Orano Federal Services Non-Proprietary Response to Request For Supplemental Information for the Review of the Model No. CR3MP Package

RSI-1. Provide the information that was used to determine the package's fixed and loose surface contamination activities reported in the application.

The premise of the containment analyses was a surface contamination value. SAR Section 1.2.2.3 and Section 5.2 indicated that surrogate data and empirical samples were used to estimate the surface contamination. A detailed discussion of the data and empirical samples that demonstrate the bounding nature of the dispersible activity (which includes fixed and loose surface contamination) was not provided.

This information is needed to determine compliance with 10 CFR 71.47(b), 71.51(a)(b).

Response:

A conservative estimate of surface contamination activity within the CR3MP is based on samples from both primary Reactor Coolant System (RCS) piping coupons and RCS leakage throughout the CR3 plant in conjunction with the calculated wetted surface areas of the packaged reactor pressure vessel (RPV) and internals (RVI). Once the reactor is opened up for inspection, and prior to shipment, this estimated activity will be verified to be within the bounding application activity based on confirmatory sampling and surveys.

Since the interior of the RPV/RVI is currently inaccessible, surrogate data was used to develop a contamination activity estimate. RCS piping coupons were chosen as surrogates based on sharing a similar operating environment (temperature, pressure, duration) as the RPV/RVI. The contamination distribution contains a comprehensive variety of radionuclides consistent with plant operating history. Periodic confirmatory sampling of wastes is performed, ensuring the radionuclide distribution is within applicable guidelines such as the NRC's branch technical position papers on waste classification. The estimated surface contamination was derived by an evaluation of all available RCS systems. These RCS systems were surveyed for segmentation, packaging and disposal. As mentioned above, the contamination activity will be empirically verified prior to shipment to be within the bounding Curie value.

RSI-2. Provide the supporting information that justifies the hydrogen concentration produced in the package and address relevant analyses that were not provided or considered.

The focus of the application's hydrogen generation calculation was the effect from grout, which is introduced into the RPV after it is drained of water, according to SAR Section 1.2.2.2. Specifically, Section 5.4.4 of the application stated that the analysis was based on the gas generated per energy absorbed parameter (G) for the cement-based grout. However, the radiolysis discussion did not address the following considerations:

a. The application did not quantify free (unbound) water within the package or address that free water often forms during processes that use cement. The radiolysis analysis should consider the effects of unbound (free) water, recognizing that water (liquid, vapor) has a (G) value of approximately 0.45 molecules/100 eV (gamma), which is much higher than the SAR's stated (G) value for grout (0.02 molecules/100 eV (gamma)).

b. The application referenced a paper (Dole and Friedman, 1986) when determining the grout's (G) value. However, other papers (see EPRI NP-5977, September 1988) have indicated (G) values ranging from 0.11 to 0.35 molecules/100 eV. There was no discussion that justified the use of the Dole and Friedman (G) value (0.02 molecules/100 eV) for the CR3MP grout rather than other values (e.g., 0.35 molecules/100 eV).

c. According to Section 5.4.4 of the application, the radiolysis calculation only considered the effect of gamma energy because it represented the majority of the content's energy; other types of radiation energy (e.g., alpha) accounted for 4% of the total. The impact on the radiolysis calculation from the other energy components may not be negligible because the application's cited radiolysis document (Dole and Friedman, 1986) noted that the grout's (G) value for alpha energy potentially could be approximately 23 times greater than the gamma energy-related (G) value.

This information is needed to demonstrate compliance with 10 CFR 71.43.

Response:

In response to sub-item (a), the RPV will be drained prior to the grouting process. Prior to grouting, RVI within the CR3MP payload will be free of any significant standing water or puddles. During the grouting process, grout flowability and placement will be controlled to ensure grout infiltrates all locations within the CR3MP payload. Any free water present prior to the grouting process will be absorbed as part of the grout curing and is accounted for in the applied grout G-values. As noted in response to item (b), the revised G-values are based on concrete of similar composition and properties as the CR3MP grout.

As part of the grouting process, various admixtures will be added to the grout which may not be reflected in available G-values for concrete. These admixtures contain additional water (which is not bound to the concrete mixture) and other highly-hydrogenous compounds. As a result, these admixtures may generate hydrogen gas at elevated rates relative to the bulk grout. Admixtures of concern have been identified and associated G-values incorporated into the SAR, ensuring that the radiolysis analysis accounts for all gas-generating materials.

In response to sub-item (b), it is acknowledged that the G-values stated in BNL-NUREG-50957, which is the underlying basis for the noted G-values summarized in EPRI NP-5977, is a suitable match for the CR3MP grout. These experimentally-derived G-values correspond to Co-60 gamma irradiation of Portland type II cement of similar characteristics. The experiment is highly-correspondent to CR3MP grout in radioactive source and material composition while the CR3MP grout absorbed dose falls within the range of the experimental data. Due to the similarity and increased conservatism resulting from the use of higher G-values, the radiolysis analysis has been revised to use grout G-values derived from BNL-NUREG-50957.

In response to sub-item (c), nearly all of the radiation energy emitted by the CR3MP payload is due to Co-60. For Co-60 specifically, 96.3% of the radiation energy emitted is gamma radiation while the remainder is beta radiation. No significant amount of alpha radiation from other isotopes should be expected since the payload does not contain nuclear fuel waste (i.e., no common alpha emitters such as actinides).

The range of Co-60 beta radiation in steel is over 100 times lower than the mean free path of Co-60 gamma radiation. Therefore, beta radiation is conservatively treated as gamma radiation. Since the range of beta radiation within the steel source material is extremely low, thus the vast majority of emitted beta radiation will not escape the steel RPV/RVI. As a result, the vast majority of beta radiation energy will be deposited in the steel RPV/RVI rather than any gas-generating materials. By treating the total beta radiation energy as gamma radiation, the calculated energy deposited in gas-generating material is conservatively high.