TROJAN ISFSI COMPLETION PROJECT

PGE/HOLTEC

MEETING WITH NRC

Presentation of Draft RAI Response

July 10, 2002

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AGENDA

- Introductions and NRC Opening Remarks
- Opening Remarks (PGE- L. Dusek)
- Draft RAI Response Format and Content
- Presentations of Draft RAI Response
  - Shielding/Radiation Protection (Holtec- E. Redmond II)
  - Confinement (Holtec- E. Redmond II)
  - Criticality (Holtec- E. Redmond II)
  - Operating Controls/Limits (PGE- G. Zimmerman)

AGENDA (cont'd)

- Presentations of Draft RAI Response (cont'd)
  - Thermal (Holtec- I. Rampall)
  - Structural (Holtec- B. Gutherman)
  - Materials (Holtec- B. Gutherman)
  - General/Design Criteria (Holtec- B. Gutherman)
- Other TS/SAR Changes (not stemming from RAI response) (PGE- G. Zimmerman)

AGENDA (cont'd)

- Summary of Tabled Open Items (NRC- C. Regan)
- Schedule Considerations (PGE- M. Lackey)
- Closing Remarks (PGE- L. Dusek)

RAI RESPONSES

- **Shielding/Radiation Protection**
  - RAI 7-1: Revise the SAR to remove references to the HI-STORM FSAR
  - RAI Response:
    - The Trojan SAR has been revised to discuss unique aspects of the Trojan shielding evaluation
    - Incorporation of HI-STORM FSAR information by reference (as recognized by RG 3.62) is maintained for information that is the same for the generic and site-specific shielding analyses

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-2: Describe the power and operating history used for the design basis fuel source term evaluation
  - RAI Response:
    - SAR Section 7.2.1 has been revised to include the power and operating history for the design basis assembly
      - A specific power of 40 MW/MTU was used for the design basis source term calculation
      - One full power cycle assumed with no credit taken for outages between operating cycles

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-3: Clarify if axial burnup profile in SAR Figure 7.2-1 is based on Trojan specific fuel data.
  - RAI Response:
    - Profile is the original licensing basis
    - Axial burnup profile is for high burnup fuel and conservatively bounds Trojan spent fuel burnup
      - Trojan maximum burnup is < 42,000 MWd/MTU
      - Peaking factors for Trojan fuel are less than 1.1
    - Trojan operated with all rods essentially fully withdrawn to ensure an even fuel burnup

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-4: Provide Reference 4 to Chapter 7, "PWR Axial Burnup Power Profile Database," by R. J. Cacciapouti
  - RAI Response:
    - Reference 4 provided as attachment to response
    - Updated axial burnup report also provided as attachment to response, and added to SAR Section 7.7 as an additional reference

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-5: Justify a cobalt impurity of 1 gm/kg in Inconel fuel components
  - RAI Response:
    - Conservatively, the cobalt impurity level for Inconel portions of the fuel assembly has been increased to 4.7 gm/kg for the Trojan shielding analysis
    - SAR Section 7.2.1.3 has been revised appropriately and the site boundary distance has been increased to 300 meters due, in part, to resulting higher calculated dose rates

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-6: Provide additional description in the SAR for the neutron sources to be stored. Are they GTCC?
  - RAI Response:
    - The neutron sources were included as fuel assembly inserts similar in design to BPRAs
    - The sources were positioned and operated within the envelope of the fuel assembly
    - The material is not GTCC, consistent with the guidance of ISG-9

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-6 Response (cont'd):
    - SAR Sections 4.2.7.4.7 and 7.2.1.6 have been added to provide discussion of why neutron sources may be ignored in the criticality and shielding analyses, respectively
    - RAI Response 4-29 addresses the effect of neutron sources on the criticality evaluation

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-7: Justify neglecting the the Cf and Sb-Be sources from the neutron source evaluation
  - RAI Response:
    - New SAR Section 7.2.1.6 has been added to discuss neutron sources
    - Due to their small number and age, these sources contribute negligibly to the overall neutron source term when compared to the fuel

RAI RESPONSES

- RAI RESPONSES
- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-7 Response (cont'd):
    - Two Cf-252 are primary sources that were delivered prior to original reactor criticality
      - Age is 24 years, or 9 half lives, making them negligible as a neutron source compared to the spent fuel
    - Four Sb-Be are secondary sources that produce neutrons from (gamma,n) reaction by gammas $\geq$ 1.66 MeV
      - Sb-Be sources would conservatively only add 0.0025% to neutron source for the ISFSI
      - Contribution is negligible and ignored in shielding analysis

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  – RAI 7-8: Justify neglecting activation of RCCAs and BPRAs from the source term
  – RAI Response:
    - Dose rate from BPRAs is negligible compared to the fuel
      – BPRAs installed for only the first operating cycle
      – Increase in dose rate for a single cask with 24 design basis BPRAs is less than approximately 1.5 percent.
      – There are only 92 BPRAs (4 casks worth)

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-8 Response (cont'd):
    - Dose rate from RCCAs is negligible compared to the fuel
      - Control bank D normally operated 10 inches inserted
      - RCCA core locations rotated
      - Did not take credit for 16% reduction from positioning and wall thickness of guide tubes
      - Increase in peak local contact dose rate for a single cask with 24 design basis RCCAs is 1.8 mrem/hr at bottom 6 ft. of cask
      - There are only 61 RCCAs out of 781 fuel assemblies (2.5 casks worth)

