CASTOR geo69 Part 72 storage system
Thermal RAIs

RAI-Th-1 Explain how the effective thermal conductivity applied to the tri-dimensional (3D) model basket's homogenized fuel correctly considers the appropriate amount of thermal radiation heat transfer.

SAR section 4.4.2.4.2 stated that radiation heat transfer among fuel rods and inner surfaces of the fuel channel, and among the fuel channel and the inner surface of the basket sheets is accounted for in the detailed 2D model and the simplified 2D model. However, SAR figure 4.4-3 indicated that the half-symmetric 3D model of the canister and cask includes the fuel channel, the helium between the fuel rods and fuel channels, and the helium between the fuel channels and outer basket sheets (i.e., as part of the homogenized fuel's effective thermal conductivity and explicitly modeled in the 3D ANSYS model). This appears to indicate that radiation heat transfer within the basket is accounted for twice, which would not be an accurate or bounding assumption. The need for accurate and bounding effective thermal properties is critical considering that some basket components are near their allowable temperature during short-term operations.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-2 Clarify that radial gaps exist among the basket sheets along the ANSYS model's basket height.

SAR section 4.4.2.2 mentioned that gaps were modelled between the individual basket sheets in radial and axial directions because there is no contact among the basket sheets. Although axial gaps along the height of the ANSYS model's basket were observed during a visual review of the thermal model, radial gaps were only observed in the upper portion of the model. Modeling of radial gaps is important because the radial direction is dominant for transferring the fuel's decay heat outward through the basket, canister, and cask and could impact ITS component temperatures and their margin with allowable temperatures. For example, SAR table 4.7-5 appears to indicate that increased thermal resistance through the transfer cask (i.e., presence of gaps within transfer cask) may result in in some ITS components (e.g., basket sheets) being above allowable temperatures.

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RAI-Th-3 Clarify and demonstrate the appropriateness of the thermal model assuming no gaps between transfer cask components.

Although SAR section 1.2.2.1.1 indicated the transfer cask is fabricated from a number of radial sections (e.g., outer shell, water jackets, lead), SAR section 1.2.2.1.6 indicated an absence of air gaps in the transfer cask body. Likewise, a visual review of the ANSYS model indicated there were no contact resistances between the radial components. However, there was no discussion that demonstrated assurance that fabrication (e.g., liners, lead shield fabrication and installation) would be possible without the presence of gaps between components (e.g., inner liner and lead shielding) and the corresponding thermal contact resistance that would result in increased component temperatures. For example, SAR table 4.7-5 appears to indicate that increased thermal resistance through the transfer cask (i.e., presence of gaps within transfer cask) may result in in some ITS components (e.g., basket sheets) being above allowable temperatures.

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RAI-Th-4 Demonstrate that spent fuel baskets and other ITS components (i.e., canister, transfer cask) for operations within the reactor building would not be affected by temperatures greater than *[withheld per 10 CFR 2.390]* and without the use of air conditioning within the reactor building.

The applicant noted in section 12.1.2 of the SAR that off-normal temperatures during CLU handling operations in the reactor building are not credible and SAR section 2.2.5.1 indicated there are no off-normal environmental temperatures within the reactor building because it is assumed that the building is air conditioned. However, active cooling of the CASTOR geo69 system's heat sink (i.e., internal reactor building temperature) via air conditioning is inconsistent with regulations requiring only passive cooling.

SAR section 12.1.2 stated that it was assumed that off-normal temperatures during CLU handling operations in the reactor building are covered by normal temperature evaluations for the DSS. Although the thermal analysis of the off-normal storage condition at a *[withheld per 10 CFR 2.390]* ambient temperature discussed in SAR section 4.5.4 indicated that ITS components were below allowable temperatures, it was not demonstrated that the content and ITS component temperatures within the canister and transfer cask (which does not include fins) is bounded by the finned CASTOR geo69 storage system thermal analysis. Likewise, the *[withheld per 10 CFR 2.390]* to begin the dewatering process would be reduced if *[withheld per 10 CFR 2.390]* (per item a, above). In addition, SAR table 4.7-5 appears to indicate that a higher ambient temperature may result in some ITS components (e.g., basket sheets) being above allowable temperatures.

This information is needed to determine compliance with 10 CFR 236(f).

