RAI Responses

CHAPTER 1 GENERAL INFORMATION

1-1 Clarify the references in the application regarding the MPC Enclosure Vessel Drawing No. 3923.

Drawing No. 3923 Notes 4 and 11 contain unclear references to the “SAR (Transportation)” and “FSAR (Storage)” regarding component safety classifications and ASME Code alternatives.

The staff notes that Section 1.3 of the application states that the MPC enclosure vessel drawings are the same as those used in the HI-STAR 100 drawing package; however, Drawing No. 3923 should clearly specify the sources of the referenced information, including revision numbers.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.33(a).

Holtec Response to RAI 1-1

The drawing has been updated to include reference to specific Cask Package SAR (HI-STAR 100 and HI-STAR 100MB) and Overpack FSAR (HI-STORM 100 and HI-STAR 100). For Note 4, reference to Table 2.1.17, ASME Code Requirements and Alternatives for the HI-STAR 100MB Package has been included, as this is the applicable information within the HI-STAR 100MB SAR. For Note 11, Table 2.1.18 has been added to Section 2.1.5 of the SAR to include materials and component classifications of the HI-STAR 100MB MPC. Reference to Table 2.1.18 has been included to Note 11 of DWG 3923.

Report numbers and revision numbers to the referenced SARs and FSAR are not included as the applicable information is found within the same report, HI-STAR 100MB SAR (Section 1.3 referencing Subsection 2.1.5).

1-2 Clarify the allowable contents of the HI-STAR 100MB package.

Sections 1.2.2 and 4.2 of the application state that the package may contain “canisterized damaged fuel and fuel debris”. However, Table 7.7.1 and Section 6.1.1 of the application state that the MPC-32M, as well as the F-32M and F-24M baskets, are designed only for undamaged fuel assemblies. The staff also notes that the proposed CoC references Table 7.7.1 for allowable contents, and that the drawings do not include a damaged fuel container.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(b).

Holtec Response to RAI 1-2

The HI-STAR 100MB package, containing MPC-32M, F-32M, and F-24M baskets, is currently analyzed to only contain undamaged fuel assemblies specified in Table 7.7.1. Sections 1.2.2 and 4.2 are revised such that they may reference package content of only in-tact fuel assemblies.

Chapter 2 STRUCTURAL AND MATERIALS REVIEW

2-1 Provide the materials standards and required mechanical properties for important-to-safety aluminum and stainless steel basket shims and stainless steel corner brackets.

Table 2.1.15 states that yield strength is a critical characteristic of the fuel basket supports (shims) for their function of positioning and cushioning of the fuel basket. However, the staff notes that the important-to-safety stainless steel solid shim in Drawing 11070 (HI-STAR 100MB Cask), the aluminum shims in Drawing 11084 (MPC-32M Basket), and the stainless steel corner bracket in Drawing 11084 (MPC-32M Basket) do not have any requirement for the material standard or mechanical properties. It is not clear how the material procurement will be controlled to ensure that critical yield strength properties are achieved.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.35(a).

Holtec Response to RAI 2-1

Holtec has revised the design drawings (Nos. 11070 and 11084) to specify Alloy X as the construction material for the stainless steel solid shims and stainless steel corner brackets. The aluminum basket shims are made of aluminum alloy B221 2219-T8511. Material properties of Alloy X and aluminum alloy B221 2219-T8511 are already specified in Table 2.2.4 and Table 2.2.7, respectively.

2-2 Clarify the mechanical properties or the heat treatment condition of the stainless steel used in the lifting trunnions.

Table 2.2.3 provides the mechanical properties of ASME Code SA-705 and SA-564 Grade 630 age-hardening stainless steel used in the lifting trunnions. Table 2.2.3 and the drawing in Section 1.3 specify the heat treatment condition of the alloys as H1025. However, the staff notes that the cited mechanical properties in the application are consistent with the properties for heat treatment condition H1100 (per Table Y-1 of ASME Code Section II, Part D).

This information is required by the staff to demonstrate compliance with 10 CFR 71.33 and 71.35(a).

Holtec Response to RAI 2-2

We regret that incorrect properties for heat treatment condition H1100 were used in Table 2.2.3, which has been revised to present the properties for heat treatment condition H1025. Holtec has confirmed that the trunnion lifting calculation (Calculation 1 of Holtec Calculation Package HI-2188083) supporting the HI-STAR 100MB SAR is based on the correct material properties for heat treatment condition H1025.

2-3 Clarify the fracture toughness test criteria for ferritic steels at a lowest service temperature (LST) of -29°C (-20°F) and provide justification for not performing the drop weight fracture toughness test for the containment welds.

