SOUTHERN CALIFORNIA
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J. L. Rainsberry
Manager, Plant Licensing

March 14, 1997

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: **Docket Nos. 50-361 and 50-362**
Request for Geological and Seismic Information
San Onofre Nuclear Generating Station
Units 2 and 3

As a result of a 10 CFR 2.206 petition to shut down San Onofre Units 2 and 3, the NRC requested information regarding geologic and seismic issues. Provided as an enclosure is Edison's "Response to NRC Request for Information Regarding Geologic and Seismic Issues." At the NRC's request, a copy of this letter, along with the enclosure, is being provided to Mr. Stephen Dwyer, the petitioner.

If you require further information regarding this matter, please feel free to call me at (714) 368-7420.

Sincerely,

J L Rainsberry

Enclosure

cc: J. E. Dyer, Acting Regional Administrator, NRC Region IV
K. E. Perkins, Jr., Director, Walnut Creek Field Office, NRC Region IV
J. A. Sloan, NRC Senior Resident Inspector, San Onofre Units 2 & 3
M. B. Fields, NRC Project Manager, San Onofre Units 2 and 3
S. Dwyer

A001 1/1

San Onofre Nuclear Generating Station
P. O. Box 128
San Clemente, CA 92674-0128
714-368-7420

RESPONSE TO NRC REQUEST FOR INFORMATION
GEOLOGIC AND SEISMIC ISSUES
SAN ONOFRE NUCLEAR GENERATING STATION

Woodward-Clyde Consultants and Geomatrix Consultants, Inc. prepared the following responses to NRC's request for geological and seismic information for San Onofre Nuclear Generating Station. The responses pertain to the probabilistic seismic hazard assessment performed in 1994 for San Onofre (SONGS PSHA). The SONGS PSHA report is the "Seismic Hazard at San Onofre Nuclear Generating Station, Final Report," dated August 25, 1995 and prepared by Geomatrix Consultants, Inc., Risk Engineering, Inc., and Woodward-Clyde Consultants.

Question 1:

"Five empirical ground motion attenuation functions were used by the estimation of the probabilistic seismic hazard at San Onofre Nuclear Generating Station (SONGS) for the Individual Plant Examination for External Events (IPEEE) program. Did the development of these functions include data from recent southern California earthquakes such as the Northridge and Landers events? If not, how do the estimates of ground motion using these functions compare with the data recorded from these two events?

Response to Question 1:

As stated in Appendix D of the SONGS PSHA report, the five attenuation relationships used in the SONGS IPEEE study were checked with their respective author(s) to be sure they were current as of 1994. In general these attenuation relationships reflected all the recent southern California earthquakes including the Landers event in various ways, but not the Northridge event. In addition, the Landers event was included in the detailed evaluation of the five attenuation relationships presented in Appendix D of the SONGS PSHA report. The Northridge event was not included in that evaluation because it was considered an inappropriate event for the SONGS PSHA purposes as discussed below.

By far the most important seismic source for the SONGS site, which is a soils site, was the Newport-Inglewood-South Coast Offshore Zone of Deformation (SCOZD)-Rose Canyon Fault zone, which is a right-lateral strike slip fault with a maximum magnitude of about 7 and a closest distance to the site of about 8 km. Therefore, the evaluation of the attenuation relationships for the purposes of the SONGS PSHA focused on the use of recordings on soils sites from strike-slip events (27 stations) and oblique events (14 stations) having magnitudes ranging from 6.1 to 7.3 at distances no further than about 18 km (see Table D-8 of Appendix D of the SONGS PSHA report). One station from the Landers event, the Joshua Tree station, qualified in this category, and, therefore, was included in this selected database for the evaluation. The evaluation including the study of residuals indicated the reasonableness of the five attenuation relationships when compared to the selected database (see, for example, Figures D-6a through D-6g of Appendix D of the SONGS PSHA report). On the basis of this extensive evaluation of the five attenuation relationships under the conditions pertinent to the SONGS PSHA, these attenuation relationships were considered to be consistent with the Landers event as well as with other recent pertinent data as of 1994.

The Northridge event was a thrust or reverse event, not a strike-slip event, and, therefore, was considered not pertinent for the evaluation of attenuation relationships for the purposes of the SONGS PSHA. Even in 1994, it was well established that thrust or reverse events result in ground motions that are different from those due to strike-slip events, and mixing them in assessing attenuation relationships mainly for strike-slip events likely would be misleading.

Nevertheless, because Question 1 mentions the Northridge event, Figure 1-1 compares the peak ground acceleration versus distance from three of the attenuation relationships using the soils site data from the Northridge event. The median as well as plus-and-minus one standard deviation relationships for thrust or reverse events are shown on Figure 1-1. As can be seen from Figure 1-1, the three attenuation relationships appear to be reasonably compatible with the Northridge event data with most data plotting between the median and $+1\sigma$ attenuation curves, even though they are considered to be not pertinent to the SONGS site.

