Enclosure (1)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 28 1983

MEMORANDUM FOR: George W. Knighton, Chief
Licensing Branch No. 3, DL

FROM: Robert E. Jackson, Chief
Geosciences Branch, DE

SUBJECT: SUPPLY SYSTEM NUCLEAR PROJECT NO. 3

Plant Name: Supply System Nuclear Project No. 3
Licensing Stage: OL
Docket Number: 50-508
Responsible Branch: Licensing Branch No. 3, Annette Vietti, LPM

We have reviewed Sections 2.5.1 through 2.5.3 of the Supply System Nuclear Project No. 3 Final Safety Analysis Report submitted by the Washington Public Power Supply System in support of their application for an Operating License. On the basis of this review we find that we require additional information and have enclosed questions prepared by the U. S. Geological Survey, Dr. David B. Slemmons, geological consultant, R. McMullen, Geology Section and J. King, Seismology Section, Geosciences Branch, Division of Engineering for your transmittal to the applicant. We recommend that a meeting be held to specifically discuss these questions.

Robert E. Jackson

Robert E. Jackson, Chief
Geosciences Branch
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Enclosure:
As stated

cc: w/enclosure

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Geoscience Review Questions, WNP-3
Seismology

230.1 (SRP 2.5.2.2, 2.5.2.4, 2.5.2.6)

The work by Ruff and Kanamori (1980) and others appear to support the view that the subduction of the Juan de Fuca plate creates a potential for large magnitude earthquakes in the subduction zone beneath WNP-3. In addition:

a) Kanamori (1983) has published an equation relating the age of the subducting plate, convergence velocity, and the largest expected magnitude event. Does this equation apply to the Juan de Fuca plate and if not, why not? Alternatively are there other convincing models that allow the estimation of the magnitude of subduction zone earthquakes under the site to values lower than would be predicted by the Kanamori (1983) relationship?

b) Are there specific examples of aseismic subduction zones which share the following features with the Juan de Fuca subduction zone: young subducted lithosphere, low convergence rate, no back-arc basin, similar maximum depths of seismicity, shallow oceanic trench, low free-air gravity anomaly, small variation in surface topography of the subducted plate and, particularly, complete seismic quiescence down to the magnitude 5 level?

c) Crustal uplift rates of approximately 2mm/yr were observed in the region from 120 to 220 km inland of the Nankai Trough for the 50 years preceding the 1944, M=8.0 Tonankai and 1946, M=8.2 Nankaido earthquake. Why shouldn't the crustal uplift and NE-compressive strain reported by Savage (1981) for western Washington be considered consistent with a similar preseismic deformation? How is the Juan de Fuca subduction zone any different from the subduction zone in the Nankai Trough and the subduction zone associated with the Rivera plate?

d) What is the magnitude of the largest shock in the plate or along the plate interface that could occur beneath the site without exceeding the SSE acceleration? Specify the attenuation and distance used in the discussion. Assign a confidence level to your magnitude estimate, or estimate a range of magnitudes and corresponding confidence levels.

230.2 (SRP 2.5.2.2, 2.5.2.4)

a) What is the magnitude of the maximum credible earthquake that could occur on the subduction zone beneath the WNP-3 site? This magnitude may be described by a range of values with associated probabilities and a best-estimate value.

b) Estimate response spectra at the site assuming the occurrence of the maximum subduction zone earthquake beneath the site, for both vertical and horizontal components of motion. Specify all assumptions about hypocentral depth and attenuation. The spectra should be calculated on a deterministic basis. If, in addition, probabilistic response spectra are presented, describe the treatment of uncertainty in the magnitude of the maximum earthquake, the attenuation relation, and the hypocentral depth. Justify the SSE spectrum in light of your deterministic (and probabilistic) results, for both vertical and horizontal ground motion.