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-8 Response (cont'd):
    - SAR Section 7.2.1.3 has been revised and Tables 7.2-8, 7.2-9, and 7.2-13 have been added to justify neglecting the activation of RCCAs and BPRAs in the development of the source term

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-9: Describe non-fuel bearing components.
  - RAI Response:
    - Original licensing basis
    - SAR Section 7.2.1.5 revised to more accurately describe non-fuel bearing components
      - fuel assembly metal fragments (e.g., portions of fuel rods, portions of grid assemblies, bottom nozzles)
      - source term considered as design basis fuel assembly
    - Material meets guidance of ISG-9, material associated with fuel assemblies

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-10: Include SAS2H/ORIGEN-S input files as an appendix to Chapter 7
  - RAI Response:
    - New appendices 7.A (SAS2H) and 7.B (ORIGEN-S) have been added to the SAR to include the requested input files

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-11: Remove SAR Section 7.2.2.1 statement, "A limit of 10^{-4}µCi/cm^2 beta-gamma and 10^{-5} µCi/cm^2 alpha will be used….
  - RAI Response:
    - The response clarifies that the 10^{-4}µCi/cm^2 beta-gamma and 10^{-5} µCi/cm^2 alpha loose surface contamination limits are not intended to be limits on a single MPC, but rather are design basis limits for contamination that is distributed on the external surfaces of all (36) MPCs collectively
    - SAR Section 7.2.2.1 has been revised to clarify the contamination limits

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-13: Revise Chapter 7 to include sketches of radial and axial shielding configurations
  - RAI Response:
    - New Figures 7.3-4 through 7.3-11 have been added to provide the requested information

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-14: Revise Chapter 7 to include an MCNP input file as an appendix for the gamma and neutron shielding close-in evaluations
  - RAI Response:
    - New Appendix 7.C has been added to the SAR to provide the requested information

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-15: Revise Chapter 7 to include both direct and skyshine gamma and neutron dose rate vs. distance tables for a single cask
  - RAI Response:
    - New Table 7.3-6 and 7.3-7 have been added to the SAR to provide the requested information

RAI RESPONSE

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-16: Revise Chapter 7 to include the loading pattern of the ISFSI
  - RAI Response:
    - A second shielding analysis has been performed using a uniform burnup and cooling time of 42,000 MWd/MTU and 9 years for all assemblies in all casks
    - ISFSI loading pattern is not credited in the shielding analysis and the site boundary distance has been increased to 300 meters due, in part, to the higher calculated dose rates
    - Table 7.3-5 has been added to the SAR to show the burnup and cooling time combinations used for the two shielding analyses. SAR text has also been revised appropriately to demonstrate the margin in the uniform analysis

RAI RESPONSE

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-17: Revise Chapter 7 to include a table of the offsite direct dose vs. distance separated by front row contribution and subsequent back rows
  - RAI Response:
    - New Table 7.3-8 has been added to the SAR to provide the requested information as contribution from front row and combined back rows, plus total side dose
    - Results are provided for the direction from the ISFSI with the highest dose rate at the Controlled Area Boundary

RAI RESPONSE

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-18: Revise Chapter 7 to include a table showing skyshine dose rate versus distance from the ISFSI
  - RAI Response:
    - New Table 7.3-9 has been added to the SAR to provide the top of cask dose rate as well as the side dose rate and total dose rate

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  – RAI 7-19: Demonstrate that the dose in any direction is below the limits of 10 CFR 72.104….
  – RAI Response:
    - Revised SAR Section 7.6.3 clarifies that total ISFSI dose combines normal condition dose with dose from off-normal conditions to demonstrate compliance with 72.104
    - SAR revision now addresses nearest resident with occupancy of 8760 hours/year (3.2 mrem/yr)

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-19 Response (cont'd):
    - Columbia River recreational usage is bounded by the evaluation of doses at the Controlled Area Boundary
      - Trojan plant FSAR specifies 5 hr/yr occupancy for shoreline/boating use of the Columbia River
      - The resultant direct dose to an individual on the river shoreline would be less than 11 mrem/year (based on 24 hours/year), which even with normal and off-normal effluents is well below the calculated doses at the Controlled Area Boundary and well within the 25 mrem/year regulatory limit
      - SAR Section 7.6.2 has been revised to reflect recreational use of the Columbia River

RAI RESPONSES

Table 7.4-4

Dose Rates at the Controlled Area Boundary and Nearest Resident from Effluent and Direct Radiation During Normal and Off-Normal Conditions

(Casks Assumed to Have Uniform Burnup And Cooling Time Of 42,000 MWD/MTU And 9 Years Cooling)

Controlled Area Boundary at 300 Meters
2080 Hours/Year

	Dose Rate from Effluent Release (mrem/year)	Direct Dose Rate (mrem/year)	Total Dose Rate (mrem/year)	Regulatory Limit (mrem/year)
10CFR72.104(a) – Normal + Off-Normal				
Whole Body ADE	0.133	18.4	18.533	25
Thyroid ADE	0.012	18.4	18.4	75
Critical Organ ADE (Max)	1.58	18.4	19.98	25
ADE: Annual Dose Equivalent				

