Safety Evaluation Report

NUREG-0059
(Suppl. 2 to NUREG-75/098)

U. S. Nuclear
Regulatory Commission

related to construction of

Palo Verde Nuclear Generating Station Units 1, 2 and 3

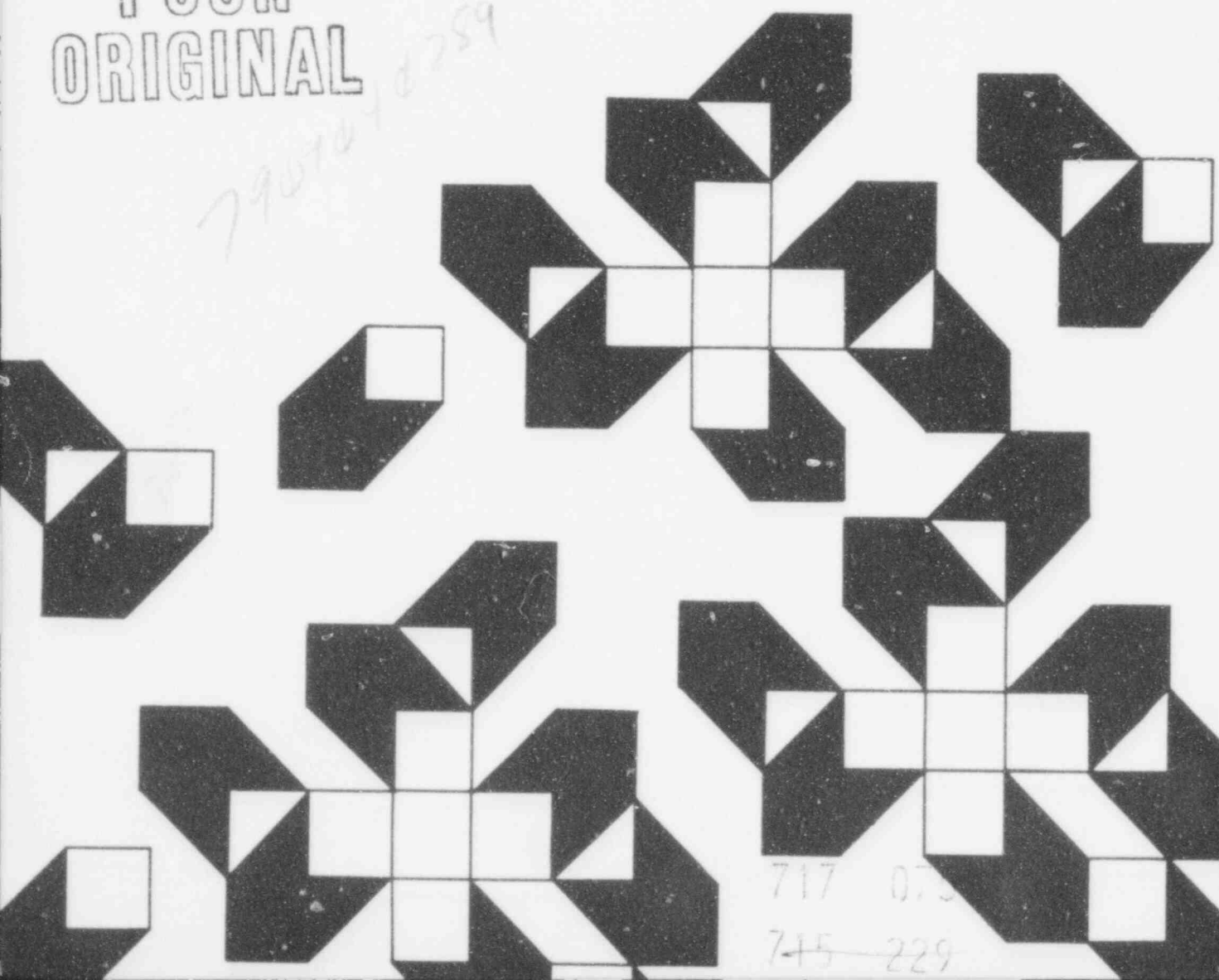
Office of Nuclear
Reactor Regulation

Docket Nos. STN 50-528
STN 50-529
STN 50-530

Arizona Public Service Company, et al

April 1976

Supplement No. 2



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NUREG-0059
(Supplement No. 2
to NUREG-75/098)

