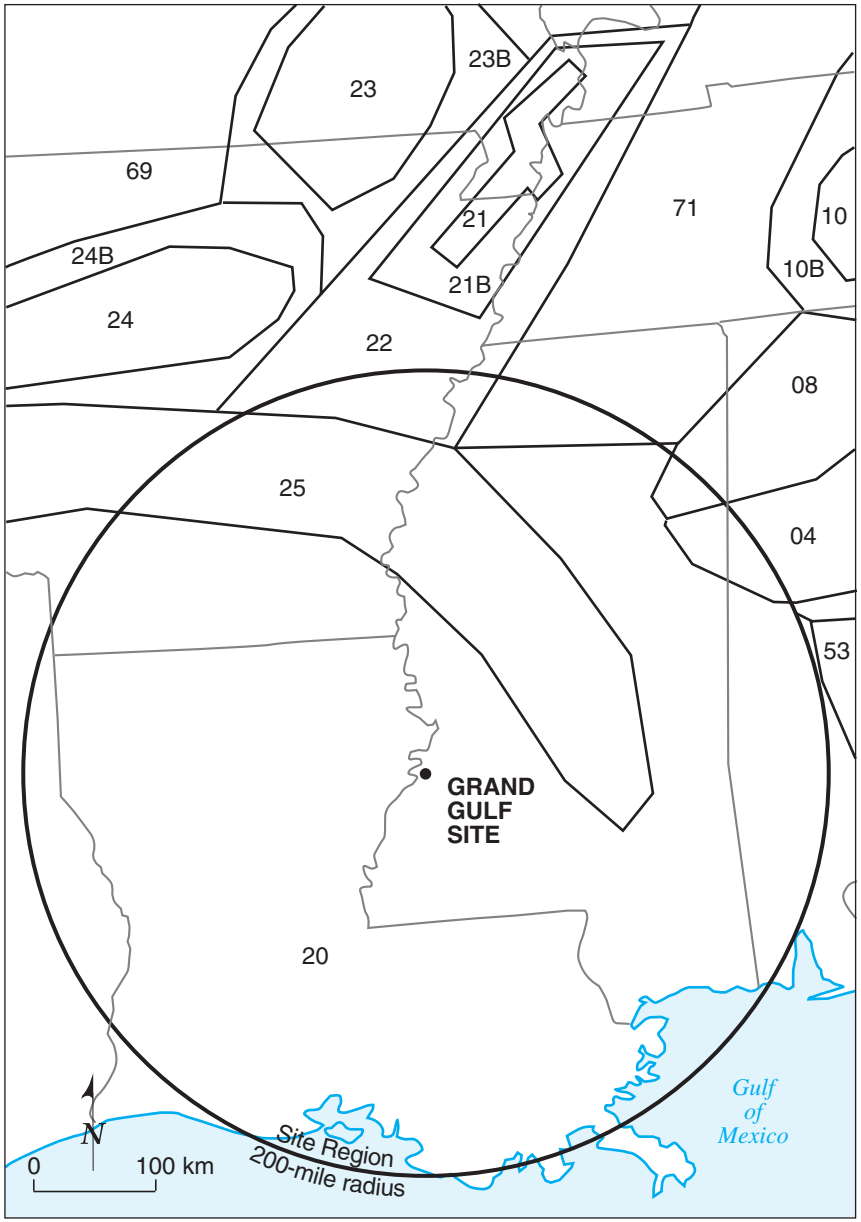
SITE SAFETY ANALYSIS REPORT

EPRI SOG
SEISMIC SOURCE ZONES
BECHTEL TEAM

FIGURE 2.5-39 REV. 0



Summary of Dames & Moore Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
20	Southern Coastal Margin	0	0	1.0	5.3 [0.80] 7.2 [0.20]
25	Ouachitas Fold Belt	60	97	0.35	5.5 [0.80] 7.2 [0.20]
71	Indiana-Illinois Block	165	266	1.0	5.7 [0.80] 7.2 [0.20]
22	Reelfoot Rift	165	266	1.0+	6.9 [0.75] 7.2 [0.25]
C15	Combined 21 & 22	165	266	N.A.	6.9 [0.75] 7.2 [0.25]
4	Appalachian Fold Belt	170	274	0.35	6.0 [0.80] 7.2 [0.20]
8	Eastern Marginal Basin	175	282	0.08	5.6 [0.80] 7.2 [0.20]
Selected sources beyond 200 mi (320 km)					
21	New Madrid Compression Zone	250	403	1.0	7.2 [0.25] 7.5 [0.75]

1 Closest distance between site and source measured from Dames & Moore seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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SITE SAFETY ANALYSIS REPORT

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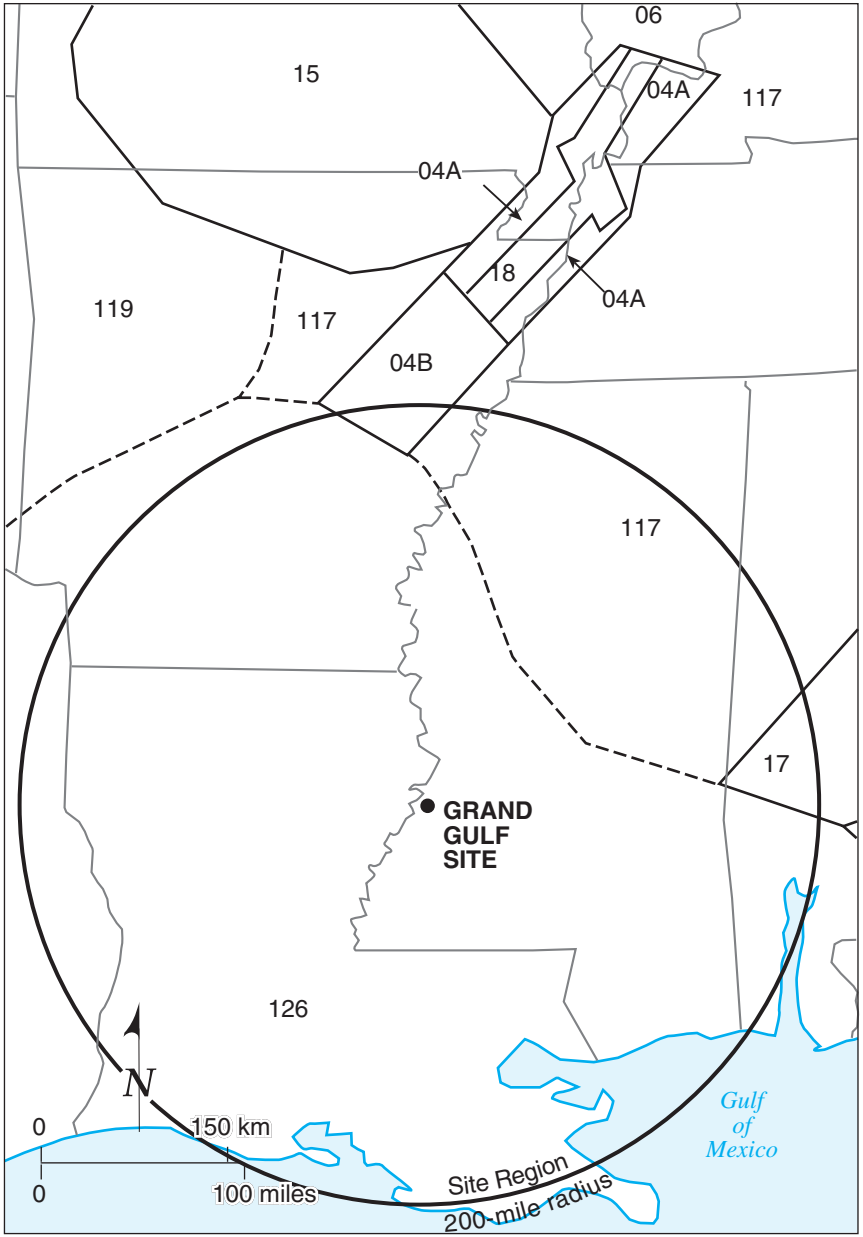
SEISMIC SOURCE ZONES
DAMES & MOORE TEAM

FIGURE 2.5-40 REV. 0



Summary of Law Engineering Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
126	Southern Coastal Block	0	0	1.00	4.6 [0.90] 4.9 [0.10]
117	Mississippi Embayment	80	128.8245	1.00	5.2 [0.50] 5.7 [0.50]
17	Eastern Basement	140	225.4428	0.62	5.7 [0.20] 6.8 [0.80]
04A	Reelfoot Rift	170	273.752	0.90	6.2 [0.50] 6.8 [0.50]
Selected sources beyond 200 mi (320 km)					
04B	Reelfoot Rift Alternative	225	362.3188	0.10	6.2 [0.50] 6.8 [0.50]
18	Postulated Faults in Reelfoot Rift	230	370.3704	1.00	7.4 [1.00]

1 Closest distance between site and source measured from Law Engineering seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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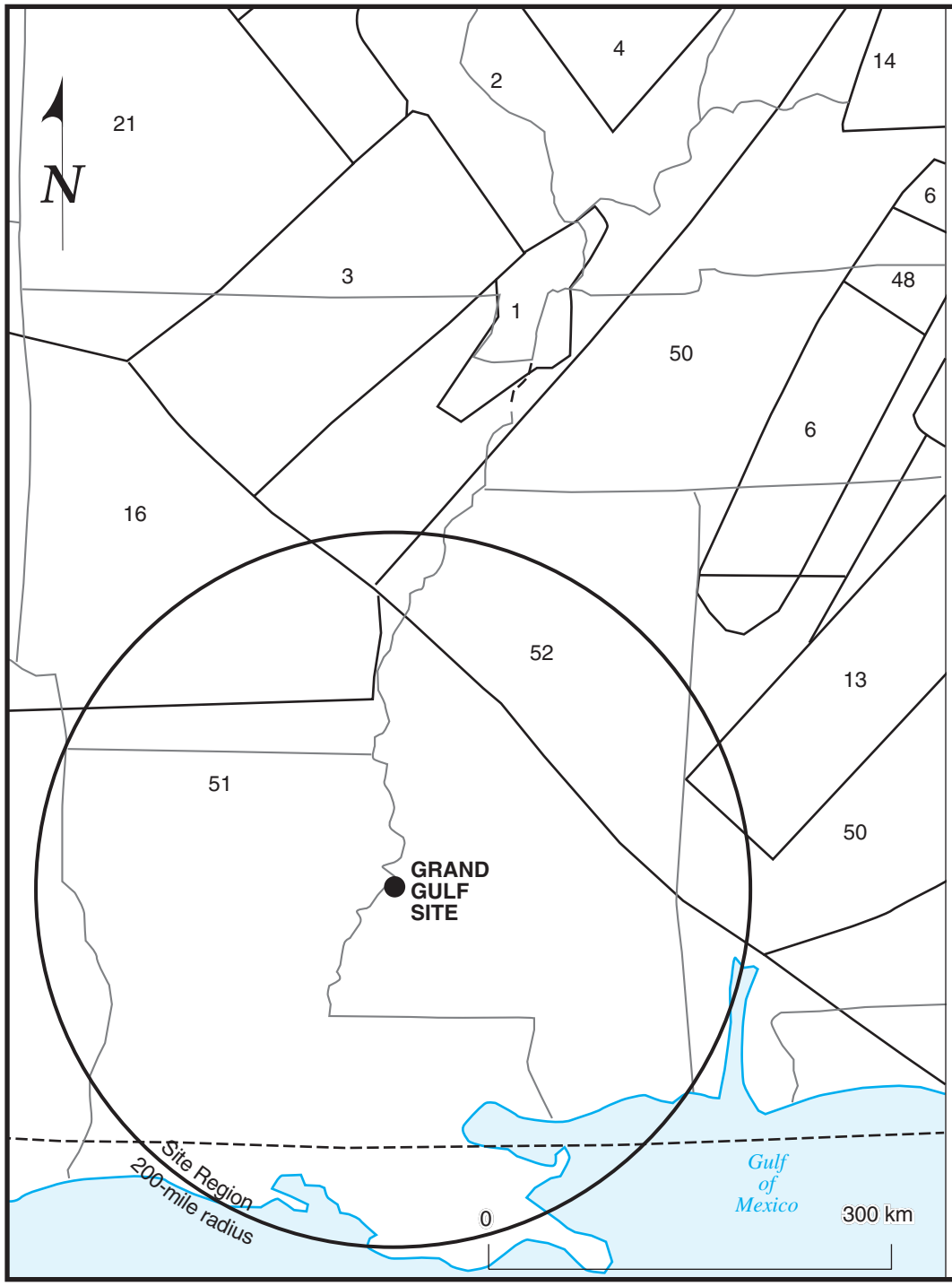
EPRI SOG
SEISMIC SOURCE ZONES
LAW ENGINEERING TESTING COMPANY TEAM

