Background: Preferential Fuel Loading

Preferential Fuel Loading (HI-STAR 100 CoC 1008 Amendment 2, Appendix B, Section 1.1.2) requires that fuel assemblies with the longest post-irradiation cooling times shall be loaded preferentially into MPC fuel storage locations at the periphery of the basket. Fuel assemblies with shorter post-irradiation cooling times shall be placed toward the center of the basket. It is required whenever fuel assemblies with significantly different post-irradiation cooling times (≥ one year) are to be loaded in the same MPC.

The basis for this requirement, originally provided in the HI-STAR Topical Safety Analysis Report (TSAR) that was used as a basis for draft HI-STAR 100 Storage CoC Amendment 0, is to prevent a cooler assembly (assembly differing by ≥ one year of post irradiation cooling time) from heating up due to being surrounded by less-cooled fuel assemblies generating more decay heat. This is based on the fact that the heat-up phenomenon can only occur with significant differences in decay heat emission characteristics between adjacent fuel assemblies having different post-irradiation cooling times.

The Preferential Fuel Loading requirement basis was removed from the TSAR prior to issuance of Revision 10, which is referenced in HI-STAR 100 Storage CoC 1008 Amendment 0. However, due to an oversight, the Preferential Fuel Loading requirement remained in the CoC from Amendment 0 through Amendment 2, with no bases or supporting analyses in the TSAR and subsequently the Final Safety Analysis Report (FSARs).

With no basis for the Preferential Fuel Loading requirement in the CoC, Holtec elected to remove this requirement in CoC Amendment 3 via a minor editorial change that was not captured in the Summary of Proposed Changes. However, since as mentioned above, there was a basis for this requirement in the TSAR prior to issuance of Amendment 0, for "completeness", below is a summary of Holtec's justification for removing Preferential Fuel Loading from CoC 1008 Appendix B. It should be noted that the justification below is more for "completeness" of the CoC change process than safety, since there is no basis for this requirement in issued CoC 1008 Amendments 0, 1 and 2 and the related TSARs and FSARs.

Proposed Change

Delete CoC 1008 Appendix B, Section 1.1.2, "Preferential Fuel Loading"

Reason for Proposed Change

The Preferential Fuel Loading requirement is not supported by analysis in the HI-STAR 100 Storage FSAR, and is not required, since the safe loading of the system is ensured by other requirements in the technical specifications. Therefore, this requirement could result in misunderstanding of the CoC loading requirements by users.

Justification

The proposed change does not impact analyses in the HI-STAR FSAR. The justifications below convey why the change does not have an impact on specific areas of analyses in the FSAR that serve as bases for CoC requirements.

Thermal

The thermal requirements for the HI-STAR 100 Storage System, including fuel cladding, as described in Chapter 4 of the HI-STAR FSAR, are not impacted by this change. Temperature limits for system components are not impacted. Thermal analyses are performed with Multi-Purpose Canisters (MPCs) uniformly loaded at design basis heat load. All storage locations in the MPC are assumed to have fuel assemblies at maximum decay heat analyzed, regardless of actual decay heat during loading due to post-irradiation cooling. Cooler assemblies are assumed to be at higher (design basis) heat loads without regard for location. Therefore fuel cladding temperature analysis and criteria are not impacted, if the Preferential Fuel Loading requirement is not in CoC. The heat load requirements previously analyzed and approved are unchanged with removal of the preferential fuel loading. Users must still comply with these heat load requirements.

However, it is noted that HI-STAR 100 FSAR Proposed Rev. 4, Section 4.4.1.1.16 on thoria rods canisters mistakenly references preferential fuel loading in the technical specifications. The reference to "preferential" is hereby removed in HI-STAR 100 Proposed Rev. 4D (Enclosure 3 to Holtec Letter 5014864), and Appendix B (Table 1.1-1) of the CoC is hereby updated (Enclosure 2 to Holtec Letter 5014864) for MPC-68/68F to require loading of thoria rod canisters toward the basket periphery in alignment with FSAR Proposed Rev. 4D, Section 4.4.1.1.16. This change to the CoC ensures the thoria rod canister loading requirements remain unchanged.

Structural

The proposed change does not impact the weight, dimensions or temperature requirements for structural components of the system in Chapter 3 of the FSAR. The fuel cladding and other component temperatures employed during structural analyses remain bounding for normal, off-normal and accident conditions. Therefore the structural analyses for the system components and fuel assemblies are unaffected by this change.

Shielding

Shielding analysis in Chapter 5 of the FSAR demonstrates dose rates as a result of varying burnup, enrichment and cooling combinations. As such, Preferential Fuel Loading, as described in HI-STAR 100 Amendment 2 CoC Appendix B TS Section 1.1.2 is not supported by shielding analysis, since a lower cooling time (any location in the fuel basket/MPC) may not equate to higher dose rates, depending on burnup and enrichment, and vice versa. The FSAR dose rate calculations are not based on any preferential loading, but on uniform loading. Sites are required to perform dose analysis based on their specific fuel loading configuration. Therefore this change does not impact shielding analysis.

Criticality

Preferential Fuel Loading with longer cooled fuel on the basket periphery is not considered in the criticality analysis of the HI-STAR 100 FSAR, since cooling time and burnup are not credited. Assemblies are assumed to be loaded as fresh fuel. Therefore removal of this requirement does not impact criticality.

Confinement

Confinement of the radioactive materials in the HI-STAR 100 System is provided by the MPC. The design of the HI-STAR 100 MPC assures that there are no credible design basis events that would result in a radiological release to the environment. Since the thermal and structural requirements for the HI-STAR 100 System as a whole and the MPC specifically, including temperature and pressure requirements, are not impacted by this change, confinement evaluation and criteria remain bounding.

Operations

The proposed change to remove Preferential Fuel Loading does not impact fuel loading, storage and unloading operations, as described in Chapter 8 of the HI-STAR 100 FSAR, since it is not required per analysis. No specific procedures for Preferential Fuel Loading are included in the FSAR.