Alternative Use of Resources

This action does not involve the use of any resources not previously considered in the Final Environmental Statement, Supplement No 1, for WBN Units 1 and 2, dated April 1995.

Agencies and Persons Consulted

In accordance with its stated policy, on August 21, 1997 the staff consulted with the Tennessee State official, Mr. J. Graves of the Division of Radiological Health, regarding the environmental impact of the proposed action. The State official had no comments.

Finding of No Significant Impact

Based upon this environmental assessment, the Commission concludes that the proposed action will not have a significant effect on the quality of the human environment. Accordingly, the Commission has determined not to prepare an environmental impact statement for the proposed action.

For further details with respect to the proposed action, see the licensee's letter dated June 20, 1997, which is available for public inspection at the Commission's Public Document Room, the Gelman Building, 2120 L Street, NW., Washington, DC, and at the local public document room located at the Chattanooga-Hamilton County Library, 1001 Broad Street, Chattanooga, Tennessee.

Dated at Rockville, Maryland, this 22nd day of September 1997.

For the Nuclear Regulatory Commission.

Frederick J. Hebdon,

Director, Project Directorate II–3, Division of Reactor Projects—I/II.

[FR Doc. 97–25631 Filed 9–25–97; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

[Docket Nos. 50–361 and 50–362]

Southern California Edison Company, Et Al., San Onofre Nuclear Generating Station, Units 2 and 3; Issuance of Director's Decision Under 10 CFR 2.206

Notice is hereby given that the Director, Office of Nuclear Reactor Regulation, has acted on a Petition for action under 10 CFR 2.206 received from Mr. Stephen Dwyer dated September 22, 1996, as supplemented by letter dated December 10, 1996, two e-mails of March 26, 1997, and an e-mail of May 28, 1997, for the San Onofre Nuclear Generating Station (SONGS), Units 2 and 3.

The Petition requests that the Commission shut down the San Onofre Nuclear Generating Station pending a complete review of the ''new seismic risk.'' As a basis for the request, the Petitioner asserts that a design criterion for the plant, which was ''0.75 G's acceleration,'' is ''fatally flawed'' on the basis of the new information gathered at the Landers and Northridge quakes. The Petitioner asserts (1) that the accelerations recorded at Northridge exceeded ''1.8 G's and it was only a Richter 7+ quake,'' (2) that there were horizontal offsets of up to 20 feet in the Landers quake, and (3) that the Northridge fault was a ''Blind Thrust and not mapped or assessed.''

The Director of the Office of Nuclear Reactor Regulation has determined that the request should be denied for the reasons stated in the ''Director's Decision Under 10 CFR 2.206'' (DD–97–23), the complete text of which follows this notice and which is available for public inspection at the Commission's Public Document Room, the Gelman Building, 2120 L Street, N.W., Washington, D.C. 20555, and at the Local Public Document Room located at the Main Library, University of California, P. O. Box 19557, Irvine, California 92713.

Dated at Rockville, Maryland, this 19th day of September 1997.

For the Nuclear Regulatory Commission.

Samuel J. Collins,

Director, Office of Nuclear Reactor Regulation.

Director's Decision Under 10 CFR 2.206

I. Introduction

By Petition dated September 22, 1996, Stephen Dwyer (Petitioner) requested that the Nuclear Regulatory Commission (NRC) take action with regard to San Onofre Nuclear Generating Station (SONGS). The Petitioner requested that the NRC shut down the SONGS facility ''as soon as possible'' pending a complete review of the ''new seismic risk.'' [1] The Petitioner asserted as a basis for this request that a design criterion for the plant, which was ''0.75 G's acceleration,'' is ''fatally flawed'' on the basis of new information gathered at the Landers and Northridge earthquakes. The Petitioner asserted (1) That the accelerations recorded at Northridge exceeded ''1.8G's and it was only a Richter 7+ quake,'' (2) that there were horizontal offsets of up to 20 feet in the Landers quake, and (3) that the Northridge fault was a ''Blind Thrust and not mapped or assessed.'' On November 22, 1996, the NRC staff acknowledged receipt of the Petition as a request pursuant to 10 CFR 2.206 and informed the Petitioner that there was insufficient evidence to conclude that the requested immediate action was warranted. Notice of the receipt of the Petition indicating that a final decision with respect to the requested action would be forthcoming at a later date was published in the **Federal Register** on November 29, 1996 (61 FR 60734).

The Petitioner provided supplemental information in support of his Petition in a letter dated December 10, 1996, two e-mails dated March 26, 1997, and an e-mail dated May 28, 1997.[2] My Decision in this matter follows.

II. Discussion

A. Regulatory Requirements Associated With Potential Earthquake Motion and the Licensing Basis for SONGS

The design bases for each nuclear power plant must take into account the potential effects of earthquake ground motion.[3] The seismic design basis, called the safe-shutdown earthquake (SSE), defines the maximum ground motion that certain structures, systems, and components necessary for safe shutdown are designed to withstand.[4] SONGS Units 2 and 3 seismic design basis is consistent with the siting criteria set forth in Title 10 of the Code of Federal Regulations, Part 100, Appendix A, ''Seismic and Geologic Siting Criteria for Nuclear Power Plants.'' Appendix A describes the nature of the investigations required to

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[1] In his e-mail dated March 26, 1997, supplementing his Petition, the Petitioner also requested removal of ''all spent fuel out of the southern California seismic zone.''

[2] By letter dated June 26, 1997, the NRC staff advised the Petitioner that his e-mail dated April 25, 1997, concerning the ability of the SONGS steam generators to withstand a major seismic event, would be treated as a separate 10 CFR 2.206 Petition.

[3] See 10 CFR Part 50, Appendix A, Criterion 2 and 10 CFR 50.34(a)(1)(i); see also 10 CFR Part 100, Appendix A, V.(a) which provides, in part, that ''the design of each nuclear power plant shall take into account the potential effects of vibratory ground motion caused by earthquakes.'' The investigative obligations of 10 CFR Part 100, Appendix A, which are only imposed explicitly on applicants for construction permits, were effective December 13, 1973 (38 FR 31279, November 13, 1973). The Licensing Board issued its decision regarding the SONGS Units 2 and 3 construction permits on October 15, 1973. However, the SONGS site was reviewed against the Appendix A criteria during the construction permit licensing review which was updated at the operating license review stage.

[4] The SSE is defined, in part, as ''that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional.'' See 10 CFR Part 100, Appendix A. III.(c).

obtain the geologic and seismic information necessary to determine site suitability and provide reasonable assurance that a nuclear power plant can be constructed and operated at a site without undue risk to health and safety of the public. Among other particulars, Appendix A requires [5]—

- Determination of the lithologic, stratigraphic, hydrologic, and structural geologic conditions of the site and the region surrounding the site.
- Identification and evaluation of tectonic structures underlying the site and the region surrounding the site, whether buried or expressed at the surface.
- Evaluation of physical evidence concerning the behavior during prior earthquakes of the surficial geologic materials and substrata underlying the site.
- Determination of the static and dynamic engineering properties of the materials underlying the site, such as seismic wave velocities, density, water content, porosity, and strength.
- Listing of all historically reported earthquakes that affected or that could reasonably be expected to have affected the site.
- Correlation of epicenters of historically reported earthquakes, where possible, with tectonic structures, any part of which is located within 320 kilometers (200 miles) of the site. Epicenters that cannot be correlated with tectonic structures shall be identified with tectonic provinces, any part of which is located within 320 kilometers (200 miles) of the site.
- For capable faults [6] that may be of significance in establishing the SSE or that are longer than 330 meters (1000 feet) and within 8 kilometers (5 miles) of the site, determination of the length of the fault; the relationship of the fault to the regional tectonics structures; and the nature, amount, and geologic history of displacements along the fault, including the estimated amount of maximum Quaternary displacement related to any one earthquake along the fault are required.