Section 2.1.3.1 states that, for components between 4 and 12 inches of thickness and a LST of -29°C (20°F), the fracture arrest criteria of Regulatory Guide 7.12 are used to

define the fracture toughness test temperature. However, Table 8.1.5 shows that the fracture initiation criteria are used to define the test temperature for the containment top flange and inner closure lid at a LST of -29°C (20°F).

Also, Table 8.1.5 of the application states that the drop weight test for containment welds is not required. It is unclear to the staff whether the absence of this test is considered to be in conformance to the ASME Code, or if it is being proposed as a Code alternative. If it is being proposed as a Code alternative, justification should be provided.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5), 71.51(a), 71.71, and 71.73(b).

Holtec Response to RAI 2-3

The relevant sentence in Section 2.1.3.1 regarding the fracture toughness test criteria for ferritic steels at a lowest service temperature (LST) of -29°C (-20°F) has been revised to read:

Except for the top flange and the inner closure lid, components thicker than 4 inches at an LST of -29ºC (-20ºF) shall meet the Nil Ductility Transition (NDT) temperature requirement determined based on the fracture arrest criteria of Regulatory Guide 7.12 [2.1.8]. If the component thickness is greater than 4 inches and the LST is -40ºC (-40ºF), the fracture initiation criteria from NUREG/CR-3826 [2.1.17] is used to determine the required NDT temperature, "T_{NDT}". The required NDT temperatures for the top flange and inner closure lid at the LST (either -29ºC (-20ºF) or -40ºC (-40ºF)) are always determined based on the fracture initiation criteria from NUREG/CR-3826.

The USNRC staff previously agreed in a letter (Letter from Mark Lombard of NRC to Stefan Anton of Holtec International dated December 9, 2014, TAC No. LA0129) that drop weight test is not needed for transport cask containment boundary weld material.

2-4 Clarify the statement regarding the susceptibility of closure lid bolts to brittle fracture.

Section 2.1.3 of the application references NUREG/CR-1815, indicating that "bolts are generally not considered susceptible to brittle fracture". The application further states that the toughness testing of the closure lid bolts provides "additional assurance" of bolt performance.

The staff does not consider this interpretation of NUREG-1815 to be correct. NUREG/CR-1815 refers to certain cases where bolts may not be "fracture critical," meaning that, if bolts were to fail, the closure lid would still perform its design function.

Absent an analysis that demonstrates that failure of lids bolts would not affect the function of the closure lid, the staff considers bolt impact toughness testing and other mechanical tests to provide the primary assurance of the performance of the bolted connection (consistent with the ASME Code Subsection NB requirements to which the containment system is designed).

In addition, NUREG/CR-6007 provides guidance for performing stress analysis of closure bolts for shipping casks containing nuclear fuels. Section 6.2 of NUREG/CR-6007 notes that the recommended analysis method requires confirmation of bolt ductile behavior by meeting the ASME toughness testing criteria for bolts.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5), 71.51(a), 71.71, and 71.73(b).

Holtec Response to RAI 2-4

The USNRC approved HI-STAR 180, HI-STAR 180D and HI-STAR 190 SARs contain the same statement regarding the susceptibility of closure lid bolts to brittle fracture. However, for clarification, Holtec has reworded the two relevant paragraphs in Section 2.1.3 to read:

SA-564 and SA-705 are also bolt materials for the Closure lid joint (Table 2.2.2). Section 5 of NUREG/CR-1815 indicates that bolts are generally not considered as fracture-critical components. However, for additional assurance, the following additional requirements are imposed in the procurement of the bolting material:

i. Regulatory Guides 7.11 and 7.12 specify the LST of 29ºC (-20ºF) for the brittle fracture test methods (Charpy V-notch tests). Conservatively, an LST of -40ºC (-40ºF) may be selected for brittle fracture tests of SA-564 and SA-705 bolts according to Table 8.1.5.

2-5 Provide the basis for finding the calculated cumulative creep strain in the aluminum basket shims to be acceptable.

Section 2.2.1.2.3 provides an analysis of the cumulative creep strain of the aluminum basket shims and concludes that the strain does not have any adverse effect on the fuel basket geometry. However, no basis is provided for that conclusion. It is not clear to the staff what degree of strain the shims may experience before intended functions are impacted.

This information is required by the staff to demonstrate compliance with 10 CFR 71.35.

