Portland General Electric Company

Stephen M. Quennoz
Trojan Site Executive

June 18, 1997

VPN-048-97

Trojan Nuclear Plant
Docket 50-344, 72-017
License NPF-1

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Response to NRC Request for Additional Information - Reactor Vessel Package

This letter transmits the PGE response to the NRC request for additional information dated May 19, 1997. Although the licensing action related to the PGE Safety Analysis Report for the Reactor Vessel Package is primarily a transportation issue, pursuant to 10 CFR 71, this response is being provided on both the Trojan Part 50 and 72 Dockets for information.

The PGE response to the NRC questions is packaged in the following four Attachments.

- Attachment I provides a restatement of the NRC questions, followed by the PGE response.
- Attachment II provides Calculation RPC 97-018 which is referred to in the response to Questions 1 and 2.
- Attachment III contains the US Ecology letters to the State of Washington.
- Attachment IV is the State of Washington letter documenting the results of the Department of Health, Division of Radiation Protection review of the US Ecology information.

In accordance with the NRC instructions in the May 19, 1997 letter, this response includes the requested executed oath or affirmation.

A001/1

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503/556-3713

If there are any questions related to the response to these NRC requests for additional information, please contact Mr. H. R. Pate, at (503) 556-7480.

Sincerely,

C P Yundt for

Stephen M. Quennoz
Trojan Site Executive

Attachments

c: L. H. Thonus, NRC, NRR
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STATE OF OREGON,)
)
)
COUNTY OF COLUMBIA)

I, C. P. Yundt, being duly sworn, subscribe to and say that I am the General Manager Plant Support and Technical Functions for Portland General Electric Company, the licensee herein; that I have full authority to execute this oath; that I have reviewed the foregoing; and that to the best of my knowledge, information, and belief the statements made in it are true.

Date June 18, 1997

C P Yundt

C. P. Yundt,
General Manager Plant Support and Technical Functions
Portland General Electric Company

On this day personally appeared before me, C. P. Yundt; to me known to be the individual who executed the foregoing instrument, and acknowledged that he signed the same as his free act.

GIVEN under my hand and seal this 18th day of June, 1997.

OFFICIAL SEAL
PAT SCHAFFRAN
NOTARY PUBLIC-OREGON
COMMISSION NO. 045755
MY COMMISSION EXPIRES JULY 27 1999

Pat Schaffran
Notary Public in and for the
State of Oregon

Residing at Clatskanie
My commission expires 7/27/99

ATTACHMENT I

PGE Response to NRC Request for Additional Information
Safety Analysis Report for Reactor Vessel Package

NRC QUESTION:

1. Provide the basis for the statement that the reactor vessel internals comprise 340 cubic feet of Greater Than Class C Waste. This statement originally appeared in your submittal dated January 30, 1997 entitled "Reactor Vessel and Internals Removal Plan". Specifically, identify the internals in the reactor vessel, the displaced volumes of each internal component, the radionuclide activities for each component, and describe how the radionuclide activities were calculated.

PGE RESPONSE:

The Trojan Nuclear Plant Decommissioning Plan (PGE-1061), Section 2.2.7 DECOMMISSIONING RADIOACTIVE WASTE PROJECTIONS, indicates that 340 ft^3 of greater than Class C radioactive waste from the reactor vessel internals is included in the conservative estimates of waste volume projections. Also, Table 2.2-4 of PGE-1061 includes the 340 ft^3 of greater than Class C waste for the reactor vessel internals. In estimating the volume of greater than Class C waste for the reactor vessel internals, it was assumed that the internals would be segmented and packaged for disposal with the high-level spent nuclear fuel. The estimated volume (340 ft^3) is calculated based on the gross container volume to be shipped and buried, and is therefore, greater than the actual segmented volume of the GTCC material in the internals (approximately 92 ft^3).

The following sub-components comprise the reactor vessel internals:

- Core Baffle - The core baffle consists of a series of axial plates which are attached to the core barrel by the core formers. The core baffle assembly provides lateral support for the fuel assemblies on the core periphery, as well as serving as a flow baffle by directing cooling water up through the core region and limiting bypass flow. The baffle consists of rectangular plates 1.125 inches thick, 154.94 inches long and of varying widths. The core baffle plates weigh a total of 26,644 pounds. The core baffle plates are Type 304 stainless steel with a density of 500 pounds per cubic foot. Therefore the volume of the core baffle is approximately 53.3 ft^3. The core baffle, if segmented, would be classified as greater than Class C waste.