The information collected in these investigations is used to determine the vibratory ground motion at the site, assuming that the epicenters of the earthquakes are situated at the point on the tectonic structures or in the tectonic provinces nearest to the site. The earthquake that could cause the maximum vibratory ground motion at the site is designated the SSE. The vibratory ground motion produced by the SSE is defined by response spectra, which are smoothed design spectra developed from a set of vibratory ground motions caused by more than one earthquake.

SONGS was licensed consistent with the seismic and geologic siting criteria for nuclear power plants set forth in 10 CFR Part 100, Appendix A, described above. The site has undergone geologic, geophysical, geotechnical, and seismic investigations and reviews that are at least as thorough and comprehensive as those of any critical facility.[7] The SONGS SSE is based on the assumed occurrence of a surface-wave (M_S) [8] magnitude 7 earthquake on the offshore zone of deformation (OZD), a right lateral strike slip fault zone, approximately 8 kilometers from the site at its closest approach. This magnitude 7 event is larger than any earthquake known to have occurred on the OZD, and the resulting ground motion estimate is larger than that which could reasonably be expected at the SONGS site from any other seismic source. The determination of the SSE was made in accordance with the criteria and procedures specified in Appendix A to 10 CFR Part 100 and using a multiple hypothesis approach in which several different methods were used to determine each parameter; sensitivity studies were performed to account for the uncertainties in the earth sciences.

In addition, the plant has design margins (capability) well beyond the demands of the SSE. The ability of a nuclear power plant to resist the forces generated by the ground motion during an earthquake is thoroughly incorporated in the design and construction of the plant. The codes that govern the construction of residential and commercial buildings are far less stringent than the requirements for nuclear power plants. As a result, nuclear power plants are able to resist earthquake ground motions well beyond their design basis, the SSE, and far above the ground motion that would result in damage to buildings designed and built to commercial codes.

The geologic and seismic siting and the design of SONGS were reviewed by the NRC staff, the U. S. Geologic Survey, the National Oceanic and Atmospheric Administration, the Advisory Committee on Reactor Safeguards and were litigated before the Atomic Safety Licensing Board before they were licensed by the Commission.[9] The NRC continually monitors the adequacy of the design of nuclear power plants in order to protect the public health and safety. The SONGS licensee performed an individual plant examination of external events (IPEEE).[10] The IPEEE is a program that involves the evaluation of the capability of a nuclear power plant to withstand the effects of several natural phenomena such as earthquakes, fires, and floods, well beyond its design bases. The most recent geologic and seismic information for the southern California region was used in the probabilistic analysis to quantify the seismic hazard and the uncertainties for the SONGS site for this program.

The ground motion from an earthquake at a particular site is a function of the magnitude and focal mechanism (type of faulting, i.e., normal, reverse, strike slip) at the earthquake source. It is also a function of the distance of the facility from the

[5] See 10 CFR Part 100, Appendix A. IV.

[6] A capable fault is a fault which has exhibited one or more of the following characteristics: (1) Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years, (2) Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault, and (3) A structural relationship to a capable fault according to characteristics (1) or (2), above, such that movement on one could be reasonably expected to be accompanied by movement on the other. See 10 CFR Part 100, Appendix A.III(g).

[7] The findings of these investigations were reviewed extensively by the staff and were litigated in proceedings concerning the issuance of the construction permit and operating licenses for SONGS Units 2 and 3. See LBP–73–36, 6 AEC 929 (1973); ALAB–248, 8 AEC 957 (1974) and see LBP–82–3, 15 NRC 61 (1982); ALAB–673, 15 NRC 688 (1982); ALAB–717, 17 NRC 346 (1983); and see Carstens v. NRC 742 F.2d 1546 (D.C. Cir. 1984), cert. denied, 471 U.S. 1136 (1985) (the Court of Appeals affirmed the Commission's granting of the operating licenses for SONGS Units 2 and 3, noting the voluminous record and substantial evidence supporting the seismic review).

[8] In 1935, Charles Richter introduced the concept of magnitude to describe the size of earthquakes. His original formula was based on events in southern California recorded on torsion seismographs within 600 km of the epicenter. This is the magnitude labeled M_L. Over the years Richter and others developed formulas to compute magnitudes from body and surface waves (m_b and M_S) at distant (teleseismic) stations as well as other methods to compute magnitudes for local events in other areas of the world. Most of these methods of computing magnitude use as the measured variable the amplitude of one or more seismic waves. All of these magnitude procedures, including the moment magnitude M_W, have been developed to produce a number which represents the size of an earthquake, and each was shingled onto Richter's original procedure so that the formulas would produce similar values at particular places on the magnitude scale. Each computation procedure has its own magnitude or distance range over which it is valid. Surface wave magnitude is normally calculated from the amplitudes of waves with periods near 20 seconds. Moment magnitude is based on the seismic moment. Seismic moment is calculated from recordings on digital seismographs and compared to the waveforms synthetic seismograms from numerical models of the fault rupture to determine the moment.

[9] See cases cited *supra* note 7.

[10] See response to Generic Letter 88–20, Supplement 4, Individual Plant Examination of External Events (IPEEE) dated December 15, 1995, discussed, *infra*, at pages 22–24.

fault and the geology immediately under the facility site. The estimates of SSE ground motion for the SONGS site conform with the procedures and criteria specified in 10 CFR Part 100, Appendix A and the Standard Review Plan (SRP) [11] Sections 2.5.1 and 2.5.2 (NUREG–0800). As previously stated, the earthquake that was determined to control the design of SONGS is a M_S=7 located on the OZD at a distance of 8 kilometers from the site. The appropriate level of conservatism for characterizing the ground motion through a site-specific spectrum as specified in SRP 2.5.2 is the 84th percentile. This level of conservatism was used in the design and licensing review of SONGS, Units 2 and 3.

Since the SONGS plants were licensed, a new magnitude scale, moment magnitude (M_W), has come into common usage. The most recently published ground motion attenuation relationships [12] use M_W. An attenuation relationship is a relationship between sized earthquake, distance to fault and the amplitude of the ground motion. Since magnitude 7 M_W is equal to magnitude 7 M_S,[13] there is no need to make a conversion between M_W and M_S when comparing the ground motion estimates obtained using the recent attenuation relationships to the SONGS SSE ground motion.

B. Responses to the Petitioner's Concerns

1. Concern that SONGS is in a High Seismic Hazard Area

In the enclosure to his letter,[14] the Petitioner referenced ''a recent paper by M. D. Petersen et al. (Seismic Hazard Analysis, AEG, 1–20–96)'' and stated that it concludes that the entire Los Angeles, Ventura, and Orange Counties are high hazard areas. The Petitioner stated that the paper also concludes that accelerations of 0.4g (pga), 1.0g (0.3-sec SA), and 0.5g (1-sec SA) can occur nearly everywhere.

The NRC staff attempted to find the reference mentioned by Mr. Dwyer but was unsuccessful. Mark D. Petersen of the California Division of Mines and Geology informed the staff that the correct reference is an article that he and his coauthors published in the Bulletin of the Seismological Society of America.[15] Dr. Petersen made a presentation at a workshop on seismic hazard in southern California in January 1996 and gave participants in the workshop preprints and reprints of some of his recent publications. The cited reference was one of these handouts.

