Structural RAIs For CASTOR geo69 Storage System

RAI-St-1 Provide a comparison between the American Society of Mechanical Engineers (ASME) design codes used in the CASTORGeo69 component design to those suggested in NUREG-3854.

The package design uses the guidance in NUREG-6407 to establish the importance to safety significance of the package components. NUREG-3854 assigns ASME design codes to the components consistent with their safety significance to the package. The methodology allows for a graded approach to package component design acceptable to the review staff.

This information is required to demonstrate compliance with 10 CFR 72.128(a)(3) for containment and 10 CFR 72.128 (a)(3) for shielding, and 10 CFR 72.124(b) for criticality.

RAI-St-2 For Safety Analysis Report (SAR) Table 3.10-55, Table 3.10-56, and Table 3.10-57, provide cross-references to Chapter 4 SAR Table 4.3-1, Table 4.6-2, and Table 4.7-4 to establish that the temperatures used in the stress analysis of the components are consistent with those from the thermal analysis.

A comparison of the listed temperatures in SAR Table 4.3-1 (Normal Conditions of Storage (NCS) and off normal conditions), Table 4.6-2 (fire condition), and Figure 4.7-4 (vacuum drying condition) indicated that the temperature considered in SAR Table 3.10-55 (Appendix 3-2) was lower than those established in the summary tables of thermal analysis in SAR Chapter 4. This does not provide assurance that the mechanical material properties and the temperatures used in the structural analysis in SAR Chapter 3 used the thermal conditions identified in Chapter 4.

This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-3 Provide allowable accident condition temperatures for all structural components identified in SAR Table 4.3-1, including shielding components in the appropriate Tables in Chapter 3.

A review of the Tables in Chapter 4 which summarize the results of the thermal analysis indicated that for many of the components in SAR Table 4.3-1 the accident condition allowable temperatures are not identified in SAR Table 3.10-55. This prevents the capture of the influence of the calculated temperatures on the mechanical material properties and thermal stresses evaluated in the structural analysis in SAR Chapter 3 for this load condition.

This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-4 Provide reference to the Chapter 7 pressure analysis Tables from which the design pressures values are introduced in the design under the different loading conditions (normal, off normal and accident).

This will ensure that the pressure evaluation results are incorporated into the design stress analysis to establish structural integrity under all required load conditions. This prevents the capture of the influence of the calculated temperatures on the mechanical material properties and thermal stresses evaluated in the structural analysis in SAR Chapter 3 for this load condition. This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-5 Design Dwg: 1014-DD-36931 Sht. 1/1 show a *[withheld per 10 CFR Part 2.390]* gap between the canister lid and top of fuel basket, and a *[withheld per 10 CFR Part 2.390]* gap between the canister body and basket shielding elements (1040-DPL-36855). Provide information on how these gaps are treated in the Finite Element Model (FEM) and their influence on the drop analysis results.

This information is required to capture the interaction between the canister and the fuel basket, and the ability of the fuel basket stacked grid elements to maintain their configuration during drop scenarios.

The information is required to demonstrate the structural integrity of the fuel basket in support of the criticality safety function required by 10 CFR 72.124(b).

RAI-St-6 Clarify which dimension (*[withheld per 10 CFR Part 2.390]* gap) is used in the FEM which is analyzed to determine the stress and strains in the fuel basket elements.

1014-SR-00002 Section 5.2 indicates that the gap between the canister and the fuel basket is *[withheld per 10 CFR Part 2.390]* while Design Dwg: 1014-DD-36931 Sht. 1/1 shows a *[withheld per 10 CFR Part 2.390]* gap between the canister body and basket shielding elements (1040-DPL-36855).

The information is required to demonstrate the structural integrity of the fuel basket in support of the criticality safety function required by 10 CFR 72.124(b).

RAI-St-7 Explain how the load in the gasket is computed for the assembly State.
In SAR section 3.1.2.8 it is stated that prior to the application of any external loads to the FEM, the bolting stress for the assembly State is added as bolt preloads and gasket forces (represented by gasket elements in the FEM).

The staff did not find an explanation like that presented for computing the bolt preloads for the gasket loads in the SAR. The staff needs an understanding of the initial State of the gasket to ensure that the performance of the gasket as a seal is maintained through the application of the external loads.