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-20: Revise Chapter 7 to discuss off-normal and accident conditions on the shielding evaluation
  - RAI Response:
    - Off-normal and accident conditions are addressed in Chapter 8
    - SAR Section 7.6.3 currently includes a reference to Table 8.2-2 for off-normal and accident doses
    - SAR section 7.6.2 and 7.6.3 have been revised to further clarify the location of the off-normal and accident dose results
    - Table7.4-4 has been added to the SAR to demonstrate compliance with 10 CFR 72.104 for normal and off-normal conditions

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-21: Include references for the data presented in Tables 7.2-5 and 7.2-6
  - RAI Response:
    - References 18-20 have been added to Chapter 7 supporting the data in Tables 7.2-5 and 7.2-6
    - Reference 21 has been added to support the data in Table 7.2-8

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-22: Revise Table 7.4-1, Figure 7.3-2 and Figure 7.3-3 to separate the dose rates by neutron and gamma doses
  - RAI Response:
    - Table 7.4-1, Figure 7.3-2, and Figure 7.3-3 have been revised to separate the dose rates, as requested
    - Table 7.4-1 also revised to remove regulatory limits specified as "design values"

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-23: Revise Table 7.4-3 to list the average distance to the cask for each activity
  - RAI Response:
    - The distances used in the occupational exposure evaluation are included in Appendix K to the shielding calculation

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-26: Revise Table 7.3-1 to include Holtite
  - RAI Response
    - Table 7.3-1 presents the the densities for materials modeled in the shielding analysis
    - Holtite is only installed in the Transfer Cask lid, is conservatively not modeled in the shielding analysis and therefore has not been added to the table
    - No SAR change required

RAI RESPONSES

- **Shielding/Radiation Protection (cont'd)**
  - RAI 7-27: Provide a copy of Table 7.4-2
  - RAI Response:
    - "Intentionally deleted" page for previously omitted table was inadvertently not sent with LCA 72-02
    - Per PGE Response to RAI Question 7-24, a new Table 7.4-2, "Normal Condition Effluent Dose Calculation Results for the Fully Loaded Trojan ISFSI" has been added to the Trojan ISFSI SAR

RAI RESPONSES

- **Confinement**
  - RAI 7-12: Revise SAR Section 7.2.2.2 and Table 7.2-1 to include iodine
  - RAI Response:
    - The iodine concentration in the source term inventory used in the original analysis was below the 0.01% cut-off for inclusion in the source term calculated by SCALE and thus was excluded
    - The source term inventory was re-calculated with no cut-off and now includes iodine and other isotopes cited in ISG-5
    - SAR Section 7.2.2.2 and Table 7.2-1 have been revised to reflect the new inventory

RAI RESPONSES

- **Confinement (cont'd)**
  - RAI 7-24: Incorporate pages 1-24 of the confinement analysis into the SAR
  - RAI Response:
    - The information on these pages of the calculation has been summarized in SAR Section 7.2.2 at a level of detail appropriate for a safety analysis report.

RAI RESPONSES

- **Confinement (cont'd)**
  – RAI 7-25: Revise confinement analysis to include the gas contribution from BPRAs
  – RAI Response:
    - Gas release from BPRAs and the volume they occupy are considered in the MPC pressure computations supporting the confinement analysis
    - MPC internal pressures used for normal, off-normal, and accident conditions bound those expected for these conditions, producing conservatively higher postulated leak rates
    - No SAR change required

RAI RESPONSES

- **Confinement (cont'd)**
  - RAI 8-1: Revise the analysis in Section 8.1.3 to evaluate the inhalation doses at the controlled area boundary
  - RAI Response:
    - The inhalation dose was conservatively calculated at 100 meters, which is well within the Controlled Area Boundary and therefore, bounding for the CAB at 300 meters
    - SAR Section 8.1.3 has been revised to clarify the description of this analysis to address the CAB

RAI RESPONSES

- **Criticality**
  - RAI 4-25: Revise the SAR to add description for the criticality evaluation to reduce the amount of information incorporated by reference from the generic HI-STAR/HI-STORM FSARs
  - RAI Response:
    - SAR Section 4.2.7 has been revised to provide the information necessary to demonstrate compliance with 10 CFR 72.124
    - Content is consistent with Chapter 6 of the proposed HI-STORM 100 FSAR (LAR 1014-1)

RAI RESPONSES

- **Criticality**
  - RAI 4-25 Response (cont'd):
    - Areas where additional information is provided include:
      - the differences in the Trojan and generic MPC-24E/EF designs
      - the approach to the criticality evaluation
      - key assumptions and inputs
      - results
      - a model description
      - the off-normal and transient scenarios (e.g., partial flooding)
      - the approach used to evaluate damaged fuel, fuel debris, and non-fuel hardware

RAI RESPONSES

- **Criticality (cont'd)**
  - RAI 4-26: Address criticality of MPC when flooded during loading and unloading operations
  - RAI Response:
    - SAR Section 4.2.7 has been revised to address this situation
    - Criticality safety is demonstrated for all operational evolutions