In the section of the paper entitled ''Hazard Maps,'' the authors state:

> The DMG probabilistic seismic hazard maps (10% exceedance in 50 years) for peak ground acceleration (pga) and 5% damped spectral acceleration (SA) at 0.3-and 1-sec periods on alluvial site conditions are shown in Figures 3 through 5. These maps may be useful in characterizing regional variations in seismic hazard in southern California but should not be used as input for detailed site-specific estimates of ground shaking in the earthquake-resistant design of individual structures.[16]

The paper then states—

> The three maps show similar hazard patterns that indicate high hazard over the entire tri-county area. The expected peak accelerations exceed 0.4g (pga), 1.0g (0.3 s SA), and 0.5g (1 s SA) nearly everywhere in the tri-county area.'' [17]

To address the acceleration values mentioned by the Petitioner with respect to SONGS, the NRC staff has produced Figure 1, which contains a plot of the SONGS SSE seismic response spectrum at 5 percent of critical damping and the values quoted from the Petersen paper. Since period in seconds is the reciprocal of frequency in Hertz, the 1-second period spectral acceleration (0.5g) is plotted at a frequency of 1 Hertz, the 0.3-second period acceleration (1.0g) is plotted at a frequency of 3.33 Hertz and the peak ground acceleration (0.4g) is plotted at a frequency of 33 Hertz. The figure demonstrates that the spectral accelerations (accelerations plotted in the response spectra) used in the design of SONGS are significantly higher than those from the Petersen paper, thus showing the conservatism of the design basis for SONGS.

2. Concern About a Large Earthquake on the San Andreas Fault

In the enclosure to his letter dated December 10, 1996, entitled ''Uncertainty Factors Affecting Seismic Risk Risk Modelling in Southern California,'' the Petitioner stated ''We must prepare for a great event on the Southern San Andreas Fault.'' He also mentioned an earthquake on the San Andreas in his e-mail message.[18]

The NRC staff agrees that there must be preparation for a large event on the San Andreas fault and finds that the SONGS seismic design is well able to withstand the demands of a large earthquake on the southern San Andreas fault. Although the geologic evidence appears to indicate that the largest event to have occurred on the southern San Andreas in the Quaternary Period (the last 2 million years) is estimated to have been in the moment magnitude (Mw) range of 7.5 to 8; to evaluate the potential ground motion at the SONGS site from a large earthquake on the southern San Andreas fault, the staff made the very conservative assumption of a moment magnitude 8.25 strike-slip earthquake at the closest distance of the San Andreas fault to the site (90 kilometers). This assumption was made to calculate the effects of a large earthquake on the San Andreas fault. The results are plotted in Figure 2 which demonstrates that the design basis (SSE) spectrum for SONGS is much higher than the ground motion estimates from the Mw 8.25 on the San Andreas fault using four recent attenuation relationships. These four empirical attenuation relationships were developed after the occurrence of the Northridge and Landers earthquakes, and include the recent strong ground motion from these events. They were performed by internationally known experts in earthquake ground motion analysis and were published in the Seismological Research Letters,[19] the peer-reviewed journal of the Seismological Society of America. The assumption of a moment magnitude 8.25 strike-slip earthquake and the

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[11] Standard Review Plan (SRP) is used as guidance for the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants.

[12] N. A. Abrahamson and W. J. Silva, ''Empirical Response Spectral Attenuation Relations for Shallow Crustal Earthquakes,'' Seismological Research Letters, 68, 94–127 (1997); David M. Boore, William B. Joyner, and Thomas E. Fumal, ''Equations for Estimating Horizontal Response Spectra and Peak Acceleration From Western North American Earthquakes: A Summary of Recent Work,'' Seismological Research Letters, 68, 128–153 (1997); K. W. Campbell, ''Empirical Near-Source Attentuation Relationships for Horizontal and Vertical Components of Peak Ground Acceleration, Peak Groud Velocity and Pseudo-Absolute Aceleration Response Spectra,'' Seismological Research Letters, 68, 154–179; K. Sadigh, C.Y. Chang, J. A. Egan, F. Makdisi, and R. R. Yongs, ''Attentuation Relationships for Shallow Crustal Earthquakes Based on California Strong Motion Data,'' Seismological Research Letters, 68 180–189 (1997).

[13] Thorne Lay and Terry C. Wallace, Modern Global Seismology, Academic Press, Inc., San Diego, California; K. W. Campbell (1995).

[14] Stephen Dwyer, Letter to Dr. Shirley Jackson and Frank J. Miraglia, Jr., with enclosure, dated December 10, 1996.

[15] Mark D. Petersen, Chris H. Cramer, William A. Bryant, Michael S. Reichle, and Tousson R. Toppozada, ''Preliminary Seismic Hazard Assessment for Los Angeles, Ventura, and Orange Counties, California, Affected by the 17 January 1994 Northridge Earthquake,'' Bulletin of the Seismological Society of America, 86, S247–S261 (1996).

[16] Id.

[17] Id.

[18] Stephen Dwyer, e-mail message to Dr. Jackson, Subject: San Onofre Nuclear Power Plant Risk, dated September 22, 1996.

[19] Abrahamson and Silva, *supra* note 12.

SONGS site foundation geology were used as input parameters for these four earthquake ground motion attenuation relationships.[20] The ground motion estimates were made at the 84th percentile level recommended by SRP Section 2.5.2. The plots of the results obtained from these four attenuation relationships and the SONGS Units 2 and 3 SSE design response spectrum are shown in Figure 2. The plotted information in the figure demonstrates that the SONGS design is well able to accommodate the demand of the ground motion of the large earthquake on the southern San Andreas fault since it envelopes the estimates of the four relationships at all frequencies.

3. Concern About the SONGS Design Basis in Light of the Landers and Northridge Earthquakes

In an e-mail message to Chairman Jackson dated September 22, 1996, the Petitioner stated—

I am a geologist in Southern California, and I am deeply concerned by the current situation at San Onofre NPP. The design criteria for this old plant was 0.75 G's acceleration. With the new information gathered at the Landers and Northridge Quakes, this criteria is fatally flawed. The accelerations recorded at Northridge exceeded 1.8 G's !!! and it was only a Richter 7+ quake. Horizontal offsets of up to 20 feet in the Landers quake were also way beyond geologists and seismologists estimates. The whole science is in disarray. Also the Northridge fault was a ''Blind Thrust' and not mapped or assessed. If we have a larger quake here on the San Andreas, or a smaller one closer to the plant, well I hate to imagine * * *. What's even worse is the fact that scientists are not able to give us the info we need to evaluate the situation.

The main points of the Petitioner's message appear to be—

- A peak ground acceleration recorded from the Northridge magnitude Mw 6.7 earthquake exceeded 1.8 g.
- The Northridge earthquake occurred on a blind fault that had not been mapped or assessed.
- The maximum horizontal displacement of almost 20 feet due to the Landers magnitude 7.3 earthquake is much larger than would be estimated.
- Scientists are not able to provide the information to evaluate the situation.

The magnitude 6.7 Northridge earthquake of January 17, 1994, occurred on a buried thrust fault in the San Fernando Valley and was similar to the 1971 San Fernando Valley earthquake. The distance from this earthquake epicenter to the SONGS site is about 130 kilometers (80 miles). The Northridge earthquake was felt at SONGS. A free-field seismic instrument at SONGS recorded a peak ground acceleration of 0.025g, which is significantly less than the SSE peak ground acceleration of 0.67g, thus indicating that an earthquake in the epicentral region of Northridge poses no threat to the plant.