FIGURE 2.5-41 REV. 0



Summary of Rondout Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
51	Gulf Coast/Bahamas	0	0	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
16	Southern Oaklahoma Aulacogen/ Ouachita	100	161.0306	1.00	5.8 [0.15] 6.5 [0.60] 6.8 [0.25]
52	Pre-Grenville Precambrian Craton	110	177.1337	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
50	Grenville Crust	125	201.2882	1.00	4.8 [0.20] 5.5 [0.60] 5.8 [0.20]
2	New Madrid Rift Complex (Reelfoot Rift)	170	273.752	1.00	6.6 [0.30] 6.8 [0.60] 7.0 [0.10]
13	Southern New York-Alabama Lineament	180	289.8551	1.00	5.2 [0.30] 6.3 [0.55] 6.5 [0.15]
Selected sources beyond 200 mi (320 km)					
1	New Madrid Seismic Zone	255	410.628	1.00	7.1 [0.10] 7.3 [0.80] 7.4 [0.10]

1 Closest Distance between site and source measured from Rondout seismic source map (Reference 9)
2 Pa = probability of activity; from Reference 10
3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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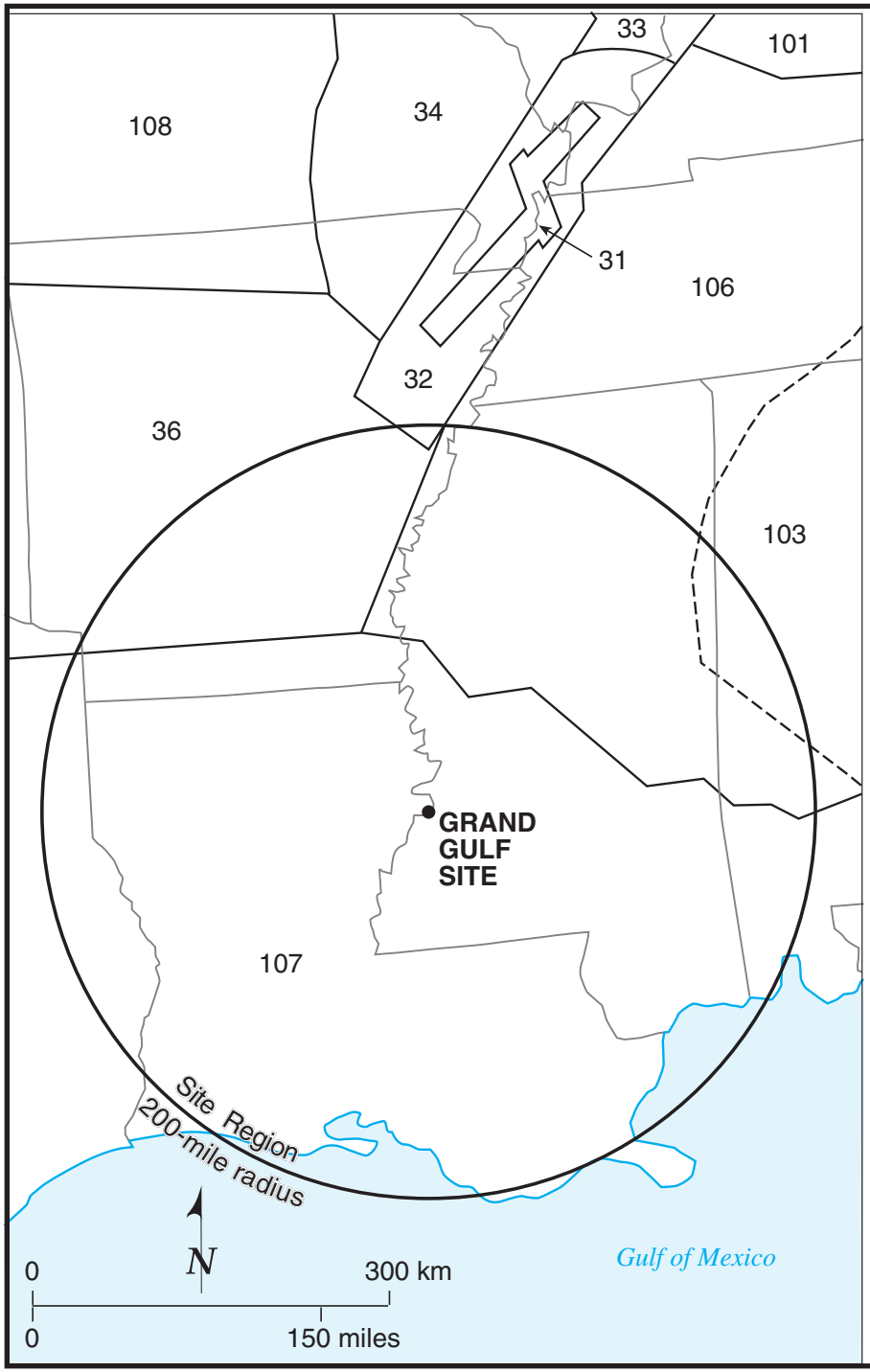
SITE SAFETY ANALYSIS REPORT

EPRI SOG
SEISMIC SOURCE ZONES
RONDOUT ASSOCIATES TEAM

FIGURE 2.5-42 REV. 0



Summary of Weston Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
107	Gulf Coast Background	0	0	1.00	5.4 [0.71] 6.0 [0.29]
106	South Central Background	60	97	1.00	5.4 [0.62] 6.0 [0.29] 6.6 [0.09]
36	Ancestral Rockies Source	100	161.0306	1.00	5.4 [0.43] 6.0 [0.41] 6.6 [0.16]
103	Backgroun dSouthern Appalachian	160	257.649	1.00	5.4 [0.26] 6.0 [0.58] 6.6 [0.16]
32	Reelfoot Rift	185	297.9066	1.00	7.2 [1.00]
C11	Combined 32 & 31	185	297.9066	N.A.	6.0 [0.13] 6.6 [0.77] 7.2 [0.10]
Selected sources beyond 200 mi (320 km)					
31	New Madrid Fault Zone	235	378.4219	0.95	7.2 [1.00]
34	Saint Louis Arm NMRC	240	386.4734	1.00	5.4 [0.23] 6.0 [0.52] 6.6 [0.21] 7.2 [0.04]

1 Closest distance between site and source measured from Weston Geophysical seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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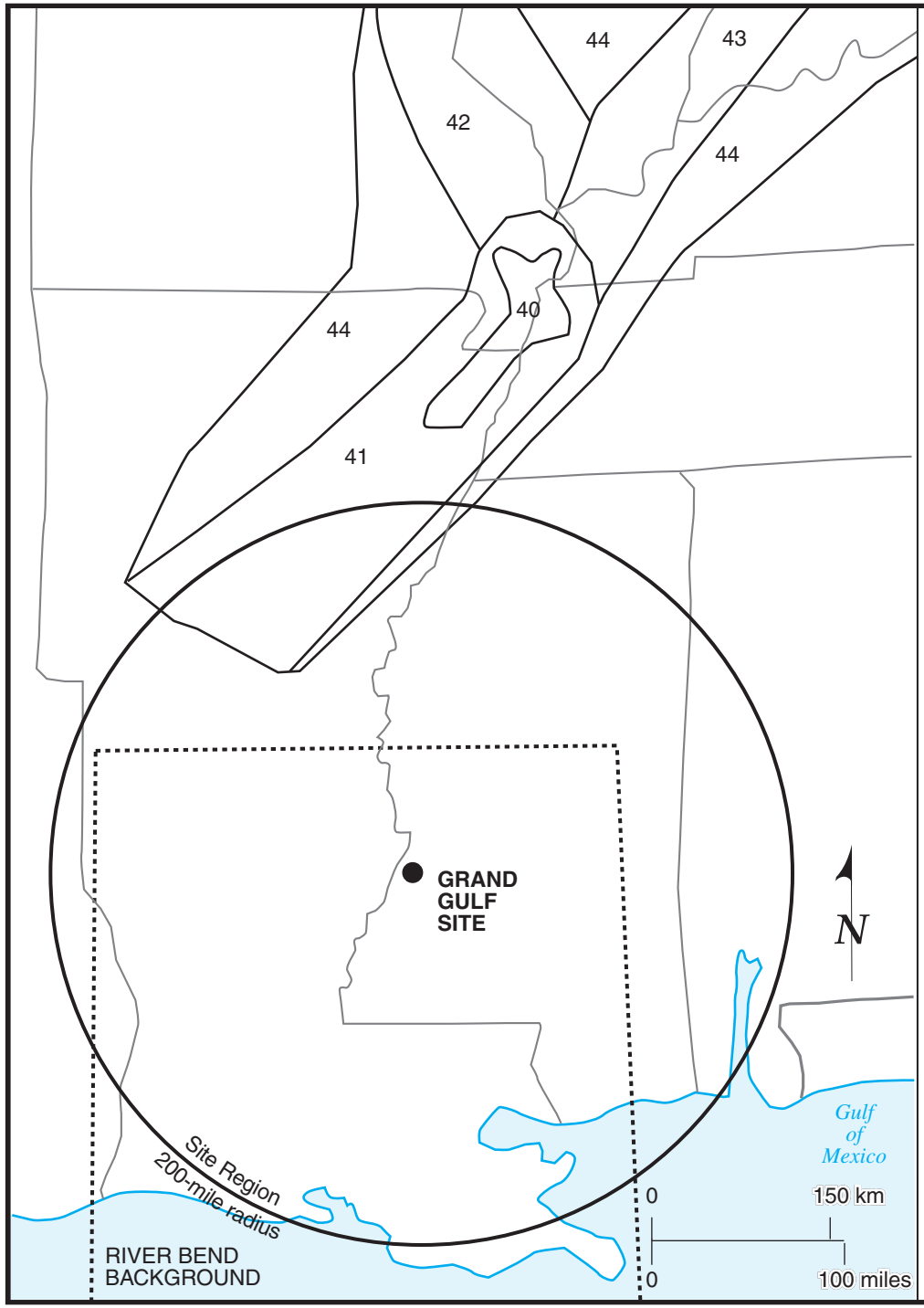
EPRI SOG
SEISMIC SOURCE ZONES
WESTON GEOPHYSICAL CORPORATION TEAM

FIGURE 2.5-43 REV. 0



Summary of Woodward-Clyde Seismic Sources

Source	Description	Distance[1] (mi)	Distance[1] (km)	Pa[2]	Mmax (Mb) and Wts.[3]
Sources within 200 mi (320 km)					
	River Bend Background	0	0	N.A.	5
41	Reelfoot Rift-New Madrid Rift Complex	130	210	1.00	5.4 [0.33] 6.8 [0.34] 7.2 [0.33]
44	New Madrid Rift Loading Volume	137	220	1.00	5.6 [0.33] 6.3 [0.34] 6.9 [0.33]
Selected sources beyond 200 mi (320 km)					
40	Disturbed Zone of Reelfoot Rift	224	360	1.00	7.2 [0.33] 7.5 [0.34] 7.9 [0.33]
43	Southern Indiana Arm and NOTA	311	500	1.00	5.8 [0.33] 6.3 [0.34] 7.4 [0.33]
42	Saint Louis Arm and NOTA	323	520	1.00	6.2 [0.33] 6.8 [0.34] 7.2 [0.33]

1 Closest Distance between site and source measured from Woodwar Clyde Consultants seismic source map (Reference 9)

2 Pa = probability of activity; from Reference 10

3 Maximum Magnitude (Mmax) and weights (wts.); from Reference 10

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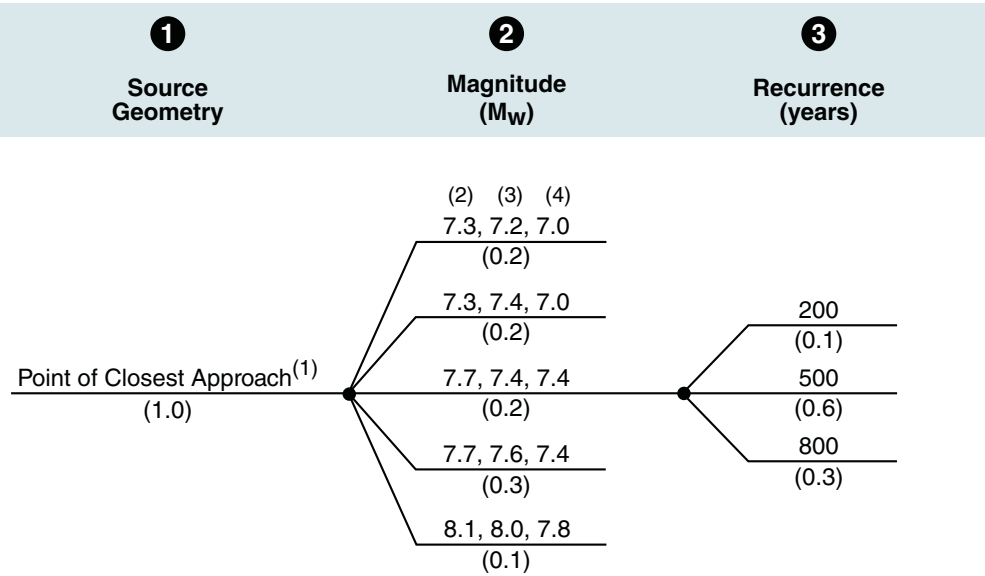
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

EPRI SOG
SEISMIC SOURCE ZONES
WOODWARD CLYDE CONSULTANTS TEAM

FIGURE 2.5-44 REV. 0



(1) Point of closest approach refers to the point on each of the East Prairie, Reelfoot fault, Blythville Arch segments of the New Madrid Seismic Zone that is closest to the Grand Gulf site. See Figure CP-01-16 for segment and point of closest approach locations.