SUPPLEMENT NO. 2

TO THE

SAFETY EVALUATION REPORT

BY THE

OFFICE OF NUCLEAR REACTOR REGULATION

U.S. NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF

ARIZONA PUBLIC SERVICE COMPANY, ET AL

PALO VERDE NUCLEAR GENERATING STATION

UNITS 1, 2 & 3

DOCKET NOS. STN-50-528, STN-50-529 and STN-50-530

APRIL 8, 1976

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1.0 INTRODUCTION AND GENERAL DISCUSSION

1.1 Introduction

The Nuclear Regulatory Commission's (Commission) Safety Evaluation Report in the matter of the application by the Arizona Public Service Company, the Salt River Project Agricultural Improvement and Power District, the El Paso Electric Company, the Southern California Edison Company, the Public Service Company of New Mexico, and the Arizona Electric Power Cooperative, Incorporated (hereinafter referred to as the applicants) to construct and operate the proposed Palo Verde Nuclear Generating Station Units 1, 2 and 3 was issued on October 10, 1975 and Supplement No. 1 to that Safety Evaluation Report was issued on February 11, 1976.

The Safety Evaluation Report described a number of outstanding issues. Supplement No. 1 to the Safety Evaluation Report presented the resolutions of all of those outstanding issues, except for one item where we stated that we would require satisfactory results from additional geological investigations. The purpose of this supplement is to update the Safety Evaluation Report and Supplement No. 1 by providing our evaluation of this matter which is now resolved. Our evaluation is presented in Section 2.5 of this supplement.

We have concluded that the Palo Verde Nuclear Generating Station can be constructed and operated as proposed without endangering the health and safety of the public.

Except for the appendices, each of the following sections of this supplement is numbered the same as the section of the Safety Evaluation Report and Supplement No. 1 that are being updated, and the discussions are supplementary to and not in lieu of the discussion in the Safety Evaluation Report and Supplement No. 1.

Appendix A to this supplement is a continuation of the chronology of the staff's principal actions related to processing of the Palo Verde Nuclear Generating Station application. Appendix B is a listing of errata to Supplement No. 1 to the Safety Evaluation Report. Appendix C is a report by the U. S. Geological Survey.

1.8 Outstanding Issues

All the outstanding issues have been resolved.

2.0 SITE CHARACTERISTICS

2.5 Geology and Seismology

In Sections 2.5.1.1 and 2.5.1.5 of the Safety Evaluation Report we stated that, subject to satisfactory results from additional studies, the geological investigations and evaluations presented by the applicants were adequate to establish the seismic design accelerations for the facility. We stated that we would require the additional studies in order to confirm the absence of faulting south of the site. We and our consultants, the U. S. Geological Survey, have now completed our review of the additional studies and our evaluation of the geologic setting south of the site and have concluded that the geologic structures and features studied have no impact upon the safety of the proposed site. The report of the U. S. Geological Survey is presented in Appendix C to this supplement. The relevant information which has been developed since the Safety Evaluation Report was published is summarized below.

In order to more clearly define the structural geology of the site vicinity in the region of Gila Bend, additional field work was undertaken by the applicants and additional information was submitted in Amendments 14, 15 and 16 to the PSAR. We and the U. S. Geological Survey made two site visits to the area in October 1975 and February 1976 in order to examine various aspects of the field relations. During the course of the investigation, examination of airphotos of the north end of the Sand Tank Mountains revealed a scarp, arcuate in plan, but trending generally northeast. The scarp is about 2.5 miles long and is located approximately 40 miles south-southeast of the site. Relief across the scarp ranges from three to five feet. The scarp displaces Quaternary alluvium in an area in which groundwater withdrawal is not known to be sufficient to induce subsidence cracking at the basin margins. Without further investigation, it must therefore be assumed that this scarp is of tectonic origin. However, its size, trend, distance from the site and lack of association with other faults indicate that if this scarp represents a fault, the fault is not of safety significance to the proposed site.