The peak ground acceleration of 1.8g from the Northridge earthquake referred to by the Petitioner was recorded by the California Division of Mines and Geology station in Tarzana. The anomalous character of the seismic response at the Tarzana site is well known.[21] The intense shaking at the Tarzana site is a condition of the site and is not characteristic of the Northridge earthquake. This fact is demonstrated by the unusually strong ground motion that was also observed there during the 1987 Whittier Narrows earthquake[22] and during the aftershocks following both the Northridge and Whittier Narrows mainshocks. In recognition of the unusually high ground motion recordings at Tarzana, there have been a number of studies of this site[23] to try to determine the cause of the high recordings. These studies have attributed the high peak ground accelerations to the site's specific geology. The anomalous site effect was found to be confined to a small area 50 meters in radius around the station; beyond this area, the ground motion recordings were down to their normally expected values. It is, therefore, inappropriate to rely on data recorded at the unique Tarzana site to make judgments about ground motion estimates at other locations. The geologic formations under the SONGS site differ from those at the Tarzana site. The SONGS site does not anomalously amplify the earthquake ground motion as the Tarzana site does. During the evaluation of the site no geologic formations under SONGS were identified that would result in exceptionally high earthquake ground motions. Further, recorded earthquakes at SONGS have not exhibited any unusual amplifications.

As a result of their studies of the near field ground motions from thrust faults, Somerville et al.[24] found that the ground motions from the Northridge earthquake, in general, are within the 84th percentile when compared to previously developed empirical attenuation relations for thrust faults. This finding indicates that the Northridge ground motion data would not cause seismologists to revise ground motion estimates for thrust fault earthquakes. The data from this earthquake have been incorporated into the strong ground motion databases and have not significantly altered the results of the attenuation relationships. In addition, it is inappropriate to use the ground motions from thrust faults for estimates in a region in which there is no potential for this type of faulting, such as the South Coast Borderland where SONGS is located.

To address the issue of whether there is a potential for buried thrust faults at the SONGS site, the staff referred to a book by Yeats et al.[25] that contains a list and a map of the regions of the world that have the potential for large reverse-fault earthquakes. Thrust faults are low angle reverse faults. In California, the regions listed are the northern California coast, the Coast Ranges of central California, and the western Transverse Ranges. The 1994 Northridge earthquake and the 1971 San Fernando Valley earthquake are related to the western Transverse Ranges. There is no indication of reverse-fault earthquakes in the South Coast Borderland where SONGS is located.

In southern California, the mountain ranges flanking the ''Big Bend'' of the San Andreas fault (the Transverse Ranges) strike east-west and are bounded on the south by north-dipping range-front reverse faults, part of a discontinuous system of faults that extends from the Santa Barbara Channel eastward to the eastern end of the San Gabriel Mountains. Other important reverse faults in this region include the Pleito fault in the southern margin of the South San Joaquin Basin; the south-dipping Oak Ridge fault in the Ventura Basin which extends eastward to the San Fernando Valley as a blind thrust that produced the 1994 Northridge

[20] Id.

[21] J. A. Rial, ''The Anomalous Seismic Response of the Ground Motion at the Tarzana Hill Site During the Northridge 1994 Southern California Earthquake: A Resonant, Sliding Block?'' Bulletin of the Seismological Society of America, 86, 1714–1723 (1996).

[22] A. M. Shakal, M. Huang, and T. Cao, ''The Whittier Narrows, California, Earthquake of October 1, 1987: CSMIP Strong Motion Data,'' Earthquake Spectra, 4 75–100 (1988).

[23] R. D. Catchings and W. H. K. Lee, ''Shallow Velocity Structure and Poisson's Ratio at the Tarzana, California Strong-Motion Accelerometer Site,'' Bulletin of the Seismological Society of America, 86 1704–1713; Rial, loc. cit.; Paul Spudich, Margaret Hellweg, and W. H. K. Lee, ''Directional Topographic Site Response at Tarzana Observed in Aftershocks of the 1994 Northridge, California, Earthquake: Implications for Mainshock Motions,'' Bulletin of the Seismological Society of America, 86, S193–S208 (1996).

[24] Paul Somerville, Chandan Saikia, David Wald, and Rover Graves, ''Implications of the Northridge Earthquake for Strong Ground Motions from Thrust Faults,'' Bulletin of the Seismological Society of America, 86 S115–S125 (1996).

[25] Robert S. Yeats, Kerry Sieh, and Clarence R. Allen, The Geology of Earthquakes, Oxford University Press, Oxford, England (1997).

earthquake; and a blind reverse-fault system beneath the Santa Monica Mountains North of the Los Angeles basin. Major earthquakes generated by these reverse faults include the 1952 Kern County earthquake in the South San Joaquin Valley (M_S 7.7), the 1971 San Fernando earthquake at the eastern edge of the Ventura basin (M_W 6.7), the 1978 Santa Barbara earthquake in the western Ventura basin (M_L 5.9), the 1987 Whittier Narrows earthquake in the Los Angeles basin (M_L 5.9), the 1991 Sierra Madre earthquake at the southern edge of the San Gabriel Mountains northeast of Los Angeles (M_L 6.0), and the 1994 Northridge earthquake in the San Fernando Valley (M_L 6.7). Of these, only the 1952 and 1971 earthquakes produced surface rupture. Global Positioning System satellite geodesy confirms the high convergence rate as a result of reverse slip on these faults,[26] indicating this is an active thrust fault area. These indications were not seen in the SONGS area.

To state that the Northridge earthquake occurred on a blind fault that had not been mapped or assessed is an oversimplification. Blind thrust faults are recognized as significant sources of seismic hazard in areas of active folding, and the Transverse Ranges-Los Angeles basin has long been recognized as such an area. If, before the Northridge earthquake, such a fault had been sought as part of a siting investigation, it or the active folding indicative of such a fault would have been found and would have been considered in the seismic hazard estimate. In addition, the potential occurrence of a M_W 6.5 to 7 on a buried fault has been assumed in the commercial design and construction codes for the area where the Northridge earthquake occurred, so in effect, the potential for blind faults has been accounted for.

The types of site investigations, borehole drilling, and seismic survey profiles normally performed for critical facilities such as nuclear power plants are not used for normal residential or commercial structures because of the high costs of such work. For residences or commercial buildings, the codes rely on more generalized hazard estimates, such as those found in Petersen et al.[27] These hazard studies incorporate all the known geologic information in their ground motion estimates.

The most promising new data for the identification of areas of potential buried thrust faults comes from geodetic measurements of the satellite-based Global Positioning System, which is capable of determining convergence rates across folded terranes. Geomorphic studies are important in that the deformation of late Quaternary stream or coastal terraces provides quantitative data on the uplift rates or lack of uplift of postulated active folds over buried faults. In fact, the locale of the 1987 Whittier Narrows, California, earthquake was identified more than 70 years ago[28] as an active anticline on the basis of warped geomorphic surfaces.

