STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 State Office Building, Portland, Oregon 97201

OPEN-FILE REPORT O-78-2

SUPPLEMENT TO THE FEBRUARY 11, 1974
PEBBLE SPRINGS REVIEW

By V. C. Newton, Jr. and N. V. Peterson
Edited by J. D. Beaulieu

Submitted to the Energy Facility
Siting Council on March 9, 1978
By Donald A. Hull, State Geologist

SUPPLEMENT TO FEBRUARY 11, 1974 - PEBBLE SPRINGS REVIEW

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Conclusions

Geologic investigations made since the DOGAMI submitted its conclusions on its first review of the proposed Pebble Springs nuclear site show no reason to change the present plant design. Design standards for the Pebble Springs plant are believed to be adequate for any unforeseen or predictable geologic event. However, the Department reserves the right to re-assess geologic hazards on a periodic basis as new data become available.

Several items concerning geology related to the Pebble Springs nuclear site have been raised since the Department submitted comments on its February 11, 1974 review.

1. The 1872 earthquake was the most prominent event brought to the attention of the NRC since our 1974 review. This is believed to be the largest historic earthquake in the northwest states, excluding Alaska. The question before us is what effect did this earthquake produce at the Pebble Springs location and what is the likelihood of another such event occurring closer to Pebble Springs?

2. The effect of explosive volcanic activity in the Cascade Mountains was discussed in our 1974 report to the Siting Council but since that time the U. S. Geological Survey and PGE consultants have conducted detailed investigations of some Cascade volcanoes. We

have reviewed these reports and have put forth our summary of the findings in this review.

3. On April 12, 1976 a magnitude 4.8 Richter earthquake occurred in the Deschutes Valley approximately 50 miles southwest of Pebble Springs. The report on this earthquake by Couch, et al, 1976, is summarized on the following pages.

4. Shannon & Wilson, Inc. consultants for Portland General Electric Company, also have made additional geologic studies subsequent to our 1974 report to the Siting Council in its Attachment No. 5 and these items have been reviewed as to their importance to the Pebble Springs site.

<u>1872 Northwest Earthquake</u>

The 1872 earthquake came to the attention of the NRC in 1974 during the documentation of the proposed Skagit nuclear plant site in northwestern Washington. Discussions of this significant earthquake were introduced into the Pebble Springs hearing in February 1976. The utility companies organized a Task Force of geological consultants consisting of N. A. Coombs, W. G. Milne, O. W. Nuttli, and D. B. Slemmons to prepare a summary report of the 1872 event.

The NRC organized an ad hoc working group of scientists to study the 1872 earthquake. Members of this group were from the U. S. Geological Survey and the National Oceanic and Atmospheric Administration. Seismologists on the ad hoc working committee were: S. T. Algermissen, R. J. Brazee, C. W. Stover and L. C. Pakiser.

Deciding in which tectonic regime the 1872 earthquake occurred was the subject of much discussion in at least three reports and debated at the October 27-28, 1977 NRC Conference held at the Portland Airport Rodeway Inn.

Discussions of the 1872 earthquake introduced plate tectonic theories to the NRC hearings. Stresses in crustal rocks believed to result from the relative motion of crustal plates along the northwest Pacific continental margin are now being considered in order to anticipate future seismicity.

Current deliberations on plate tectonics in the northwest region suggest that the Farallon plate (see Figure 1) is being thrust under the North American continent in a north-easterly direction at a rate of 4 cm per year. Thus, active subduction is believed to be causing stresses in crustal rocks of northwest Washington and southwest British Columbia. The greatest seismicity appears to be in the area seaward of Washington and British Columbia on the continental slope along the plate boundaries. Historic earthquakes are clustered around the Seattle onshore and Vancouver Island area but in a smaller number than offshore and at the onshore locations they are thought to be generated in the breaking up of the subducted Farallon plate.

Consultants for the utility companies and those for the NRC agree to a large degree that the intensity of this earthquake was between VIII and IX at the epicenter and that it's epicenter was located between Lake Chelan in north-central Washington and the area northward to southern British Columbia; the focal depth was between 60 and 70 km and that the magnitude was calculated to be between 7.0 and 7.5 Richter (providing the focal depth was greater than 40 km).

Evidence offered at the October 27-28, 1977 Portland meeting established reasonably well that the 1872 earthquake occurred along the eastern margin of the Northern Cascade tectonic province 170 miles from the site.

The Columbia Plateau was described as a separate distinct province from that of the Northern Cascades at the October, Portland meeting (see Figure 2). Therefore, since the 1872 earthquake has not been related to known surface faulting and the earthquake believed to have originated in the lower continental crust, we can assume that another such earthquake could occur on the margin of the Northern Cascade Province within 100 miles of Pebble Springs (see Figure 3).

This relocation of the 1872 earthquake would place Pebble Springs within the VI isoseismal if the 1872 earthquake is rated Intensity VIII and within the VII isoseismal if the earthquake is rated Intensity IX. In either case the maximum seismic design for the Pebble Springs plant is adequate.

Volcanic Hazard

Since our February 1974 review of geologic factors, more in-depth studies have been made by the U. S. Geological Survey and PGE consultants concerning volcanic hazards. More information has been collected on extent and thickness of ash falls from Cascade volcanoes and hypotheses developed on how future eruptions could affect a nuclear plant at Pebble Springs.