The two attenuation relationships not included in the comparison should provide similar results as those shown on Figure 1-1 as can be seen from the comparison of the effects of all five attenuation relationships presented on Figures 6-11 and 6-12 of the SONGS PSHA report.

Question 2:

"Provide the results from any geological or geophysical investigations performed in the SONGS region that contain information about the tectonic regime, the potential for thrust earthquakes, the existence or non-existence of buried or blind thrust faults, or the potential for surface displacement on the order of that which resulted from the Landers earthquake."

Response to Question 2:

The development of a source model and the characterization of seismic sources completed as part of the probabilistic seismic hazard assessment at the San Onofre Nuclear Generating Station for the Individual Plant Examination of External Events program (SONGS PSHA report) incorporated recent research and data on the tectonic setting of the site region. The assessment explicitly considered the seismic potential of recognized blind fault sources as well as the potential for unknown blind thrust faults near the SONGS site based on consideration of the tectonic setting and style and rate of Quaternary deformation in the region. The potential for surface displacements along strike-slip faults on the order of that which occurred from the 1994 Landers earthquake was considered in assessing the potential for large-magnitude earthquakes resulting from multiple segment and multiple-fault ruptures in the characterization of seismic sources in the site region. Each of these issues are addressed in more detail in the following sections.

Tectonic Setting

The SONGS site lies within a relatively stable structural block bounded by major northwest-trending strike-slip faults. Relative motion between the Pacific and North America plates in the site region is characterized by transpressive dextral shear and is accommodated largely by dextral strike slip centered along the San Andreas fault system and faults in the borderlands of southern and Baja California, and to a lesser degree, by a component of Basin and Range extension parallel to the plate boundary, extension in the Gulf of California, and contractional structures in the Transverse Ranges and Los Angeles basin region (Zoback and others, 1981; Weldon and Humphreys, 1986; Argus and Gordon, 1988; Stein and Yeats, 1989). Recent analyses of geodetic data (Feigl and others, 1993; Larson, 1993) indicates that a significant component of dextral shear occurs on offshore faults along the southern California borderland. These data in addition to fault-specific slip rate data compiled from offshore observations and paleoseismic studies of onshore extensions of faults, were used to provide constraints on the range of likely slip rate values for faults along the southern California borderland.

The tectonic setting of the site is significantly different from the complex tectonic regime of the Los Angeles basin that is marked by north-south convergence associated with the geometry of the "big bend" in the San Andreas fault. This difference is reflected in the markedly different rate of earthquake occurrences between the two regions and a more diffuse spatial pattern of seismicity than the linear patterns associated with strike-slip faults to the south (see Plate 1, SONGS PSHA report).

Blind Fault Sources

Recognized and potential blind thrust fault sources in the Los Angeles basin were included in the source model used in the SONGS PSHA (see Response to Question 5).

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 deposits and geomorphic surfaces (e.g., Stein and Yeats, 1989). Information regarding the nature and rate of Quaternary deformation along the coastal region in the vicinity of SONGS is provided by marine terrace investigation. Mapping of marine terraces along the western flank of the San Joaquin Hills to the north of the site indicates a uniform uplift rate of 0.25 m/kyr for the past 80 to ~120 ka (Barrie and others, 1992). Lajoie and others (1992) estimate a similar long-term average uplift rate of 0.19 m/kyr for the coastal region between San Onofre Bluff and Torrey Pines north of Soledad Mountain in San Diego. They note that there has been no significant crustal tilt perpendicular to the coastline during much of Quaternary time. Also, there is no indication from the marine terrace studies of significant tilt parallel to the coastline during much of Quaternary time (Lajoie and others, 1992). The Pleistocene uplift rates in this region (0.19 to 0.25 m/kyr) are comparable to uplift rates for other fault-bounded structural blocks within regions dominated by right-lateral crustal displacements in coastal California, which are 0.1 to 0.3 m/kyr (Muhs and others, 1992).

The marine terrace data and other mapping indicates that geologically young folds, such as those associated with known blind thrusts have not been mapped or identified in the vicinity of the SONGS site. On the basis of the apparent lack of late Quaternary anticlinal fold development, it was concluded that there are no seismogenic blind thrust faults in the nearby site region (excluding the recognized blind fault sources characterized in the Los Angeles basin) that are capable of generating significant earthquakes. In the hazard analysis, we allow for the possibility of unknown sources, including smaller-scale (maximum M_w 5.5 - 6.5) blind thrust faults, within the areal source zones.