RAI-Th-5 Discuss the ability of the fins to resist deformation during short-term operations, including the transferring of the storage cask that is described in SAR section 1.2.2.4, and their ability to retain effectiveness over time due to the buildup of dirt and debris, recognizing that fin performance is dependent on fin condition.

The CASTOR® geo69's performance is based on a finned storage system design. However, there was no discussion of the robustness of the fins to resist deformation and damage during short-term operations (e.g., changing from vertical and horizontal orientations). In addition, there was no sensitivity analysis of thermal performance due to damaged fins and impacts of dirt or debris buildup between fins (e.g., thermal resistance, change in emissivity and absorptivity) and no discussion whether there is a need for periodic operations (i.e., maintenance) to remove dirt and debris.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-6 Clarify and update the various parameters used in the pressure calculations so as to provide pressure results associated with low burnup fuel, which has a higher fission gas release fraction than the analyzed 0.15.

The fission gas release fraction for normal, off-normal, short-term, and accident conditions (e.g., SAR tables 7.2-4, 7.3-4, 7.4-4, 7.4-5) was based on a 15 percent value for high burnup fuel. However, there was no indication that pressures based on high burnup fuel would bound a low burnup fuel, which is assumed to have a 30 percent fission gas release fraction.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-7 Provide in the SAR the minimum and maximum allowable temperatures of the VMQ (vinyl-methyl-silicon rubber) and FKM (fluorocarbon rubber) elastomeric seals during normal conditions.

SAR section 1.2.1.2.2 and section 8.2.5.2 indicated that VMQ and FKM seals are used for leakage rate testing purposes. The VMQ and FKM seals' maximum and minimum allowable temperatures are needed to confirm that the seals would function during test operations.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-8 Provide additional discussion and justification for the water convection heat transfer parameter described in SAR section 4.7 and the water flow rate mentioned in SAR table 9.1-1.

Section 4.7.1 of the CASTOR® geo69 storage SAR indicated a water convection heat transfer coefficient for short-term operations within the pool. However, the description in Section 4.7 appears to indicate relatively small temperature differences between components in the water pool. Buoyant heat transfer correlations between parallel walls with small temperature differences would indicate convection heat transfer coefficients less than the assumed value in the SAR. The sensitivity of temperatures (and resulting relevant time constraints) for much lower heat transfer coefficient values was not considered in the SAR's analysis.

It appears from SAR Table 9.1-1 (step 4.2.6) that flushing water in the annulus between the canister and transfer cask is necessary for cooling purposes, but a calculation supporting the flow rate was not provided.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-9 Provide results of thermal energy balances (e.g., numerical residuals), spatial grid generation sensitivity results for steady-state runs, and time step sensitivity results of transient runs for the CASTOR geo69 storage system ANSYS thermal models.

Although SAR chapter 4 provided normal, off-normal, short-term, and accident condition results of the three-dimensional half-symmetric CASTOR geo69 package thermal analyses, there was no discussion that confirmed grid and timestep parameters were appropriate. In addition, there was no discussion that the thermal analyses were appropriately converged. These numerical parameters are used to determine the relevance of the numerical results described in the SAR.

This information is needed to determine compliance with 10 CFR 72.236(f).

RAI-Th-10 Justify in the SAR the maximum allowable temperatures for the containment gaskets during hypothetical accident conditions.

SAR section 4.0 and table 4.3-1 “Temperature limits of components” provided the maximum allowable temperatures for the metallic gaskets during hypothetical accident conditions. These limits exceed the manufacturer’s operating temperature limit, as described in SAR appendix 8-4, “Material Qualification, Metal Gaskets.” In addition, SAR section 4.6.2.2 indicated gasket temperatures greater than the reported *[withheld per 10 CFR 2.390]* allowable temperature. Provide the justification for allowing the gaskets to exceed the manufacturer’s operating limit, including any basis for short term use.

This information is needed to demonstrate compliance with 10 CFR 72.236(f).

RAI-Th-11 Clarify and discuss how the increased area of the fins was considered when imposing insolation boundary conditions during normal conditions and for the increased radiation heat transfer during engulfing fire accident conditions.

SAR section 4.4.2.3 indicated that the package’s radial fins were not explicitly modeled; rather, a surface enhancement factor was applied to the heat transfer coefficient at the model’s corresponding unfinned surface. However, there was no discussion regarding the increased thermal input to the fin’s additional area from insolation during normal conditions and the increased radiation heat transfer during the fire accident condition.

This information is needed to determine compliance with 10 CFR 72.236(f).