The hypothesis used by PGE consultants accepts the idea that volcanism develops in evolutionary stages with the latest stage being the most violent one. The late stage is also the one with the greatest variation in chemical composition of eruptive material. Mt. Mazama is the only volcano in the Cascades believed to have reached this late stage of development.

A Mt. Mazama (violent type) eruption is viewed as improbable at any of the other Cascade volcanoes based upon the evolutionary theory of volcano development. There is no record of a Mt. Mazama magnitude and late stage volcanic eruption anywhere else in the Cascade Range. Glacier Peak in north central Washington and Mt. St. Helens in southwestern Washington are believed by geologic researchers to hold the greatest probability of ash eruptions within the next 100 years or so. The potential for ash fall at Pebble Springs has been postulated using the theory that future eruptions will be similar to the latest events. Since Mt. St. Helens is the most likely volcano near Pebble Springs to erupt within the next 100 years, it is postulated that a future event will be similar to the one that occurred at Mt. St. Helens 3,600 years ago (Y_N ash layer). Also for added conservatism, the PGE consultants have assumed that the eruption would take place at Mt. Hood which is 26 miles closer to Pebble Springs than Mt. St. Helens.

Shannon & Wilson conjectured that with all factors at "worst case" conditions, a total uncompacted ash fall at Pebble Springs could be 8.5 inches at a rate of 0.5 inches per hour for 9 hours (a compacted thickness of 5.5 inches). This was their recommended design basis for the Pebble Springs plant. Conversations between the authors and Donald Mullineaux, U. S. Geologic Survey in Denver, confirm that no new data has become available on volcanism in the Cascades to require changes in PGE's latest design assumptions.

We believe the conclusions reached by Shannon & Wilson, the U. S. Geological Survey and the National Regulatory Commission are well documented and reasonable. The design recommended using "worst case" conditions for a St. Helens type layer Y_N eruption cited by Shannon & Wilson are conservative in our opinion.

Deschutes Valley Earthquake

The April 12, 1976 earthquake in Deschutes Valley approximately 50 miles

Southwest of Pebble Springs was studied in detail by Richard W. Couch and others, 1976. Measured magnitude was 4.8 Richter, Intensity VI. Felt effects at the Pebble Springs site were estimated to be Intensity III.

This is the largest historic earthquake recorded on the Oregon Columbia plateau west of the town of Umatilla. The Couch investigations determined that seismicity was probably related to thrust faulting similar to that along the crest of the Tygh Ridge anticline 24 miles northwest of the epicenter. Calculations by the seismologists placed the focal depth at approximately 15 km.

The earthquake occurred within the Columbia Plateau Province but it has not been identified with surface faulting. Thus a similar size earthquake could be assumed to occur within the Pebble Springs site area or on a known fault closest to the Pebble Springs site. The closest faulted structure is the Arlington-Shutler lineament which comes within 3 miles of the plant site. However, the fault is of the normal type and not a thrust fault.

Moving the epicenter of the April 12, 1976 Deschutes Valley earthquake to the site does not exceed the maximum earthquake design of the Pebble Springs plant. Seismic design of the main structures allows for an Intensity VII response at the site and a magnitude 6-7 Richter 55 miles from the site.

Mew Data Submitted

Portland General Electric Company submitted additional information relating to geology of the Pebble Springs site in Attachment 5. In this statement regional tectonics are described in the context of crustal plate movements. Tectonic provinces of Oregon and Washington are described in the attachment.

Additional investigations including trenching of the Wallula-Walla Walla fault zone are reported and no Holocene movement was detected along this fault. However, recent mapping by the U. S. Geological Survey (Personal Communication with D. A. Swanson, 1978) uncovered Holocene displacement in slope gravel and loess along a north-south trending fault exposed in a road cut near the town of Milton Freewater in northeastern Oregon. The vertical offset was estimated to be no more than one meter. The fault is located a few kilometers south of the Rattlesnake Hills - Walla Walla structural trend and along the northern boundary of the Blue Mountain physiographic province. The recent fault movement indicates that stresses are currently active in crustal rocks of the region.

This discovery of recent active fault movement does not require any adjustments in the design basis for the Pebble Springs plant since PGE consultants considered faults in the Wallula - Walla Walla area to be "capable" of continued movements. The length and displacement of the fault near Milton Freewater suggest that future seismicity will be of a magnitude considered in the site investigations.