Field studies were made of various surfaces to the west of the Gila River at a distance of 12 to 20 miles from the site in the area of Enterprise Ranch. Scarps in this area do not appear to be fault controlled but rather to be erosional in origin. Fairly continuous exposures of bedded sedimentary strata cross the trend of the scarps without evidence of displacement. Since there are no indications of faulting in this area and considering the poor preservation of the various surfaces whose origin and initial base level are uncertain, no further investigation can be expected to generate information relevant to the safety of the proposed site.

In addition to the field studies, two other lines of evidence have been developed regarding possible faulting south of the site along the trend of the Gila Bend lineament. The first of these is a compilation of well data at the northern end of Gila Bend which shows that the Palo Verde Clay extends from the Arlington basalt to the Gillespie basalt flow without evidence of disruption. The second line of evidence against faulting in the Gillespie narrows, which has recently been presented, is based on borings across the narrows made between 1909 and 1911, for the Gillespie dam. A geologic profile constructed through the borings shows that the surface of the bedrock is without any sharp changes in slope which would suggest displacement. These new lines of evidence support and confirm data we described in the Safety Evaluation Report which indicate undisturbed river terraces crossing the trend of the Gila Bend lineament.

Several recommendations are contained in the geology section of the U. S. Geological Survey report in Appendix C to this supplement. We have concluded that these suggestions, including mapping of excavations and implementation of a monitoring program as well as graphical changes in the PSAR involving earthquake data and a distant (40 mile) fault, have been accomplished in a satisfactory manner by appropriate PSAR revisions through Amendment 16.

In Section 2.5.1.3 of the Safety Evaluation Report we stated that the likelihood of groundwater declines approaching those assumed in the applicants' subsidence calculations was very remote and, furthermore, that such minimal subsidence as might occur at the site due to groundwater withdrawal would be uniform beneath each of the units and would present no hazard to Category I structures. However, we also stated that we were still reviewing the applicants' assumptions and calculations concerning subsidence due to groundwater withdrawal. We and our consultants, the U. S. Army Corps of Engineers, have now completed our evaluation of these assumptions and calculations and have found them to be conservative and, accordingly, our conclusions discussed above have not changed. The relevant information developed since the Safety Evaluation Report was published is summarized below.

Data presented by the applicants in a letter dated November 13, 1975, suggest no more than five inches of subsidence (settlement) resulting from a decline of the groundwater to an average depth of 335 feet below the existing ground surface. This approximate depth coincides with the upper surface of an essentially incompressible rock-like unit - a fanglomerate. The applicants further suggest, to be very conservative, a subsidence range of six to ten inches. We reasonably expect groundwater declines at the site to be less than 100 feet, but we would use 200 feet in subsidence calculations to be conservative. Our calculations would result in subsidence values somewhat less than the applicants'. Our overall conclusion, therefore, is that the assumptions and calculations presented by the applicants in the subsidence analysis are conservative. Furthermore, site investigations indicate uniform subsurface conditions underlie the Category I structures. Similarity of soils coupled with regional withdrawal of groundwater is expected to result in uniform subsidence, if subsidence were to occur.

The applicants have committed to the installation of a monitoring system capable of assessing the accuracy of the settlement analysis, as well as evaluating subsidence resulting from the extraction of groundwater. The monitoring program will consist of monitoring points (instrumental, vertical control and groundwater levels) within and around the perimeter of the excavation, onsite and offsite. The monitoring program, consisting of extensometers and rebound-settlement monitor stations and some bench marks on rock establishing vertical control, will be implemented prior to the start of excavation. Offsite monuments are also to be established as part of the monitoring system. Groundwater levels (both the perched and regional) are to be monitored in order to assess the applicants' assumed groundwater declines. The applicants have committed to maintaining the monitoring system consisting of both on and offsite bench marks and groundwater measurements points throughout the life of the facility.

Based on our evaluation we reaffirm our previous conclusions that the likelihood of groundwater declines approaching those used in the applicants' calculations is remote and that the minimal subsidence resulting from groundwater withdrawal is expected to be regional and as such would present no hazard to the proposed facilities. We have also concluded that the monitoring system described by the applicants is an effective means of detecting incipient harmful effects which could be caused by subsidence attributable to fluid extraction.