The seismogenic potential of the San Mateo Thrust fault, a 30-km-long fold and thrust belt that underlies the continental slope seaward of the Newport-Inglewood-South Coast Zone of Deformation (SCOZD) fault zone (Crouch and Bachman, 1989; Fischer and Mills, 1991), (Fig. A-6, SONGS PSHA report), also was evaluated in the hazard analysis. Crouch and Bachman (1989) and Crouch and Suppe (1993) interpret thrust faults within this belt as rooted into an older regional detachment that has become reactivated locally. They consider development of this fold-thrust belt to be the result of northeast-southwest shortening that is normal to, and decoupled from, the northwest-trending strike-slip deformation along the Newport-Inglewood-SCOZD (Crouch and Bachman, 1989; Crouch and Suppe, 1993). Mills and Fischer (1991) note that this "blind" thrust ramp may extend as far south as Encinitas. They state that the thrust ramp may represent a major basement discontinuity offshore of San Onofre near the left-stepping break that separates the Dana Point and Oceanside segments of the Newport-Inglewood fault zone. They describe a series of fault-propagation folds and thrusts extending upward from the thrust ramp into the overlying Neogene sequence. Vertical slip rates on these thrusts are estimated to be 0.08 to 0.5 mm/yr for the Pliocene and 0.01 mm/yr for Quaternary time (Mills and Fischer, 1991).

Fischer and Mills (1991) separate structures in this zone into an inner thrust-fault-fold complex, which is probably a part of the flower structure of the Newport-Inglewood-SCOZD, and an outer thrust-fold complex (Fig. A-7, SONGS PSHA report). Fischer and Mills (1991) note that the outer thrust complex appears to be cut by the main thrust fault of the inner complex. They infer that the thrust faults along the inner margin are active, as is evidenced by their surficial topographic expression and the displacement of Quaternary reflectors.

A key factor in the assessment of the seismogenic potential of these thrust faults is the geometry and downdip extent of these structures. As shown on Figure A-7 (SONGS PSHA report), thrust faults within the inner thrust-fold complex that appear to coalesce with the main trace of the Newport-Inglewood-SCOZD within the upper 4 to 5 km of the crust, have the appearance of positive flower structures along strike-slip fault systems and likely are the result of local strain partitioning (Lettis and Hanson, 1991) along the SCOZD. The outer thrust faults, which appear to represent reactivation of an older detachment fault, likely are truncated by the main inner thrust fault within the upper 3 km of the crust and, therefore, would not extend to seismogenic depth. Based on these observations, none of the thrust faults within the San Mateo thrust zone were judged to be independent seismic sources that will contribute to the seismic hazard of SONGS.

Potential for Large Displacement Events

The M_w 7.3 1992 Landers earthquake produced approximately 80 km of surface rupture within a preexisting, integrated system of faults separated by complex intersection points (Unruh and others, 1994). The magnitude of the horizontal offset varied along the fault trace, but was typically 2 to 3 m (Kanomori and others, 1992), with maximum strike-slip offset around 6 m (Sieh and others, 1993). Rupture length, area, and displacement were consistent with other M_w 7.3 earthquakes (Wells and Coppersmith, 1994).

The potential for similar large displacement events that would contribute significantly to the seismic hazard at SONGS was addressed in the SONGS PSHA in the identification and assessments of the maximum magnitude for individual fault sources.

The maximum earthquakes associated with the faults identified as seismic sources in the SONGS PSHA model were evaluated by assessing the maximum dimensions of rupture for an individual earthquake on each of the faults and then employing empirical relationships between earthquake rupture dimensions and earthquake magnitude developed by Wells and Coppersmith (1994). The rupture dimensions considered in the SONGS model were maximum rupture length, maximum rupture area (length times downdip width), and displacement per event. The thickness of seismogenic crust is well-constrained for onshore regions of southern California due to the density and quality of seismic networks. These data allow for reasonable estimates of the downdip width of most structures. The assessment of rupture length is less well constrained. To capture the uncertainty in the estimated rupture length, a range of values based on single- and multiple-segment and multiple-fault rupture scenarios were incorporated into the assessments. Knowledge of regional fault kinematics and paleoseismic evidence regarding fault behavior was used to assess the potential multiple-fault and multiple-fault segment ruptures. Paleoseismic evidence of large displacement events (e.g., displacement per event data from trenching or scarp heights) that is available for some of the onshore faults was considered in the maximum magnitude assessments for these faults. In the absence of specific displacement per event data, empirical relationships relating magnitude to subsurface length and magnitude to rupture area were used to assess each seismic source. Where paleoseismic evidence for slip per event is available, these data were included in the analysis, with relatively equal weight given to the three approaches. The final result of the analysis was a probabilistic distribution of maximum magnitude for each source (see Appendix B, SONGS PSHA report) that reflects the uncertainties in rupture parameters and judgments about these parameters.

Rupture length scenarios for all the significant strike-slip faults included in the SONGS source model included multiple-segment ruptures comparable to or longer than the rupture that occurred during the 1992 Landers earthquake (see Table A-1, SONGS PSHA report). The maximum magnitude assessments for the SCOZD, the controlling source for the SONGS site, included multiple-segment and multiple fault-rupture scenarios that allow for ruptures of 75 km and 115 km. The resulting maximum magnitude probability distribution for the SCOZD includes maximum events of M_w 7.25 to 7.5, comparable to or greater than the Landers earthquake.