RAI RESPONSES

- **Criticality (cont'd)**
  - RAI 4-27: Show that damaged fuel and fuel debris criticality evaluations bound failed fuel conditions
  - RAI Response:
    - SAR Section 4.2.7 has been revised to add discussion of the criticality evaluation of damaged fuel and fuel debris and how it is bounding for the Trojan situation
    - Methodology the same as described in HI-STORM LAR 1014-1

RAI RESPONSES

- **Criticality (cont'd)**
  – RAI 4-27 Response (cont'd):
    - Damaged fuel and fuel debris limited to four DFCs/FFCs per MPC
    - No damaged fuel assemblies or fuel debris are permitted to be loaded in adjacent fuel cell locations
    - Collapse of and relocation of damaged fuel considered
    - Bare fuel rod arrays used to model damaged fuel rods with cladding replaced by moderator

RAI RESPONSES

- **Criticality (cont'd)**
  - RAI 4-28: Provide an analysis of the most reactive position of the fuel assemblies in the fuel cells.
  - RAI Response:
    - The assumption that the fuel assemblies are centered in the fuel cells is consistent with the same assumption approved generically for HI-STAR and HI-STORM per NUREG-1536
    - SAR Section 4.2.7.4.2 has been revised to provide discussion similar to HI-STORM FSAR
    - To have all assemblies loaded into the MPC in a manner that reactivity of the system is maximized would require "precision loading" of the MPC and is not considered a credible scenario
    - Random loading of assemblies has a negligible effect on the reactivity of the system

RAI RESPONSES

- **Criticality (cont'd)**
  - RAI 4-29: Show that including Cf neutron sources do not create a criticality concern
  - RAI Response:
    - Neutron sources do not increase the reactivity of the system
    - SAR Section 4.2.7.4.7 has been revised to discuss neutron sources

RAI RESPONSES

- **Criticality (cont'd)**
  – RAI 4-30: Clarify use of terms "damaged fuel container" and "failed fuel container"
  – RAI Response:
    - After LCA submittal, one fuel assembly (C18) was re-classified as damaged
    - Needed another container to store this assembly
    - DFC and FFC is terminology difference
    - SAR and TS revised appropriately throughout to allow damaged fuel and fuel debris in either DFC or FFC

RAI RESPONSES

- **Criticality (cont'd)**
  - RAI 4-31: Resolve discrepancy with fuel assembly C18
  - RAI Response:
    - Discrepancy resolved in Holtec report
    - Assembly C18 is now classified as a damaged fuel assembly requiring storage in a DFC
    - SAR 3.1.1 changed to reflect the number of fuel assemblies in respective categories

RAI RESPONSES

- **Operating Controls/Limits**
  - RAI 10-1: Justify reference to NUREG-1745
  - RAI Response:
    - Reference to NUREG-1745 has been deleted
    - LCOs for Trojan technical specifications are not methodology-based

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  – RAI 10-2: Provide Tech Spec limit for MPC drain-down time
  – RAI Response:
    - Drain-down time is not a safety issue; controlled administratively as a precautionary measure
    - SAR has been revised and clarified to indicate purpose and non-significance of drain-down time

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  - RAI 10-3: Add limit to tech specs for amount of fuel debris to be stored in fuel debris canisters
  - RAI Response:
    - TS Section 2.1.1.c has been revised to restore current limit on fuel debris in process can capsules (7.5 kg of fissile material and 20 Ci plutonium per MPC)
    - Other fuel debris is limited by INTACT FUEL ASSEMBLY
      - Maximum of 4 fuel debris canisters per MPC
    - Process can contents bounded by analyzed fuel debris limit

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  – RAI 10-4: Add burnup and cooling times for BPRAs and TPDs to tech specs
  – RAI Response:
    - Burnup and cooling times for BPRAs and TPDs have been added to tech specs
      – BPRAS: ≤ 15,998 MWd/MTU; ≤ 24 years
      – TPDS: ≤ 118,674 MWd/MTU; ≤ 11 years

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  - RAI 10-5: Provide information on neutron sources in tech specs
  - RAI Response:
    - Tech specs have been revised to add information on the Californium and Sb-Be neutron sources
      - Cf: $\leq$ 15,998 MWd/MTU; $\leq$ 24 years
      - Sb-Be: $\leq$ 88,547 MWd/MTU; $\leq$ 9 years

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  - RAI 10-6: Add program to measure contact dose rates to tech specs
  - RAI Response:
    - Trojan Administrative Tech Spec 5.5.4.a already requires program to measure contact dose rates
    - No change to tech specs is necessary

RAI RESPONSES

- **Operating Controls/Limits (cont’d)**
  - RAI 10-7: Add specific loading pattern to tech specs
  - RAI Response:
    - Shielding analysis has been revised assuming single, bounding burnup and cooling combination for all casks
    - Specific loading pattern is no longer applicable

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  - RAI 10-8: Provide maximum loose surface contamination limits in tech specs
  - RAI Response:
    - Section 5.5.4.c of tech specs has been restored to specify design basis limits for maximum loose surface contamination for Concrete Casks and Transfer Cask
      - 1000 dpm/100 cm^2 beta-gamma
      - 50 dpm/100 cm^2 alpha