- Core Formers - The core formers are basically structural support members, providing the form for the core baffle plates and attaching these plates to the core barrel. Core formers are located at several different elevations along the longitudinal axis of the reactor core. At each of eight elevations, the formers consist of four units, for a total of thirty-two

pieces. The formers weigh a total of 12,740 pounds. The core formers are Type 304 stainless steel. The volume of the core formers is approximately 25.5 ft^3. The core formers, if segmented, would be classified as greater than Class C waste.

- Core Barrel - The core barrel consists of two major sections, the upper and lower core barrels. The barrel is a right circular cylinder with a nominal inside diameter of 148 inches and a nominal wall thickness of 2.38 inches in the active core region. The activation analysis model includes all of the lower core barrel (61,850 pounds) and a portion of the upper core barrel (14,280 pounds). The core barrel is Type 304 stainless steel. The volume of the core barrel is approximately 152.3 ft^3. The core barrel is not classified as greater than Class C waste.

- Thermal Pads - The thermal pads are located at four azimuthal angles, attached to the outside of the lower core barrel. These thermal pads each consist of two pieces and are axially centered on the reactor core midplane. Their purpose is to reduce the neutron flux to the vessel wall at locations where the core is closest radially to the wall. The thermal pads are 2.75 inches thick and 149.7 inches long. They cover approximately 135° azimuthal, or about 37.5% of the circumference. The four sets of thermal pads weigh a total of 20,950 pounds. The thermal pads are Type 304 stainless steel. The volume of the thermal pads is approximately 41.9 ft^3. The thermal pads are not classified as greater than Class C waste.

- Lower Core Plate - The lower core plate supports the fuel assemblies from underneath, contacting the fuel assembly bottom nozzles. The plate is 2.00 inches thick and 146.66 inches in diameter. The plate weighs 6,700 pounds and is Type 304 stainless steel. The volume of the lower core plate is approximately 13.4 ft^3. The lower core plate, if segmented, would be classified as greater than Class C waste.

- Lower Core Support Columns - The region below the core support plate and above the core support contains the core support columns. Additionally, this region contains columns which support the travel path of instrumentation which is inserted into the reactor core. The weight of these columns is estimated to be 5,109 pounds. The columns are Type 304 stainless steel. Their volume is approximately 10.2 ft^3. The lower core support columns are not classified as greater than Class C waste.

- Lower Core Support - The lower core support is a massive piece of metal which supports the entire weight of the reactor core, and some of the internal components. The support rests on radial supports welded to the reactor pressure vessel. The lower core support is Type 304 stainless steel and has a diameter of 151.75 inches, a thickness of 20 inches, and an overall weight of 60,000 pounds. The volume of the lower core support is approximately 120 ft^3. The lower core support is not classified as greater than Class C waste.

- Region Below Core Support and Above Upper Tie Plate - This region below the lower core support contains fifty-six instrument tubes and support columns. The total mass of Type 304 stainless steel in this region was estimated to be 4,072 pounds. The volume is approximately 8.1 ft^3. This is not classified as greater than Class C waste.

- Upper Core Plate - The upper core plate serves as the locating guide for the upper fuel assembly nozzles. The plate is 3.00 inches thick, 147.25 inches in diameter, and weighs 7,980 pounds. The upper core plate is Type 304 stainless steel and has a volume of approximately 16 ft^3. The Upper Core Plate is not classified as greater than Class C waste.

- Upper Core Support Columns - Above the upper core plate and attached to it, are the upper core support columns. These columns provide support for the control rod assemblies moved in and out of the core, as well as support for various pressure and temperature instrumentation. There are forty-eight support columns and sixty-one guide tubes in the region between the upper core plate and the upper support assembly. The mass of Type 304 stainless steel is estimated at 11,569 pounds. This mass does not include all of the mass of the support tubes and guide columns which extend well beyond the upper bound of the analysis models. The volume of the upper core support columns is approximately 23 ft^3. The upper support columns are not classified as greater than Class C waste.

The reactor vessel internals components that, if segmented, would be classified as greater than Class C waste are the Core Baffle, Core Formers, and the Lower Core Plate. The combined volume is approximately 92 ft^3.