Question 3:

"Provide any assessment of the ground motion at the SONGS site from a magnitude 7 earthquake on the South Coast Offshore Zone of Deformation at a distance of 8 kilometers. Did any such assessments consider the ground motions recorded from earthquakes that have occurred since the licensing of SONGS, Units 2 and 3, such as those at Coalinga, Petrolia, Loma Prieta, Landers and Northridge?"

Response to Question 3:

As presented in the response to Question 1, the five attenuation relationships used in the SONGS IPEEE study were extensively evaluated using the selected database consistent with a magnitude 7 strike-slip or oblique earthquake at a distance of 8 km within the limitation of the available recorded data. The results of this evaluation were reported in Appendix D of the SONGS PSHA report. The selected database used in the evaluation of the attenuation relationships included oblique events, such as the Loma Prieta event, as well as other appropriate strike-slip events because the available recorded data pertinent to the SONGS PSHA were very limited. The inclusion of oblique events in the database should be conservative because ground motions from oblique events in general tend to be higher than those from strike-slip events.

A part of this extensive evaluation of the attenuation relationships at a magnitude of 7, for example, was shown on Figure D-10b of Appendix D of the SONGS PSHA report in terms of normalized horizontal pseudo-spectral response accelerations. In addition, Figures D-14a through D-14e of Appendix D of the SONGS PSHA report showed the results of standard error evaluation at magnitudes 6-1/2 and 7. As presented in Appendix D of the SONGS PSHA report, the results of this extensive evaluation of the attenuation relationships indicated that the five attenuation relationships provide the ground motion data at the SONGS site consistent with the selected database pertinent for the site: magnitude about 7 at a distance of about 8 km from strike-slip (as well as from oblique) events.

As discussed above and in the response to Question 1, the attenuation relationships used in the study, which form the basis for the ground motion assessment at the site, are quite consistent with the Landers, Northridge, and Loma Prieta events. The Coalinga (magnitude 6.4) and Petrolia (magnitude 7) events like the Northridge event are reverse and thrust events, respectively, making them not pertinent to the strike-slip focus for the SONGS site.

Since Question 3 mentions the Coalinga and Petrolia events, Figures 3-1 and 3-2 compare the peak ground acceleration versus distance from three of the attenuation relationships using the soils site data from the Coalinga and Petrolia events, respectively. The median as well as the plus-and-minus one standard deviation relationships for thrust or reverse events are shown on these figures. As can be seen from these figures, the three attenuation relationships appear to be reasonably compatible with the data from the Coalinga and Petrolia events with the data falling between $\pm 1\sigma$ of the attenuation relationships, even though they are considered to be not pertinent to the SONGS site.

Question 4:

"The SONGS Final Safety Analysis Report states in Section 2.5.1.1.3.4.2 that there are faults east of the South Coast Offshore Zone of Deformation that are the types of faults that result from deformation associated with folding and appear to be intraformational faults generated by the folding of the sediments. What type of faults are the intraformational faults? Are they fold axis faults, bedding plane faults or some other type? What is the sense of motion on these faults (i.e., normal, reverse)?"

Response to Question 4:

The intraformational faults discussed in this section are those faults which are the result of flexure folding within the younger, competent material overlying the Monterey Formation. This type of fold/fault feature is common in mildly deformed terrain involving competent strata. As noted by Fischer and Mills (1991), this type of deformation is a typical response of thick, younger Neogene sediments to right-lateral shear. According to Moore (1980), broad folding of the underlying Monterey Formation caused development of a series of anticlines and synclines in the overlying Plio-Pleistocene sediments. The faulting and buckling that occurred within these anticlinal/synclinal folds, confined to the unit overlying the Monterey Formation, resulted from squeezing of the beds of very incompetent and impermeable material which developed high pore pressure. Ehlig (1980) notes that the faults associated with the folds do not extend deep into the section, upward to the sea floor, or to the Pleistocene erosional unconformity. The length of these features is on the order of a few hundred meters.

According to Moore (1980), the intraformational faults are minor, confined to the axes of the folds and do not display any well-developed sense of displacement. However, the high-resolution profiles suggest possible extension across the crest of the fold and possible normal displacement on the flanks of the fold. There was no measurable sense of reverse/thrust displacement or a thickening of the section by incompetent or flow folding.

Question 5:

"Provide any assessment in your possession regarding the potential for blind thrust faults in the SONGS site region. Provide any assessment regarding the size of earthquakes on the faults, if they exist, and any estimates of the vibratory ground motion at the SONGS site from these events.

