S.H 254
PDR

PGE Portland General Electric Company

Charles Goodwin, Jr. Assistant Vice President

September 15, 1980

Trojan Nuclear Plant
Docket 50-344
License NPF-1

Mr. Thomas M. Novak
Assistant Director for Operating Reactors
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Novak:

Your letter of July 25, 1980 requested additional information regarding the recent volcanic activity at Mt. St. Helens and its relation to the Trojan Nuclear Plant. The attached information is submitted in response to this request.

The information in the attachment responds to NRC Questions 361.1, 2 and 3 in the enclosure of your letter. Responses to the remaining three NRC questions (Nos. 361.4, 5 and 6) are still under evaluation. Due to the broad scope of these NRC questions, the remaining information will not be submitted until October 15, 1980.

Sincerely,

For
C. Goodwin, Jr.
Assistant Vice President
Thermal Plant Operation and Maintenance

CG/GAZ/KM/sa/41m8B29
Attachment

c: Mr. Lynn Frank, Director
State of Oregon
Department of Energy

Mr. Robert A. Clark, Chief
Operating Reactors Branch No. 3
Division of Licensing
U. S. Nuclear Regulatory Commission

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ADDITIONAL INFORMATION IN RESPONSE TO NRC
REQUEST REGARDING ERUPTION OF MT. ST. HELENS

TROJAN NUCLEAR PLANT
PORTLAND GENERAL ELECTRIC CO.
DOCKET NO. 50-344

Question 361.1 Since Mount St. Helens volcanism may continue for an indefinite time period describe, based upon the post-March 1980 volcanic activity, the volcano-related phenomena that have affected the Trojan Nuclear Plant. Describe and assess the effect of each of these phenomena on the Trojan Nuclear Plant. Address as a minimum in your response the following: (1) tephra thickness and accummulation rates, and (2) mudflows, pyroclastic flows, and debris flows and (3) lateral blast. With respect to (2) above provide volume estimates (mudflows and debris flows) based on recent events in the Toutle River and Swift Creek-Muddy River areas.

Response:

Since March 27, 1980, volcanic eruptions, of varying intensity, have occurred on April 1, May 18, May 25, June 12, July 22, August 7 and August 15. Coincident with these eruptions, the following tephra amounts have been observed at the Trojan Nuclear Plant:

Date of Eruption	Ashfall at Trojan
April 1 (phreatic)	Trace
May 18	None
May 25	<3 mm (1/8 in.)
June 12	Trace
July 22	None
August 7	None
August 15	None

The accumulation rate for the only measurable ashfall at Trojan (that of May 25) was approximately 1 mm/hr (.04 in./hr).

These tephra falls have had minimal impact on the Trojan Nuclear Plant, causing only slight accumulations of ash on exterior surfaces.

Pyroclastic flows and associated ash clouds did not affect the Trojan Nuclear Plant. Similarly, mudflows and debris flows did not present a hazard to the Plant, advancing 30 km (18-1/2 river miles) west-northwest down the Toutle River Valley, a distance of approximately 100 km (62 river miles) from Trojan. The volume of these mudflows and debris flows are estimated at about 156×10^6 m^3 (205×10^6 yd^3). Smaller mudflows advanced into the Pine-Muddy Creek River areas, totaling 3.1×10^6 m^3 (4×10^6 yd^3).

Mudflow-induced floods and debris-laden waters with bulk densities as high as 2.17 g/cm^3 (.78 $lb/in.^3$) at Castle Rock, Washington, on May 18 at 20:45 PDT deposited approximately 61×10^6 m^3 (80×10^6 yd^3) of sediment downstream from the Toutle River at the confluence with the Cowlitz River. About 42×10^6 m^3 (55×10^6 yd^3) of sediment and debris are estimated to have filled channels in the Columbia River. Fluvial silts, muds and unsorted debris were deposited by the mudflow floods. Soundings performed by the Corps of Engineers on May 24 showed that the river channel in front of the Trojan Nuclear Plant was partially infilled, with a maximum deposition of 12 meters (40 ft). This deposition of material did not affect the intake structure and was confined to the deeper parts of the river channel.

As shown in Plate 1, the devastation zone consists of an area of about 500 km^2 (193 $miles^2$) which was affected to differing degrees by the events of May 18. Areas most severely affected by the debris avalanches and pyroclastic flows were confined to the northern flanks of the volcano and a 17-mile reach of the upper North Toutle River. The maximum thickness of these deposits was 600 ft (183 m) near Spirit Lake; average thicknesses was 200 ft (61 m). Other areas affected were drainages buried or scoured by mudflows which partly mixed with the existing debris avalanches. Major mudflows occurred in the upper reaches of the North Toutle and South Toutle Rivers. The mixture of relatively cool debris and hot pyroclastic material apparently formed a fluidized system of intermediate temperature. This is similar to the ash hurricane described by Taylor (1951), which occurred at Mt. Lamington. Most of this area was not deeply buried - tree stumps and downed trunks stand above the ash hurricane deposits. The pattern of directions in which the downed trees now lie reveals the direction from which the ash hurricane travelled. Vectors for flow of these turbulent clouds are shown in Plate 1. They reveal that the flow was strongly controlled by gravity and topography - the flows followed drainages and passed around highs.