As discussed in the Trojan Reactor Vessel Package - Safety Analysis Report, dated March 31, 1997, the activation radioactivity was determined through calculations performed by TLG Services, Inc. (TLG) in support of the Trojan Nuclear Plant Radiological Site Characterization Report. These calculations consisted of one-dimensional neutron transport and point neutron activation analyses of the reactor vessel and its internals. These calculations were performed to estimate the neutron-induced radionuclide inventory. The calculations were performed using the FISSPEC and O2FLUX computer codes, written by TLG, and the ANISN and ORIGEN2 computer codes, obtained through the Oak Ridge National Laboratory's Radiation Shielding Information Center (RSIC). Reduction of the output from these programs and ancillary calculations were performed using the ANISNOUT and O2READ computer codes, written by TLG, and the Microsoft EXCEL computer code.

The neutron-induced radionuclide inventories were estimated using a two-step analytical approach. The first step was to determine the magnitude and spectrum of the neutron flux beyond the boundaries of the reactor core. This was accomplished using the ANISN one-dimensional neutron transport computer code with five radial and axial geometric models. The results of the

radial transport calculations were normalized against plant-specific neutron flux data obtained from an available reactor vessel neutron fluence surveillance capsule report.

The ANISN outputs were subsequently collapsed into two-energy group formats (fast and thermal) and into a series of ORIGEN2 point activation/depletion calculations. Additional input to the ORIGEN2 calculations included material compositions and historical plant performance data. The radionuclide activities for each component are presented in Table 1 of Calculation RPC 97-018 which is provided as Attachment II for information.

NRC QUESTION:

2. Provide the methodology and results of the waste classification for the pressure vessel with the internals intact. Describe how the waste classification conforms to the recommendations in Section 3.3 of the Branch Technical Position on Concentration Averaging and Encapsulation (BTP), dated January 17, 1995. Demonstrate that the waste classification considered each of the internal components as a separate entity in the averaging.

PGE RESPONSE:

The Reactor Vessel and Internals will be packaged as one integral component containing neutron activated metals. The analysis to determine the waste classification was performed in accordance with the general requirements of BTP Section 3.3 which states:

> "For neutron-activated materials or metals, or components incorporating radioactivity in their design, the waste classification volume or weight should be taken to be the total weight or displaced volume of the material, metal, or component (i.e., major void volumes subtracted from the envelope volume)."

The activity was averaged over the entire metal volume of the component. The volume utilized does not include voids filled with grout, shielding, closure plates, or impact limiters. The waste classification was performed using the activation analysis done as part of the Site Characterization Report that supported the Trojan Decommissioning Plan. A copy of the PGE analysis that determined the waste classification, PGE Calculation RPC 97-018, Revision 0, is provided as Attachment II.

The Branch Technical Position Section 3.9 provides "Alternate provisions" for packaging large intact components. Under the alternatives provision, the licensee's obligation is to demonstrate, to the NRC or Agreement State, that land disposal of the object will meet the performance objectives in Subpart C of 10 CFR Part 61. US Ecology performed ground-water

and direct exposure dose analyses to support the disposal approval process by the State of Washington. The State of Washington, as an Agreement State, has determined that the waste classification of the Trojan waste appears to be consistent with the NRC BTP. The Trojan package, therefore, satisfies the alternative provisions of Section 3.9 of the BTP. A summary discussion of the bounding performance objective from Subpart C of 10 CFR Part 61 follows.

For activated metals, the intruder scenarios represent the worst case dose pathway. Since the intact vessel could not conceivably be handled by an inadvertent intruder, the intruder discovery scenario is the most appropriate. Assuming this scenario, several observations are appropriate:

1. The only long lived gamma emitter present is Nb-94 which is present in its highest concentrations in the core baffle within the pressure vessel. The core baffle contains 2.23 curies of Nb-94 which is 68% of the total Nb-94 activity of 3.29 curies. The baffle will be shielded by low density cellular concrete (LDCC), the vessel wall, and steel plate.

2. The estimated exposure rate on the surface of the intact vessel after 500 years is less than 0.02 mR/hr. When this dose rate is considered in the context of the appropriate intruder discovery scenario, the objectives of 10 CFR Part 61 Subpart C are clearly satisfied.