Response to Question 5:

The source model used in the recent probabilistic seismic hazard assessment for SONGS (SONGS PSHA report) explicitly incorporated blind thrust fault sources in the site region. The recognition and characterization of the seismic potential of active blind thrust faults in the Los Angeles basin continues to be an ongoing and evolving topic of research. The geometry, activity, and slip rates for these structures are not well constrained (WGCEP, 1995),and alternative models available in 1994 (e.g., Davis and others, 1989; Shaw, 1993) were incorporated into the source model used in the SONGS PSHA. Given the distance of the recognized blind sources and the uncertainties in the geometries of these potential fault sources, the potential blind thrust sources were generalized into two blind fault source zones, Los Angeles basin source zones A and B. The parameters used to model these blind fault sources are summarized in Table A-1, and the contribution to spectral acceleration at 10 Hz and 1 Hz are shown on Figures 6-4 and 6-9, respectively, of the SONGS PSHA report.

The Elysian Park thrust system as originally defined by Davis and others (1989) extends from Orange County in the southeast through downtown Los Angeles and westward beneath the Santa Monica Mountains along the Malibu coast to Point Mugu. Dolan and others (1995) conclude based on geomorphic analysis that this zone of contractional deformation actually comprises two distinct thrust fault systems, an east-west-trending thrust ramp beneath the Santa Monica Mountains that they refer to as the Santa Monica Mountains thrust fault, and a west-northwest-trending system (the Elysian Park ramp) that occupies the northeastern part of the Los Angeles basin. They further subdivide the Elysian Park ramp into two segments, the Los Angeles segment extends from the Elysian Park Hills northwest of Los Angeles through downtown and East Los Angeles, and the Puente Hills segment (referred to as the Whittier segment by Shaw and Suppe, 1996) that extends southeastward beneath the Puente Hills.

The SONGS PSHA model, which was developed prior to publication of Dolan and others (1995), also treats the Santa Monica thrust fault and the Elysian Park thrust fault system as independent seismic sources. The Santa Monica thrust lies at a distance of over 100 km from the SONGS site, and thus was not included as a fault source. The Los Angeles basin source zone A included in the SONGS PSHA model incorporated a blind thrust fault geometry comparable to that of the Los Angeles segment of the Elysian Park thrust as shown by Dolan and others (1995) and Shaw and Suppe (1996). The maximum magnitude probability distribution for the Los Angeles basin source zone A (see Appendix B, SONGS PSHA report) incorporates maximum magnitude estimates up to M_w 7.1. This magnitude distribution captures the magnitude estimates for single segment (M_w 6.6) and multiple segment (M_w 6.9) ruptures as proposed by Dolan and others (1995) and Shaw and Suppe (1996).

The Whittier (Puente Hills) segment of the Elysian Park thrust underlies the Whittier fault, a documented active strike-slip fault. Dolan and others (1995) postulate that the Whittier fault may represent partitioned strike-slip above the blind thrust fault zone, but the structural interaction of these fault systems is not well constrained by available data. The cross section presented by Shaw and Suppe (1996) does not extend far enough east to show the intersection of the Whittier fault with the Elysian Park ramp. Davis and others (1989) in their modeling of the Elysian Park thrust require the Whittier fault to be inactive. The SONGS PSHA model did not explicitly include the Whittier segment of the Elysian Park thrust, but did account for the possibility of blind thrust events of up to M_w 6.5 in this part of the Los Angeles basin in the characterization of the Central Los Angeles basin regional source zone (Figure A-2a, SONGS PSHA report). The Elysian Park thrust, including the Whittier segment as modeled by Shaw and Suppe (1996), at its closest approach lies about 70 km from the SONGS site. Given the proximity of other major active strike-slip faults to the SONGS site and their relative contribution to hazard at the site (see Figure 6-6, SONGS PSHA report), the Elysian Park thrust will not contribute significantly to the total seismic hazard at the site.

Los Angeles basin source zone B incorporated the possibility of a significant blind fault source in the western Los Angeles basin. When the SONGS seismic source model was developed, a number of alternative geometries and dips for blind faults in this region of the basin had been proposed. The SONGS model incorporated two alternative geometries, a northeast-dipping and a southwest-dipping ramp, to address these uncertainties. The low probability (0.2) of activity assigned to this source zone was based on the judgment of the likelihood that significant deformation in this region results from activity on buried thrust faults.