The SONGS site lies in a relatively stable structural block bounded by major northwest-southeast trending strike-slip faults. The relative motion between the Pacific plate and the North American plate is accommodated, in part, by dextral strike slip along the San Andreas fault system and faults in the borderlands, extension in the Gulf of California, and contraction in the Transverse Ranges and the Los Angeles basin region.[29]

The tectonic setting of the SONGS site is significantly different from the complex regime of the Transverse Ranges and the Los Angeles basin. This difference is reflected in the higher seismicity in the Transverse Range and the Los Angeles basin than in the SONGS site area. The presence or absence of blind thrust faults in a region is indicated by the presence or absence of significant uplift and folding of late Quaternary period deposits and geomorphic surfaces[30] as evidenced in the Transverse Ranges and the Los Angeles basin region. Mapping of marine terraces along the western flank of the San Joaquin Hills to the north of the SONGS site indicates a uniform uplift rate for the past 80 to 120 thousand years.[31] Lajoie et al.[32] reported on the coastal region between San Onofre Bluff and Torrey Pines north of Soledad Mountain in San Diego and noted that there has been no significant crustal tilt perpendicular to the coastline during much of the Quaternary Period. There is also no indication from the marine terrace studies of significant tilt parallel to the coastline during much of the Quaternary Period. The marine terrace data, along with other geological mapping and geophysical surveys, have not identified geologically young folds or blind thrust faults in the SONGS site vicinity. The closest capable fault to the site is the OZD 8 kilometers from the site, and it is the postulated earthquake on this fault that dominates the seismic hazard at SONGS. Therefore, the statement that the Northridge earthquake occurred on a blind fault that had not been mapped or assessed, and the implication that such a condition could also exist at the SONGS site, are not valid.

The Landers magnitude M_W 7.3 earthquake of June 28, 1992, was in the Eastern California Shear Zone (ECSZ) approximately 140 kilometers from the SONGS site. The ECSZ is a complex zone of predominantly right lateral strike-slip faulting. The earthquake was caused by strike-slip faulting on five fault segments with a total rupture length of about 70 kilometers.[33]

Campbell and Bozorgnia[34] used 167 accelerograms recorded during the Landers earthquake to study the ground motions from this event. A comparison of these recordings with ground motions predicted by contemporary attenuation relationships indicated that relationships developed before the Landers earthquake made a reasonable prediction of the Landers ground motions within 60 kilometers of the fault, and relationships developed after

[26] Id.

[27] Mark D. Peterson, *et al., supra* note 15.

[28] F.F. Vickery, ''The Interpretation of the Physiography of the Los Angeles Coastal Belt,'' Bulletin of the American Association of Petroleum Geologists, 11, 417–424 (1927).

[29] M.L. Zoback and R.E. Anderson, ''Cenozoic Evolution of the State of Stress and Style of Tectonism in Western United States,'' Philosophical Transactions of the Royal Society of London, 300, 407–434 (1981); R. Weldon and E. Humphreys, ''A Kinematic Model of Southern California,'' Tectonics, 5, 38–48 (1986); D.F. Argus and R.G. Gordon, ''Sierra Nevada-North America Motion From VLBI and Paleomagnetic Data—Implications for the Kinematics of the Basin and Range, Colorado Plateau, and California Coast Ranges,'' EOS Transactions, American Geophysical Union, 69, 1418 (1988); R.S. Stein and R.S. Yeats, ''Hidden Earthquakes,'' Scientific American, 260, 48–57 (1989).

[30] Stein and Yeats, *supra* notes 25 and 29.

[31] D.T. Barrie, T. Totnall, and E. Gath, ''Neotectonic Uplift and Ages of Pleistocene Marine Terraces, San Joaquin Hills, Orange County, California,'' in E.G. Heath and W.L. Lewis (editors), The Regressive Pleistocene Shoreline Coastal Southern California, South Coast Geological Society, Inc., 1992 Annual Field Trip Guide Book No. 20, 115–122 (1992).

[32] K.R Lajoie, D.J. Ponti, C.L. Powell, II, S.A. Mathieson, and A.M. Sarna-Wojcicki, ''Emergent Marine Strandlines and Associated Sediments, Coastal California; a Record of Quaternary Sea-Level Fluctuations, Vertical Tectonic Movements, Climatic Changes, and Coastal Processes,'' in E.G. Heath and W.L. Lewis (editors), The Regressive Pleistocene Shoreline Coastal Southern California, South Coast Geological Society, Inc., 1992 Annual Field Trip Guide Book No. 20, 81–104 (1992).

[33] Yeats, et al., *supra* note 25.

[34] K.W. Campbell and Y. Bozorgnia, ''Empirical Analysis of Strong Ground Motion from the 1992 Landers, California, Earthquake,'' Bulletin of the Seismological Society of America, 84, 573–588 (1997).

the Landers earthquake did a reasonably good job of predicting the Landers ground motions within the distance ranges for which they were applicable. This information shows that there was nothing extraordinary about the ground motions from the Landers earthquake that would challenge the adequacy of the near field ground motion estimates made for the SONGS SSE. To demonstrate the adequacy of the SONGS SSE ground motion, Figure 3 contains a plot of the SSE response spectrum and the 84th percentile response spectra obtained from the four recent earthquake ground motion attenuation relationships to estimate the ground motion for a magnitude M_W 7 earthquake at a distance of 8 kilometers. The SONGS response spectrum envelopes the response spectra of all four relationships at all frequencies.

To address the issue of the 20 feet (6 meters) of fault displacement as a result of the Landers earthquake, the staff has reviewed the work of researchers on this subject. Post-earthquake investigations have found that slip on the Landers earthquake faults was extremely heterogeneous both along strike and down dip. The magnitude of the horizontal offset varied along the fault trace, but was typically 2 to 3 meters with maximum strike-slip offset of about 6 meters.[35] This offset is not unusual and is within the range of offsets for an earthquake of this size.[36] The U.S. Geological Survey, with NRC sponsorship, has conducted paleoseismic studies of the fault segments that ruptured during the Landers earthquake. Trenches across the faults provide clear evidence of the two most recent pre-1992 surface faulting events. The most recent faulting, Holocene age, has displacements essentially the same as the 1992 event. Evidence from the trenches also indicates that the segments that ruptured during the 1992 event had ruptured during the previous events.[37] If, before the Landers earthquake, these faults had been subjected to the type of investigations that nuclear power plant sites undergo, the earthquake and fault rupture potential would have been identified.

There are no faults at the SONGS site capable of surface offset. The fault nearest to the SONGS site capable of significant surface offset is the OZD, which is 8 kilometers from the site. Assuming that there were to be offsets on the order of 6 meters or more on the OZD, they would have no detrimental effect on SONGS because of the distance of the fault, the orientation of the fault, and the potential ground motion to which the plant is designed.

With respect to the Petitioner's statement that scientists are not able to provide the information to evaluate the situation, the staff notes that numerous papers have been published in the scientific literature and presentations made at national and international scientific meetings on these two earthquakes. In addition, the Seismological Society of America has devoted one issue of its Bulletin[38] to the Northridge earthquake and another issue to the Landers earthquake.[39] The information about these events is understood and is widely distributed in the professional community.

4. Concern About ''Seismic Analysis Uncertainties''

In the enclosure to his letter dated December 10, 1996, the Petitioner provided a list of 10 seismic analysis uncertainties[40] and implies that these must be addressed because new surprises will occur with each event.

The Petitioner appears to have compiled a list of uncertainties in estimating seismic hazard from the Petersen paper.[41] There is nothing unique about this list. These are the types of issues a geologist or a seismologist performing earthquake hazard investigations must routinely confront. They are among the points that the NRC Seismic and Geologic Siting Criteria for Nuclear Power Plants and the NRC SRP were developed to address.