(2) Blythville Arch: weighted average = M_W 7.6

(3) Reelfoot Fault: weighted average = M_W 7.5

(4) East Prairie Fault: weighted average = M_W 7.3

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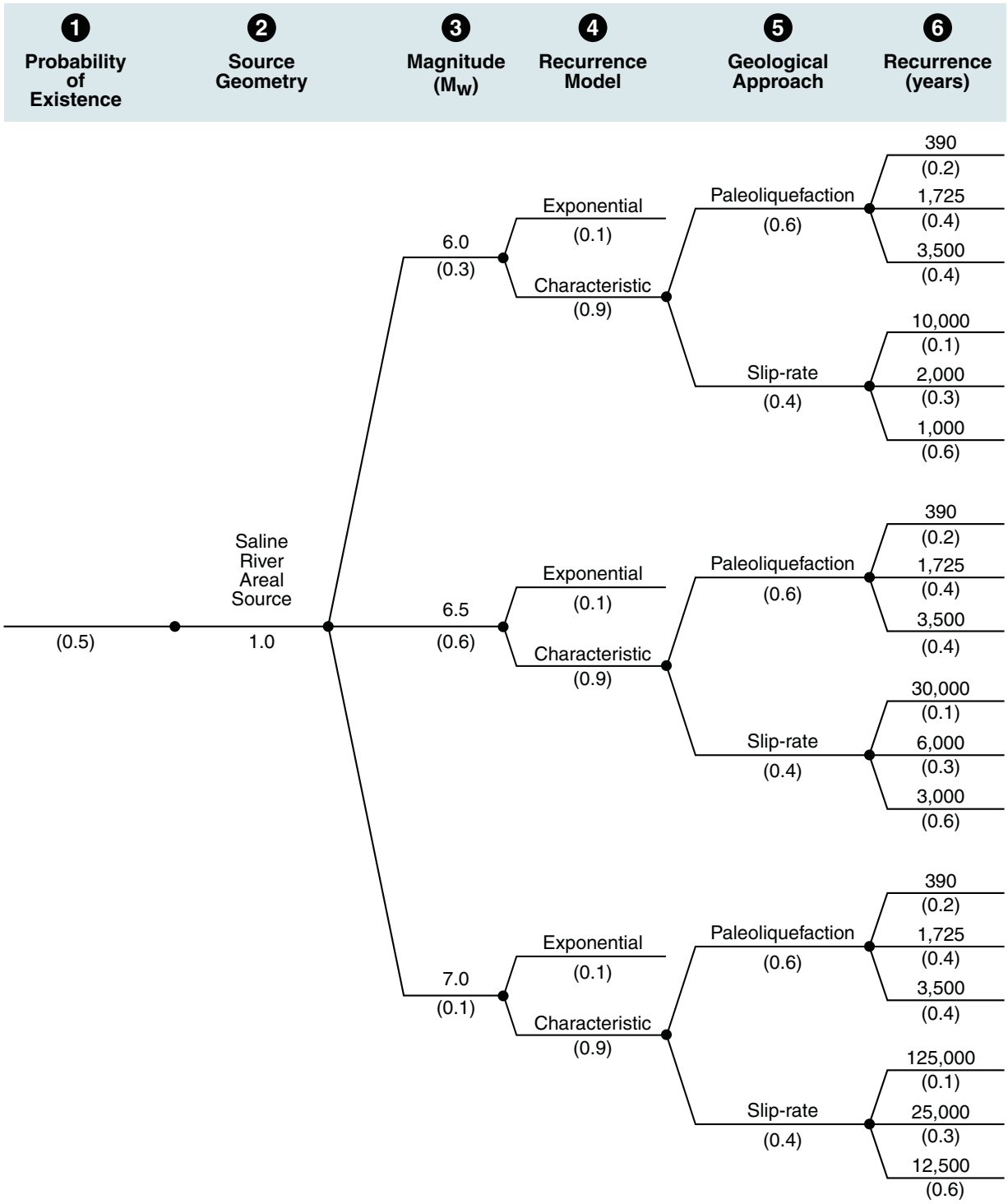
LOGIC TREE
FOR NEW MADRID SEISMIC ZONE

FIGURE 2.5-45 REV. 0



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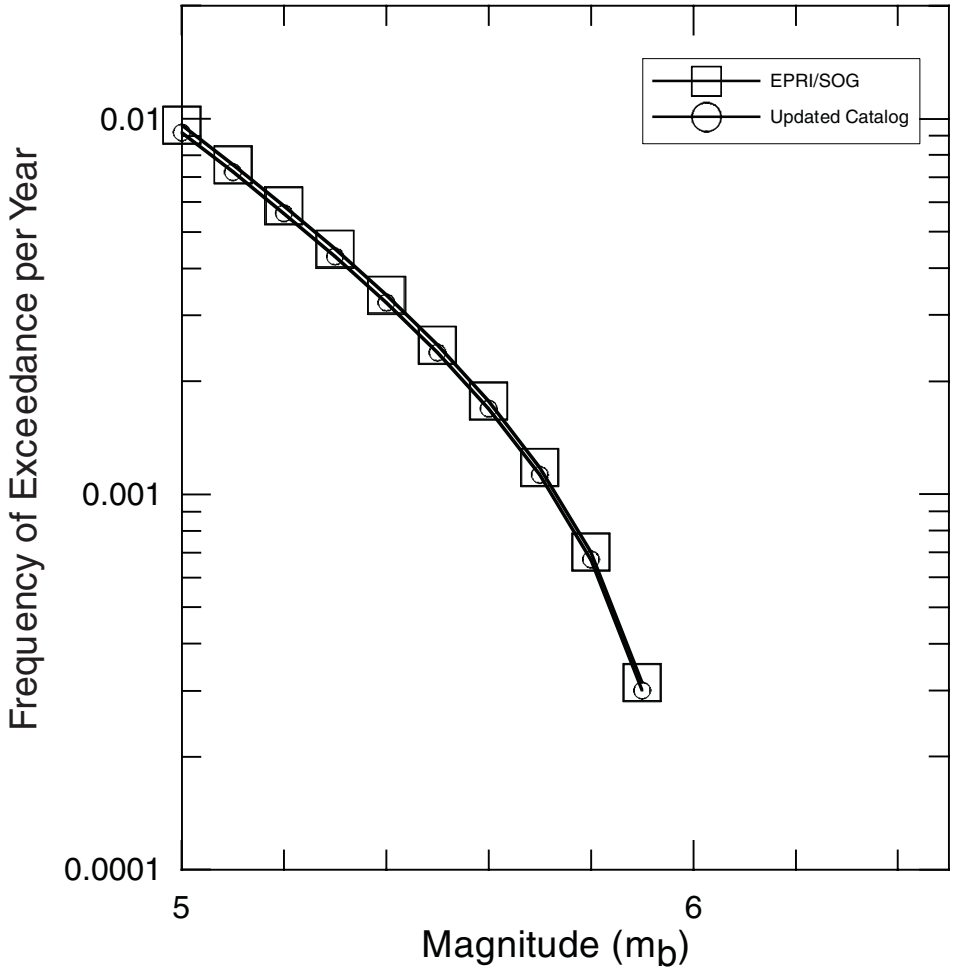
LOGIC TREE
FOR SALINE RIVER SOURCE ZONE

FIGURE 2.5-46 REV. 0



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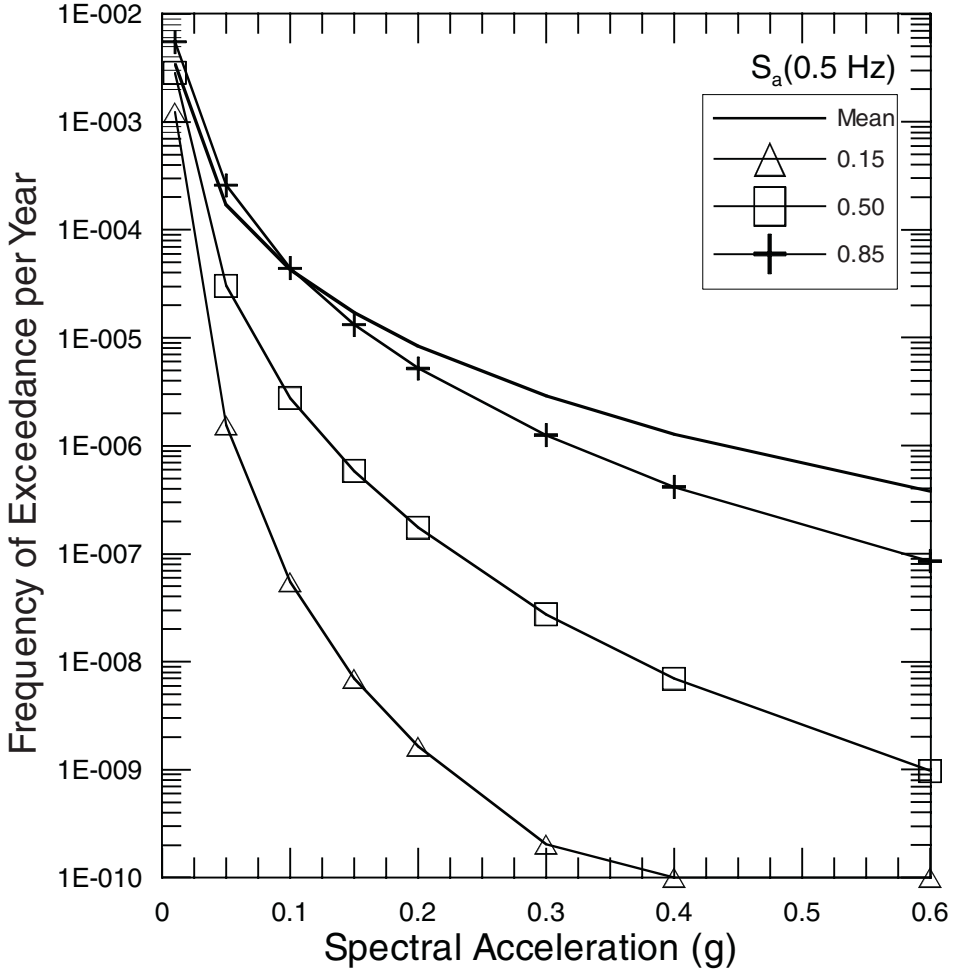
SITE SAFETY ANALYSIS REPORT

COMPARISON OF THE SENSITIVITY OF ESTIMATES OF EARTHQUAKE OCCURRENCE RATES TO UPDATING THE EPRI EARTHQUAKE CATALOG TO 2001

FIGURE 2.5-47 REV. 0



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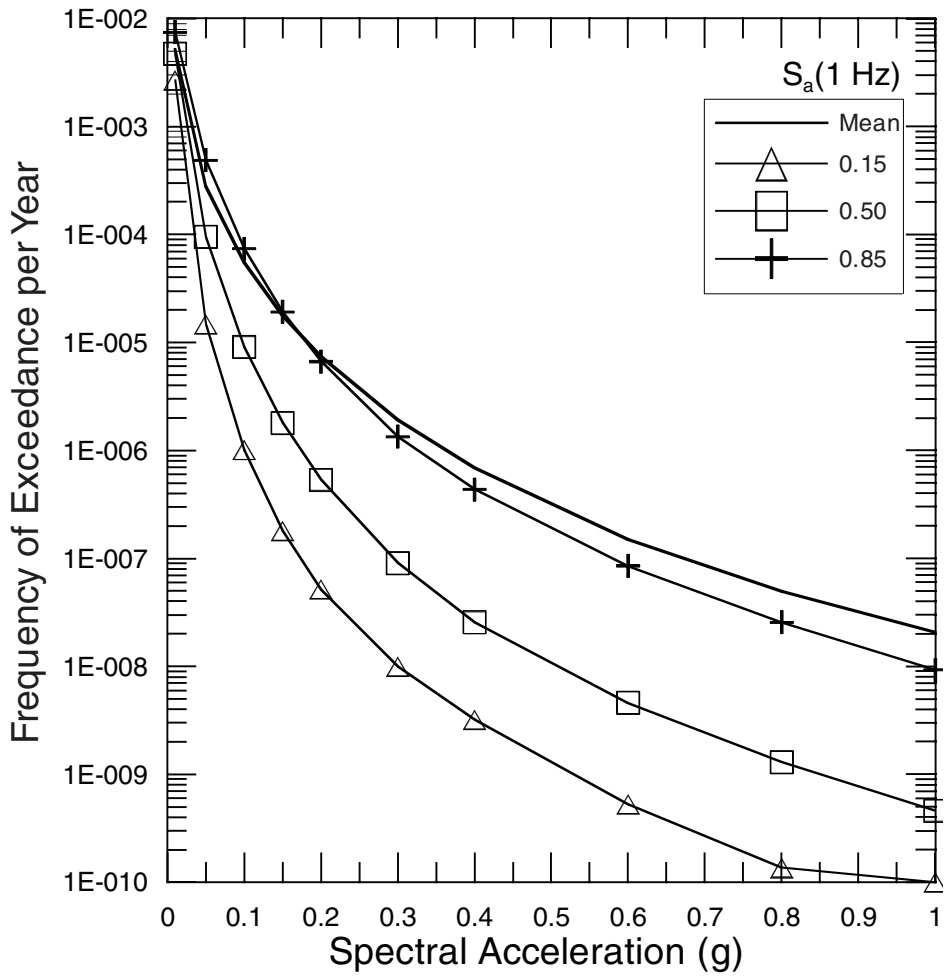
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