Models that require an east-dipping ramp under the western part of the Los Angeles basin imply uplift in the west basin that is not expressed geologically (D. Ponti, U. S. Geological Survey, personal communication, March 1994). On the basis of the geomorphic position of marine deposits in the Torrance and Long Beach plains, vertical tectonism during the past 600 ka in this area has been negligible (Ponti and Lajoie, 1992). The Pleistocene uplift, evidenced by elevated marine terraces in the vicinity of the Newport-Inglewood fault (Lajoie and others, 1992) and the Palos Verdes anticlinal uplift, is consistent with models of strike-slip or oblique-slip along the Newport-Inglewood and Palos Verdes faults (WGCEP, 1995). Local uplift of the Palos Verdes anticlinorium likely is caused by the dip-slip component of fault motion, which may occur as oblique slip in a restraining bed (Ward and Valensie, 1994) along the principal strike-slip Palos Verdes fault system (Nardin and Henyey, 1978; McNeilan and others, 1996; Stephenson and others, 1995). The rate of uplift (0.7 $\pm$0.2 m/kyr) expected beneath the anticlinorium based on the ramp geometry modeled by Shaw and Suppe (1996) is greater than the 0.3 to 0.4 m/kyr uplift rates reported for the Palos Verdes peninsula based on dated marine terraces (Bryant, 1987; Ponti and Lajoie, 1992; Muhs and others, 1992, and McNeilan and others, 1996). Shaw and Suppe (1996) suggest this discrepancy may be due to incomplete or incorrect fault geometries, errors in their calculated slip rate for the Compton thrust, and/or the assumption of rigid-block translation above the ramp which does not account for isostatic compensation or relaxation of the crust.

The northeast-dipping blind fault incorporated in the Los Angeles basin source zone B, incorporates the geometry of the Compton thrust ramp as modeled by Shaw and Suppe (1996). Both models allow for an approximately 25 degrees northeast-dipping ramp that at their closest distance are 40 to 45 km from the SONGS site. The maximum magnitude probability distribution for the Los Angeles basin source zone B (see Appendix B, SONGS PSHA report) ranges from M_w 6.3 to 7.4. Maximum magnitude estimates of M_w 7.3 (Dolan and others, 1995) and Shaw and Suppe (1996) fall within this range.

In summary, the characterization of blind thrust fault sources for the SONGS PSHA explicitly incorporated all published information regarding blind thrusts at the time of the analysis. As noted above, the additional information that has been published since the SONGS PSHA is subsumed within the range of source characteristics included in the analysis. All of these analyses show a negligible contribution to site hazard due to the proximity of several nearby strike-slip faults. Therefore, it is concluded that continued study of Los Angeles basin blind thrust faults will not lead to significant changes to the SONGS site hazard.

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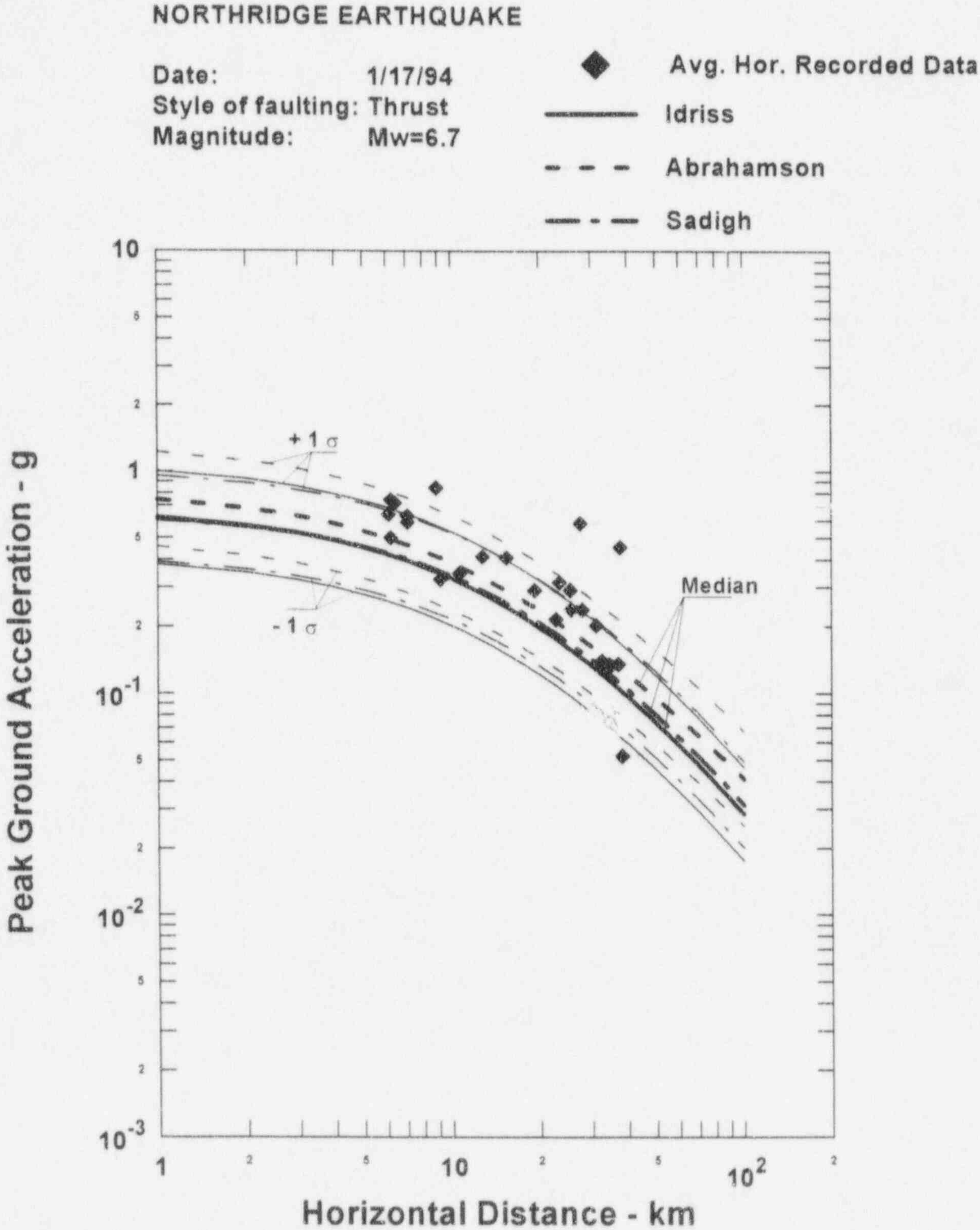