A P P E N D I X

V. C. Newton
N. V. Peterson

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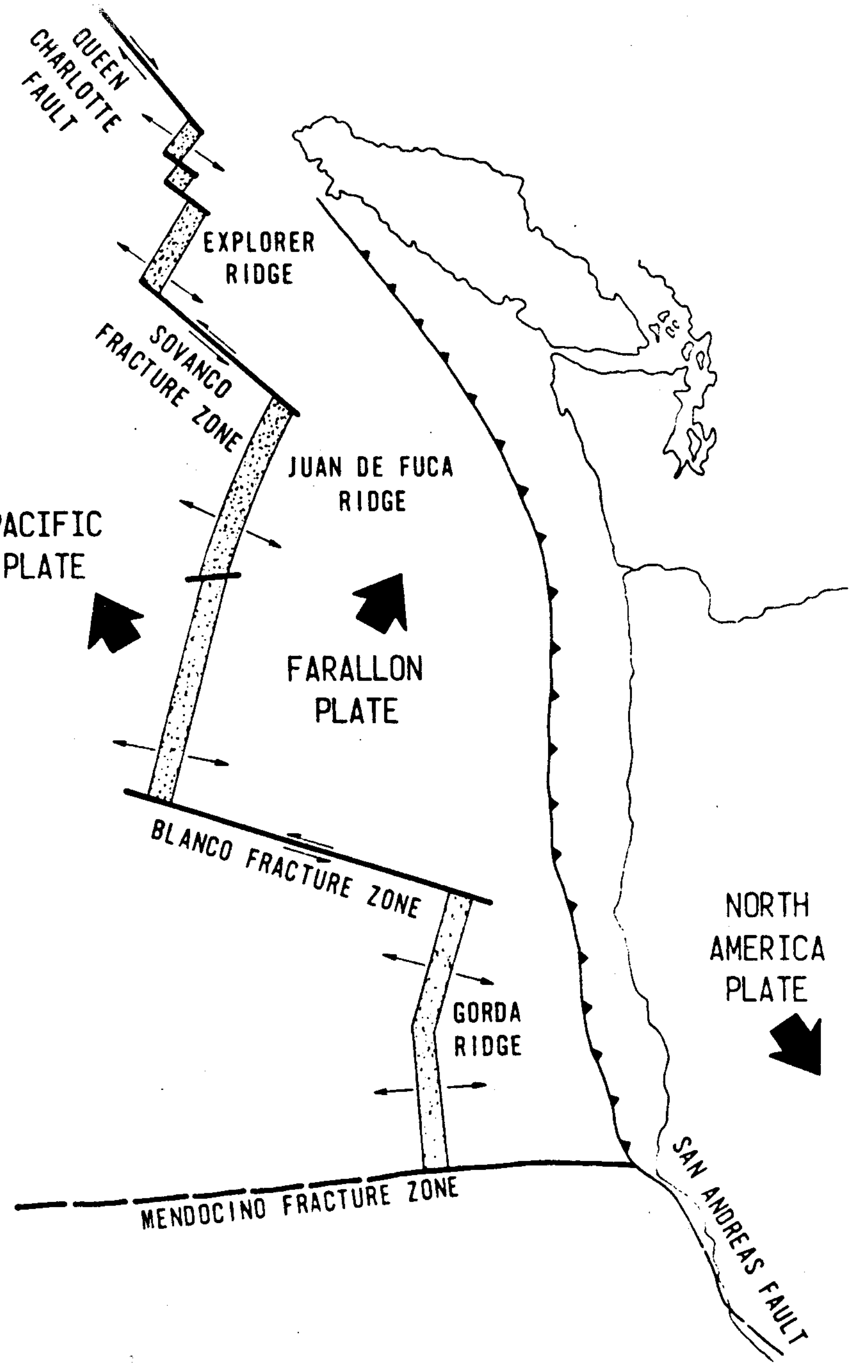