230.3 (SRP 2.5.2.1, 2.5.2.3)

The depth and configuration of the subducting Juan de Fuca plate is critical to the calculation of the effect of the Benioff zone earthquake at the site.

a) Attention is called to FSAR Figure 2.5-31. No location errors are specified for most of the earthquakes plotted thereon, especially for those occurring in a region which projects to the southwest of Olympia on section AA' and particularly for depth of focus. Referring to Crosson (1972), Figure 6, the site and most of the area in which these earthquakes occur is off-scale and the location errors are likely to be large. Several factors influence the accuracy in depth of focus, most important of which is station coverage which changed greatly during the time interval covered. The applicant is therefore asked to provide a number of diagrams similar to Crosson's Figure 6 for periods which reflect significant changes in network coverage and showing error bars that indicate the accuracy of hypocentral locations.

b) Figure 2.5-36C shows seismicity (for example in the vicinity of Mt. St. Helens) that does not appear to have been plotted in the sections shown in Figure 2.5-31. Yet Figure 2.5-31 states that earthquakes within 150 km of a line striking N60°E through the site have been included on the section. Two questions arise: (1) what earthquakes (if any) have been omitted from the section (Figure 2.5-31), and (2) why is the aperture for the section so wide since a width of 300 km results in earthquakes in the Willamette depression being projected to points west of the site into what may be an entirely different tectonic province?

c) Expand your explanation of the decrease in seismicity on the sections through the site west of point B in Figure 2.5-31.

d) The geometry and location of the flexure in the subducting plate is assumed to be the western boundary to down-dip tension earthquakes. Therefore, its position is critical. Clarify your reasoning for locating the position of the flexure.

e) The Puget Sound earthquake of February 15, 1946, is a large earthquake with uncertain depth (Rasmussen, Millard, and Smith, 1974). If this event was relocated at a shallower depth or farther to the west, it may significantly alter the applicant's conclusions about the earthquake potential of the subduction interface or the overriding plate. The International Seismological Summary for 1946 (1954) lists over 40 observations for this earthquake. The observations range in distance from as close as Seattle to as far as Lome in the Ivory Coast. Despite the existance of these data, the applicant chose not to do a computer relocation (FSAR p. 2.5-120). We request that the applicant relocate this earthquake using the published I.S.C. data and establish the relationship of this earthquake to the Juan de Fuca-North American plate interface.

230.4 (SRP 2.5.2.3, 2.5.2.4)

a) Estimate the maximum magnitude possible for a "random earthquake" in the shallow crust within a 32-km radius around the site.

b) Inasmuch as the 17 March 1904 earthquake has not been associated with a structure at any of its various hypothetical locations (pp. 2.5-127, 128, FSAR), show why the size of this earthquake should not be considered the size of the "random earthquake."

c) With respect to the 17 March 1904 earthquake, provide all references not in the public sector for the intensities shown in Figure 2.5-90, as well as for any other locations for which information is available which could be used to assess intensity. Provide the documentation for the relocation of the earthquake to "south of Port Townsend" and the assignment of a smaller size (both attributed to the Pacific Science Center, Victoria, B.C., as "Milne, 1981, private communication: and "Rogers 1981, private communication").

d) Identify the maximum historical earthquake, not associated with known geologic structure, in the tectonic province of the site. Following Appendix A to 10CFR100, assume this earthquake can occur in the vicinity of the site, estimate the resulting ground motion, and assess the adequacy of the SSE spectrum for this occurrence.

230.6 (SRP 2.5.2.4, 2.5.2.6)

Estimate the annual exceedance probability for the SSE, using as sources random earthquakes, subduction zone earthquakes, as well as earthquakes on significant, capable linears. Show the relative contribution of these sources to the annual exceedance probability. If an integrated assessment of exceedance probabilities is performed, assigning subjective weights to different tectonic models, the exceedance probabilities for each model should be presented separately.

230.5 (SRP 2.5.2.4, 2.5.2.6)

Estimate site-specific spectra for a range of percentiles for the maximum earthquake on the Olympia Lineament, using strong-motion data in the appropriate magnitude and distance range. Justify the SSE spectra in light of the site-specific spectra.

References

Crosson, R.W., (1972). Small earthquakes, structure and tectonics of the Puget Sound region, Bull. Seism. Soc. Am., vol. 62, no. 5, pp. 1133-1171.

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Ruff, L., and Kanamori, H., (1980). Seismicity and the subduction process, Physics of the Earth and Planetary Interiors, vol. 23, pp. 240-252.

Savage, J. C., Lisowski, M., and Prescott, W. H., 1981, Geodetic strain measurements in Washington, J. Geoph. Res., vol. 86, pp. 4929-4940.

