HOLTEC NON-PROPRIETARY INFORMATION

Response to 2nd Request for Additional Information
Holtec International
Docket No. 71-9373
HI-STAR 190 Transportation Package

Chapter 2 – Materials Evaluation

NRC RAI 2-1

2-1 Justify the adequacy of the proposed sampling process using MIL-STD-105 for reasonably demonstrating that MPCs, with degraded conditions exceeding surface defects equal to or greater than 2mm depth, will be identified prior to transport.

In response to RAI 2-8, dated April 8, 2016, the applicant stated that the MPC enclosure vessel shell shall undergo a surface defect inspection prior to shipment to ensure that existing defects and flaws do not develop into cracks during hypothetical accident conditions of transport. The applicant further stated that this inspection may be conducted on the population of MPCs at an Independent Spent Fuel Storage Installation (ISFSI) using a statistical testing approach suggested in Military Standard MIL-STD-105E (1989) titled "Sampling Procedures and Tables for Inspection by Attributes". The applicant clarified that not every MPC at a given ISFSI requires inspection.

However, the applicant did not provide a basis for the adequacy of the proposed standard guide for reasonably demonstrating that MPCs, with degraded conditions exceeding the proposed acceptance criteria, are adequately identified prior to transport.

This information is required to determine compliance with 10 CFR 71.71 and 71.73.

HOLTEC RESPONSE TO RAI 2-1

In order to ensure the nuclear pedigree of the sampling process for the selection of MPCs to be eddy current tested (ECT), we propose to commit to the same statistical approach (the same tiering system) used for selection of coupons for the production coupon testing program of Metamic-HT neutron absorber for ensuring Minimum Guaranteed Values are met. This tiering system, which is based on Military Standard MIL-STD-105E [8.1.11], was initially developed and implemented by Holtec International in 2009 to ensure important to safety characteristics of Metamic-HT material. This tiering system continues to be implemented successfully with the large scale production of Metamic-HT. To strengthen the justification for using a sampling process, we also propose to perform eddy current testing on all ISFSI lead canisters identified by the ISFSI's Part 72 aging management program. Lastly for completeness and to maintain reasonable assurance during implementation of the MPC inspections, we propose to set an expiration date of 5 years on the transport approval for MPCs that have met the acceptance criteria for ECT. The proposed changes have been incorporated in SAR Revision 0.D (provided with this RAI response) and include the following:

SAR Subsection 8.1.8 has been revised to reflect the aforementioned proposed commitments and includes reference to Table 8.1.11 for the specification of the tier system for MPC selection for eddy current testing. Table 8.1.11 proposes the same tiering system specified in Table 8.1.4B used for Metamic-HT production coupon testing except with more stringent requirements specified in the table notes. A Lot of MPCs is defined in Table 8.1.11. The user may elect to perform ECT on every MPC in a lot instead of using the statistical approach for the selection of MPCs to be ECT'd. See SAR Subsection 8.1.8 and Table 8.1.11 for details.

Further complementary changes are also proposed in Section 1.0, Subsection 7.1.2, Appendix 7.B, Table 8.2.1 and Table 8.A.1. Lastly, in connection with NRC RAI 2-3, the limitation for the initial 20-year storage period has been removed. However to facilitate a smooth transition between storage of MPCs at an ISFSI and transportation shipments of MPCs shortly after initial storage, MPCs containing high burnup fuel and stored under the provisions of 10CFR72 for an initial duration of 5 years or less do not require the MPC enclosure vessel shell surface defect inspection specified in SAR subsection 8.1.8 and Table 8.2.1.

NRC RAI 2-2

2-2 Revise the application to include the referenced engineering evaluation (technical bases) in response to RAI 2-10 regarding the radiation hardness of the elastomeric seals.

In response to RAI 2-10, dated April 8, 2016, the applicant stated: "Holtec has performed an engineering evaluation to establish bounding maximum service life limits for the elastomeric seals used in HI-STAR 190. A maximum replacement duration based on the evaluation is added to SAR table 8.2.1. SAR Sections 2.2.3, and 8.2.3.6 are updated to include discussions of elastomeric seals." The referenced engineering evaluation is not cited in the revised application.

This information is required to determine compliance with 10 CFR 71.43(d).