Holtec Response to RAI 2-5

The creep analysis is documented in Calculation 6 of Holtec Calculation Package HI-2188083. The creep model used in the analysis was developed by Holtec, reviewed by the USNRC and previously accepted in conjunction with the HI-STAR 180, HI-STAR 180D and HI-STAR 190 transport cask licenses, where the same aluminum basket shim material was used. A sentence is added in Section 2.2.1.2.3 to point out that the predicted cumulative creep strain (0.0228%) is negligibly small, and therefore it will not affect the basket shim's ability to support the fuel basket.

2-6 Clarify missing or incorrect information regarding the thermal properties of materials.

The application appears to have either missing or incorrect information, regarding:

- The title of Table 3.2.4 states that it provides the thermal conductivity of extruded basket shims and solid shims material. However, only data for the extruded basket shims is provided.
- Note 3 of Table 2.2.2a states that sources for thermal expansion coefficient for the SA-193 Grade B7 alloy steel bolting includes Tables TE-1 and TE-4 of the

ASME B&PV Code Section II Part D. The staff notes that Table TE-4 is associated with nickel alloys.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33(a)(5) and 71.35(a).

Holtec Response to RAI 2-6

HI-STAR 100MB SAR Tables 3.2.4 and 2.2.2a are revised to address comments.

2-7 Provide missing information that is cross-referenced in the application.

The application appears to be missing information to which the application cross-references:

- Section 2.2.1.1.6 states that the drawings in Section 1.3 provide the materials specifications for the closure lid seals. The drawings are missing that information.

- HI-STAR 100MB cask drawing No. 11070: Note 14 states that critical characteristics of the Holtite shielding materials are defined in Table 2.2.13. The staff notes that this table addresses Holtite-B only; the critical characteristics of Holtite-A are found in Table 2.2.14.

This information is required by the staff to demonstrate compliance with 10 CFR 71.31(c) and 71.33(a)(5).

Holtec Response to RAI 2-7

Note 17 has been added to Holtec drawing No. 11070 to reference Table 2.2.11 of the HI-STAR 100MB SAR for the applicable material specifications for closure lid seals. The cask shielding materials do not include Holtite-A, and therefore Table 2.2.14 is not referenced by the drawing.

2-8 Justify that the age-hardened stainless steel lid closure bolts will not be subject to overstress due to differences in thermal expansion with the closure lid.

The HI-STAR 100MB cask drawing specifies ASME SA-564 Type 630 and SA-705 Type 630 age-hardened stainless steels as potential materials for the lid closure bolts. The staff notes that the Type 630 materials have a lower coefficient of thermal expansion compared to that of the lid material (ASME SA-350 Grade LF3 alloy steel).

For example, at a temperature of 200°F, Table 2.2.2b states that the thermal expansion coefficient of the Type 630 bolting material is 6.3×10^{-6} in/in per degree F, while Table 2.2.1 states the coefficient of the lid material is 6.7×10^{-6} in/in per degree F. It is unclear if, upon installation of the lids and bolts, a greater lid expansion, upon heat-up, could overstress the bolts.

This information is required by the staff to demonstrate compliance with 10 CFR 71.51(a)(1).

Holtec Response to RAI 2-8

A new analysis has been performed to demonstrate that the age-hardened stainless steel lid closure bolts will not be subject to overstress due to differences in thermal expansion with the closure lid. This new analysis is documented in Holtec Report HI-2188083 as Calculation No. 9, and it is referred to in Section 2.6.1.2 of the updated SAR.

2-9 Provide additional justifications for the conservative arguments made for the puncture simulation scenarios.

In Section 2.7.3, "Puncture", the applicant states that for both puncture scenarios (sidewall and top-end) the results obtained from the HI-STAR 190 package analysis conservatively bound the HI-STAR 100MB because the "geometric configuration of the HI-STAR 100MB cask over pack is similar to the HI-STAR 190 package".

For the horizontal drop puncture scenario, the applicant provided, in addition to the HI-STAR 190 results, an additional calculation using the Nelms' equation to demonstrate compliance.

For the top end drop puncture scenario, the applicant stated that "… the 1-m top end drop accident is acceptable for the HI-STAR 100MB package, since the puncture resistance of the HI-STAR 100MB outer lid is almost identical to that of HI-STAR 190 in terms of lid material, thickness, total number of bolts. The heavier weight and larger lid diameter of the HI-STAR 190 package are more than enough to offset the effect of a slightly (4.3%) smaller lid thickness for HI-STAR 100MB." It is not clear to the staff how the usage of the Nelms' equation in the horizontal drop puncture scenario and the statement from the last sentence in the excerpt above, for the top end drop scenario, provide conservative arguments for both cases.

Provide additional justification as to why (i) the conclusion reached above with the methods used is in fact conservative and (ii) no additional puncture tests need to be performed for the HI-STAR 100MB.

