Thermal Clarification Question #1: Provide in section 4.5.11 of the final safety analysis report (FSAR): 1) the effect of the helium convection contribution to the boiling calculation in the FSAR, and 2) the uncertainty and its contribution to the estimate of boiling for the correlation used in section 4.5.11 of the FSAR. In addition, for the bounding dry shielded canister (DSC) provide the following information in sections 4.5.11 and 9.1.3 of the FSAR: description of the removal, or bleeding, of the hotter water from the transfer cask (TC) / DSC annulus, including the flow rate, and the replenishment with cooler water, including the cooling water temperature and DSC wall temperature, if needed to be implemented quickly during an unforeseen excursion.

Although the contribution due to helium and rapid boiling in the TC/DSC annulus was discussed in section 7.3 of proprietary calculation No. 503948-0405, "Thermal Evaluation of EOS-37PTH in EOS-TC125 During the Vacuum Drying Process for the 2019 Davis Besse Dry Cask Loading Storage Campaign," the calculation in section 4.5.11 of the FSAR did not include the effect of the helium convection contribution. In addition, heat transfer correlations have uncertainties associated with them, the uncertainty, and its contribution to the estimate of boiling were not included in section 4.5.11 of the FSAR for the heat transfer correlation that was used. Including these effects should result in a calculation that better reflects the rapid boiling that took place at Davis Besse.

Section 4.5.11 of the FSAR, pages 4-100 and 4-102, describes that the water in the annulus is monitored and replenished with fresh water. That is in part consistent with section 9.1.3, "DSC Drying and Backfilling," of the FSAR, which states, "CAUTION: During performance of steps listed in Section 9.1.3, monitor the TC/DSC annulus water level and replenish if necessary.," and in addition states, "In addition, a feed and bleed system with continuous flow of fresh water can also be used to control the boiling of annulus water for high heat load systems." In a feed and bleed system, the removal of hotter water from the annulus can aide in controlling rapid boiling of annulus water for high heat load systems so that the annulus water remains in the natural convection regime of a boiling curve.

Boiling of annulus water was demonstrated at Davis Besse where rapid boiling occurred in the TC/DSC annulus, where an approximately ½ inch gap area between the spent fuel canister and transfer cask began to rapidly boil during the loading of DSC No. 9 with a heat load of 46.4 kW. A feed system was in place rather than a feed and bleed system. An issue with boiling is that one does not know *a priori* the boiling regime that will occur due to unknown conditions that can exist (e.g., the effect of helium convection contribution), or unforeseen excursions. Details of the feed and bleed system to control boiling (as mentioned above), including the system's design parameters, the calculations for determining those parameters (e.g., flow rate and water temperature (inlet and outlet)), and the basis for those calculations, should be provided in chapters 9 and 4, respectively, if needed to be implemented due to unknown conditions that can exist, or very quickly during an unforeseen excursion. Not being dependent upon nucleate boiling during operations can add margin to operations.

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

Response/Discussion: TN discussed relying on operational experience. TN stated that rapid boiling has not occurred since implementing the additional operational control to limit the external pressure such that the pressure cannot fall below 0.75 Torr. The U.S, Nuclear Regulatory Commission (NRC) staff noted that the operational experience was not necessarily at the bounding decay heat. Also, TN has implemented the additional operational control to introduce helium in a step wise manner. The NRC staff noted that a step wise introduction of helium is a new feature that has not been addressed. For example, introduction of helium control was not quantified or specified in the Operations chapter of the SAR nor was its relevance to minimize heat flux to the DSC boundary discussed. Likewise, The NRC staff noted the importance of water being in contact with the DSC boundary when exposed to high internal heat flux; currently the SAR does not specify the water level to cover the DSC (i.e., “add water from the top as required”) and, in fact, indicates that water level can be 12 inches below the top of the DSC. TN stated that based on the margins, the uncertainty is of less importance. The NRC staff noted that the uncertainty of the convective heat transfer should be quantified, then the staff can have a better idea if it is of less importance. TN stated that their analysis with no water in the annulus is conservative, and therefore, when there is water in the annulus, the water will remain within the nucleate boiling regime, or below. However, NRC staff asked if the condition with no water in the annulus is really a bounding condition (to prevent another event like what happened at Davis Besse, which demonstrated the EOS system decay heat is such that the DSC boundary/shell (for example, in a focused region) can be exposed to a high convective flux from the entering helium after it passes across the fuel rods). The NRC staff noted that because boiling occurred, that could indicate that the heat flux was higher (by orders of magnitude) than calculated in the SAR change pages. TN noted that the high heat flux is a short-term phenomenon, and the thermal inertia of the water, cask, and cask lid is large. The NRC staff noted that analysis with the convective heat transfer contribution of the helium and the uncertainty of the heat transfer correlation has not been provided for the system. TN can clarify in their supplemental response to Observation 4-9.

The NRC staff asked if the analysis is the licensing basis, and the operational controls are defense in depth, or if TN is relying on the operational controls to limit rapid boiling. The NRC staff noted that if the analysis is the licensing basis, then the operational controls are defense in depth; however, if operational controls are used to limit boiling, then the operational controls need to be described. The NRC staff is not convinced that the analysis is the bounding case (concern is with the high heat fluxes that can occur to the DSC shell), and that the analysis without water in the annulus is not representative of what occurred at Davis Besse. The basis/analysis is needed to predict what the DSC shell temperature would be if high heat fluxes occur (particularly if there is no water in the annulus). The NRC staff asked if a temporal-spatial analysis (e.g., CFD) was performed to understand how entering helium flowed across the fuel rods (which transferred heat to the helium) and transferred energy to the DSC boundary. The response was no. TN suggested to provide an analysis that clarify the operational basis and the licensing basis in the SAR. TN also suggested to provide an analysis to include helium introduction.