The seismology section of the report by the U. S. Geological Survey in Appendix C to this supplement expresses disagreement with the applicants' Zone B and states that the largest earthquake which could occur randomly within the zone containing the site would be of magnitude 5.0. The applicants had used a magnitude 4.0 in this context. However, the U. S. Geological Survey's report goes on to state agreement with the applicants' conclusion that an acceleration of 0.2 gravity is adequate for use at this site.

Item (1) in Section 2.5.2.5 of the Safety Evaluation Report described our evaluation of such a random earthquake, which was assumed to occur near the site but beyond the region of intense geologic investigation conducted within 5 miles of the site. As discussed there we determined that even if a magnitude 5.0 earthquake were assumed to occur 5 miles from the site the accelerations would not be expected to exceed 0.2 gravity. Accordingly, our previous conclusion that an acceleration of 0.2 gravity is adequate for use at this site remains unchanged.

21.0 CONCLUSIONS

In Section 21.0 of the Safety Evaluation Report, we stated that we would be able to make certain conclusions upon favorable resolution of the outstanding matters set forth in Section 1.8 of the Safety Evaluation Report. We have discussed these matters in Supplement No. 1 and in this supplement and indicated a favorable resolution of each matter. Furthermore, there are no other issues outstanding.

Accordingly, we affirm the conclusions listed in Section 21.0 of the Safety Evaluation Report.

APPENDIX A

CONTINUATION OF THE CHRONOLOGY OF THE RADIOLOGICAL SAFETY REVIEW OF PALO VERDE NUCLEAR GENERATING STATION UNITS 1, 2 AND 3

January 20, 1976	Letter from U. S. Geological Survey to NRC staff providing draft review of Palo Verde PSAR.
January 29, 1976	Letter from applicants submitting non-proprietary version of financial information previously submitted in Amendment 14A.
February 5, 1976	Meeting with applicants to discuss geology.
February 10, 1976	Letter from applicants submitting additional geological information to be incorporated into Amendment 16.
February 18, 1976	Letter from applicants submitting additional geological information to be incorporated into Amendment 16.
February 23, 1976	Letter from U. S. Geological Survey to NRC staff providing draft review of Palo Verde PSAR.
February 23, 1976 through February 27, 1976	Evidentiary hearings held by Atomic Safety and Licensing Board concerning the Palo Verde construction permit application.
March 1, 1976	Applicants submitted Amendment 16 incorporating additional geological information.
March 22, 1976	Letter from applicants providing commitments to meet certain interface requirements stated in the SER, Supplement 1.
March 29, 1976	Letter to applicants stating that inadequate justification had been provided for withholding the financial information in Amendment 14A from public disclosure.

March 31, 1976	Applicants submitted Amendment 16A revising the earliest and latest dates for completion of construction in the license application to agree with other information previously submitted in the PSAR and Environmental Report.

APPENDIX B

ERRATA TO SUPPLEMENT NO. 1 TO THE SAFETY EVALUATION REPORT
FOR THE PALO VERDE NUCLEAR GENERATING STATION UNITS 1, 2 AND 3
DATED FEBRUARY 11, 1976

Page	Line	
Page Following Title Page	—	Delete entire page.
1-1	19	Change "issues" to "issue"
7-3	3	Change "most reactors" to "most other previously licensed pressurized water reactors"
Appendix A Page 15-11	—	Add the following assumptions: "(9) 1.2 peaking factor (10) 0.45% of the fuel reaches at least incipient centerline melting after rod ejection accident (11) 100% of noble gases and 50% of iodine in fuel reaching incipient centerline melting temperature are released to the primary coolant"

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

APR 1 1976

Mr Bernard C. Rusche
Director of the Office of Nuclear
Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Rusche:

Enclosed please find the U.S. Geological Survey Final Review of the Arizona Public Service Company's Palo Verde Nuclear Generating Station, Units 1, 2, and 3, NRC Docket Nos. STN 50-528, -529, and -530.

The geology portion of this review was prepared by Richard Van Horn and the seismology by Stanley R. Brockman.