This information is required to demonstrate the structural integrity of the cask and canister seals in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-8 Provide simulation results that demonstrate that the material models used in the fuel basket analysis can duplicate the results of the material test data.

In a drop test the material performance is confirmed by the drop test, the results of the drop test confirm the behavior of the material over the range of the load demand. Since the applicant has relied solely on simulation, the staff needs confirmation that the selected material models can duplicate the entire range of performance demanded of the material. This is especially true for the accumulation of strain in the computation for instability.

This information is required to demonstrate the structural integrity of the fuel basket in support of the criticality safety function required by 10 CFR 72.124(b).

RAI-St-9 Provide a comparison of the acceptance criteria and methodology of analysis used from KTA to those found in ASME codes in the design of components important to safety (in this case the fuel basket).

CASTORGeo69 is to be licensed for use in the US. The regulatory review staff are familiar with the codes and standards used in the US regulatory environment and the supporting guidance documents. As a result, the staff finds it difficult to draw a ready comparison between the U.S. and German and European standards used in the application, significantly increasing the required regulatory review time and effort.

This information is required to demonstrate the structural integrity of the fuel basket in support of the criticality safety function required by 10 CFR 72.124(b).

RAI-St-10 Provide a comparison of the results of bolt pre-loads analyzed using the guidance in NUREG/CR- 6007 with those obtained using VDI 2230 and KTA 3201.2 in the SAR.

The staff is unfamiliar with the guidance provided in VDI 2230 and KTA 3201.2 for bolt preload computations. NUREG-6007, “Stress Analysis of Closure Bolts for Shipping Casks,” is used by the staff in the review of closure bolts. The information provided by the requested comparison will allow the staff to evaluate the acceptability of the computed values in meeting the requirements of the US regulatory practices.

This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-11 Provide an explanation of the methodology and the acceptance criteria used in the stripping analysis of the lifting bolts as per KTA 3201.2.

The stripping of the bolts threads is a viable failure mechanism under this loading condition. However, the staff is not familiar with the design methodology of KTA 3201.2. Either a parallel can be drawn to a U.S. code of practice or discussion is needed for the staff to evaluate the analysis performed and its acceptability using an U.S. code of practice.

This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-12 Show the equivalence of using the VDI 2230-2 to compute the force in the trunnion connection bolts to that of a U.S. design code.

The staff reviews designs based on the design codes provided in NUREG/CR-3854, "Fabrication Criteria for Shipping Containers." For example, in this case, the reviewer would likely be guided to the use of ASME Section VIII, Division 1, or ASME Section III, Subsection NF, for an acceptance criterion and the methodology in ANSI N14.6 for bolt stress analysis.

This information is required to demonstrate that the structural integrity of the trunnion connection bolts meets the requirements of 10 CFR 72.122 (h)(5) and is consistent with the functional objectives in NUREG- 0612.

RAI-St-13 Identify conditions where LS–DYNA was used in the analysis of CASTORgeo69 storage cask.

The applicant, in the SAR Chapter on descriptions, states that no handling accidents are considered as all handling operations are conducted used single-failure-proof cranes. The only dynamic condition considered in the storage cask analysis is the non-mechanistic tipover which is performed using the Electric Power Research Institute (EPRI) guidance documents. Knowing which computer code was used for the analysis is needed to determine the appropriateness of the finite element properties used in the analysis.

This information is required to demonstrate the structural integrity of the cask and canister in support of the containment safety function required by 10 CFR 72.128(a)(3).

RAI-St-14 Explain the conversion of the FA and component weight into inertial loads and its application as *[withheld per 10 CFR Part 2.390]* elements in the fuel basket FEM.

The fuel basket is not modeled in its entirety. The FA weights and effect of the deceleration forces are computed and applied to the FEM to capture the effect of the FA in the structural response of the fuel basket grid. A clear understanding of the representation of the inertial forces in the FEM is critical for understanding of the subsequent response analysis of the fuel basket.

This information is required to demonstrate the structural integrity of the fuel basket in support of the criticality safety function required by 10 CFR 72.124(b).