The geologic and seismic investigations and reviews that were performed for the licensing of SONGS Units 2 and 3 were deterministic in nature. In the deterministic method, the uncertainties were not explicitly quantified. Rather, a multi-method approach with sensitivity studies was used. For instance, to determine the maximum magnitude estimate for a fault empirical relationship, such as magnitude as a function of the parameters slip rate, the fault length, the rupture length per event, the rupture area, and the historical seismicity were used. Also, various fault segmentation models were used in magnitude estimates. To determine the ground motion from a magnitude 7 earthquake at a distance of 8 kilometers, attenuation relationships from the statistical analysis of empirical ground motion data, theoretical numerical modeling studies, and the response spectra from magnitude 6.5 and larger earthquakes recorded at distances of 13 kilometers and less were used. The SSE for the SONGS site enveloped all of these estimates. The geology in the site region was investigated by geologic mapping, excavation of faults, offshore and onshore seismic reflection profiles, onshore refraction profiles, geophysical surveys, drill holes, well logs, trenching, geomorphic surveys, and geodetic studies. The information from these various studies was analyzed by experienced professional geologists and geophysicists, and the site characteristics were thus developed in a conservative manner. Independent studies and reviews were performed by the NRC staff, the U.S. Geologic Survey, the National Oceanic and Atmospheric Adminstration, and the Advisory Committee on Reactor Safeguards. These studies and reviews confirmed the licensee's determinations.

The uncertainties in seismic hazard estimates can be addressed quantitatively through a probabilistic seismic hazard analysis. In 1991, the NRC issued Supplement 4 to Generic Letter 80–20 requesting licensees of nuclear power plants to perform an IPEEE to identify plant-specific vulnerabilities to severe accidents. Among the events to be assessed were earthquakes, internal fires, high winds and tornadoes, external floods, and transportation and nearby facility accidents. As part of the SONGS IPEEE

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35 Carlos Lazarte, Jonathan D. Bray, Arvid M. Johnson, and Robert E. Lemmer, ''Surface Breakage of the 1992 Landers Earthquake and Its Effects on Structures,'' Bulletin of the Seismological Society of America, 84, 547–561 (1994).

36 Donald L. Wells and Kevin J. Coppersmith, ''New Empirical Relationships Among Magnitude, Rupture Length, Rupture Width, Rupture Area, and Surface Displacement,'' Bulletin of the Seismological Society of America, 84, 974–1002 (1994).

37 David P. Schwartz. Personal communication with Dr. Robert Rothman, of the NRC staff, June 1997. Dr. Schwartz is a senior geologist employed by the U.S. Geological Survey in Menlo Park, California and a international authority on paleoseismology.

38 Bulletin of the Seismological Society of America, Volume 86, Number 1, Part B Supplement, February 1996.

39 Bulletin of the Seismological Society of America, Volume 84, Number 3, June 1994.

40 List of Seismic Analysis Uncertainties: (1) How to quantify slip rates and maximum magnitudes along with their uncertainties for all fault sources. (2) How to incorporate blind thrusts with appropriate weighting. (3) What seismogenic zone widths to use for various fault zones. (4) Which magnitude distributions are most appropriate for various faults. (5) How to incorporate background seismicity and which ''b'' value is most appropriate for exponentially distributed earthquakes. (6) Whether to use source zones or simple point sources in modelling background seismicity. (7) Which alternative segmentation models are viable (including alternative cascades models for ''A'' zones). (8) How to incorporate geodetic data directly in the model. (9) Which attenuation relations are most appropriate and how to model ground motion from large (M>8) earthquakes. (10) How to resolve the discrepancy between the rate of earthquakes in this and other seismic hazard models and the historic earthquake record (especially in the Transverse Ranges).

41 Peterson, *et al., supra* note 15.

program, a state-of-the-art probabilistic seismic hazard analysis was performed. In response to an NRC request for information, Southern California Edison submitted its contractor's final report on the seismic hazard study.[42] In the seismic hazard study, ground motion exceedance probabilities were calculated using hypotheses about the causes and characteristics of earthquakes in the region. Scientific uncertainty about the causes of earthquakes and about the physical characteristics of potentially active tectonic features lead to uncertainty in the inputs to the seismic hazard calculations. These uncertainties were quantified using the tectonic interpretations developed by earth scientists knowledgeable about the region. These experts evaluated the likelihood associated with alternative tectonic features and with alternative characteristics of these potential sources. These and other uncertainties were propagated through the entire analysis. The result of the analysis is a spectrum of hazard curves and their associated weights. These curves quantify the seismic hazard at the site and its uncertainty.

The major components of the probabilistic seismic hazard analysis are the identification of the seismic sources, the determination of the earthquake magnitude distribution and rate of occurrence for each source, the estimation of the ground motion, and the incorporation of these factors by the probability analysis into the hazard curves. The Risk Engineering, Inc., report[43] more than adequately demonstrates how the uncertainties of the type the Petitioner listed in the enclosure to his letter were addressed. The comparison of the probabilistic seismic hazard results to the SSE indicates that the SSE response spectrum has an annual probability of being exceeded in the range of 5×10^{-6} to 4×10^{-4}, depending on the frequency. This estimate is similar to the probabilistic hazard estimates for other critical facilities in the western United States. The low frequency of exceedance of the SSE ground motion provides further assurance that the licensing basis for SONGS provides adequate protection of the health and safety of the public.

[42] Risk Engineering, Inc., ''Seismic Hazard at San Onofre Nuclear Generating Station, ''Prepared for Southern California Edison Co., Final Report (1995).

[43] Id.

5. Concern About the Failure of Welded-Steel Frames in Commercial Buildings During the Northridge Earthquake

In an e-mail message to Dr. Shirley Jackson,[44] the Petitioner stated—

> The breaking of welds in steel buildings in the San Fernando Valley is a warning that all sorts of steel welds and fittings are vulnerable. The number of such welds and fittings at SONGS is almost uncountable, and it's therefore unrealistic to believe that they will all be undamaged or broken at forces far below the Design Basis Event of 67%g.

It appears that the Petitioner is referring to the failure of welded-steel moment-resisting frames (WSMFs) in high-rise residential and commercial buildings during the 1994 Northridge earthquake. Following the Northridge earthquake, inspections of many otherwise intact buildings indicated structural damage to WSMFs. The WSMFs were specifically designed on the basis of the assumption that they would be capable of extensive yielding and plastic deformation. The deformation was assumed to be accomplished by the yielding of plastic hinges in the beams at their connections to the columns. Damage was expected to consist of moderate yielding at the connections and localized buckling of the steel elements. However, contrary to the design assumption, the WSMF failures were brittle fractures with unanticipated deformations in girders, cracking in column panel zones, and fractures in beam-to-column weld connections. A number of factors related to seismic analysis and design, materials, fabrication, and construction have been identified as contributing to the failure of the WSMFs and are the focus of research projects sponsored by the Federal Emergency Management Agency.[45]

The method of computing seismic loads, their combination with other non-seismic loads, the acceptance criteria, and the quality assurance requirements for nuclear power plants are significantly more conservative than those for non-nuclear buildings designed using building codes for residential or commercial structures. For nuclear power plants, two levels of ground motion, based on very conservative siting criteria, are determined for designing the safety-related structures, systems, and components. For the lower level of vibratory motion, the operating-basis earthquake,[46] the load factors, and acceptable allowable stresses ensure that the stresses in plant structures remain at least 40 percent below the yield stress of the material. For the higher level vibratory motion, the SSE, the associated load factors, and allowable stresses ensure that the stresses in steel structures do not exceed the yield stress of the material. The NRC staff design review guidance specified in SRP Section 3.7.2 does not accept the use of inelastic deformation of any steel member or connection in nuclear power plants for design-basis seismic events. Also, the use of broadband design response spectra, conservatively defined structural damping values, consideration of amplified forces at higher elevations in the plants, and consideration of all three components of the design-basis vibratory motion in the dynamic analysis ensure that the loads and load paths of the seismic events are properly considered in the design, as opposed to the use of static shear forces in non-nuclear structures. For these reasons, the failure of WSMFs in residential and commercial buildings as a result of the Northridge earthquake is not relevant to nuclear power plants.