Beyond the deforested area lies a scorched zone varying in width from a few hundred feet to over a mile. The extent of this zone is also related to topography (Plate 1). The greatest extent is in relatively flat areas and in drainages where the hot flow could spread out. These scorch zones border tree-blowdown areas north and east of Mt. St. Helens and are characterized by partially defoliated standing trees, contrasting sharply with nearly unaffected timber.

Reports of fatalities and injuries show that they were confined to the area within a 32 km (20-mile) arc north of the volcano.

The Trojan Nuclear Plant has not been affected by these volcanic associated events. There has been no loss of offsite power, no loss of cooling water supplies, no flooding onsite and no facility or equipment damage attributable to eruptions at Mt. St. Helens.

Question 361.2 Discuss the potential for an eruption, similar to the May 18, 1980 event, occurring on the west-southwest flank of Mount St. Helens and directed toward the Trojan Nuclear Plant. If such an event were to occur how would it effect the plant? Include in your response as a minimum, the following phenomena: tephra, air blast, pyroclastic flows, mudflows, and debris flows.

Response

The potential for an eruption in the near future similar to the May 18 eruption, but directed to the west-southwest, is extremely small. First, products of future eruptions would be largely directed to the north by the shape of the existing crater. Second, most of the summit and the pre-May 18 bulging north flank was removed during the May 18 eruption, thus little material is available to supply or drive a devastating debris avalanche and another major eruption such as occurred on May 18. Third, repose intervals of Mt. St. Helens between violent eruptive sequences have generally exceeded 100 yr and are not known to be less than 50 yr for lesser eruptions; however, should a west-southwest eruption occur with winds unfavorable to the Trojan Nuclear Plant, the following might be anticipated:

Ashfall

In the event of a tephra eruption similar to May 18, but directed west-southwest with winds from east-northeast, a maximum ash thickness resulting from air fall and lateral ash clouds would be about 4.5 cm (1.8 in.) at 56 km (35 miles) downwind of Mt. St. Helens. Reported times of heaviest ashfall near Packwood, Washington, on May 18, about 34 air miles northeast from the volcano, suggest a rate of accumulation of 1.3 cm/hr (.51 in./hr).

An impending ashfall at the Plant (irrespective of volume) would activate an Administrative Order. Preparations for cleanup and maintenance of necessary systems would be implemented.

An ashfall at the Plant similar to the above is considered extremely remote due to prevailing winds. An analysis was made of upper air wind data from the two radiosonde stations closest to Mt. St. Helens [Salem, Oregon (1958-1978) and Quillayute, Washington (1968-1978)]. These results showed that approximately 1 percent of the time the winds aloft at all measured elevations (500, 400, 300, 200 mb) have a common direction towards Trojan in the sector of 33-100 degrees. Conversely, approximately 25 percent of the time the winds are in a common direction toward the plume travel of the May 18 eruption (taken as 191-259 degrees). This dispersion effect of easterly winds explains the isopach pattern of the May 25 and June 12 eruptions.

Air Blast, Debris Avalanche and Pyroclastic Flows

Investigations, subsequent to the May 18 eruption, show that effects of the "blast" are best explained as the result of a massive debris avalanche which was overtaken by, and mixed with, a large pyroclastic flow. These events formed a turbulent, violent, ash hurricane which created the effects shown in Plate 1. An important observation is the lack of a vertical plume for at least the first few minutes of the eruption. An explosion of gas-charged magma would have erupted both vertically and laterally. Absence of a vertical column implies a lack of energy adequate to expel material with ballistic velocity. Thus, the energy which propelled the ash hurricane was sequentially limited to: 1) the kinetic energy developed as the avalanche accelerated down the north flank; 2) the thermal energy in the lithic debris erupted; and 3) the kinetic energy added as the hot avalanche of lithic debris accelerated down the north slope over the debris from the bulge. Because no juvenile material was contained in the initially-erupted tephra, the thermal energy involved was simply the product of the heat capacity and temperature of the debris and of the gases which drove the material out of the crater. Thus, a major portion of the energy was kinetic and distribution of the energy and direction of flow was controlled by the shape of the volcano's north flank immediately after the avalanche.