COMPARISON OF PREDICTED MEDIAN PEAK GROUND ACCELERATIONS WITH RECORDED DATA
NORTHRIDGE EARTHQUAKE (1/17/94)

Project No. 934E361B	Date: 28 FEB 97	Project: SONGS IPEEE	Fig. 1-1

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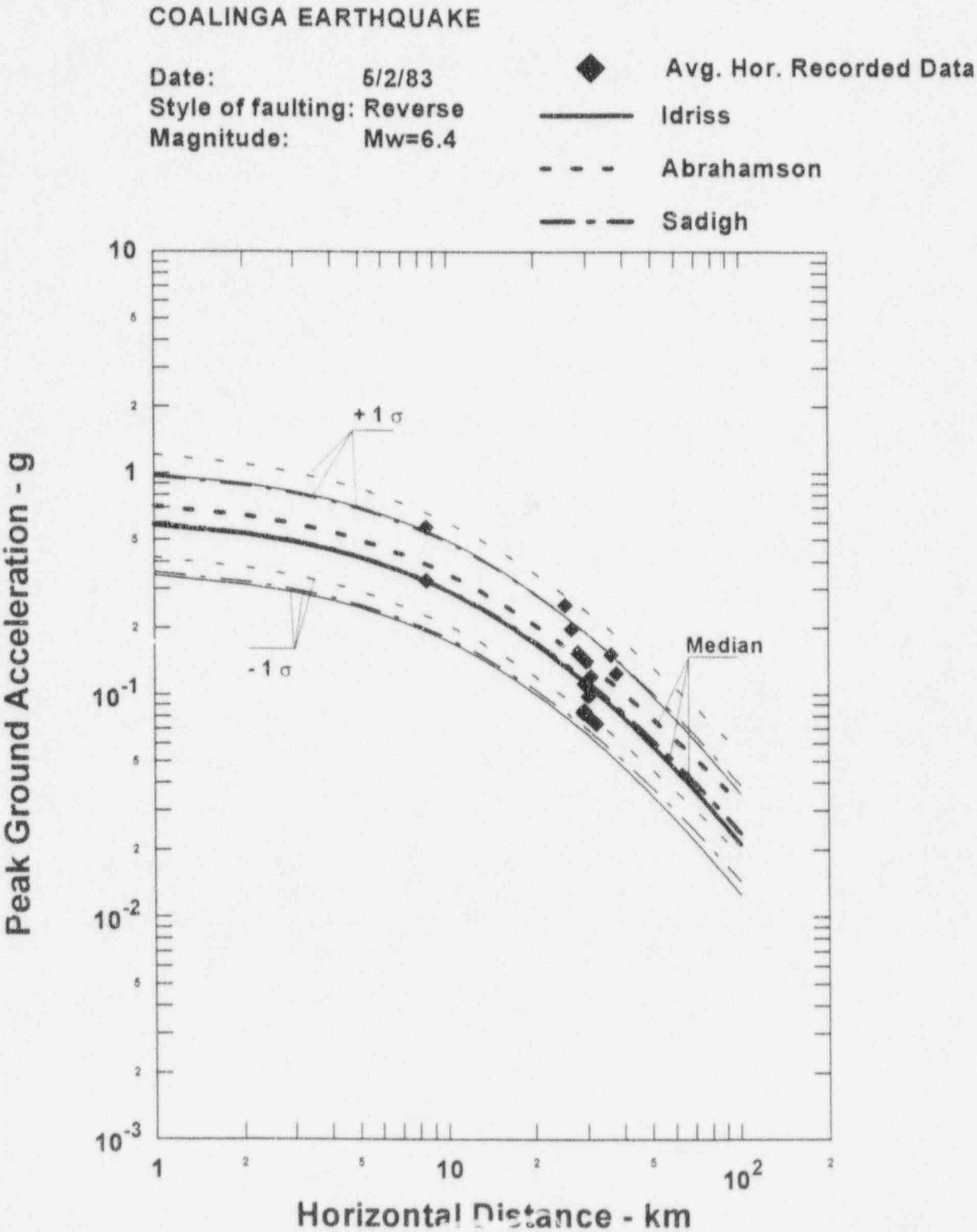