GGNS SEISMIC HAZARD
RESULTS FOR S_a(0.5 Hz) FOR
ROCK SITE CONDITIONS

FIGURE 2.5-48 REV. 0



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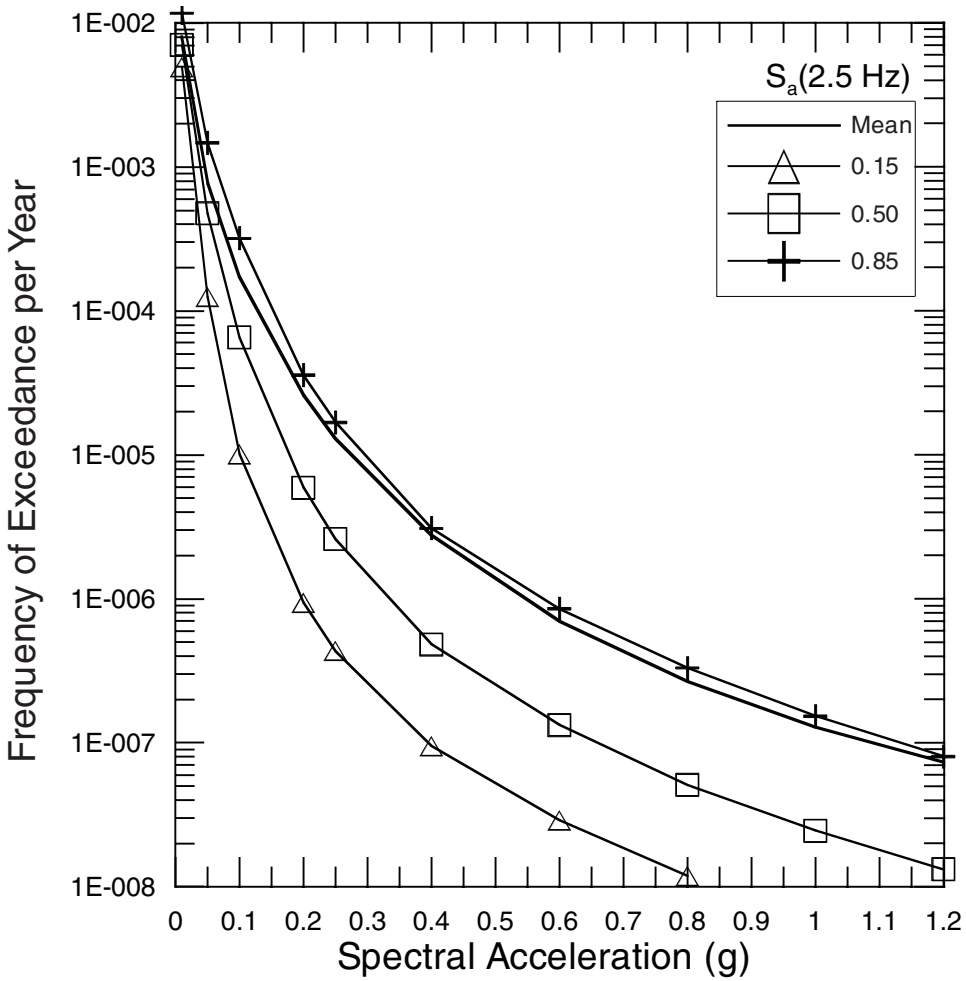
SITE SAFETY ANALYSIS REPORT

GGNS SEISMIC HAZARD RESULTS FOR
S_a(1 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-49

REV. 0



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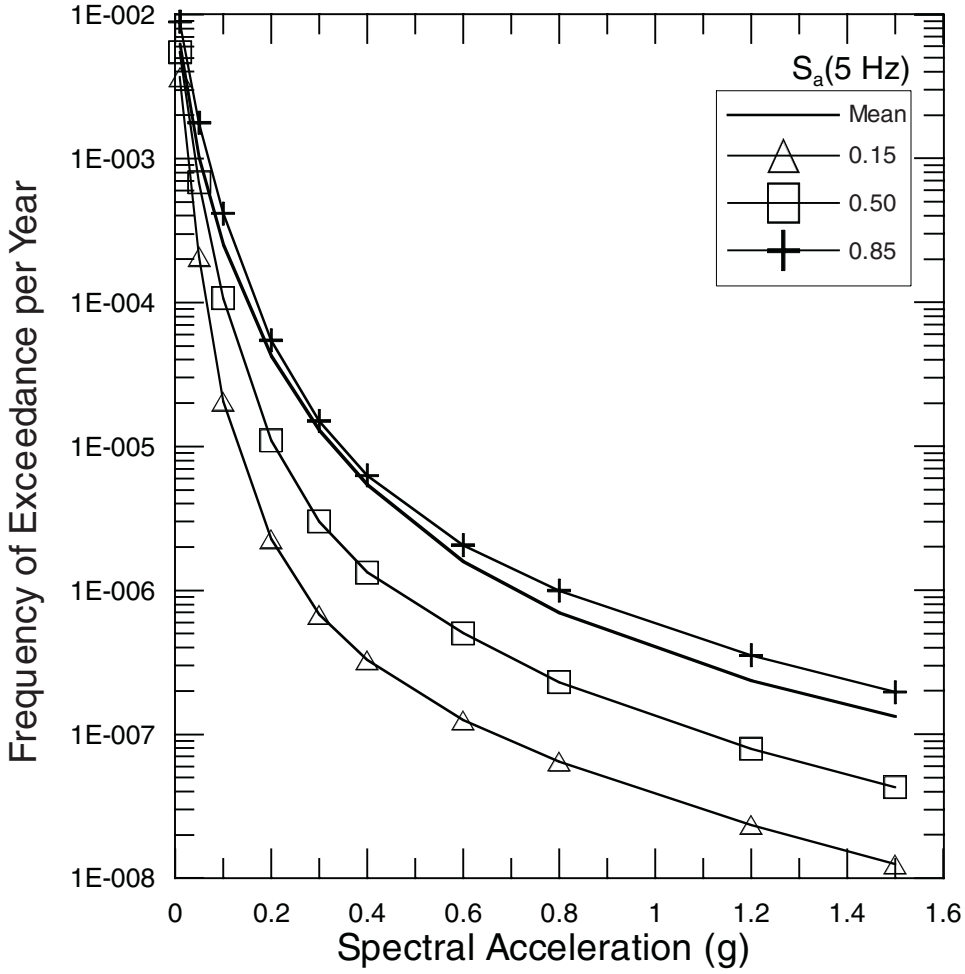
SITE SAFETY ANALYSIS REPORT

GGNS SEISMIC HAZARD RESULTS FOR
S_a(2.5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-50 REV. 0



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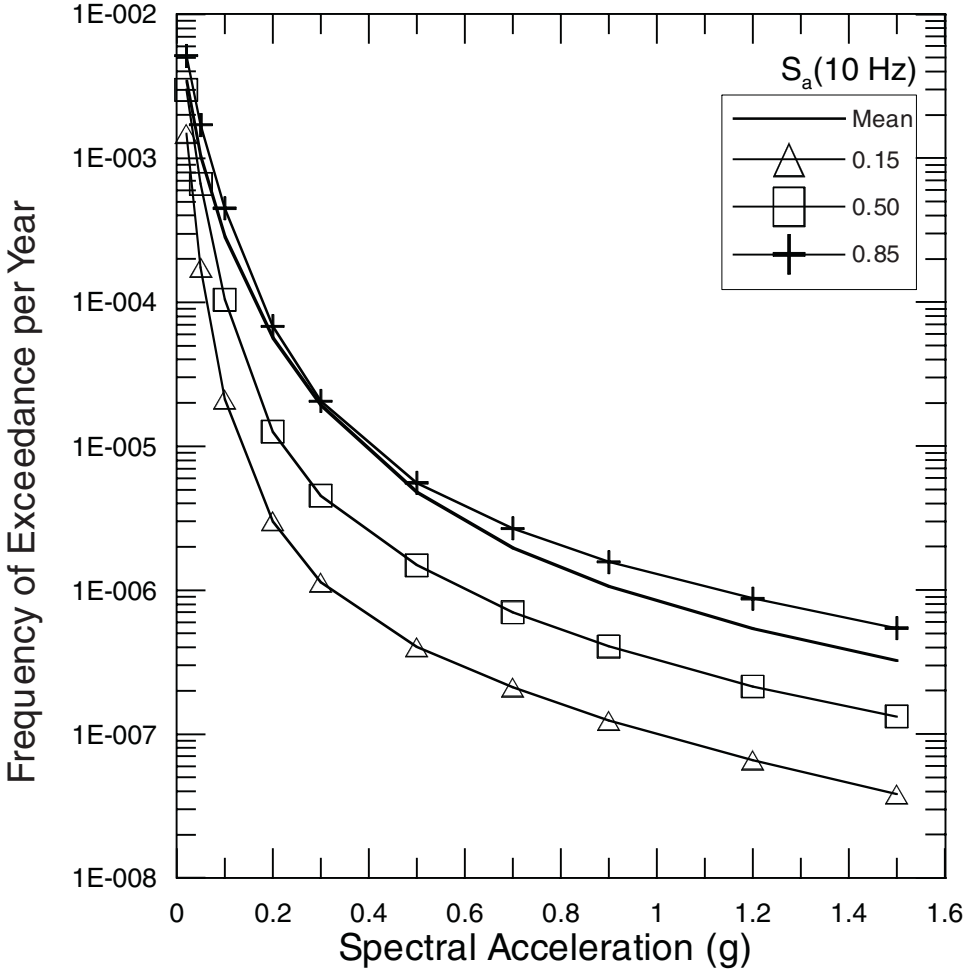
GGNS SEISMIC HAZARD RESULTS FOR
Sa(5 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-51 REV. 0



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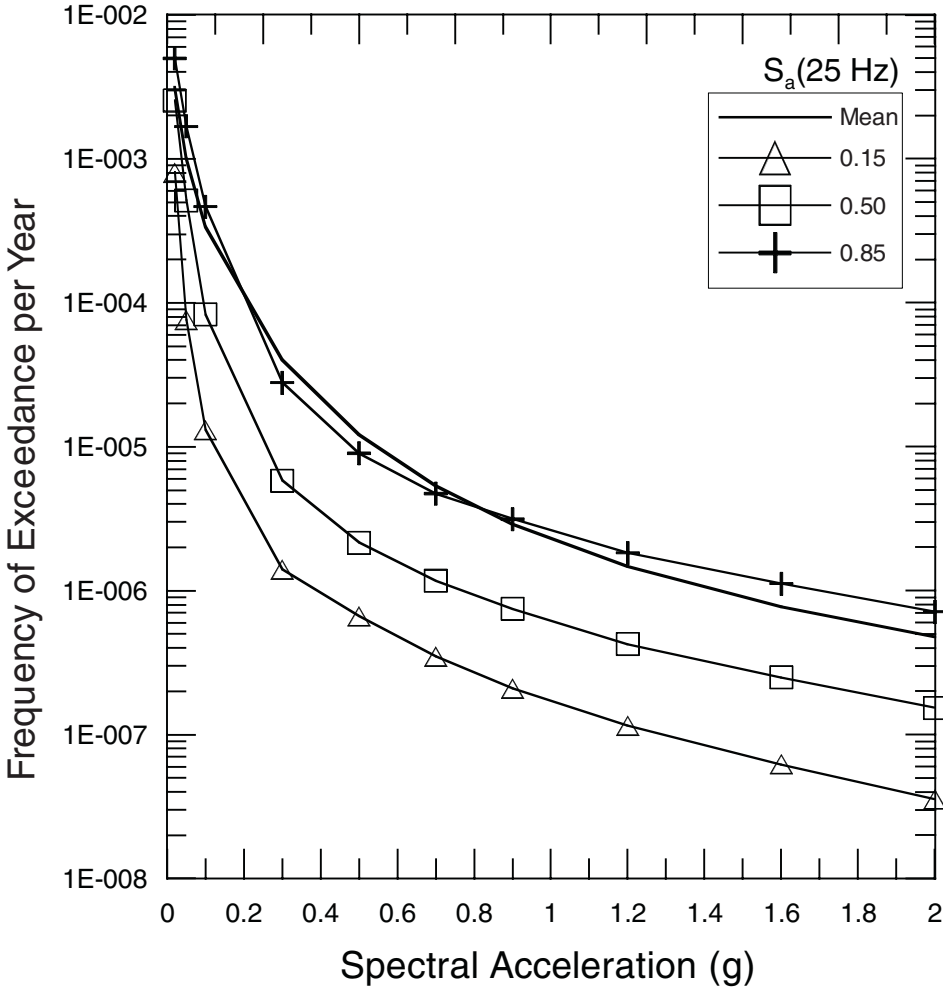
GGNS SEISMIC HAZARD RESULTS FOR
Sa(10 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-52 REV. 0