SEISMICITY AND TECTONICS
COLUMBIA PLATEAU
PEBBLE SPRINGS NUCLEAR PROJECT

RELATIVE MOTIONS
FARALLON. PACIFIC AND
NORTH AMERICA PLATES

NOVEMBER, 1977 | 0-805

SHANNON & WILSON, INC.
GEOTECHNICAL CONSULTANTS
PORTLAND, OREGON

FIG. 1

MAJOR PHYSIOGRAPHIC PROVINCES OF OREGON AND WASHINGTON

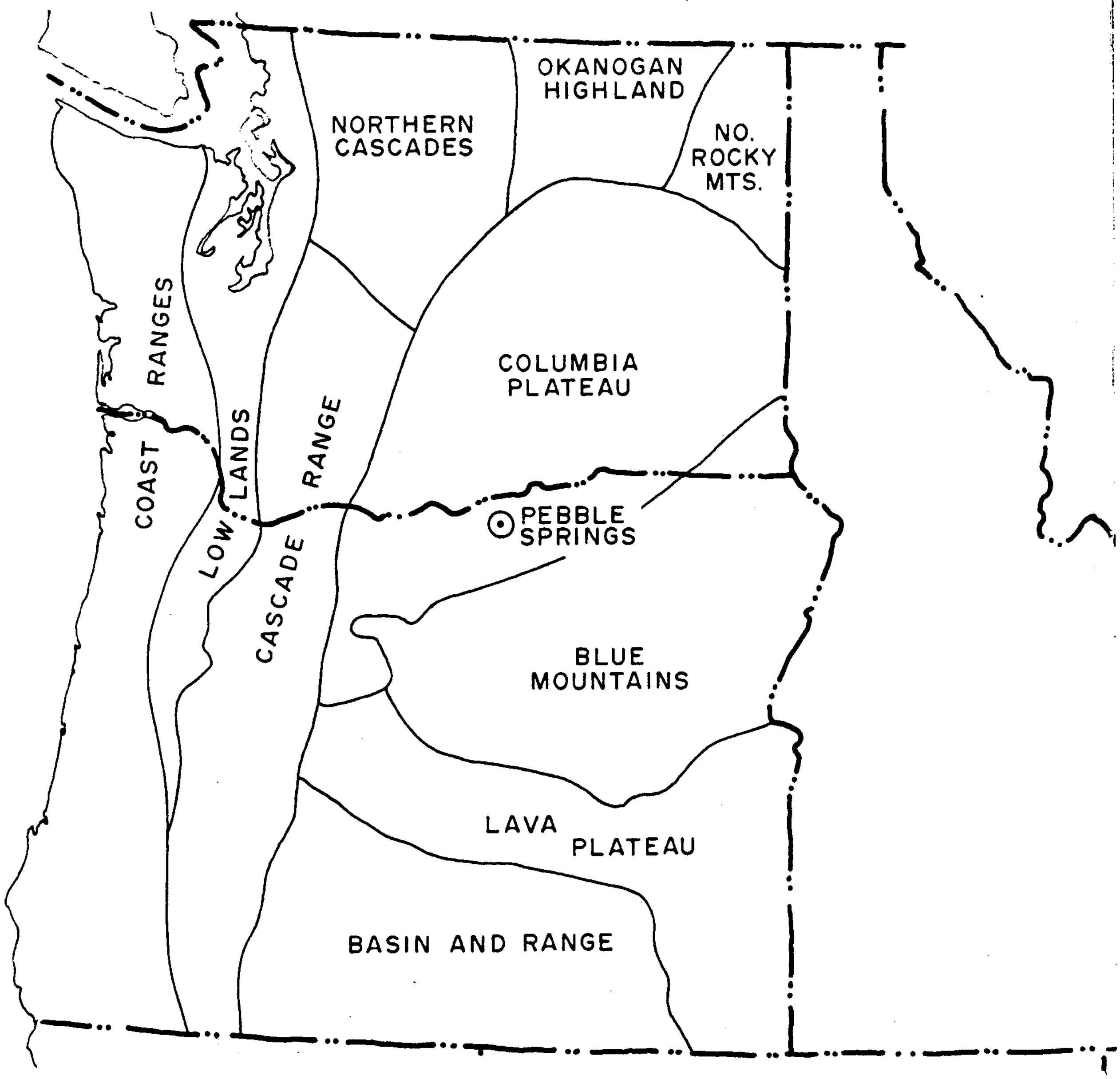
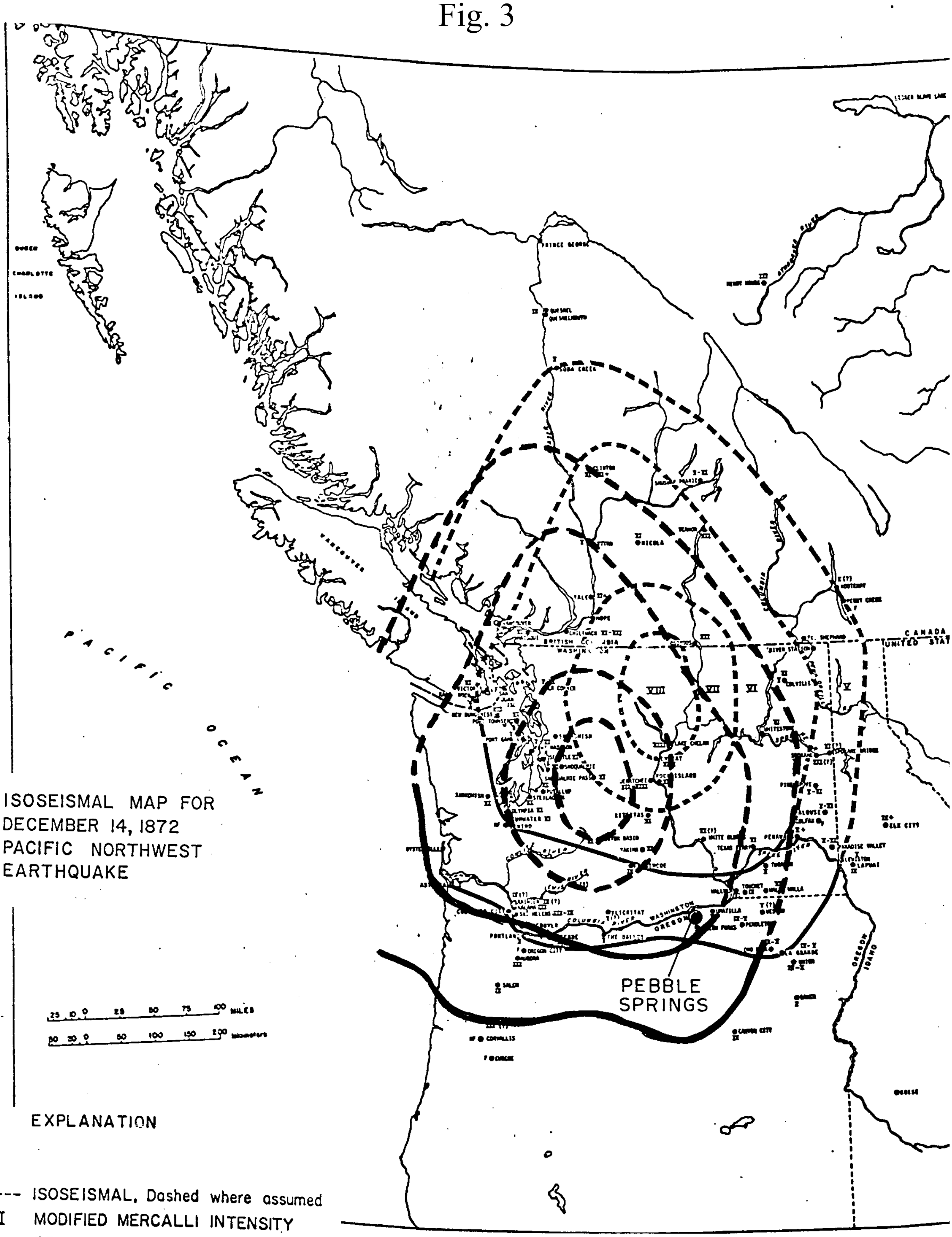