HOLTEC RESPONSE TO RAI 2-2

The referenced engineering evaluation, Holtec Proprietary Report HI-2146294, "Shielding Analysis for the HI-STAR 190 Cask" latest revision, has been added as reference [5.0.7] in Chapter 5 of SAR Revision 0.D. SAR Paragraph 8.2.3.6 and Table 8.2.1 have been revised with proposed changes to identify the conditions that require seal replacement "seal remains free of debris, there are no tears or gouges that occurred during lid or port cover plate removal, and there is no evidence of excessive compression set (i.e., seal projects past the plane of the top seating surface of seal groove)."

NRC RAI 2-3

2-3 Revise the application to require inspection of MPCs loaded with high burnup fuel (HBF). Revise the application to require MPCs loaded with HBF in their initial storage period to also be inspected for unacceptable defects due to age-related degradation.

In response to RAI 2-10, dated April 8, 2016, the applicant revised the application to require that MPCs containing HBF *and* stored beyond the duration of the initial 20-year

storage period under the provisions of 10 CFR Part 72 shall undergo an MPC enclosure vessel shell surface defect inspection prior to shipment, according to Appendix 7.B. The application, however, does not provide a technical basis that assures MPCs loaded during the initial 20-year storage period will be free of defects exceeding the proposed 2mm depth acceptance criterion.

Therefore, the staff expects that the proposed surface defect inspections will also be performed in MPCs loaded with HBF per a justified sampling process irrespective of their storage period, i.e., MPCs loaded under their initial storage period (up to 20 years per current CoC 1032 and CoC 1040) as well as those under any renewed storage period (beyond 20 years up to 60 years).

This information is required to determine compliance with 10 CFR 71.55(e), 71.73 and 71.85(a).

HOLTEC RESPONSE TO RAI 2-3

The SAR has been revised to remove the limitation of the initial 20-year storage period. See Holtec response to RAI 2-1 for full details.

NRC RAI 2-4

2-4 Revise the application to remove all referencing to a ductile-to-brittle transition temperature for the various zirconium-based cladding contents, and clarify that the proposed licensing basis relies on defense-in-depth analyses assuming justified cladding failure and fuel reconfiguration.

The proposed technical basis for a ductile-to-brittle transition temperature (DBTT), as discussed in response to RAI 8-2, is inadequate and insufficient. The discussion does not support adequate DBTTs with reasonable confidence, e.g. demonstrate with 95% confidence that the proposed DBTT values bound the 95th percentile of the DBTT statistical distribution in the reviewed data.

Further, the applicant's conclusion that "M5® cladding studies show that due to low hydrogen absorbed content the alloy keeps a significant residual ductility and it is expected that the DBTT for M5 alloy will be bounded by DBTT reported for Zircaloy" is inconsistent with the existing database of ring compression testing of M5®.

The staff, however, notes that an approach using DBTT test data is not required if safety analyses are performed assuming fuel reconfiguration based on 3% and 100% (or a justified %) cladding failure for normal conditions of transport and hypothetical accident conditions, respectively [see draft Regulatory Information Summary - ADAMS Accession No. ML14175A203]. These analyses are already part of the application per Table 1.2.4 of the application, "Multi-Layered Approach for Transport Safety for HBF." Therefore, the DBTT discussion is not necessary per Enclosure 2, "High Burnup Fuel Transportation Licensing Approach," of the draft RIS.

This information is required to determine compliance with 10 CFR 71.71 and 71.73.

HOLTEC RESPONSE TO RAI 2-4

In lieu of the approach using DBTT test data, an approach that relies on defense-in-depth analysis assuming justified cladding failure and fuel reconfiguration is adopted as the proposed licensing basis for HBF transportation consistent with Enclosure 2 of the draft Regulatory Information Summary (RIS 2015-XX) - ADAMS Accession No. ML14175A203. Moreover the safety analyses that is already part of the SAR assumes fuel reconfiguration based on 3% and 100% cladding failure for normal conditions of transport and hypothetical accident conditions, respectively as endorsed by the draft RIS 2015-XX and as already reflected in Table 1.2.4 of the SAR. The proposed approach allows the transportation of uncanned HBF "that has been in dry storage" or via "direct shipment from the pool".