COMPARISON OF PREDICTED MEDIAN PEAK GROUND ACCELERATIONS WITH RECORDED DATA
COALINGA EARTHQUAKE (5/2/83)

Project No. 934E361B	Date: 28 FEB 97	Project: SONGS IPEEE	Fig. 3-1

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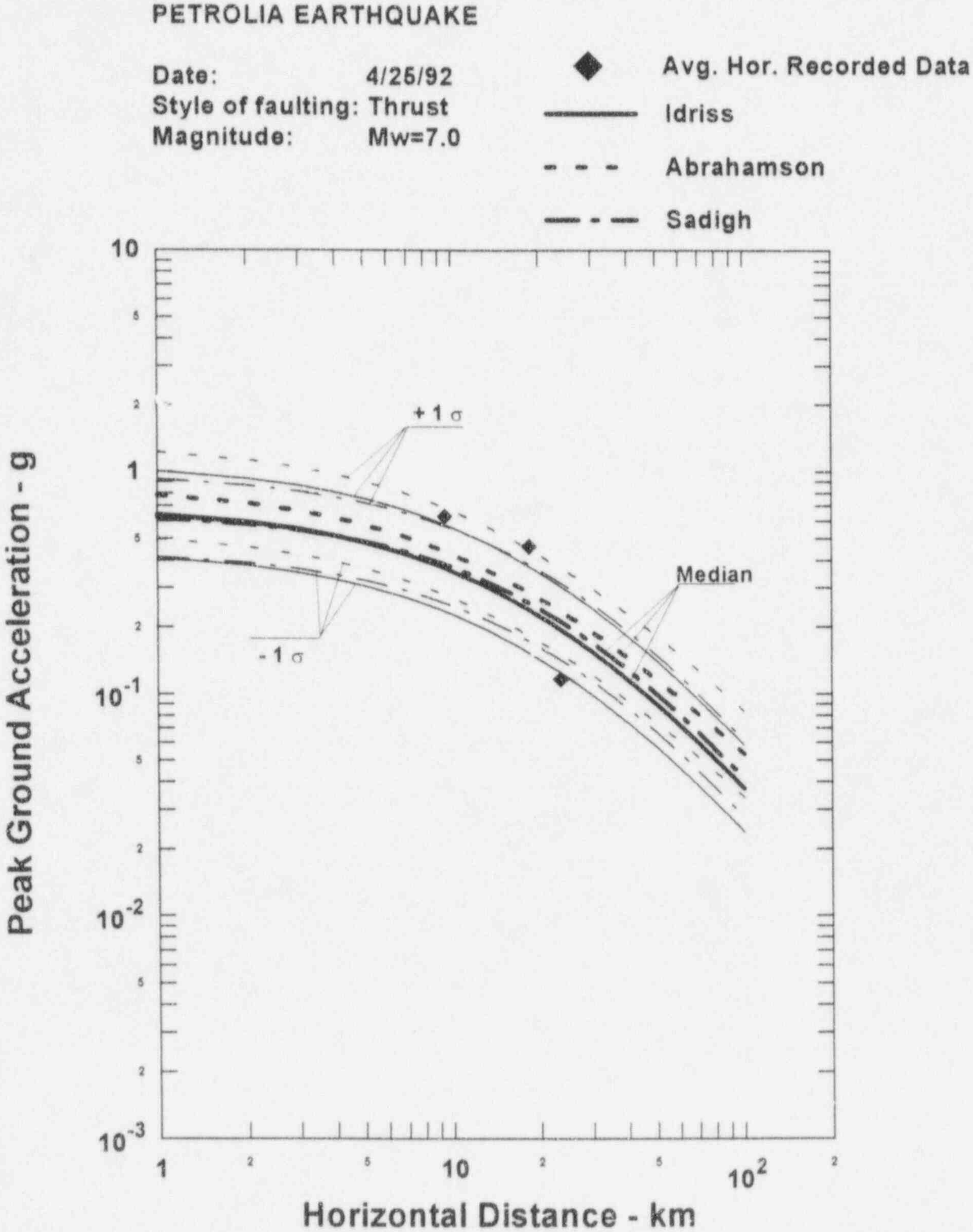

COMPARISON OF PREDICTED MEDIAN PEAK GROUND ACCELERATIONS WITH RECORDED DATA PETROLIA EARTHQUAKE (4/25/92)			
Project No. 934E361B	Date: 28 FEB 97	Project: SONGS IPEEE	Fig. 3-2

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