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  – RAI 10-9: Provide fuel parameter specifications, flux trap size, and minimum ^{10}B content in tech specs
  – RAI Response:
    - Tech specs have been revised to add fuel parameter specifications, flux trap size, and minimum ^{10}B content

RAI RESPONSES

- **Operating Controls/Limits (cont’d)**
  - RAI 10-10: Revise Bases to remove statement about mis-loading an MPC
  - RAI Response:
    - Bases have been revised to reflect that use of administrative controls preclude the mis-loading of an MPC

RAI RESPONSES

- **Operating Controls/Limits (cont'd)**
  - RAI 10-11: Include criteria for cavity dryness and moisture level in Chapter 10 of SAR
  - RAI Response:
    - Forced Helium Dehydration (FHD) system will not be used for moisture removal and drying of MPC at Trojan
    - All references to FHD system have been deleted from SAR and tech specs

RAI RESPONSES

- **Thermal**
  - RAI 4-7: Evaluate sensitivity of neglecting heat dissipation from MPC lid and baseplate
  - RAI Response:
    - Assumption is consistent with generic HI-STORM thermal analysis
    - Sample case run with 10% heat dissipation via MPC lid and baseplate
      - Peak cladding temperature lower by 13.5^{o}F
      - MPC shell temperature lower by 12.3^{o}F
      - Concrete cask inner surface temperature lower by 3.7^{o}F
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-8: Confirm internal boundary condition for the concrete cask model
  - RAI Response:
    - 17.4 kW and axial distribution from Figure 7.7 of the thermal-hydraulic analysis were used as boundary condition
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-9: Confirm whether axial heat conductance is considered in the concrete and stainless steel
  - RAI Response:
    - Axial heat conductance is considered for the MPC and the concrete cask
    - Material thermal properties applied to elements of FE model
    - FLUENT computes axial heat flux based on local temperature gradient and thermal conductivity
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-10: Conservatism in constricting air duct openings (screen gage and blockage)
  - RAI Response:
    - Trojan screens employ 23 gage (0.025 in.) wire thickness
    - 20 gage (0.035 in.) wire thickness was assumed in analysis
    - Reduced flow area from 81% (actual) to 74% (analyzed value) provides 7% conservatism in flow area and 19.8% conservatism in hydraulic pressure loss
    - Higher pressure loss conservatively underestimates air flow and heat transfer providing bounding case

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-10 Response (cont'd):
    - Design basis includes 50% blockage (off-normal) and 100% blockage (accident); compared to short term limit (1058°F)
    - For accident case, concrete temperature limit reached first at 57.1 hours, ending simulation
    - No quantitative study was performed to determine what blockage fraction would be required to reach PCT limits
    - Two thirds ducts blockage qualitatively evaluated (29°F increase @ 50% blocked; therefore, expect <647°F @ two-thirds blocked)
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-11: Clarify bullets 2 and 5 in SAR Section 4.2.6.4 and discuss use of absorptivity and emissivity
  - RAI Response:
    - Discusses why approach is applicable and conservative
    - For bullet 2: revised SAR to modify licensing basis to add solar insolation as an input for normal operations (base case)
      - Fuel cladding temperature increased 5.3°F to 548.4°F, still well below limit of 647°F
      - MPC shell temperature increased 4.2°F to 284.7°F, still well below limit of 450°F
      - Annulus air flow rate increased 65 lb/hr to 2,361 lb/hr, increasing heat transfer rate

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-11 Response (cont'd):
    - For bullet 5: discussed modeling the most disadvantageously placed cask and referred to RAI 4-12
      - Hypothetical reflecting cylinder/reflecting boundary bounds all possible cask-to-cask effects by reflecting 100% of heat emitted
      - In actual practice, some heat would escape to environment
    - Discussed treatment of absorptivity and emissivity in model
      - Absorptivity = 1.0 ensures all incident energy is absorbed
      - Emissivity = 0.80 conservatively models less radiation cooling by the concrete than would occur in situ with actual concrete emissivity = 0.87 per SAR Table 4.2-13

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-12: Justify not accounting for surrounding cask and justify base case ambient temperature
  - RAI Response:
    - Bounding model incorporates hypothetical reflecting cylinder/insulating boundary approach
      - Consistent with HI-STORM FSAR Appendix 4.B
      - 100% of heat emitted is reflected back to cask being analyzed
      - In reality, some heat would escape to environment
    - Base case temperature is from existing licensing basis and bounds the normal temperature for site
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-13: Why was axial conductivity considered for MPC and not for concrete cask?
  - RAI Response:
    - In the concrete cask model, heat <u>dissipation</u> from the MPC lid and baseplate was conservatively neglected to overstate the MPC shell temperature
    - For the MPC model, axial heat dissipation was permitted to avoid gross overstatement of end temperatures
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-14: Why were the MPC and concrete casks not simulated in tandem?
  - RAI Response:
    - No tandem simulation is consistent with HI-STORM generic modeling
    - Thermal CFD software (FLUENT) not capable of modeling internal MPC convection concurrent with overpack chimney action (references cited)
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-15: Define conservatism in PCT gained by using a) ELV approach, b) not accounting for flux trap gaps, and c) assuming canister internal pressure to be 4.5 atm
  - RAI Response:
    - Discussion is provided justifying why the approach used is applicable and conservative
    - ELV approach is a straight line temperature profile that bounds the non-linear MPC shell axial temperature variation computed by the concrete cask model.
      - Straight line input overstates MPC cavity top and bottom shell temperature inputs by 79°F and 105°F, respectively in PCT computations