All referencing to ductile-to-brittle transition temperature for the various zirconium-based cladding contents proposed in Chapters 2, 7 and 8 of the SAR by response to RAI 8-2 has been removed from the SAR. The discussion proposed in Section 2.11 of the SAR has been replaced with a discussion in-line with the defense-in-depth approach described above. Footnote No. 4 of Table 1.2.4 of the SAR has been revised in-line with the defense-in-depth approach described above. RIS 2015-XX has been added to Section 1.7 of the SAR as reference [1.2.13]. References [2.11.13] through [2.11.15] have been deleted from Section 2.12 of the SAR. Section 7.0, Subsection 7.1.2, Appendix 7.B, Subsection 8.1.9, Table 8.1.11, and Table 8.2.1 of the SAR contain proposed changes to remove the DBTT approach.

Chapter 3 - Thermal Evaluation

NRC RAI 3-1

3-1 Revise the convergence index (GCI) calculation using non oscillating results from the different grids to demonstrate that they are in the asymptotic region. Show that an order of accuracy larger than 1 can be used to obtain the GCI.

Section 3.3.1.6 of the SAR states that "*It is demonstrated in the GCI calculation that the calculated peak cladding temperatures are in the asymptotic region for the simulation series.*" However, the staff examined the results provided in calculation package (Holtec Report HI-2146286) and observed the calculated results are oscillating. Therefore, oscillating results can't be used to demonstrate asymptotic convergence. Procedures to demonstrate asymptotic convergence are provided in American Society of Mechanical Engineers Verification and Validation 20-2009 (ASME V&V 20-2009), "Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer". Also an order of accuracy larger than one (equal to the calculated value) can be used to obtain the GCI as long as the criteria specified in ASME V&V 20-2009 are met: "*A minimum of four grids is required to demonstrate that the observed order p is constant for a simulation series. A three-grid solution for the observed order p may be adequate if some of the values of the variable φ predicted on the three grids are in the asymptotic region for the simulation series.*" Otherwise first order of accuracy should be used in the GCI calculation. The staff needs this information to evaluate the accuracy of the discretization error and its impact on predicted thermal results.

This information is required to determine compliance with 10 CFR Part 71 (71.71 and 71.73)

HOLTEC RESPONSE TO RAI 3-1

Statement in Section 3.3.1.6 of the SAR is revised to remove the discussion on asymptotic convergence and the GCI calculation is revised using first order of accuracy. GCI is now calculated as 0.516%. The estimated error in peak fuel cladding temperature is calculated as 3.3 K. The revised calculation is documented in Appendix D of HI-2146286R3. The discretization error is small compared to the available safety margins. All conclusions made in Chapter 3 of the SAR remain unchanged.

Chapter 5 – Shielding Evaluation – PROPRIETARY QUESTIONS

Holtec response to Proprietary Questions withheld per 10CFR2.390

Chapter 7 – Package Operations

NRC RAI 7-1

7-1 Revise Chapter 7, "Package Operations", of the application to clarify that the user must confirm that the analyzed configuration of stored high burnup fuel has been maintained throughout the renewed storage period of the MPC prior to transport in the Model No. HI-STAR 190 package.

The application assumes that the configuration of HBF stored in an MPC during a renewed storage period (i.e. 20-60 years) has been maintained. Although age-related degradation of the fuel is not expected to compromise the configuration of the fuel during the renewed storage period, an Aging Management Program (AMP) is expected to be in place for providing confirmation to this effect (refer to Appendices B and D in NUREG-1927, Rev. 1).

Therefore, prior to transport in the Model No. HI-STAR 190 package, the user would be expected to confirm that the general licensee implementing the approved HBF AMP has not concluded that the analyzed configuration has been compromised during the renewed period of dry storage.

This information is required to determine compliance with 10 CFR 71.55(e), 71.73 and 71.85(a).

HOLTEC RESPONSE TO RAI 7-1

Appendix 7.B and Chapter 8 (Paragraph 8.1.9.2 and Table 8.2.1) of the SAR have been revised to require the user of MPC's containing high burn-up fuel that were stored beyond the duration of the initial 20 year license period under the provisions of 10CFR 72 to confirm that the general licensee implementing the approved HBF Aging Management Program has not concluded that the analyzed configuration of the HBF has been compromised during the period of extended storage. The approved Aging Management Program is required to be specified and performed under the aegis of the HI-STORM FW FSAR (Docket # 72-1032) or the HI-STORM UMAX FSAR (Docket # 72-1040).