Provide a side by side comparison in table format of the pertinent material characteristics (thicknesses, material strengths, dimension, etc.,) necessary for the puncture analysis of the HI-STAR 190 and 100MB packages.

This information is required by the staff to determine compliance with 10 CFR 71.71(c)(10) and 71.73(c)(3).

Holtec Response to RAI 2-9

The following table lists the key cask design parameters for the HI-STAR 100MB and the HI-STAR 190 transport packages that govern the outcome of the 1-m puncture drop evaluation. For the horizontal drop scenario, the 6" diameter puncture bar needs to penetrate through the outer shell, the Holtite B shielding material, and the intermediate shell layers before it can cause unacceptable puncture results. A comparison of the key design dimensions for the horizontal drop scenario indicates that HI-STAR 100MB cask has a slightly greater puncture-resisting capacity than that of HI-STAR 190 cask. Additionally, the HI-STAR 190 package is more than 40% heavier than the HI-STAR

100MB package. Thus, any potential damage caused by a 1-m horizontal drop of the HI-STAR 100MB package onto the puncture bar is bounded by that of HI-STAR 190. In addition to the above justification, Appendix F to Holtec Report HI-2188068 documents the application of the Nelms' equation (a conservative empirical formula for estimating penetration of lead backed steel plates) in the horizontal drop puncture scenario as a conservative estimate of the puncture bar penetration.

For the closure lid puncture case caused by the 1-m top end drop accident, HI-STAR 100MB closure lid bolts are subjected to significantly smaller structural challenge than that of HI-STAR 190 because of (1) the impact energy is at approximately 30% smaller than that of HI-STAR 190 package, (2) the slightly smaller closure lid diameter, and (3) identical bolt diameter, bolt material, and total number of bolts. Finally, the local damage (penetration) of the HI-STAR 100MB closure lid is also bounded by that of HI-STAR 190 because of the significantly smaller impact energy. If we conservatively ignore the small difference in closure lid diameters and assume that the puncture bar deforms elastically, the impact force is then proportional to the square root of the package weight. Namely, the HI-STAR 190 closure lid puncture force is about $(1.4)^{0.5}$ *or 1.183 times that applied to the HI-STAR 100MB closure lid, which easily compensates for the lid bending capacity ratio of* $(6.0/5.75)^2$ *or 1.089 due to the slight difference in lid thickness. Therefore, the puncture force induced primary bending stress in the HI-STAR 100MB lid is also bounded by that of HI-STAR 190.*

Lastly, no other puncture tests need to be performed for the HI-STAR 100MB since (a) the two locations analyzed are the most vulnerable locations on the cask and (b) any off-center puncture strike would cause the cask to rotate and mitigate the impact force applied to the cask. The puncture strikes evaluated in the HI-STAR 100MB SAR are also consistent with previous transport cask license applications submitted by Holtec (e.g., HI-STAR 180, HI-STAR 180D, HI-STAR 190).

[PROPRIETARY INFORMATION WITHHELD PER 10 CFR 2.390]

Chapter 3 THERMAL REVIEW

3-1 Provide the maximum NCT and HAC temperatures of the inner seal in the (i) closure lid, (ii) vent port, (iii) drain port and, (iv) test plug seal at the test port in Table S.6.2 of Report HI-2188066 for the HI-STAR 100 MB package containing the MPC-32M.

The applicant has only provided the maximum NCT and HAC temperatures for the closure lid seal in Table S.6.2 of Report HI-2188066 and did not justify that the seal temperatures of the package, predicted from the computer model, are both consistent with the package heat removal path under NCT and HAC and below their corresponding NCT and HAC limits for containment performance.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Holtec Response to RAI 3-1

Cited Report tables revised to incorporate requested temperatures.

3-2 Provide the maximum HAC fuel cladding and component temperatures of the HI-STAR 100 MB package with the MPC-32M to justify the HAC bounding correlation between the packages containing the F-32M fuel basket and the MPC-32M.

The applicant provided the maximum NCT and HAC fuel cladding and component temperatures in Tables 3.1.1 and 3.1.3, respectively, for the HI-STAR 100 MB package with the F-32M basket, and the maximum NCT fuel cladding and component temperatures, in Table S.6.2 of Report HI-2188066, for the HI-STAR 100 MB package with the MPC-32M.

Even if the HI-STAR 100 MB package containing the MPC-32M is bounded under NCT by the package with the F-32M basket, the bounding correlation may not exist under HAC because the heat flow path and direction, and the parameters used in the NCT thermal model, can be different from those used in the HAC thermal model.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73(c)(4).