The required analyses were submitted to the Washington State Department of Health for review and are provided as Attachment III. The Washington State Department of Health reviewed the analyses and concluded that "the waste classification of the Trojan waste appears to be consistent with the Nuclear Regulatory Commission's January 17, 1995 Final Branch Technical position on Concentration Averaging and Encapsulation." The letter from the State of Washington Department of Health is provided as Attachment IV. The documents referenced above demonstrate that the Reactor Vessel with the internals installed, configured as described in the PGE Safety Analysis Report, satisfy the requirements of 10 CFR Part 61 Subpart C performance objectives. Based on the submittals and approval by the Washington Department of Health, the reactor vessel package with the internals installed meets the requirements of the Branch Technical Position, Section 3.9 Alternative provisions.

Further Waste Disposal Performance Objectives Discussion

NUREG 0782 Draft Environmental Impact Statement on 10 CFR 61 "Licensing Requirements for Land Disposal of Radioactive Waste" listed four basic performance objectives that should be achieved in waste disposal. These are:

1. Protection of the inadvertent intruder.

2. Assure long term stability to eliminate the need for long term maintenance after operations cease.

3. Protect public health and safety over the long term.

4. Assure safety during the short-term operational phase.

The degree to which the disposal of the Trojan Reactor Vessel and Internals would meet these performance objectives was considered in the decision to pursue this alternative. Specifically, protection of the inadvertent intruder, long term site stability, and safety during the short term operational phase were all enhanced by the unit disposal alternative as opposed to the segmentation alternative. In particular, the occupational and radiological safety advantages in handling a single package and the minimal impact on long term site performance objectives as compared to handling multiple high dose rate liners weighed especially heavily in this decision. The discussion of the dominant performance objective, protection from an inadvertent intruder, follows to demonstrate that the performance objectives of 10 CFR Part 61 are satisfied by the burial of the reactor vessel and internals as a single package.

Intruder Assessment Scenarios

Inadvertent intrusion assumes that an individual, or group of individuals, intrudes into the waste either accidentally or without realizing that there is a potential hazard. The former case is considered most likely but is assumed to be quickly recognized by the individual with minimal resulting exposures. More significant exposures are expected to occur if the intruder does not realize that there is a potential hazard. This could occur if there is a breakdown in institutional controls.

There are two possibilities for inadvertent intruder exposures to low level radioactive wastes. These include the Intruder-Construction scenario and the Intruder-Agriculture scenario. Population exposures are also considered based upon waste that is uncovered and brought to the surface being transported offsite by surface water and wind.

The Intruder-Construction scenario assumes that some time after the end of operations at the facility, institutional controls break down and an intruder inadvertently constructs a house on the disposal facility. The intruder is assumed to dig a three meter deep foundation that is 10 m by 20 m in dimension at the bottom. Exposures are assumed to occur through the suspension of contaminated dust via inhalation and direct exposure, consumption of food grown nearby upon which airborne contamination is assumed to have settled, and via direct gamma exposure to the waste during excavation.

The Intruder-Agriculture scenario assumes that an individual inadvertently lives on and consumes food grown on the disposal facility. Farming is a surface activity and generally does not involve disturbing the soil for more than a few feet. As long as the cap of one or two meters is maintained over the waste then it is unlikely that agricultural activities would ever contact the waste. To implement this scenario at the end of the institutional control period, however, a porion of the soil excavated during the intruder-construction activity is assumed to be backfilled around the house foundation. The remainder is assumed to be utilized in the agricultural scenario. The house is assumed to be located at the center of a 50 m circle which includes the agricultural area.

The exposure pathways associated with this scenario include:

1. Inhalation of contaminated dust suspended due-to tilling activities,

2. Direct gamma exposure from standing in the contaminated cloud,

3. Consumption of food (leafy vegetables) dusted by fallout from the contaminated cloud

4. Consumption of food grown in the contaminated soil

5. Direct gamma exposure

When assessing exposures from inadvertent intrusion, the physical form of the Trojan reactor vessel must be considered. The Trojan reactor vessel is a right cylindrical carbon steel vessel, 42 feet 6 inches tall and 17 feet 1 inch in diameter that will weigh approximately 950 tons when disposed. Additionally it will be disposed at least 5 m (16.5 feet) below grade. As stated in NUREG 0782, " .. intruder scenarios analyzed contain one very large assumption - that the soil/waste mixture in which construction or agriculture takes place is more or less indistinguishable from dirt." That is, the waste has decomposed to the point that the intruder does not know he is contacting waste. This assumption is necessary since without it, the scenarios could not happen.