Fig. 2

Fig. 3



------ ISOSEISMAL, Dashed where assumed
VII MODIFIED MERCALLI INTENSITY
F FELT
NF NOT FELT

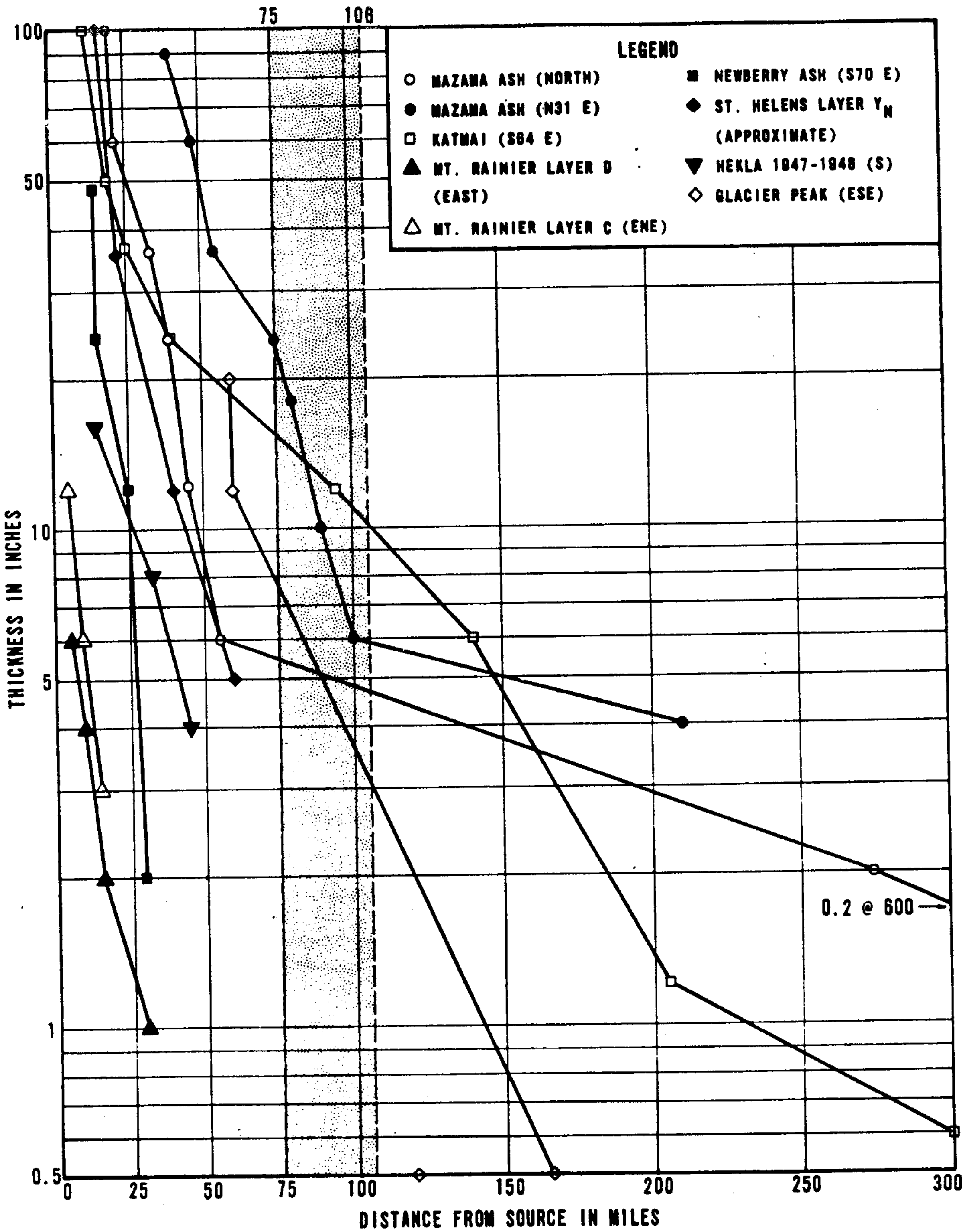


FIG.4 THICKNESS/DISTANCE RELATIONS OF VOLCANIC ASH FALL DEPOSITS

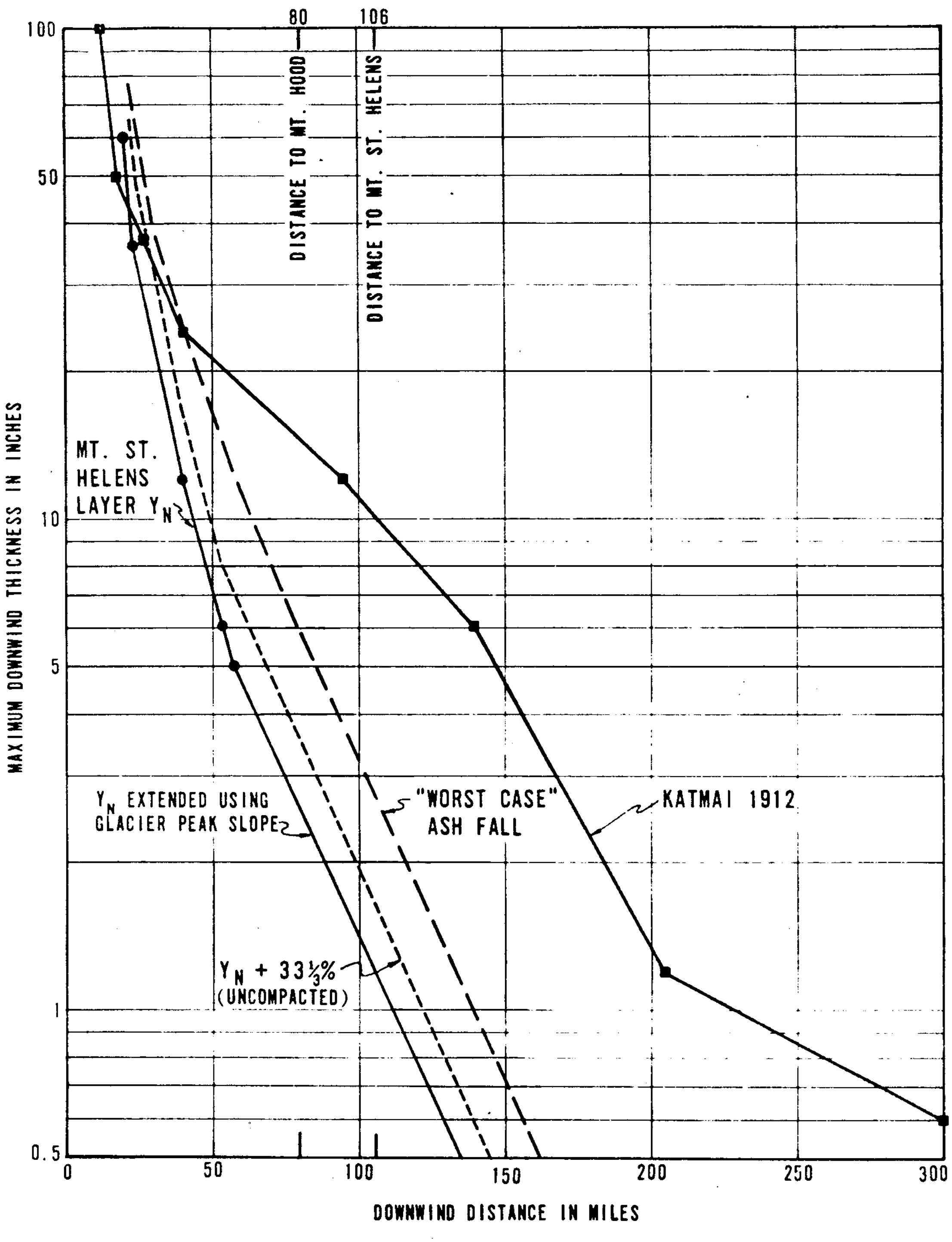


FIG. 5 POSTULATED "WORST CASE" ASH FALL - DISTANCE/THICKNESS

DEPARTMENT OF
GEOLOGY AND MINERAL INDUSTRIES

P. O. Box 417

521 N.E. "E" STREET • GRANTS PASS, OREGON • 97526 • Phone (503) 476-2496

ROBERT W. STRAUB
GOVERNOR

January 6, 1978

Vernon C. Newton
1069 State Office Building
Portland, Oregon 97201

Dear Vern:

As requested in a letter to Ralph from the Department of Energy, dated November 18, 1977, I have reviewed the pertinent references relating to "Volcanic" geologic hazards at the Pebble Springs project.

I have specifically studied the references to explosive volcanic activity and the potential for ash fall at the plant site. The volcanic hazard study by Shannon and Wilson for PGE is thorough and I consider their conclusions for a "worst case" ash fall accumulation of 6" at the plant site to be reasonable and conservative.

The design of the plant, assuming an ash fall accumulation rate at the site of $\frac{1}{2}$" per hour for 9 hours with a total of 8.5 inches, is certainly conservative and will be adequate to negate any geologic hazard that may exist from explosive volcanic activity.

If you need further information, let me know.

Sincerely,

Norman V. Peterson
District Geologist

NVP:rep

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

P. O. Box 417

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ROBERT W. STRAUB
GOVERNOR

February 2, 1978

Vernon C. Newton
Department of Geology
and Mineral Industries
1069 State Office Building
Portland, Oregon 97201

Dear Vern:

Before we submit our final report to DOE on the volcanic hazards at Pebble Springs we should review the latest Shannon & Wilson replies to questions raised by the USGS or NRC. I talked to Rick Kienle on the phone and he suggested that we get these from PGE. I understand that PGE has agreed to a design based on the USGS findings in their status review dated November 5, 1976. This would be a design based on an 8½" ashfall at the site.

I think in our report we talked about a 9½" ashfall and I am wondering where you got that number.

I did make calls to D. Crandall and D. Mullineaux to see if they had any further reservations or data. They said they felt the 8½" ashfall was a reasonable figure on which to base the design.

If you can't get the reports from PGE give me a call and we can talk it over.