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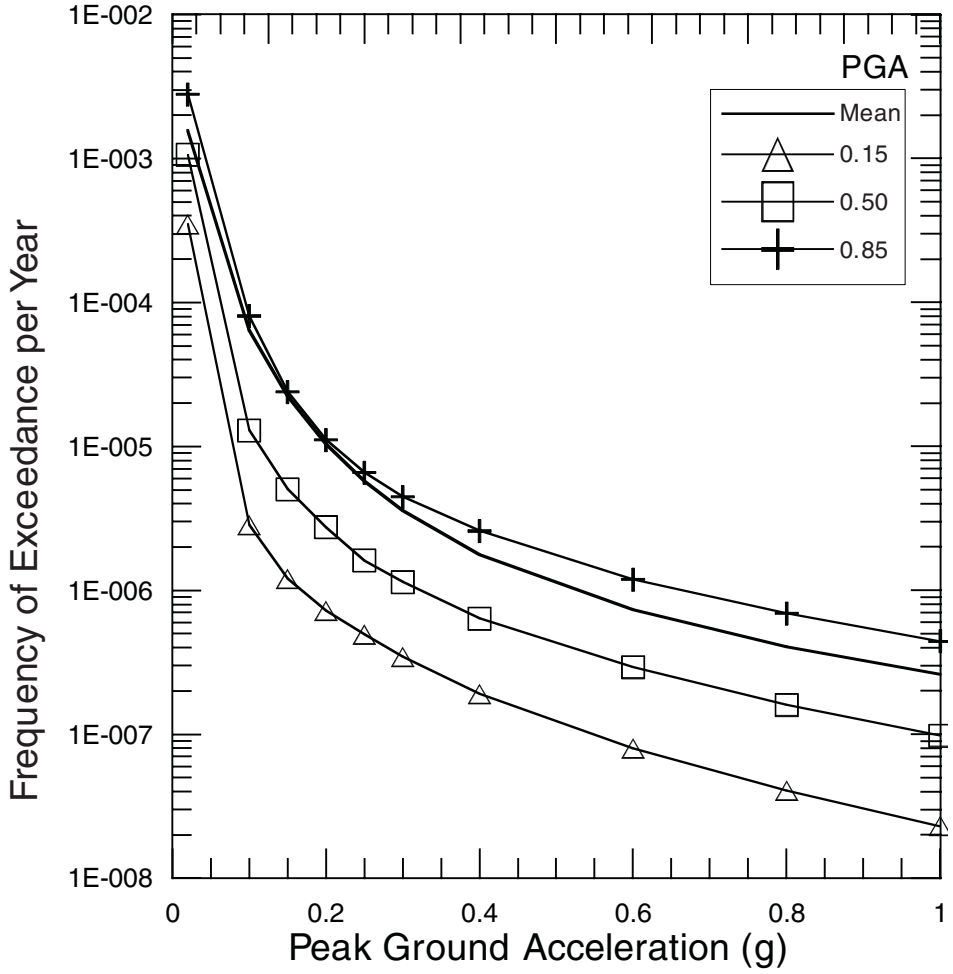
GGNS SEISMIC HAZARD RESULTS FOR
S_a(25 Hz) FOR ROCK SITE CONDITIONS

FIGURE 2.5-53

REV. 0



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GGNS SEISMIC HAZARD RESULTS FOR
PGA FOR ROCK SITE CONDITIONS

FIGURE 2.5-54 REV. 0

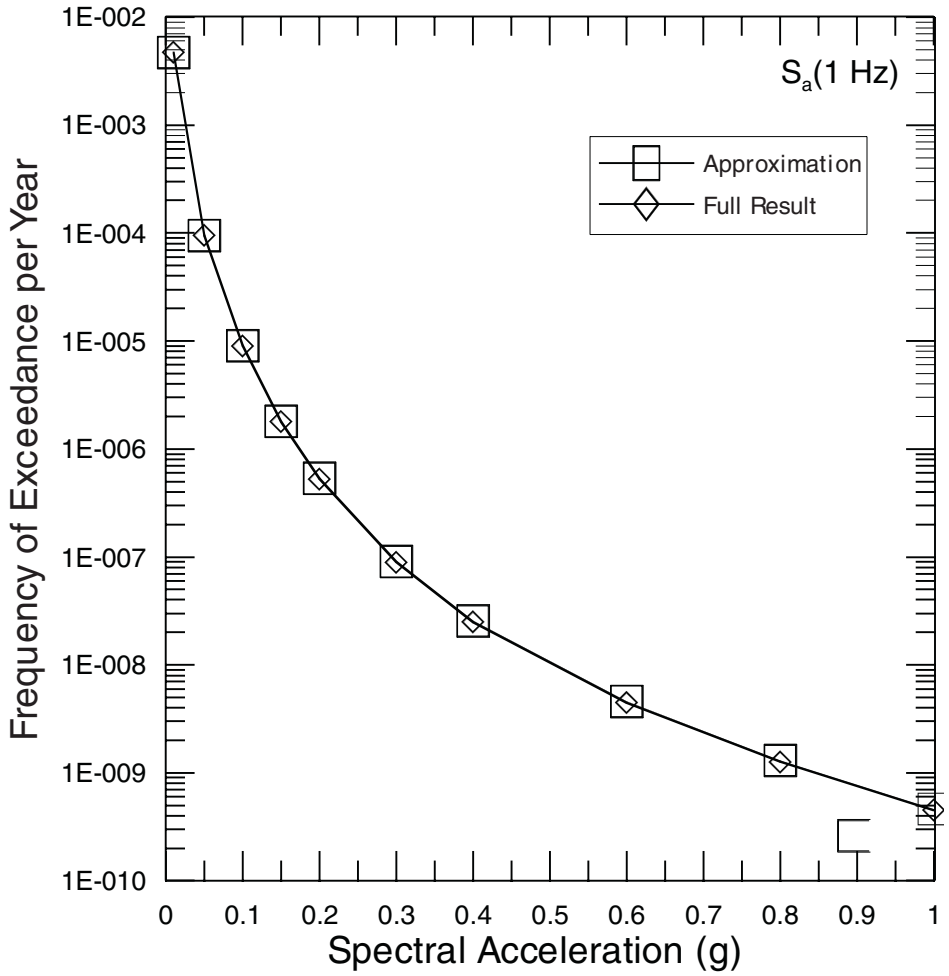

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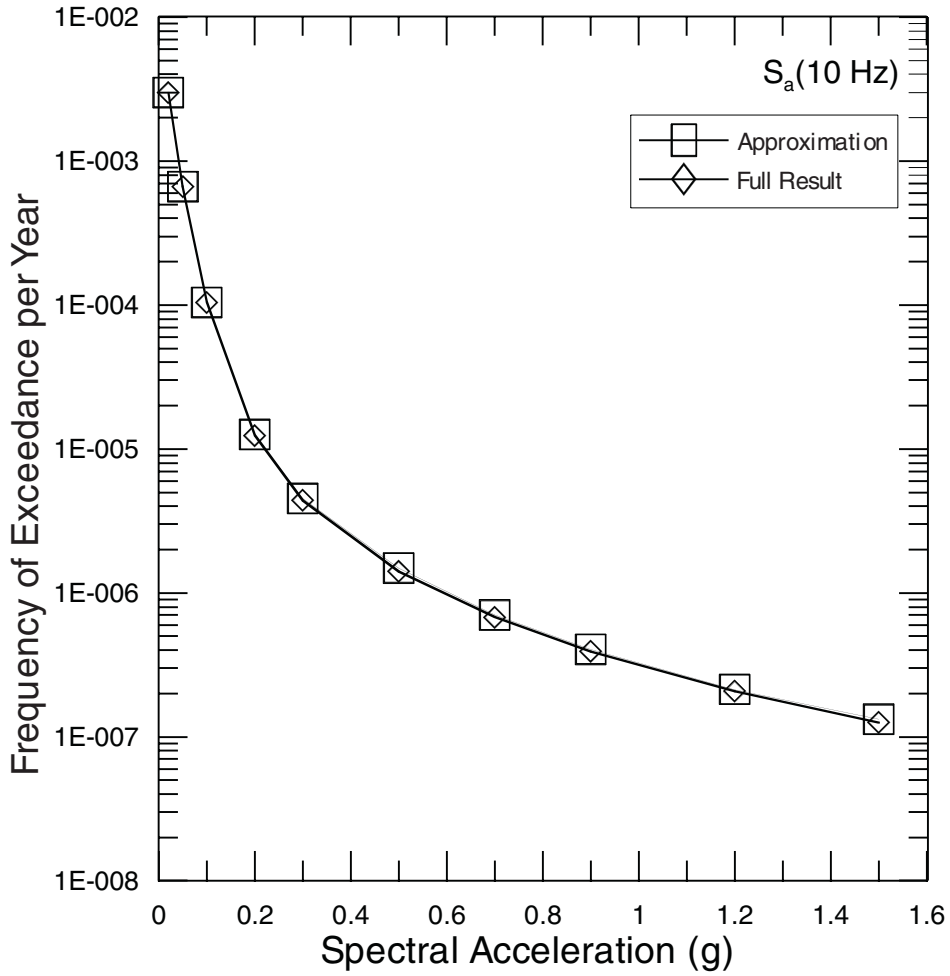
ILLUSTRATION OF THE SENSITIVITY OF THE GGNS MEDIAN SEISMIC HAZARD RESULTS FOR S_a 1 Hz TO USING A REDUCED NUMBER OF SEISMICITY OPTIONS FOR THE ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-55 REV. 0



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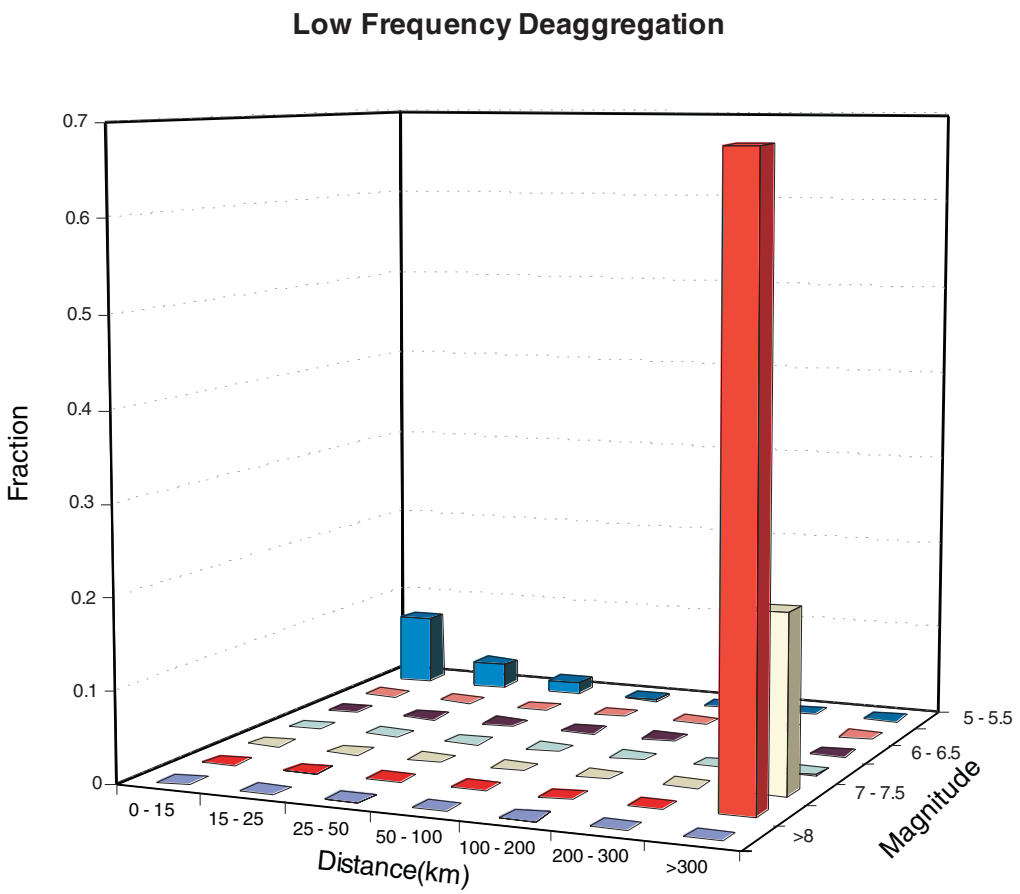
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

ILLUSTRATION OF THE SENSITIVITY OF THE GGNS MEDIAN SEISMIC HAZARD RESULTS FOR S_a 10 Hz TO USING A REDUCED NUMBER OF SEISMICITY OPTIONS FOR THE ORIGINAL EPRI SOG SEISMIC SOURCES