Given the physical size and composition of the reactor vessel (i.e., 5 to 8 inch thick carbon steel vessel walls, stainless steel internals, and void spaces filled with grout) the only credible exposure pathway associated with the Intruder Construction and Intruder Agriculture scenarios is the direct gamma exposure pathway. This results from the fact that the reactor vessel is not, nor will it degrade, into a form that is indistinguishable from dirt. There is no credible means by which the activity contained within the activated metal of the internals could become tilled up or mixed with soil such that jt could become suspended in air or that vegetables could be grown in it. Consequently, only the direct gamma exposure pathway is considered.

To assess the direct gamma exposure pathway, the dose rates on the exterior of the reactor vessel and internals, as they will be disposed, were modeled using the MICROSHIELD computer code. Assessments of dose rates at this point is conservative and appropriate in that it would be representative of an intruder digging down to, but not actually contacting, the reactor vessel as it lays on its side in the disposal trench. The intruder would then construct his house on the vessel.

Vessel external dose rates were projected at time of shipment and in increments over the subsequent 500 years. It is important to note that at the projected time of shipment, the vessel will contain an estimated 1.15E6 Curies of Co-60. Due to transportation regulations, the external dose rate will be limited to 200 mR/hr at the surface of the vessel. Consequently, the vessel, as shipped and disposed must provide sufficient radiation shielding to attenuate the radiation from Co-60 and other nuclides to acceptable levels. The acceptability of this dose rate for long term disposal guidance is provided in the 1995 revision to the US NRC Branch Technical Position on Waste Classification. This document assigns a limit of 0.02 mR/hr on the surface of the disposal container as the acceptable dose rate from encapsulated sealed sources and activated metals 500 years after disposal. This limit is met by the reactor vessel and internal package 100 years following disposal.

General Discussion of the Merits of the Two Options For the Reactor Vessel and Internals Removal Project

There are two alternatives for disposal of the Trojan Reactor Vessel and Internals. These alternatives are segmentation, placing pieces in individual steel liners, then disposing of the liners; or leaving the internals in the Reactor Vessel, filling the reactor vessel with a low density cellular concrete, and then disposing of one large package. Segmentation of the Reactor Vessel Internals would most probably use a plasma-arc torch (or equivalent equipment) to cut up the subcomponent parts that comprise the internals. The cutting would be conducted in the water filled refueling canal in Containment utilizing underwater tooling. The internals would be cut into pieces small enough to be placed in shipping casks for transport to the disposal facility. The liners would be removed from the transport cask at the disposal facility and placed in vertical disposal caissons, engineered concrete barriers, or radioactive waste disposal trenches depending on the isotopes and activity contained in each liner. A study of the segmentation indicated that it would result in as many as 44 liners for disposal at the US Ecology site in Richland, Washington.

Disposing of the Internals By Segmentation

Segmentation would result in some internal parts being classified as greater than class C waste (GTCC). A total of 39 to 44 GTCC storage cans would be generated from the segmentation

process. These cans would remain at Trojan until the US DOE develops a disposal option. A byproduct of the plasma-arc method of segmentation is "dross" (i.e., welding slag and fine particles) generated during the cutting process. Dross consists of the molten and vaporized metal from the cutting process that has condensed and solidified in the refueling canal water. This material is "caught" in buckets located below the piece being sectioned or is removed from the refueling canal water via mechanical filtration. The majority of this material is not expected to be classified as greater than class C waste (GTCC). This dross and filters would be sent for disposal in shipping cask liners.

Contamination control is one of the radiological hazards associated with this approach. The tasks of filling intermediate and high activity liners with waste and placing the liners in the transportation casks are performed underwater in the refueling canal or spent fuel pool. Due to the high radiation levels associated with these liners, hands-on decontamination of external surfaces is not possible. Contamination levels on the liner can range from 1E5 to >1E6 dpm/100 cm^2. Hot particles created during reactor operation or during the segmenting process will also be present. Consequently, there is substantial potential for the spread of contamination when the liner is lifted from the cask at the disposal facility or when cleaning gasketed cask closure surfaces.