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-15 Response (cont'd):
    - Not taking credit for flow in flux trap gaps understates flow area by 395 in^2 and understates cooling flow by 21.5%
    - Underestimating MPC internal pressure by 0.42 atm understates the thermosiphon mass flow rate of helium and provides 8.5% conservatism in convective heat transfer
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-16: Why was ANSYS and not FLUENT used to develop effective conductivities?
  - RAI Response:
    - ANSYS was used in generic HI-STORM work
    - FLUENT not capable of simulating a square array of cylindrical rods inside a square cell cross-section with conduction, convection, and radiation heat transfer occurring simultaneously
    - No SAR changes required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-17: Provide axial conductivities used for fuel basket and downcomer gap for all simulations
  - RAI Response:
    - Provided table of axial conductivity values for normal, off-normal and transient (vacuum drying) conditions
    - No SAR change required

RAI RESPONSES

- Thermal
  - RAI 4-18: Provide methods and uncertainties when calculating heat load per fuel assembly
  - RAI Response:
    - Heat load for each Trojan fuel assembly as of January 1, 1998, was determined using the OCRWM Spent Fuel Computer Database, DOE/RW-0184-R1, "Characteristics of Potential Repository Wastes." (ORIGEN-II)
    - These heat loads and methodology are currently approved by the NRC as reflected in the current Trojan ISFSI licensing basis.

RAI RESPONSES

- Thermal
  - RAI 4-18 Response (cont'd):
    - For verification, a sampling of the heat load values derived from the OCRWM code was compared to the results of similar calculations using the code endorsed by the NRC in Regulatory Guide (RG) 3.54, LWRARC 1.0 (ORIGEN-S)
    - The heat load of Trojan fuel assembly M47, the hottest Trojan fuel assembly, as of November 9, 2001 (9 years cooling), was calculated using both codes. The OCRWM code yielded results slightly more conservative than the LWRARC 1.0 results. This resulted in a bounding heat load of 725 Watts.

RAI RESPONSES

- Thermal
  - RAI 4-18 Response (cont'd):
    - Per NUREG/CR-5625, "Technical Support for a Proposed Decay Heat Guide Using SAS2H/ORIGEN-S Data," the average uncertainties between LWRARC 1.0 calculated heat rates and measured heat rates are 1.5 ± 1.3% for PWR fuel
    - Based on comparisons between OCRWM and LWRARC 1.0 results, the published uncertainties for LWRARC 1.0 are reasonably representative of the average OCRWM results

RAI RESPONSES

- Thermal
  - RAI 4-18 Response (cont'd):
    - In addition to the conservatism built into the calculation methodology, potential uncertainties in the development of the hottest fuel assembly heat load is accounted for in the assumption that a heat load equivalent to that of the hottest fuel assembly (M47) is placed in each of the 24 MPC fuel basket cells for a design basis heat load of 17.4 kW per MPC
    - Furthermore, the design basis heat load assumed a load date of November 1, 2001. Since actual loading is not anticipated to begin until late-2002, the understatement of cooling time in the calculation provides additional conservatism.

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-19: Provide 3-D simulation of three inlet ducts blocked condition
  - RAI Response:
    - Justification provided for why approach used is applicable and conservative
    - Simulated 67% reduction in annular flow area
      - Annulus flow resistance increased by $(1)^2/ (0.333)^2 = 9.0$
      - Air flow rate reduced from 2296 lb/hr to 1118 lb/hr
      - Fuel cladding temperature increases 7.1°F to 550.2°F, still well below limit of 647°F
      - MPC shell temperature increases 35.4°F to 315.9°F, still well below limit of 450°F

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-19 Response (cont'd):
    - Axisymmetric model approach used is consistent with generic HI-STORM work
    - Circumferential location of air ducts is a second order effect
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-20: Provide representative FLUENT input and output files for MPC and concrete cask normal operation cases
  - RAI Response:
    - Input and output files provided on ZIP disk
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-21: Provide number, location, calibration, etc., re Concrete Cask temperature monitors
  - RAI Response:
    - Trojan ISFSI SAR Sections 1.3.2 and 5.4.1 revised to specify four RTDs in each air outlet duct
    - Initial calibration only, due to characteristic of RTD. Significant shift is not expected based on NUREG/CR-5560, "Aging of Nuclear Plant Resistance Temperature Detectors"

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-21 Response (cont'd):
    - Response provides description of measures to identify device malfunctions and vent blockage
      - Daily temperature monitoring is the primary method of ensuring RTDs are functioning properly
      - Monthly review of temperature data to ID unusual temperature readings that may indicate need to replace RTD
      - Weekly visual inspections of air inlets considering ALARA implications of inspections