FIGURE 2.5-56 REV. 0



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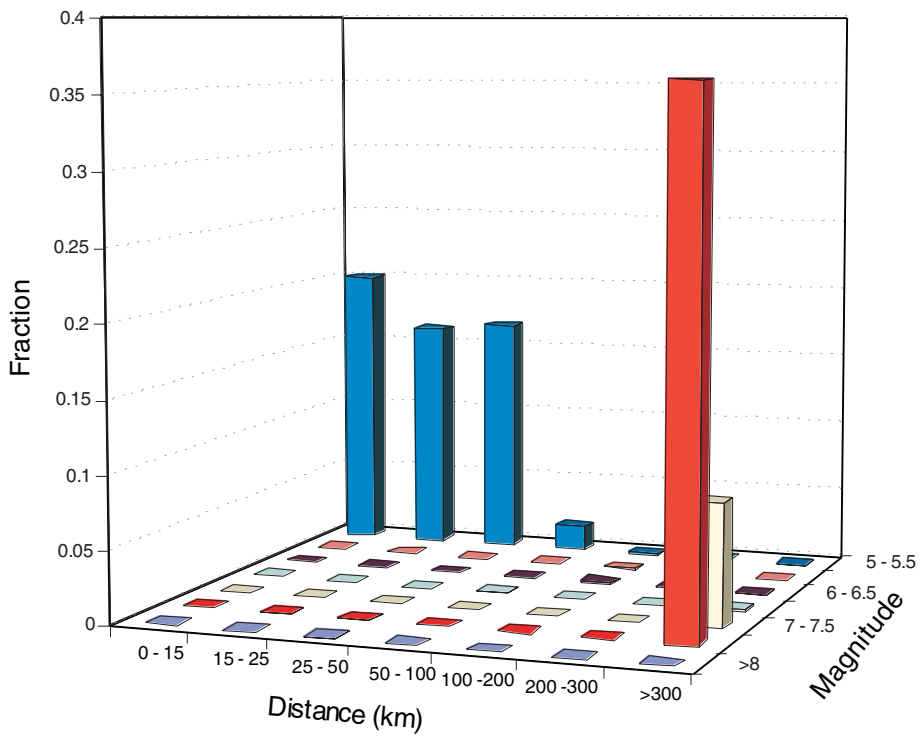
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

DEAGGREGATION FOR LOW FREQUENCY (S_a(1-2.5Hz)) GROUND MOTIONS AT THE GGNS ESP SITE

FIGURE 2.5-57 REV. 0

High Frequency Deaggregation



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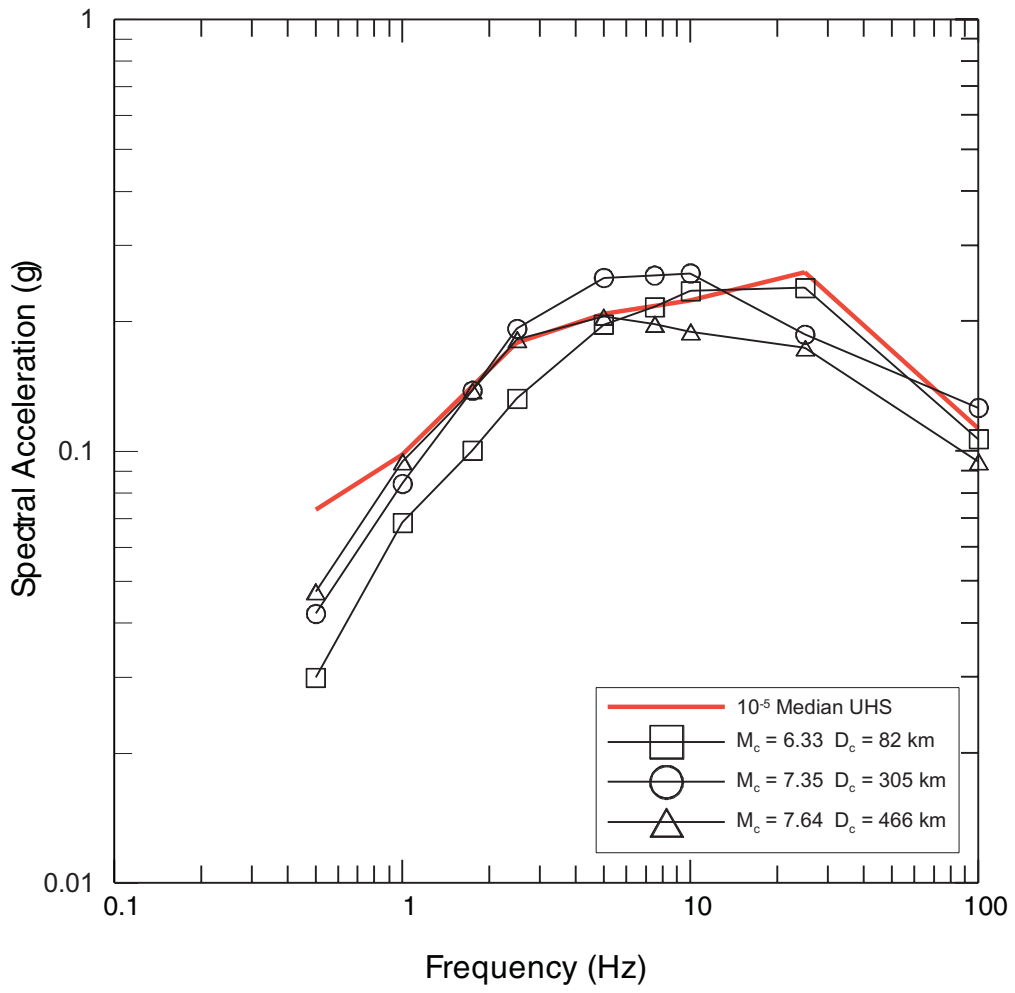
DEAGGREGATION FOR HIGH FREQUENCY (S_a(5-10Hz)) GROUND MOTIONS AND AT THE GGNS ESP SITE

FIGURE 2.5-58 REV. 0



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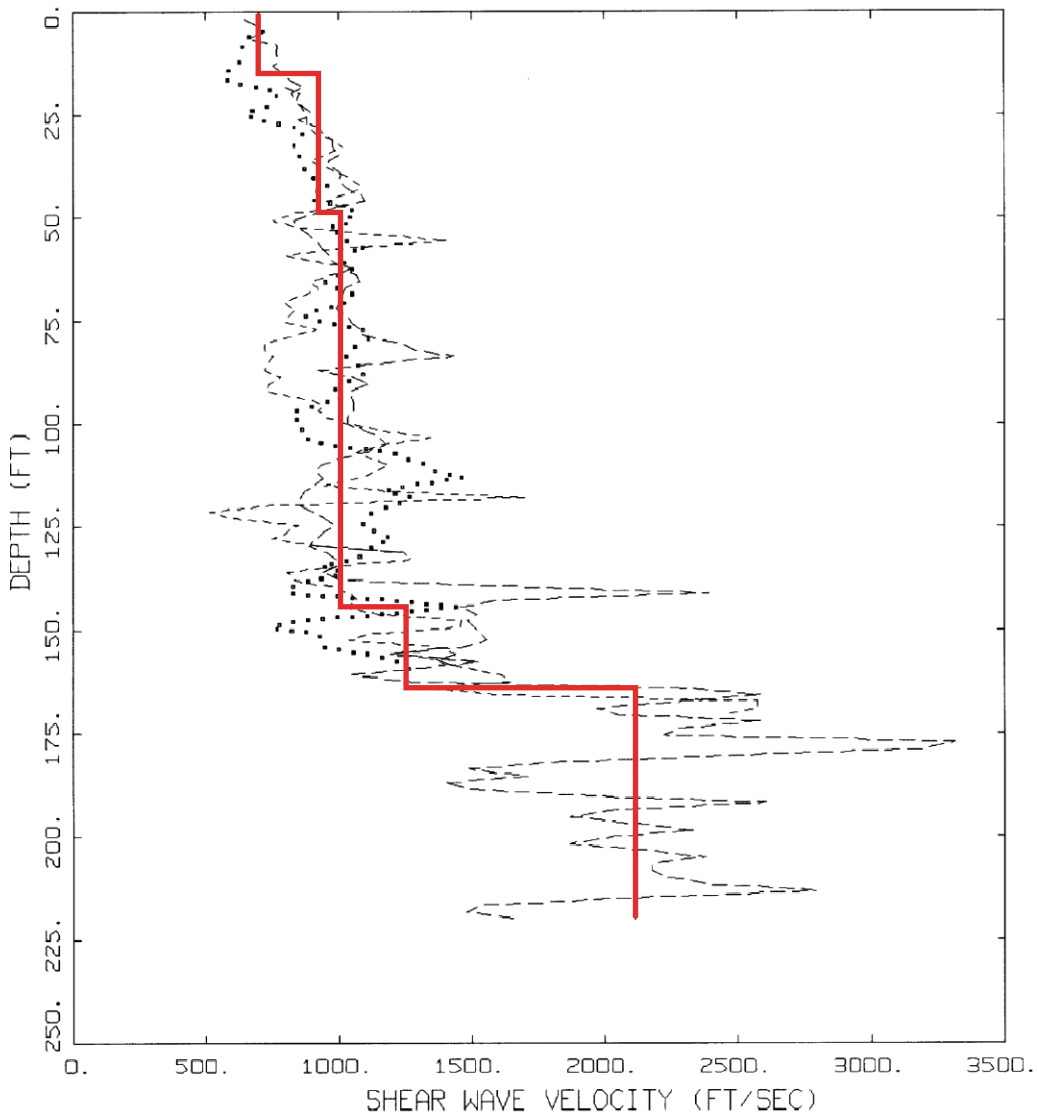
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

COMPARISON OF THE GGNS 10^{-5} MEDIAN UNIFORM HAZARD RESPONSE SPECTRUM AND THE MEDIAN RESPONSE SPECTRA ASSOCIATED WITH THE CONTROLLING EARTHQUAKES

FIGURE 2.5-59 REV. 0



GRAND GULF
SITE SPECIFIC PROFILES

LEGEND
BASE CASE MODEL
PROFILE B-3
PROFILE B-2A
PROFILE B-1

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GRAND GULF NUCLEAR STATION SITE
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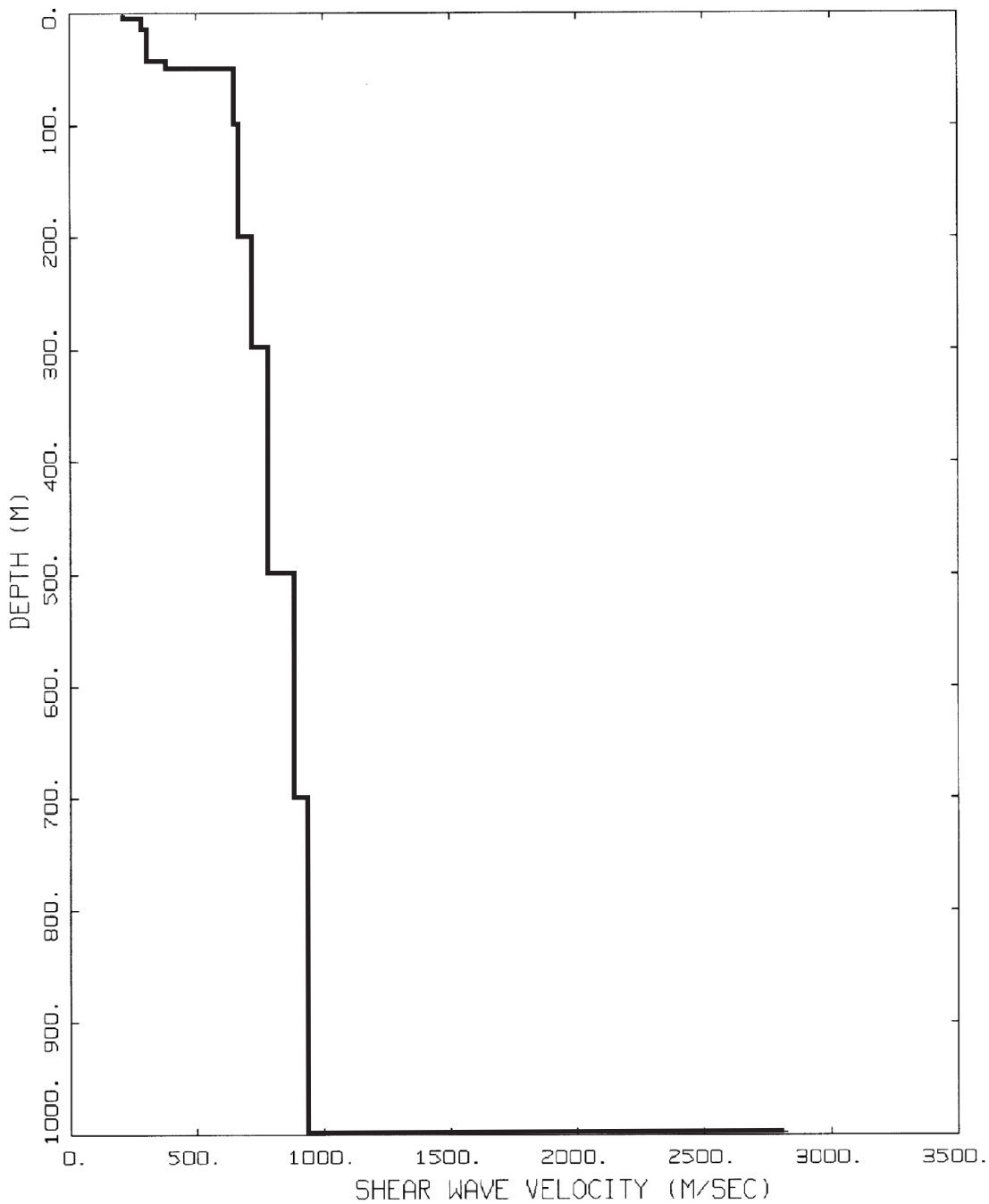
BASE CASE SHEAR-WAVE VELOCITY PROFILE
AND SUSPENSION LOG MEASUREMENTS