Disposal of low, moderate, and intermediate liners involves unloading the liner from the transportation cask and placing it in the disposal trench or in a concrete caisson. This operation is generally performed utilizing long handled tools with the unloading technician remaining in as low a radiation area as possible. Typical personnel radiation exposures associated with unloading these shipments ranges from 50 to 150 mR for each cask.

Unloading high activity casks is a far more demanding task due to the extreme radiation levels involved and the severe consequences that would result from a mishap during the unloading process. High activity liners are unloaded from the shipping cask vertically and are disposed of in concrete caissons constructed in the disposal trench. While these operations have been performed many times with minimal radiological impacts because each evolution was carefully planned and executed, the potential, however, exists for significant radiological hazards to be created in the event of an equipment malfunction or handling mishap.

Additional disadvantages are also present with respect to long term facility closure. Cask liners filled with reactor internal sections (that are not classified as GTCC) contain void spaces which are undesirable from a waste form perspective. Void spaces in waste packages may lead to channeling of rainfall percolating through the waste and may lead to waste slumping. The disposal caissons are designed to minimize the effects of void spaces inside the disposal liners, however, elimination of void spaces is preferable with respect to the waste form. The dross generated by segmentation is also problematic in that it consists of solid particles ranging in size from macroscopic slag down to fine particles 0.5 microns in diameter. While they would be solid

particles, it is not clear at what size they would be considered to be an inherently stable waste form such as irradiated metal. In the event of inadvertent intrusion into the waste at some time after institutional controls have lapsed, the form of the dross and the pieces of segmented internals is such that it could be relatively easily transported to the surface and dispersed.

Potential hazards associated with segmentation can be controlled and minimized through proper radiological controls planning, however, these issues must be recognized as distinct and significant disadvantages to this method of disposal.

Reactor Vessel and Internals Removal As a Single Package

Disposal of the reactor vessel with internals in place as a single package has significant operational and disposal advantages.

The Reactor Vessel and Internals will be received at the site as one package. The exterior of the reactor vessel is the outside of the shipping container. Consequently, external dose rates will be less than 200 mR/hr on contact with the vessel. Since the external dose rates will be less $\leq$ 200 mR/hr on contact, the radiological hazards associated with off loading will be minimal. The external surface of the reactor vessel will also have to meet DOT contamination limits, consequently external contamination levels will be sufficiently low to prevent any spread of contamination during handling and disposal.

The reactor vessel will be filled with Low Density Cellular Concrete (LDCC) to minimize void spaces. The LDCC will be pumped into the vessel and will be allowed to set up. Additional grout will then be pumped into the vessel to fill void spaces to the maximum extent practicable. Since the unit will be disposed by itself in a single trench, it will not have any effect on other waste at the site. The structural strength of the reactor vessel will preclude changes in the trench such as slumping. Since the internals will not be cut up, what would have become GTCC waste and dispersible dross will remain inside a heavy walled vessel. Overall, disposing of the Reactor Vessel and Internals as a package provides distinct advantages in terms of operational safety and waste form.

A separate disposal trench will be constructed at the US Ecology site to receive the Trojan reactor vessel. Constructing a separate disposal trench does not impact the life of the disposal site since it is expected that the facility will have at least 50% unused capacity at the end of the facility lease in 2063. There is only one other nuclear power plant located within the Northwest and Rocky Mountain Compacts and continued waste receipts beyond 2063 are not currently planned. The trench will be constructed with a long access ramp to minimize the grade the vessel transporter must negotiate. The access ramp will terminate at the bottom of the disposal trench. The vessel will be transported to the US Ecology site and down into the

disposal trench as single package. The package will then be unloaded into its final resting position.

Conclusion

PGE has performed an extensive assessment of the storage and disposal options for the reactor vessel and internals. The selected option of transportation and disposal of the reactor vessel and internals as one integral component (containing neutron activated metals and stabilized by low density cellular concrete) is the best available solution from the perspective of protecting the public health and safety. The analyses performed and summarized in this response demonstrate that the radioactive material in the singular reactor package is classified consistent with regulatory guidance and can be safely buried at the licensed US Ecology radioactive waste disposal facility.

ATTACHMENT II