[44] Stephen Dwyer, e-mail message to Dr. Shirley Jackson, Subject: 2.206 Petition Re: SONGS Seismic Hazards, dated May 28, 1997.

[45] FEMA 267, ''Interim Guidelines: Evaluation, Repair, Modification and Design of Welded Steel Moment Frame Structures, Program to Reduce the Earthquake Hazards of Steel Moment Frame Structures,'' Federal Emergency Management Agency, Washington, DC (1995).

On the basis of its review of the Petitioner's request that the SONGS units be shutdown due to inadequate protection against potential earthquake ground motion, the staff has concluded that the Petitioner has not presented a basis for such an action.

III. Conclusion

On the basis of the above assessment, I have concluded that no substantial health and safety issues have been raised by the Petitioner that would require taking the action requested by the Petitioner. As explained above, the SONGS site has undergone extensive geologic, geophysical, geotechnical, and seismic investigations and reviews, including a recent analysis to quantify the seismic hazard and uncertainties for the SONGS site. Furthermore, SONGS was licensed consistent with the seismic and geologic siting criteria for nuclear power plants set forth in 10 CFR Part 100, Appendix A. The Petitioner has not provided any information in support of his concerns and requested actions, including information regarding recent earthquakes, which the NRC staff was not already aware. Accordingly, the Petitioner's requested action, pursuant to Section 2.206, is denied.

A copy of this Decision will be filed with the Secretary of the Commission

[46] See 10 CFR Part 100, Appendix A, III(d).

for the Commission to review in accordance with 10 CFR 2.206(c) of the Commission's regulations. As provided by this regulation, the Decision will constitute the final action of the Commission 25 days after issuance, unless the Commission, on its own motion, institutes a review of the Decision within that time.

Dated at Rockville, Maryland, this 19th day of September 1997.

For The Nuclear Regulatory Commission.

Samuel J. Collins,

Director, Office of Nuclear Reactor Regulation.

BILLING CODE 7690–01–P

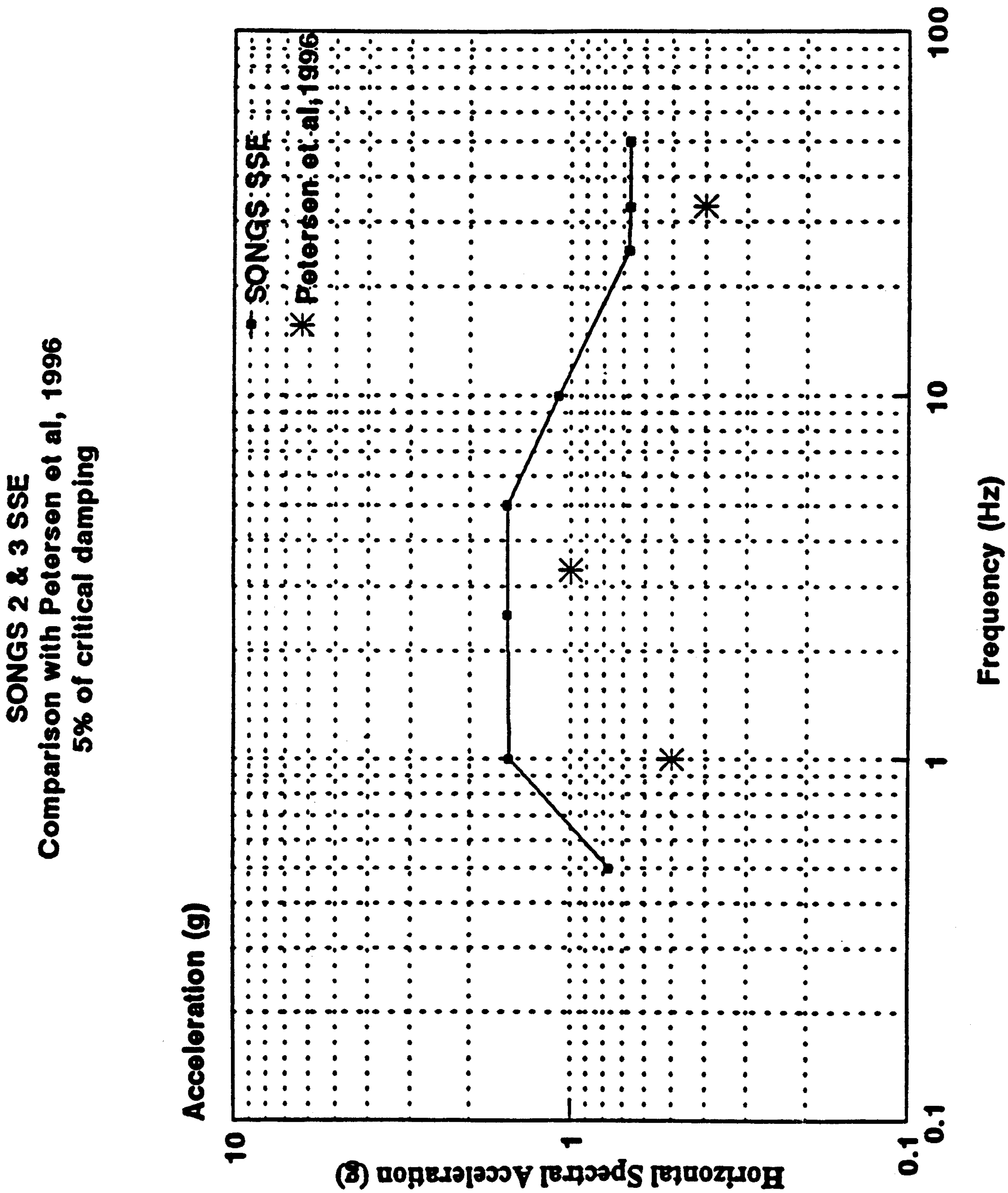
SONGS 2 & 3 SSE
Comparison with Petersen et al, 1996
5% of critical damping
Acceleration (g)
Horizontal Spectral Acceleration (g)
10
1
0.1
0.1
1
10
100
Frequency (Hz)
SONGS SSE
Petersen et al,1996