Sincerely yours,

Henry W. Coulter

Acting Director

Enclosure

717 087

~~715 241~~

Final Review
Palo Verde, Ariz.
Richard Van Horn
Stanley R. Brockman
March 30, 1976

Arizona Public Service Company
Palo Verde Nuclear Generating Station, Units 1, 2, and 3
Maricopa County, Arizona
NRC Docket Nos. STN 50-528, -529, and -530

The regional geological and seismological aspects of the Palo Verde site as presented in Volumes II through X of the Preliminary Safety Analysis Report (PSAR); Amendments 1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 14, and 15 to the PSAR; a 62-page report "Supplemental Geologic and Geomorphic Data," dated February 12, 1976, prepared by the applicant in response to questions pertaining to the site (this was subsequently modified and submitted officially on March 3, 1976, as Amendment 16 and was received by the USGS on March 29, 1976); Volumes I and II of the "Geologic Investigation of the Gillespie Dam Alternate Siting Area, Arizona," prepared by Fugro, Inc.; and a report "The Late Cenozoic History of the Phoenix Basin, Arizona," by Troy L. Pewe dated October 31, 1975, were reviewed. Literature pertaining to the site area has been reviewed, and geologists of the U.S. Geological Survey, Arizona Bureau of Mines, and the Arizona Transportation Department have been consulted. Field conferences in the vicinity of the site on July 8, 1975, October 2, 1975, and February 5, 1976 were attended by USGS personnel. Airphotos were inspected and field examinations were conducted on October 3, 1975, and February 2-4, 6, and 7, 1976, in the vicinity of the site.

Geology

The Palo Verde site is 80 km (50 miles) west of Phoenix, Arizona, near the southeast end of the Palo Verde Hills in the Sonoran Desert physiographic subprovince of the Basin and Range province. The basement

rocks underlying the site consist of metamorphic and granitic rocks of Precambrian age. These are overlain by volcanic rocks and weakly to strongly cemented sedimentary rocks of middle to late Tertiary age. These rocks are in turn overlain by moderately to poorly consolidated alluvial fan deposits, lake beds, volcanic rocks, and alluvium of late Tertiary to Holocene age. The site lies athwart a northwest-trending finger of the Phoenix basin that may be filled by more than 1,200 feet of alluvial deposits overlying consolidated rock. Consolidated rock crops out at the north and south boundaries of the site.

Northwest-trending lineations dominate the structural pattern of the area. This is reflected in the trend of nearby mountain ranges and intervening basins, in the strike of the volcanic and sedimentary bedrock layers, and in the trend of most faults, dikes, and joints in the general area.

Faults are not known to intersect a 2-million-year-old lacustrine clay that underlies the site, and fault scarps are not known to present near the site. The nearest probable fault scarp is formed on a late Cenozoic alluvial fan deposit and is 65 km (40 miles) southeast of the site and about 1 km in length; its capability was not determined. No capable faults were identified within 150 km of the site.

Subsidence of possible late Cenozoic age is suggested by the distribution and thickness of alluvial deposits and the possible tilting of regional extent of the 2-million-year-old lacustrine beds that has produced no known effects at the site.

The reviewer recommends continuous geologic surveillance and mapping of all excavations in the site area for evidence of late Cenozoic faulting and a periodic geodetic monitoring program for subsidence caused by

tectonic activity or by the withdrawal of ground water. The reviewer also recommends that the epicenter location map (Figure 2.5-57) and any other pertinent maps be brought up to date to include the 5.2 magnitude earthquake near Chino Valley, Arizona, of February 4, 1976. The scarp in sections 24 and 25, T. 6W., R. 4W., mentioned on page 16 of the "Supplemental Geologic and Geomorphic Data" prepared by the applicant on February 12, 1976, should be shown as a Quaternary fault on Figure 2.5-57 and on other applicable figures.

Seismology

The site is located 80 km west of Phoenix, Arizona, in a region of relatively low seismicity, and lies within Zone 2 of Algermissen's (1969) risk map. Zone 2 corresponds to a maximum intensity of VII (MM)*.

As previously stated, the nearest probable fault scarp is 65 km southeast of the site and has a mapped length of about 1 km. No capable faults have been identified within 150 km of the site. The nearest historic earthquakes were about 60 km from the site and occurred in 1906 and 1937. The site, which is situated on about 100 m of firm sediments overlying unfaulted bedrock, has experienced intensity VII several times. VII is believed to be the maximum intensity felt in the site vicinity.