Best regards

Norm

Norm Peterson

NVP:rep

PORTLAND GENERAL ELECTRIC COMPANY
121 S.W. SALMON STREET
PORTLAND, OREGON 97204

WILLIAM J. LINDBLAD
VICE PRESIDENT

July 1, 1977

Docket Nos. 50-514
50-515

Director of Nuclear Reactor Regulation
ATTN: Mr. Steven A. Varga, Chief
Light Water Reactors Branch 4
Division of Project Management
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Varga:

We have reviewed the NRC staff positions on our Pebble Springs Nuclear Plant CP application transmitted by your letter of May 26, 1977 concerning the Decay Heat Removal System (DHRS) and potential hazard of volcanic ash fall. Our response to these positions and documented resolution of remaining items which affect completion of the next SER supplement, is as follows:

(1) Geology, Seismology and Geotechnical Engineering (SER Section 2.5, Item 6 - The potential hazard of volcanic ash air fall to the site).

PGE will design the Plant for the following conditions:

a. The grain size distribution of the volcanic ash at the site will be in accordance with the data in Figure 10 of our Volcanic Hazard Study previously submitted to you.

b. A total of 8.5 in. of loose ash will be assumed to accumulate at the site within a 24 hr period based on a 35-percent compaction factor (i.e., a compacted ash thickness of 5.5 in.). The maximum assumed rate of ash fall will be 0.5 in. per hr for 9 hrs.

c. The acidity of the ultimate heat sink water and reservoir will be determined by using the 8.5 in. of accumulated ash in conjunction with Figure 11 of our Volcanic Hazard Study.

d. PGE will factor into plant design the drifting of volcanic ash at the site from high winds during and after the postulated volcanic eruption. PGE will also develop a contingency plan for mitigating the consequences of drifting volcanic ash.

Detailed plant design features, plant procedures, and bases necessary for detailed design, such as the physical and chemical characteristics of volcanic ash, are under development and will be submitted for NRC review prior to or during Operating License review.

(2) Decay Heat Removal System (SER Section 7.4.1).

The basic NRC regulatory position on system isolation, as provided in Section A of Enclosure 1 to the NRC letter of February 4, 1976, requires a high degree of assurance that the low-pressure DHRS be isolated from high pressure in the Reactor Coolant System (RCS). The Pebble Springs DHRS overpressure protection design meets the intent of this position and is identical to the WPPSS 1 & 4 design, which has been previously accepted by the NRC, and B-SAR-205 and Greene County designs which are in latter stages of NRC review.

The DHRS is isolated from the RCS by two 480-V a-c motor-operated valves in series. The valve positions are indicated in the control room. The valves have independent diverse interlocks to prevent the valves from being opened unless the RCS pressure is below the DHRS design pressure. Failure of a power supply does not cause any valve to change position. The valves also have independent diverse interlocks to provide power actuation to automatically close each valve if the pressure in the RCS approaches the design pressure of the DHRS. These design features are in accordance with Section C of Enclosure 1 to the NRC letter of February 4, 1976.

Both series motor-operated valves in each suction line are supplied power from the same load group. This power supply arrangement precludes the valves from closing automatically given a single failure of an a-c power supply with the DHRS operating in its normal decay heat removal mode. PGE therefore agrees with the NRC statement that "the system cannot isolate automatically given a single failure in any one of the power trains". However, PGE does not agree with the NRC's

May 26, 1977 position that "the single-failure criterion must be satisfied for the isolation function". The criterion basic to this issue is not failure of the system to isolate automatically given an assumed single failure but rather loss of capability of the system to perform its safety function given an assumed single failure. PGE's position is that the single-failure criterion, as applied and implemented in the design of the DHRS, is fully met at the system level where the safety function is performed.

Relief valves are provided in both DHR suction lines inside Containment downstream of the second isolation valve from the RCS. These valves provide overpressure protection of the DHRS from component failures or operator errors during plant cooldown or heatup with the DHRS in operation and the DHR suction line isolation valves failed in an open position. These relief valves are sized to relieve the fastest rate of pressure increase anticipated to reach the DHRS design pressure. The capacity of the relief valves is specified for the worst transient or incident that could overpressurize the DHRS. Each valve is designed to Seismic Category I and ASME Section III, Class 2 requirements. The design basis sizing for the DHR suction line relief valves, including a transient pressure analysis of the RCS, is discussed in PSAR Section 9.3.5.4.1.4.

We are confident that the DHRS design fully meets the requirements of General Design Criteria 19 and 34 of Appendix A to 10 CFR 50, those of Appendix K to 10 CFR 50, and those of the NRC regulatory positions transmitted in the letter of February 4, 1976.

(3) Main Steam and Feedwater Line Isolation (SER Sections 7.3.8 and 7.3.9).

Redundant signals, corresponding to Channels A and B, are provided from the ESFAS to (a) trip the main turbine-generator unit, (b) trip each turbine-driven main feedwater pump, and (c) close each main feedwater control valve and bypass control valve in the feedwater lines upstream of the main feedwater isolation valves. The trip signals are buffered, non-Class IE signals isolated from Class IE portions of the ESFAS by isolation devices which meet the requirements of Regulatory Guide 1.75. This interface is accomplished within the main control room area.

(4) Ice Flooding (SER Section 2.4.5)

The Seismic Category I spray pond will be supplied with heated service water during freezing weather (during power operation) to prevent ice formation. The spray network piping and risers both above and below the pond surface will be kept drained in freezing weather. The deicing lines, which bypass the spray network, will be located below the pond surface and below the frost line. This commitment replaces our earlier SER review comment (which stated plans to not incorporate means for spray pond deicing) transmitted in an April 9, 1976 letter from J. L. Williams to J. F. Stolz.