Figure 1

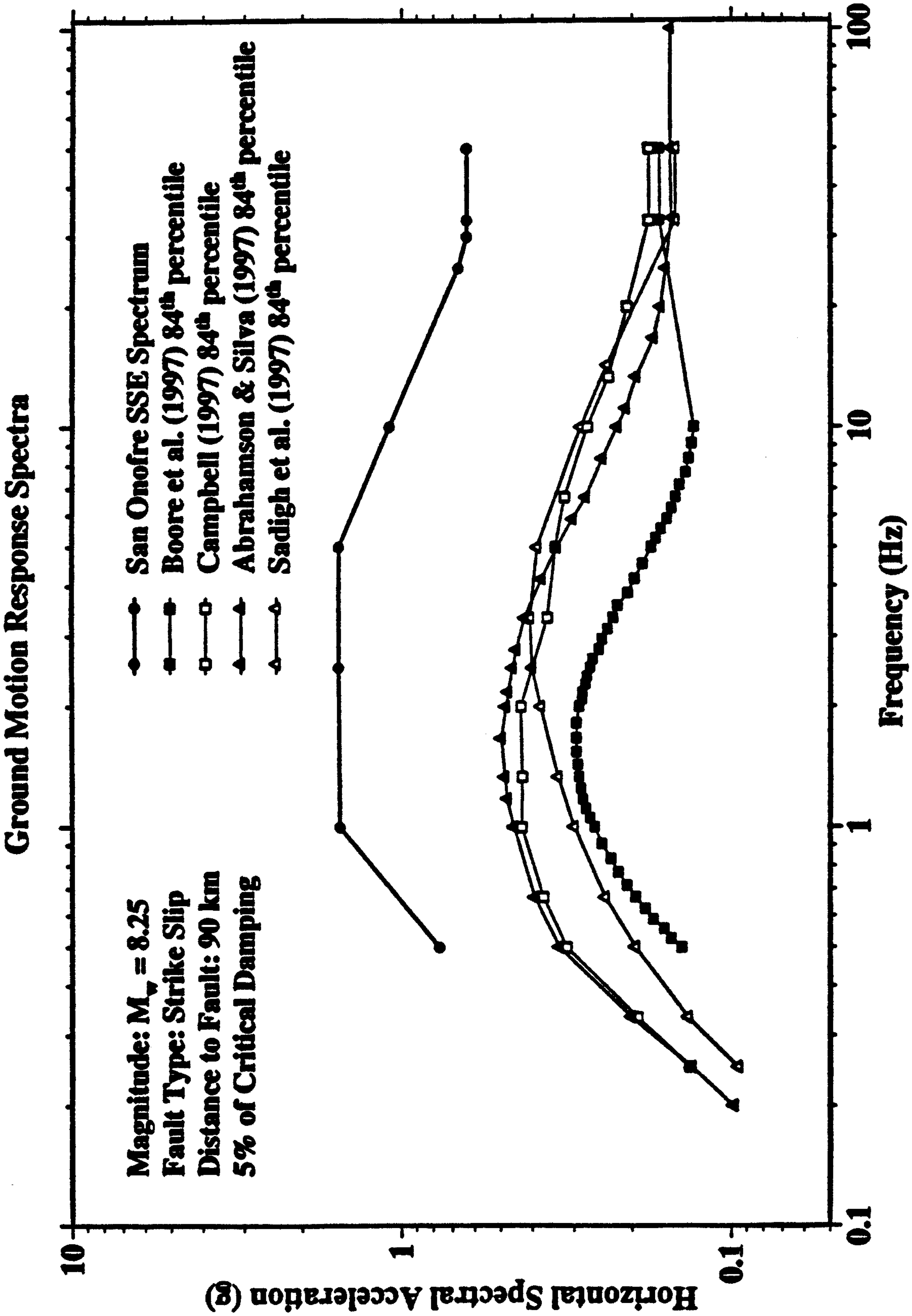
Ground Motion Response Spectra
Magnitude: M_w = 8.25
Fault Type: Strike Slip
Distance to Fault: 90 km
5% of Critical Damping
San Onofre SSE Spectrum
Boore et al. (1997) 84th percentile
Campbell (1997) 84th percentile
Abrahamson & Silva (1997) 84th percentile
Sadigh et al. (1997) 84th percentile
Horizontal Spectral Acceleration (g)
10
1
0.1
Frequency (Hz)
0.1
1
10
100

Figure 2

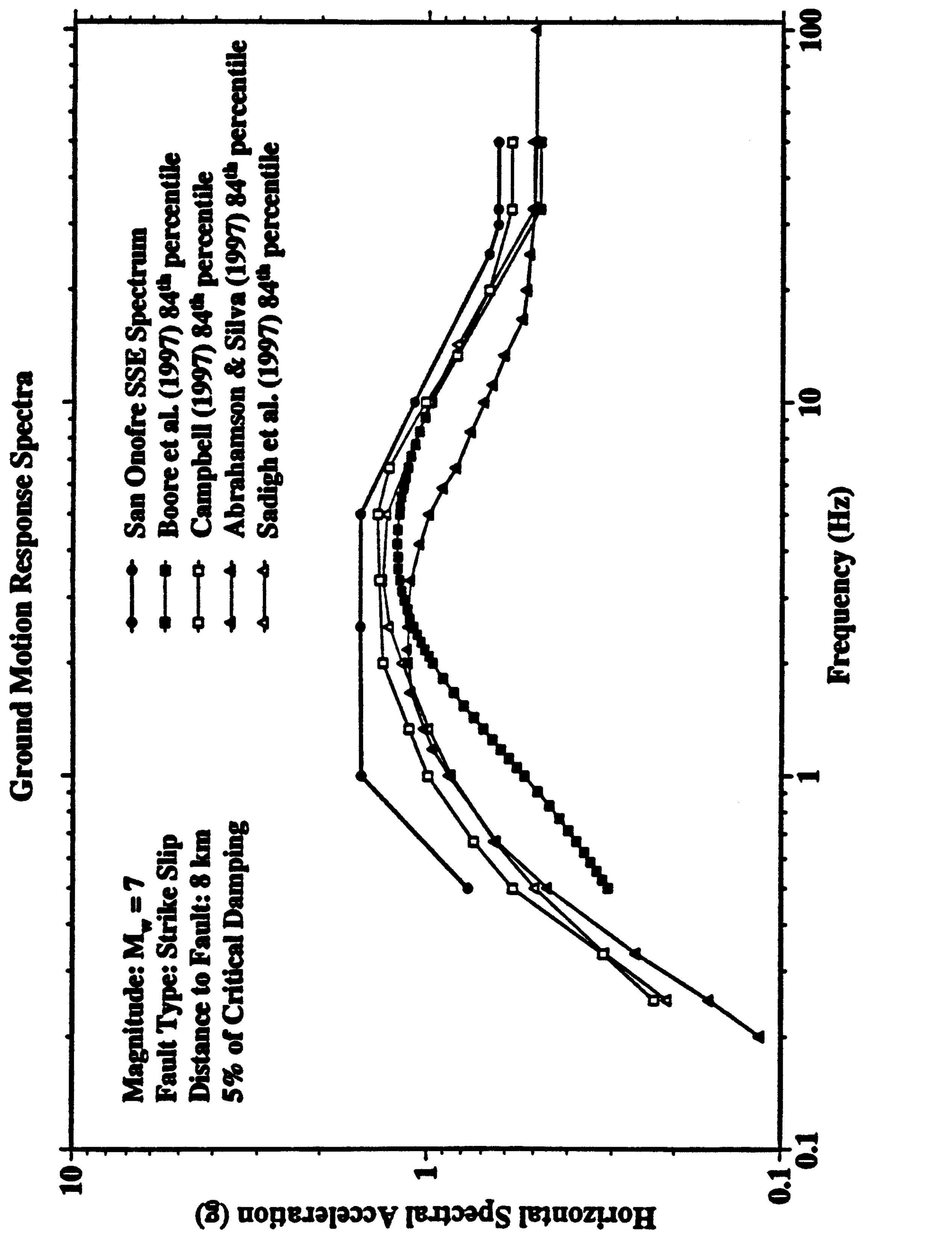

Figure 3

[FR Doc. 97–25632 Filed 9–25–97; 8:45 am]
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