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-22: Describe any benchmarking efforts against predicted values for loaded casks
  - RAI Response:
    - SAR Section 9.2.3.2 and Table 9.2-1 specify requirements for heat transfer validation testing
      - Ambient and outlet temperature measured for lowest and highest heat loads casks after steady state is reached.
      - Actual delta T's compared to computed delta T's
      - If actual values are higher than computed values, additional evaluation will be performed and corrective actions taken as appropriate
    - Similar to generic HI-STORM test program
    - No SAR changes required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-23: Quantify the degree of overstatement of downcomer gap conductivity resistance and why overstatement is reduced during vacuum drying
  - RAI Response:
    - Absence of helium and associated convection during vacuum drying eliminates dominant heat transfer mode, leaving conduction and radiation as sole modes
    - Reduction in overstatement of gap conductivity resistance during vacuum drying reduces gross over-prediction of fuel cladding temperatures during this transient evaluation, while remaining conservative
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 4-24: What are the physical bases for using more conductive FLUENT porous media inputs for vacuum drying simulations?
  - RAI Response:
    - During vacuum drying simulation, convection is eliminated and conduction/radiation remain
    - Using more conductive porous media input reduces unnecessary conservatism for this transient and avoids gross over-prediction of fuel cladding temperatures
    - No SAR change required

RAI RESPONSES

- **Thermal (cont'd)**
  - RAI 5-1: Clarify use of vacuum drying system versus helium recirculation moisture removal system, and indicate PCT for each
  - RAI Response
    - The helium recirculation moisture removal system option has been eliminated
    - TS and SAR revised to reflect vacuum drying as the method that will be used to dry the MPC cavity
    - PCT during vacuum drying already provided in SAR Section 4.7.5.2

RAI RESPONSES

- **Structural**
  - RAI 4-6: Provide defense-in-depth for MPC transfer operations at Transfer Station
  - RAI Response:
    - MPC drop calculation revised to make it Trojan specific (e.g., drop height, orientation, and embedded impact limiter)
    - Maximum Stresses in MPC Shell less than Level D per ASME III, Subsection NB. MPC confinement integrity is maintained.
    - Maximum fuel basket stresses less than ASME limits. Fuel basket does not buckle or exhibit large deformations.
    - Boral sheathing weld stress (@ 60 g) less than design basis limits. The criticality control elements will stay in place.
    - Deceleration of fuel < 60 g. Fuel assemblies will not be damaged such that retrievability will not be adversely affected.

RAI RESPONSES

- **Materials**
  - RAI 4-1: Justify alternatives to ACI-349 for concrete temperature limits.
  - Response 4-1:
    - Concrete Cask temperature limits were previously evaluated and approved by NRC in SER, 3/31/98
    - Concrete Casks have been fabricated in accordance with SAR criteria
    - No SAR changes required

RAI RESPONSES

- **Materials (cont'd)**
  - RAI 4-2: Revise Table 4.2-2a to restore missing unit of measure
  - Response 4-2:
    - SAR Table 4.2-2a revised to restore missing unit of measure (Fahrenheit symbol "F") for the local area concrete temperature

RAI RESPONSES

- **Materials (cont'd)**
  - RAI 4-3: Identify the coating(s) to be applied to the Transfer Cask and the Concrete Cask
  - RAI Response:
    - Coatings are identified in the response:
      - Transfer Cask
        - Primer – Keeler & Long 6548/7107 White Epoxy
        - Top Coat – K&L E-1-7155 Epoxy Enamel
      - Concrete Cask
        - Carboline Carbozinc 11 VOC

RAI RESPONSE

- **Materials (cont'd)**
  - RAI 4-3 Response (cont'd):
    - Identification of Concrete Cask and Transfer Cask coatings added to SAR Section 4.2.4.2.8.
    - Same coatings already licensed for use on transfer cask and concrete cask
    - Product numbers for Concrete Cask and Transfer Cask coatings added to new licensing drawings in Trojan ISFSI SAR Appendix 1.A

RAI RESPONSES

- **Materials (cont'd)**
  - RAI 4-4: Clarify whether Zirlo will be stored at the Trojan ISFSI
  - Response 4-4:
    - Response clarifies that Zirlo will not be stored at the Trojan ISFSI
    - No SAR change required

RAI RESPONSES

- **Materials (cont'd)**
  - RAI 4-5: Provide a table of fuel temperature limits
  - RAI Response:
    - SAR Table 4.2-12 contains the fuel cladding temperature limits for normal, off-normal, and accident conditions
      - Long term limit (normal): 647°F
      - Short term limit (off-normal and accident): 1058°F
    - Footnote to SAR table added for clarification
    - 9 yrs/39,345 MWD/MTU provides bounding combination of calculated peak clad temperature and PCT limit for all fuel in inventory (smallest margin)

RAI RESPONSES

- **General/Design Criteria**
  - RAI 1-1: Provide licensing drawings with additional detail
  - Response 1-1:
    - New licensing drawings created for MPC, Transfer Cask, and Lift Yoke and moved to SAR Chapter 1
      - New drawings include nominal dimensions, critical tolerances, material specifications, pressure-retaining and other load-bearing weld symbols, NDE inspections, and coating requirements

RAI RESPONSES

- **General/Design Criteria**
  - Response 1-1(cont'd):
    - Additional information remains in other documents:
      - General arrangement of storage system in SAR Figure 1.3-1
      - Fabrication codes, standards, and specifications delineated in the SAR (Tables 4.2-1 and 4.2-2)
      - Detailed fabrication dimensions and tolerances are on proprietary design drawings submitted