FIGURE 2.5-60 REV. 0



GRAND GULF
SITE SPECIFIC PROFILE

LEGEND
——— BASE CASE MODEL TO 1 KM

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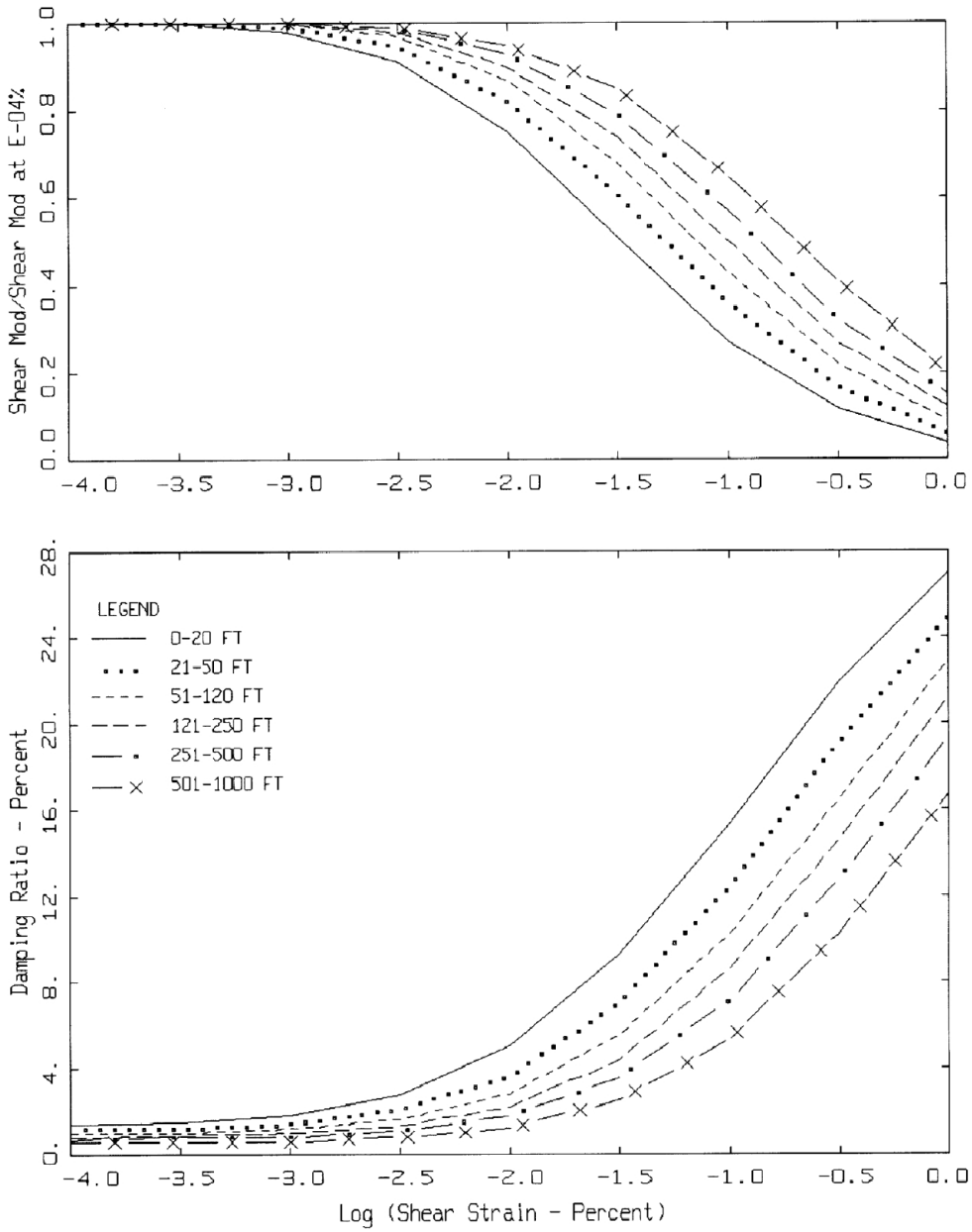
BASE CASE SHEAR-WAVE VELOCITY PROFILE
EXTENDED TO A DEPTH OF 1,000M

FIGURE 2.5-61 REV. 0



MODULUS REDUCTION AND DAMPING CURVES
EPRI(1993)

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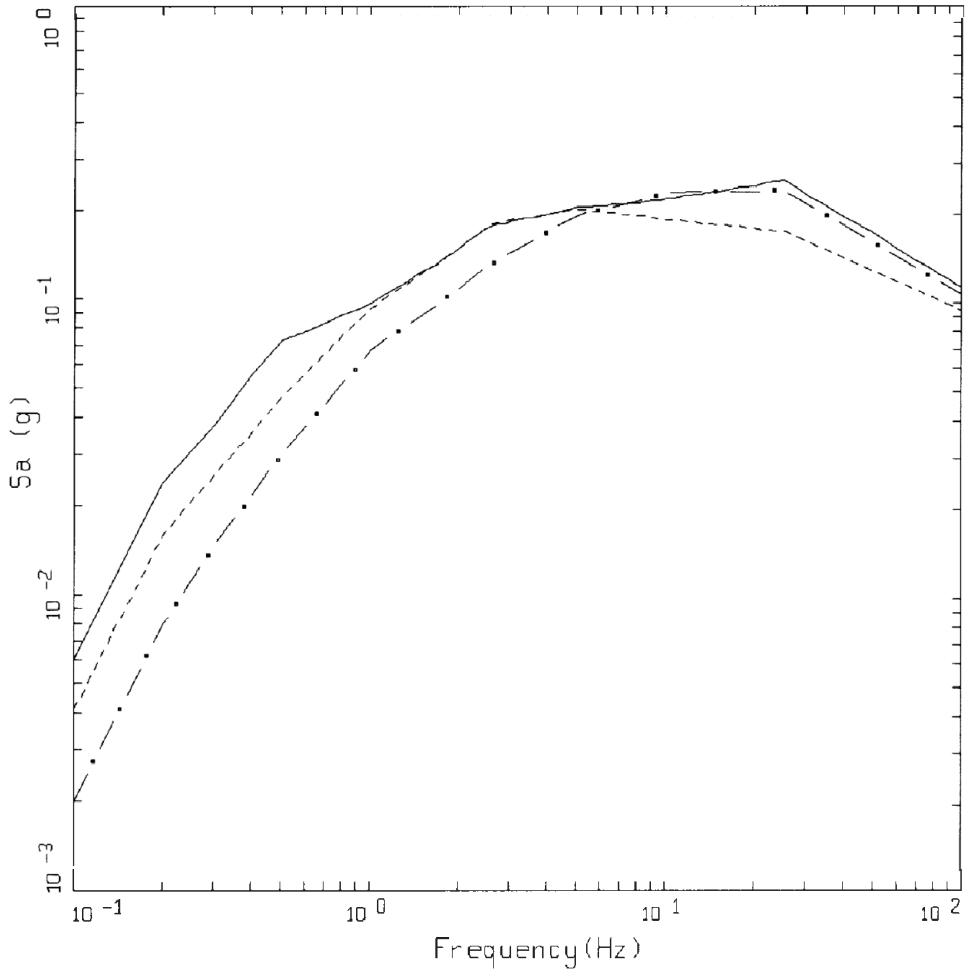
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

COHESIONLESS SOIL MODULUS
REDUCTION AND DAMPING CURVES
(EPRI, 1993) ADOPTED FOR THE SITE

FIGURE 2.5-62 REV. 0



GRAND GULF ROCK MOTIONS
HORIZONTAL, 10-5 APE

LEGEND

UHS; PGA = 0.113 G

1-2 Hz; PGA = 0.095 G

5-10 Hz; PGA = 0.107 G

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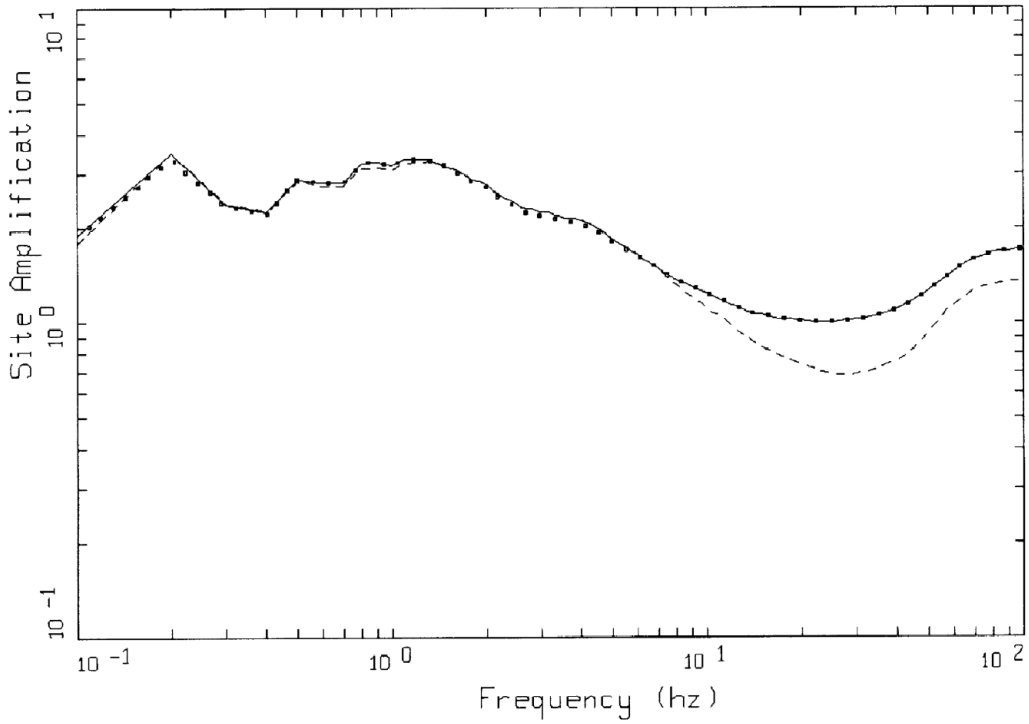
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

MEDIAN 10-5 APE HARD ROCK UHS AND CORRESPONDING SCALED 1 TO 2 HZ AND 5 TO 10 HZ SPECTRA, EXTENDED TO 0.1 HZ FOR SITE RESPONSE ANALYSES.

FIGURE 2.5-63 REV. 0



TOP OF LOESS
MEAN AMPLIFICATION

LEGEND
ENVELOPE
MEAN 1-2 HZ
MEAN 5-10 HZ

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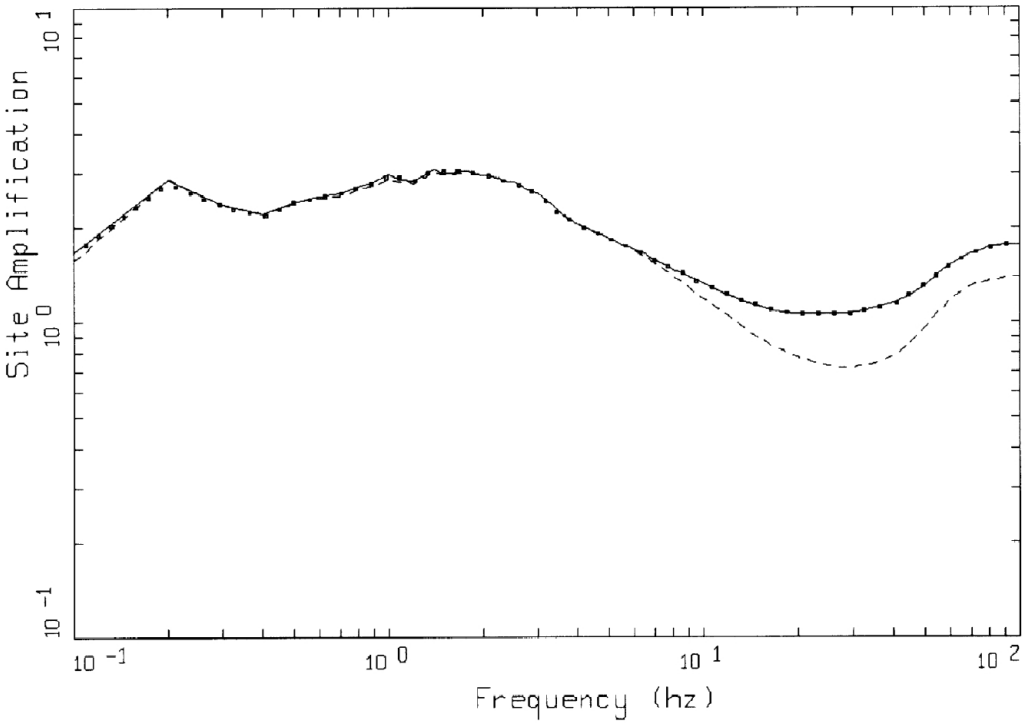
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