(5) Containment Monitoring System (SER Section 7.3.10)

We have responded to your April 15, 1977 letter, which requested that PGE provide a detailed evaluation of the potential consequences of a refueling accident inside the Containment, via our recent transmittal of June 28, 1977. The results of PGE's evaluation confirm the conclusions of the NRC's preliminary review that the potential site boundary radiation exposures due to a fuel handling accident inside Containment are well within the exposure guidelines of 10 CFR 100 even assuming no isolation of Containment. Therefore, there remains no safety requirement to isolate Containment by closing the supply and exhaust dampers whenever Containment radiation exceeds a certain level.

We consider Items 1 through 5 to completely resolve the NRC concerns related to these issues at the CP stage of licensing. Please use the commitments of this letter in preparation of an SER supplement allowing completion of ACRS review for the CP stage of licensing. If you know of other areas of NRC review (site suitability or safety review) which require further PGE input prior to LWA and CP issuance, please inform us immediately.

Sincerely,

W. J. Lindblad
Vice President
Engineering-Construction

WJL/JWL/DRS/nky

c: Dr. Fred D. Miller, Director
Oregon Department of Energy

J. L. Frewing

S. R. Christensen

D. J. Broehl

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

May 26, 1977

Docket Nos. 50-414
50-415

RECEIVED
JUN - 1977
Vice President

Portland General Electric Company
ATTN: Mr. William J. Lindblad
Vice President
621 Southwest Alder Street
Portland, Oregon 97205

Gentlemen:

SUBJECT: UNRESOLVED PEBBLE SPRINGS ISSUES

The Pebble Springs Safety Evaluation Report, including Supplement 1 and 2, identified outstanding issues and staff positions in Sections 1.8 and 1.9 respectively. These issues have been resolved to our satisfaction with the exception of the decay heat removal system and the potential hazard of volcanic ash fall. Enclosed are staff positions with regard to the two unresolved items.

Your comments are requested as soon as possible.

Sincerely,

Steven A. Varga, Chief
Light Water Reactors Branch 4
Division of Project Management

Enclosure:
As stated

ccs:
Listed on following page

Copies to: Messrs. Williams, Goodwin, Broehl, Grund, Heider, Yundt, Christensen, Starner, Frewing (ACTION), Sullivan, Gaidos, Morris (Bechtel), Ward (B&W), Weislogel (PP&L), Jacobsen (PSP&L), Reading File, PS File

ENCLOSURE

2.5 Geology, Seismology and Geotechnical Engineering
(Item 6 - Potential Hazard of Volcanic Ash Fall)

The SER, published in January 1976, stated that the design basis is unresolved for volcanic ash fall at the site.

The applicant reevaluated the potential ash fall at the site and presented the results of the study in a report, "Volcanic Hazard Study (VHS) - Potential for Volcanic Ash Fall at Pebble Springs Nuclear Plant Site" (Revision 1, May 17, 1976). Based on our review and that of the USGC, it is our position that the applicant must design the plant for the following condition: -

1. Grain size distribution of the volcanic ash at the site shall be modeled in accordance with the data dn Figure 10 of the UHS report.
2. Rate of ash fall shall be modeled generally in accordance with the 1912 Katmar eruption, assuming a maximum rate of 0.5 inches per hour for 9 hours, and a total accumulation of 8.5 inches of fresh loose ash. The Katmai eruption averaged about 0.44 inches per hour for approximately 9 hours. We have determined that a maximum rate of 0.5 inches per hour is a reasonable, conservative rate for design purposes. The maximum ash fall is based on Mulleneaux's recent work at Mt. St. Helens on the Yn layer in which he measured 8.0 inches, 62 miles along the axial trace of the plume; and 2.0 inches, 174 miles along the near axial trace. When this data are applied to Figure 13 of the VHS report and the upper bound curve reconstructed, the total compacted thickness at the site is about 5.5 inches.

Applying a 35% compaction factor, as recommended by USGS, a total of 8.5 inches of loose ash would accumulate at the Pebble Springs site.

3. Acidity of the ultimate heat sink water and reservoir is to be determined by using the 8.5 inches of accumulated ash in conjunction with Figure 11 of the VHS report.

4. Substantial drifting of volcanic ash fall at the site can occur from high winds during and after the postulated volcanic eruption. Consequently, steps must be taken to protect safety-related equipment and structures for this possibility. The applicant is required to factor this matter in the plant design and to develop a contingency plan for mitigating the consequences of drifting volcanic ash.

We will review the plant design and appropriate procedures prior to the issuance of an operating license for this facility to assure full compliance.

7.4.1 Decay Heat Removal System

The staff has reviewed the applicant's latest response in PSAR Amendment No. 9, Appendix 6A, Part IV. The decay heat removal system suction valve interlock protects the low pressure decay heat removal system from excessive pressure when the reactor coolant system pressure exceeds 675 psig. There are a total of four valves, two in series in each of the two suction lines. The two valves at upstream are interlocked by RCS pressure from ESFAS channels A and B, and the rmeaining two valves are interlocked by pressurizer pressure from channels A and B.

Though redundance and diversity are incorporated into this design, the design does not meet the single failure criterion because of power supply assignment to valve motor operators. The two series motor-operated valves on one line are supplied 480-V power from Load Group I while the series valves on the other line are supplied power from Load Group II. With this configuration, the system cannot isolate automatically given a single failure in any one of the power trains. Our position is that the single failure criterion must be satisfied for the isolation function.