RAI RESPONSES

- **General/Design Criteria**
  - Response 1-1(cont'd):
    - Additional information remains in other documents (cont'd)
      - Welding, examination techniques and criteria are per ASME Code and are listed in the SAR (Sections 3.3.2.2 and 4.2.4.2.1 and Table 4.2-1
      - Operational information is contained in SAR Chapter 5
      - ITS classification of components is contained in SAR Section 3.3.3.1 with detailed categorization of sub-components on design drawings

RAI RESPONSES

- **General/Design Criteria (cont'd)**
  - RAI 3-1: Radiological characteristics for non-fuel hardware
  - Response 3-1:
    - SAR Table 3.1-2 revised to add burnup and cooling time limits for non-fuel hardware and neutron sources
    - SAR Section 3.1.1.1 revised to refer to table
    - Same information also added to TS Table 2-2

RAI RESPONSES

- **General/Design Criteria (cont'd)**
  – RAI 3-2: MPC Closure Weld Information
  – Response 3-2:
    - Information exists in SAR Section 3.3.2.2 for field closure welds
      – VT, PT, hydro-test, helium leak test
      – MPC lid-to-shell weld receives multi-layer PT per ISG-4
    - SAR Section 3.3.2.2 revised to add information for other confinement boundary welds performed in shop
      – VT, RT, PT and helium leak test
    - All confinement boundary NDE requirements are the same as generic HI-STORM CoC requirements

RAI RESPONSES

- **General/Design Criteria (cont'd)**
  - RAI 3-3: Low probability of flawed welds
  - Response 3-3:
    - SAR Sections 3.3.2.2 and 3.7 were revised to provide a cross-reference to the NRC-authored research paper on probability of weld flaws in stainless steel spent fuel storage canisters

RAI RESPONSES

- **General/Design Criteria (cont'd)**
- RAI 4-32: Provide justification for new and revised ASME Code alternatives in SAR Table 4.2-1a
  - RAI Response:
    - All Code alternatives listed in Trojan SAR have been previously reviewed and approved by the NRC for the HI-STAR and HI-STORM Systems, as applicable
    - Since original LCA submittal, additional Code alternatives were reviewed and approved generically for HI-STAR and HI-STORM (docket references provided)
    - Table 4.2-1a has been expanded to include latest approved alternatives to ASME Code

RAI RESPONSES

- **General/Design Criteria (cont'd)**
  - RAI 5-2: Include qualification standards and criteria for leak testing personnel in SAR
  - RAI Response:
    - SAR Section 9.1.3 (in lieu of Chapter 5-Operations) has been revised to specify that personnel performing NDE examinations and weld leak testing will be qualified in accordance with SNT-TC-1A

OTHER TS/SAR CHANGES

- Design-Related Changes
  - Transfer Cask structural analysis modified in SAR Section 4.7.4.1.2 (changed from 125-ton HI-TRAC values to 100-ton HI-TRAC values)
  - Stress values in SAR Table 4.2-8
    - Corrects $P_L + P_b + Q$ value for baseplate design internal pressure (from 21.9 to 19.4)
    - For clarification, adds $P_L + P_b + Q$ values for shell, baseplate, and lid normal handling

OTHER TS/SAR CHANGES

- Operational/Procedural Changes
  - “Significantly higher than expected” trigger for an investigation to ensure that Concrete Cask radiation levels are within regulatory limits is eliminated, and wording revised to ensure that “trigger points” for evaluations are designed specifically to meet 10 CFR 20 and 10 CFR 72.104 limits. (SAR Section 5.1.1.2)
  - Related to Table 7.4-1 change to eliminate the column for “design” values (see PGE Response to NRC RAI Question No. 7-22), new wording requires an evaluation prior to moving the loaded Concrete Cask to the Storage Pad if the measured surface and working (i.e., distance of 1 meter) radiation levels exceed the <u>calculated</u> values in Table 7.4-1. (SAR Section 5.1.1.2)

OTHER TS/SAR CHANGES

- **Operational/Procedural Changes**
  - Changes description of closure weld removal for operational flexibility (SAR Section 5.1.1.3)

OTHER TS/SAR CHANGES

- Operational/Procedural Changes (continued)
  - Eliminates pre-loading requirement re: Transfer Cask with dummy MPC into Cask Loading Pit (SAR Section 9.2.3.1.2 and Table 9.2-1)
    - Objectives of this requirement were already accomplished with TranStor™ components to the extent that no benefit is gained from repeating

OTHER TS/SAR CHANGES

- Editorial - Corrections/Clarifications
  - Transfer Cask water jacket operation (SAR Sections 4.7.3.1, 5.1.1.2, 5.1.1.3, 5.2.1.1.1)
  - Concrete Cask spacing consistent with TS (SAR Section 5.1.1.4)
  - Concrete Cask transport speed is changed from “less than 2 ft/sec” to “no greater than 2 ft/sec” per Section 8.1.1.1.3 (SAR Section 5.1.1.4)

OTHER TS/SAR CHANGES

- Editorial - Corrections/Clarifications (continued)
  - "Basket" replaced with "MPC" (SAR Section 5.2.1.1.9)