MEAN TRANSFER FUNCTIONS CORRESPONDING TO 1 TO 2 HZ AND 5 TO 10 HZ SCALED SPECTRA (FIGURE 63) AND ENVELOP: TOP OF LOESS

FIGURE 2.5-64 REV. 0



TOP OF 1,000 FT/SEC MATERIAL
MEAN AMPLIFICATION

LEGEND
ENVELOPE
MEAN 1-2 HZ
MEAN 5-10 HZ

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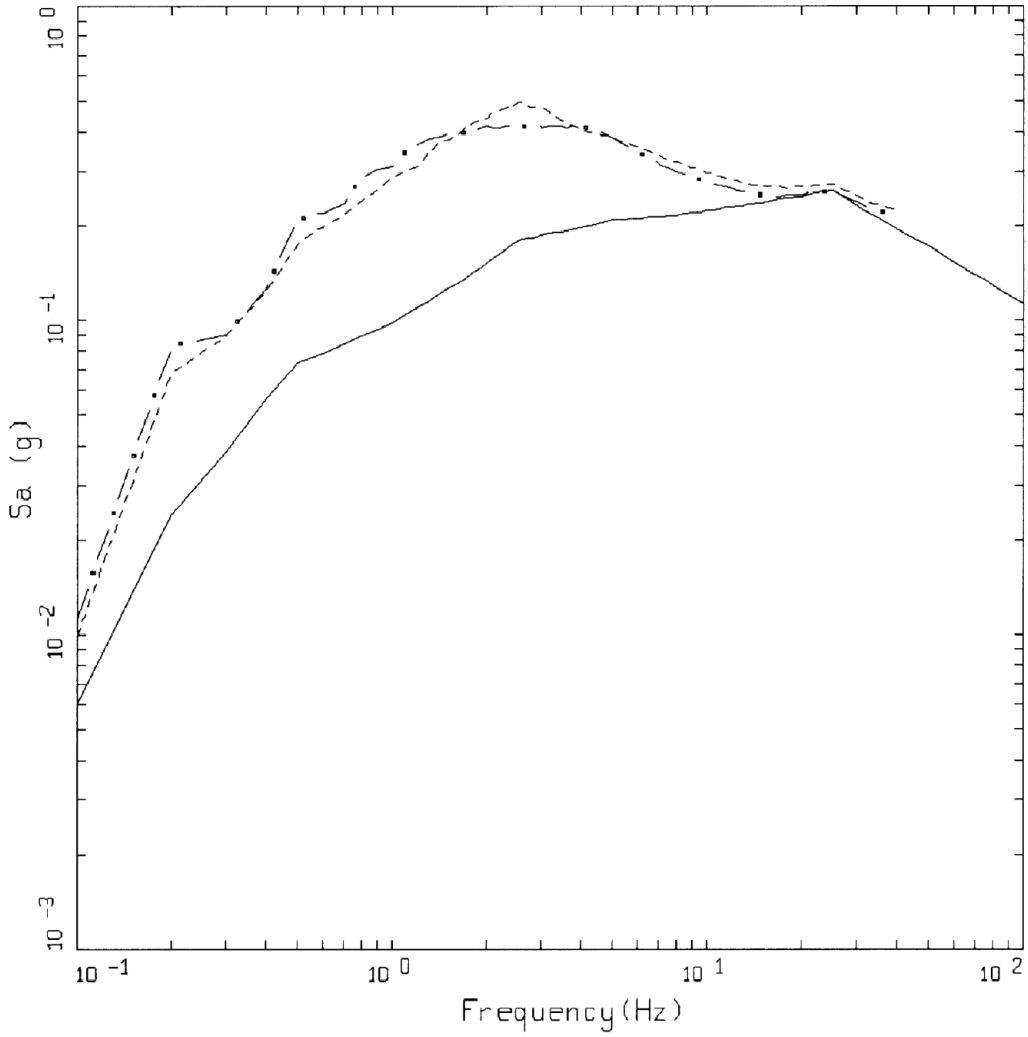
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

HARD ROCK OUTCROP UHS AND CORRESPONDING SOIL MOTIONS: DASH-DOTTED, TOP OF LOESS; DASHED, TOP 50 FT OF MATERIAL REMOVED

FIGURE 2.5-65 REV. 0



GRAND GULF SOIL MOTIONS
HORIZONTAL, 10-5 APE

LEGEND

——— ROCK UHS; PGA = 0.113 G

- - - - - 1,000 FT/SEC SOIL SURFACE, 0.200 G

— · — TOP OF LOESS, 0.192 G

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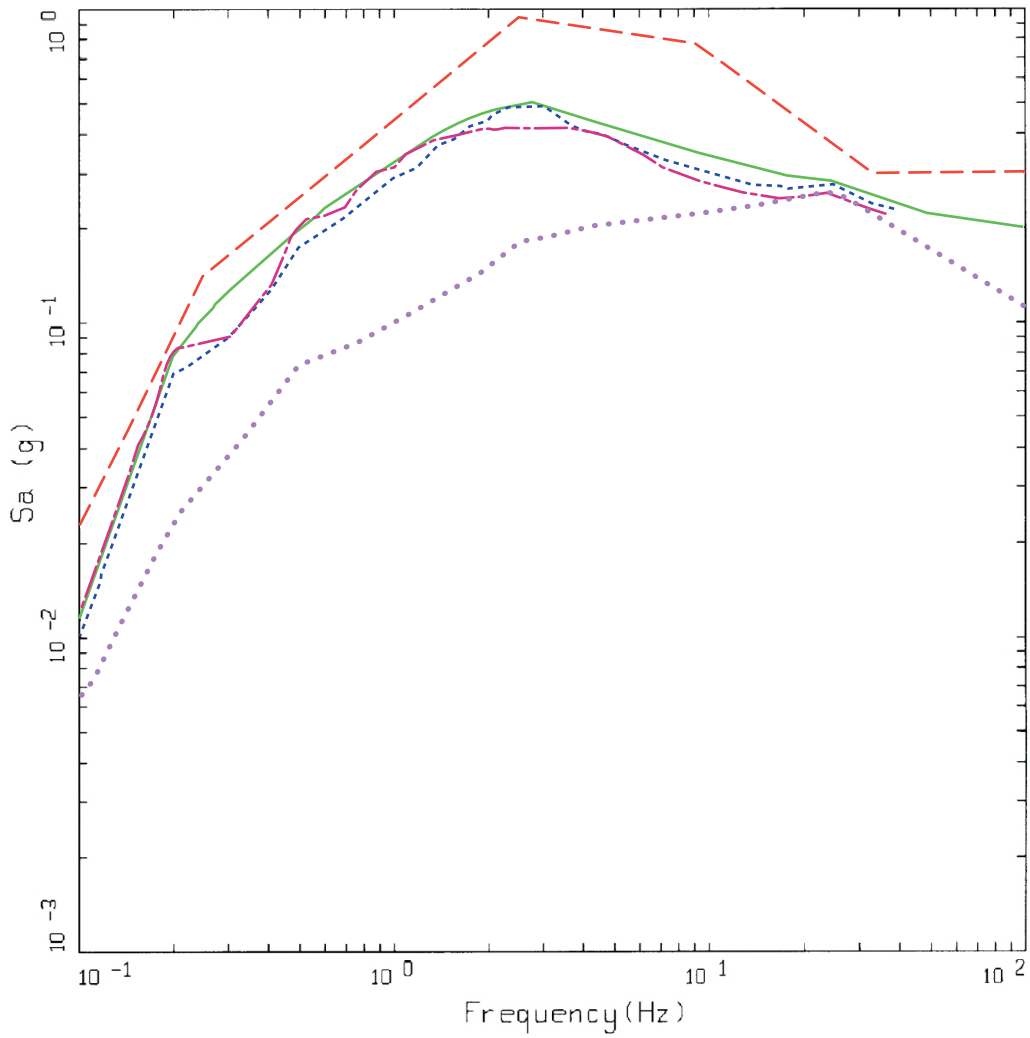
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

MEAN TRANSFER FUNCTIONS CORRESPONDING TO 1 TO 2 HZ AND 5 TO 10 HZ SCALED SPECTRA (FIGURE 63) AND ENVELOP: TOP OF 1,000 FT/SEC MATERIAL, DEPTH 50 FT (FIGURE 60)

FIGURE 2.5-66 REV. 0



GRAND GULF, 10-5 APE CONTROL MOTION
SOIL DESIGN MOTION

LEGEND

- 5 %, SOIL DESIGN MOTION, PGA = 0.200 G
- 5 %, 10-5 APE ROCK UHS, PGA=0.113 G
- 1,000 FT/SEC SOIL SURFACE, 0.200 G
- TOP OF LOESS, 0.192 G
- 5 %, R.G. 160 SCALED TO 0.3 G

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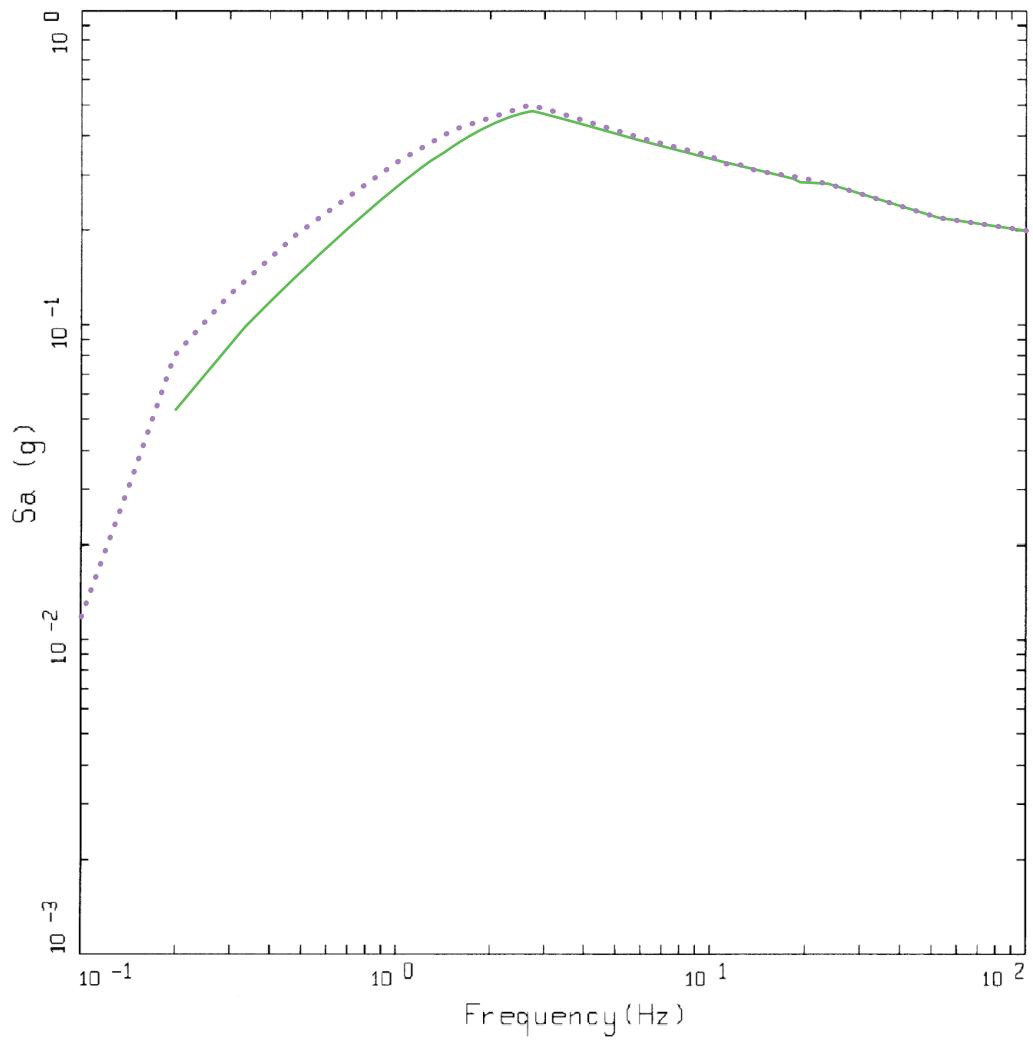
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

HORIZONTAL SOIL DESIGN GROUND MOTION (SOLID) AS ENVELOP OF TOP OF LOESS MOTION (DASH-DOTED) AND MOTION WITH TOP 50 FT OF LOESS REMOVED (DASHED). NRC R.G. 1.60 SPECTRUM SCALED TO 0.3G (LONG DASHES)

FIGURE 2.5-67 REV. 0



GRAND GULF, 10-5 APE
VERTICAL MOTION AT SOIL SURFACE

LEGEND

VERTICAL SOIL DESIGN MOTION, PGA = 0.200 G

5 %, HORIZONTAL SOIL DESIGN MOTION, PGA = 0.200 G

SERI
GRAND GULF NUCLEAR STATION SITE
EARLY SITE PERMIT APPLICATION
SITE SAFETY ANALYSIS REPORT

VERTICAL SOIL DESIGN MOTION
BASED ON R.G. 1.60 V/H RATIOS

FIGURE 2.5-68 REV. 0