Without the additional kinetic energy provided by gravitational collapse of the bulge, the ash hurricane would have been restricted in its extent, as were the pyroclastic flows of gas-charged juvenile tephra which occurred later in the day of May 18 and during the eruptions of June 12 and July 22. Thus, a repeat of the initial eruptive event of May 18 would also require a large input of kinetic energy. It is very doubtful that such a contribution of kinetic energy could occur at present. First, the old summit area of the volcano is already gone and is thus not available to contribute mass or potential energy to an avalanche. The remnants of the summit only rise to about 8400 ft above MSL, some 1200 ft lower than before May 18. Second, if collapse of one of the remaining flanks of the volcano occurred, most of the collapse would likely be into the nearly vertical-sided crater, rather than onto the gentle lower slopes. Finally, if, through some highly unlikely circumstance, collapse of one of the flanks did occur on the lower slopes, the contribution of kinetic energy would be much lower than on May 18 because of the lesser amount of mass available and the lower summit elevation. Such a hypothetical event, given the present geometry of the volcano, would produce a debris avalanche significantly smaller than that of the May 18 eruption.

Plate 2 shows the potential limit of destruction should a May 18 style eruption occur to the southwest. This model accounts for the present configuration and down slope topographic features. Beyond this destruction zone would be a scorched zone varying from a few hundred feet to over a mile. The extent of this zone would also be related to topography. Such an event would, of course, be devastating to areas immediately downhill. However, because of the lesser energy and mass available, the effects away from the immediate flanks of the volcano would be much less than those which occurred on May 18 and would thus not have an effect on the Trojan Nuclear Plant.

Mudflow - Flooding

Plate 2 shows the potential extent of mudflows and flooding in the Lewis River and Kalama River drainages due to a southwest directed eruption.

Subsequent to the eruption on May 18, the Northwest River Forecast Center of the National Weather Service performed a failure analysis of Swift Dam using their Dam Break and Wave models. The analysis further contemplated subsequent failure of Yale and Merwin Dams. The flood wave generated by this scenario would reach Woodland, Washington, in about 1 hr and inundate areas to a height of 35-40 ft MSL. This model further predicts this wave to reach Rainier, Oregon, in approximately 3 hr with a peak elevation of less than 30 ft MSL. A similar analysis performed by Foundation Sciences, Inc. of the Kalama River shows that a mudflow generated flood would cause a 7-ft wave at its confluence with the Columbia. Neither of these flood waves would reach design flood elevation of the Trojan Nuclear Plant.

The Corps of Engineers has estimated that 55 X 10^6 cubic yards of material was deposited in the Columbia River on the 18th of May. Estimates by Foundation Sciences Inc., of debris production for a postulated southwest directed eruption, is for an additional 23 X 10^6 cubic yards of material to reach the Columbia River via the Lewis River drainage and 5 X 10^6 cubic yards via the Kalama River drainage. This additional material is estimated to cause a maximum layer of deposition of 25 ft. at the mouth of the Lewis River and 12 ft. at the mouth of the Kalama River. The deposition from the Lewis River would extend downstream from the Lewis River for about 5 miles, and thus would not affect Trojan which is about 11 miles downstream. Since the post-May 18th channel in front of the Trojan intake structure has a minimum bottom elevation of -35 MSL, the additional deposition from the Kalama River would not reach the intake structure elevation of -10 MSL.

Question 361.3 Based upon information directly obtained by PGE or reported by others as a result of the current volcanic activity, provide a map showing the distribution and cumulative thickness of ashfall within a 40 mile radius of Mount St. Helens. Provide separate maps depicting the ash distribution and thickness of the ashfalls of the May 18, May 25 and June 12 events within the same radius. Describe the effect, including thickness and duration of fallout of each of these ashfall events (or any intermediate events) at the Trojan Nuclear Plant.

Response

The distribution and cumulative thickness of ashfall within a 40-mile radius of Mt. St. Helens is given in Figure 1. Figures 2, 3 and 4 provide the 40-mile radius distribution and thickness of the ashfalls of the May 18, May 25 and June 12 respective eruptions.

The May 18 eruption was not detected at the Trojan site as its plume was directed from Mt. St. Helens to the northeast.

The June 12 eruption, as well as that of April 1, was barely detectable at Trojan with only a trace (or dusting) of deposition. There was no effect on Trojan from either of these eruptions.

The May 25 eruption deposited less than 3 mm (1/8 in.) of ash over a 3- or 4-hr duration. Since it was raining concurrent with the ashfall, the period of deposition is approximate since objective observations of when the rain contained ash is not that precise. As previously stated, this deposition had minimal impact on the Trojan Nuclear Plant, causing only slight accumulations on exterior surfaces.