The applicant has subdivided the Southwest into provinces designated A through E. The site is contained within Zone D, while their proposed Safe Shutdown Earthquake (S.S.E.) is located in Zone C. The San Andreas fault zone is in Zone A, whose nearest boundary is about 200 km from the

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* Modified Mercalli intensities are used throughout this report.

site. The nearest boundary of Zone E is more than 300 km from the site but was included in the PSAR to show the northern termination of Zones C and D (PSAR page 2.5-103AA).

Within Zone D is a circular area designated Zone B which contains, according to the applicant, implied Quaternary faulting and epicenters that they believe may be reasonably associated with this faulting. The largest earthquake within this area is a magnitude 5.0 and was about 115 km from the Palo Verde site. We do not believe there is adequate geologic or seismologic evidence to define such a zone.

Zone D is depicted in general, as an area the shape of an isosceles triangle, and is characterized by little Quaternary faulting and sparse, low level seismic activity (PSAR page 2.5-1031). Magnitude 5.0 is the largest earthquake to occur in this zone; one occurred March 15, 1958, 115 km southwest of the site (previously identified with Zone B) while another occurred more recently on February 4, 1976, 150 km north of the site.

The PSAR depicts Zone C as a "...band of rather diffuse seismicity... extending northwest across Arizona." They believe the zone is characterized by several major geologic features unique to that zone. According to the instrumental record, the earthquakes range in magnitude up to 5.6 and have not been associated with specific faults.

A free-field acceleration of 0.2 g, corresponding to the SSE, has been chosen for the high frequency input to the Regulatory Guide 1.60 spectra. Several situations are examined to validate the SSE value: a San Andreas-type event, a Sonora, Mexico-type event and a random event within the site province. A magnitude 8+ earthquake is postulated to occur about 200 km from the site, at the point on the boundary of Zone A

nearest the site. We agree that an acceleration of less than 0.1 g would be generated at the site. (Davenport, 1972; Donovan, 1973; Schnabel and Seed, 1973).

A magnitude 8 earthquake 115 km northeast of the site is postulated for the Sonora-type event. An intensity of VII would be expected at the site. Using various authors, (Davenport, 1972; Donovan, 1973; Schnabel and Seed, 1973), the applicant derives values of 0.04 g to 0.17 g from relations of acceleration magnitude and distance. Acceleration, intensity, and distance relations (Barosh, 1969; Coulter and others, 1973; Newmann, 1954) give a range of 0.02 g-0.19 g. The spectra from four seismograms from the 1952 Kern County earthquake and two from the 1971 San Fernando earthquake were scaled for distance and magnitude. The applicant feels that the resultant spectra may be conservatively enveloped with the Regulatory Guide 1.60 spectrum anchored at 0.2 g.

With one exception, we conclude that the seismic hazards likely to affect the Palo Verde site have been adequately considered. We disagree with the Zone B suggested by the applicant, thus the largest earthquake which could occur randomly within the zone containing the site would be magnitude 5.0 However, USGS seismologists agree with the applicant that for the Palo Verde site 0.2 g is an adequate value to be used as the zero period acceleration in the development of the appropriate design response spectra as described in the Regulatory Guide 1.60, Revision 1, December 1973.

References

Algermissen, S. T. (1969), Seismic Risk Studies in the United States, Proc. Fourth World Conference on Earthquake Engineering, Santiago, Chile.

Barosh, P. J. (1969), Use of Seismic Intensity Data to Predict the Effects of Earthquakes and Underground Nuclear Explosions in Various Geologic Settings, Geol. Survey Bull. No. 1279, 93 p.

Coulter, H. W., Waldron, H. H., and Devine, J. F. (1973), Seismic and Geologic Siting Considerations for Nuclear Reactors, Proceedings, Fifth World Conference on Earthquake Engineering, Rome, Italy.

Davenport, A. G. (1972), A Statistical Relationship Between Shock Amplitude, Magnitude, and Epicentral Distance and its Application to Seismic Zoning, Engg. Sci. Res. Report BLWT-4-72, Univ. of W. Ontario, London, Ontario.

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Newman, Frank (1954), Earthquake Intensity and Related Ground Motion, Univ. of Washington Press, 94 p.

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