Geosciences Review Questions, WNP-3
Geology

231.1 Standard Review Plan (SRP) Sections 2.5.1.1, 2.5.3.1, 2.5.3.2 and 2.5.3.5

A major northwest-trending fault in the Humptulips River area (Tabor and Cady, 1978) projects northwestward under Quaternary deposits to an outcrop of steeply dipping Pleistocene deposits (op. cit) on the west Fork of the Humptulips River. The capability of this fault may be important to the site in light of the following. Offshore studies by Silver (1972) and Snavely and Wagner (1982) indicate a subduction tectonic style characterized by eastward (landward) dipping thrust faults that generally steepen westward (upwards) and that have offset sediments as young as Quaternary. Considering this structural framework, evaluate the possibility that the Humptulips fault, if capable, extends southeastward as a continuous fault or fault zone along the steepened west limb of the Wynoochee anticline (Rau, 1967) and on into the less well-defined Melbourne anticline (Gower and Pease, 1965) or alternatively to the southeast of these structures. Is the Humptulips fault throughgoing and capable? If so, evaluate the effects on the site. Vibroseis records along the Chehalis River might help evaluate the thrust fault hypothesis and reportedly have been obtained by AMOCO.

231.2 SRP Sections 2.5.1.1, 2.5.3.2 and 2.5.3.5

Assuming that a "....subduction tectonic style characterized by eastward dipping thrust faults that generally steepen westward (upwards)....", described in question 231.1 is correct for the site vicinity, would your conclusion regarding the non-capability of the "reverse" and "normal" faults remain the same? Would a thrust fault model allow the presence of undiscovered faults in the site vicinity? If thrust faults exist in the site vicinity what would be their effect on the site? Document and provide supporting bases for your responses.

231.3 SRP Sections 2.5.1-I and 2.5.1.2

Update the FSAR to include recent seismic reflection, remote sensing, and geophysical data that encompass the site area within a radius of about 25 miles. If any new suspect tectonic structures or lineaments of such size or proximity to the site are identified which would exceed the impact of the Olympia lineament on the site earthquake design basis, determine whether or not those features represent capable faults. Evaluate the impact on the site. Document and provide the bases for your responses.

231.4 SRP Sections 2.5.1-I and 2.5.1.2

Many of the natural drainage features in the site vicinity occur along projections of mapped faults although the faults are shown to terminate away from the stream valleys but along their trends. Also many drainages are oriented in a pattern that is parallel to to the NNW and NE striking fault pattern, yet the streams are not considered to be fault controlled by the applicant. Present the evidence that supports the conclusion that the drainage features are not fault controlled.

231.5 SRP Sections 2.5.1.1, 2.5.2.2, 2.5.3.1, 2.5.3.2 and 2.5.3.5

The applicant has dismissed offset magnetic anomalies KK and HH on the Juan de Fuca plate as probably due to episodic jumping of short transform faults connecting offset segments of the spreading ridge a la Hey 91977) (FSAR 2.5-44). Provided that successive jumps are in the same direction and occur after equal increments of spreading, the jumps should produce a V-shaped wake consisting of a pair of lineaments intersecting at the ridge. Although KK seems to form such a wake, mirrored in the Pacific plate, HH is less convincingly matched (c.f. Barr, 1974 and Elvers and others, 1973). Considering the difficulty of identifying the mirror image of HH, evaluate the hypothesis that HH is a fault as suggested by Pavoni (1966), and that the on-shore subcrustal extension of HH could be the source of deep-seated major earthquakes in the Puget Sound region (Fox, 1983). Evaluate the response at the site of a major earthquake on fault HH.

231.6 SRP Sections 2.5.1.1 & 2.5.1-IV

Provide the bases for reducing the assumed maximum downwind thickness of volcanic ash at the site from 6 inches to 1.75 inches as stated on FSAR page 2.5-81. What maximum thickness of tephra landfall, and what maximum rate of ashfall was used as the design basis for the WNP-3 plant.

231.7 SRP Sections 2.5.3.1, 2.5.3.5 and 2.5.2.2

Summarize the field geological, remote sensing, and geophysical data that have a bearing on the overall length and capability or non-capability of the Olympia lineament (including recent analyses by the U. S. Corps of Engineers Districts in Seattle and Portland).

References

Barr, S. M. 1974, Sea Mount formed near the crest of Juan de Fuca Ridge, NE Pacific Ocean; Marine Geology, vol. 17, pl-19.

Elvers, Douglas, Srivastava, S, P., Potter, Kenneth, Moorley, Joseph, Sdidel, Dean, 1973. A symetric spreading across the Juan de Fuca and Gorda rises as obtained from a detailed magnetic survey; Earth and Planetary Sciences Letters, vol. 20 p. 211-219.

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