Holtec Response to RAI 3-2

To address comment FLUENT model of MPC-32M package deployed to compute temperature response under HAC. The computed temperatures are evaluated in the revised SAR Chapter 3. Tables 3.1.6 and 3.1.7 added to support evaluation.

3-3 Provide the thermal expansion of the MPC-32M under HAC to justify the bounding correlation, under HAC, of the thermal expansion between the HI-STAR 100 MB packages containing the MPC-32M and the F-32M.

The applicant provided the NCT thermal expansion of the fuel and the fuel basket for both the F-32M and MPC-32M in Table S.6.9 of Report HI-2188066 and the HAC thermal

expansion of the fuel and the fuel basket only for the F-32M basket in Table S.6.10 of Report HI-2188066.

Even if the temperature rise for the package with the MPC-32M is expected to be similar to that calculated for the package with the F-32M basket, the bounding correlation of the thermal expansion under NCT may be different from that under HAC because the heat flow path, direction, and the thermal phenomena under NCT could be different from those under HAC.

Therefore, the applicant should provide the HAC thermal expansion of the MPC-32M, especially when there is a “negative” differential expansion of the fuel axially at the hottest fuel location for the package with the F-32M basket.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73(c)(4).

Holtec Response to RAI 3-3

To address comment Table S.6.20 added in revised report to incorporate HAC thermal expansion of the MPC-32M fuel basket. The expansion calculations input HAC temperatures obtained from FLUENT model of the MPC-32M package. See RAI 3-2 response.

3-4 Clarify the thermal conductivities of Holtite-A and Holtite-B used in the thermal analyses of NCT, HAC 30-minute fire, and HAC post-fire cooldown, in Table 3.2.2 and Table 3.2.12.

The applicant presented thermal conductivities of 0.25 W/m-K for Holtite-B and 0.4 w/m-°K for Holtite-A in Table 3.2.2, but stated in Note #2 of Table 3.2.12 that “During fire, no reduction in Holtite-B heat conduction effectiveness is assumed. During post-fire cooldown, conductivity of air is assumed.” It’s not clear to the staff what are the thermal conductivities of Holtite-A and Holtite-B used for thermal analyses of NCT, HAC 30-minute fire and its post-fire cooldown.

The applicant should clarify (a) the thermal conductivities of Holtite-A used in the thermal analyses of NCT, HAC fire and HAC post-fire cooldown and (b) the thermal conductivities of Holtite-B used in the thermal analyses of NCT, HAC fire, and HAC post-fire cooldown.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.71 and 71.73(c)(4).

Holtec Response to RAI 3-4

Thermal conductivities used under NCT, HAC fire and post-fire cooldown are tabulated below:

[PROPRIETARY INFORMATION WITHHELD PER 10 CFR 2.390]

3-5 Verify that the number of 120% of the maximum per cell decay heat is appropriate for the regionalized loading pattern permitted to store the hot fuel in the packages with either the F-32M basket or the MPC-32M canister.

The applicant stated in Note #2 of Table 7.7.5 that the hot fuel heat load is limited to 120% of the maximum per cell decay heat, under loading tabulated in Table 7.7.5, but did not justify that this number of 120% of the maximum per cell decay heat is appropriate for the regionalized loading patterns permitted in the packages with either the F-32M basket or the MPC-32M canister.

The applicant should also justify that the maximum NCT and HAC fuel cladding and component temperatures, as well as the NCT and HAC thermal expansions for the fuel and the fuel basket, are still below their corresponding NCT and HAC limits.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Holtec Response to RAI 3-5

The Note#2 condition cited above suitably addressed in the calculation package supporting HI-STAR 100MB SAR [3-5-1]. In it loading scenarios are defined wherein decay heat in cells away from core are increased to 120% by borrowing heat from core cells and fuel temperatures computed. The results support the conclusion that bounded heat variations do not challenge fuel temperatures as they are implemented in a manner that moderates thermal loads and coincident temperatures in hot interior locations.

[3-5-1] HI-STAR 100MB thermal report HI-2188066, Section S.6.8, Rev. 2.

Chapter 4 CONTAINMENT REVIEW

4-1 Define clearly the containment boundaries, in Section 4.1 and 4.1.4, to be consistent with the containment boundary shown in Figure 4.1.2 for a single lid cask.

The HI-STAR 100MB includes options for a single lid cask when used with the MPC-32M and a dual lid cask when used with a bare basket, i.e., F-32M or F-24M. Sections 4.1 and 4.1.4 specify that the containment system of the single lid cask consists of the containment shell, containment top flange, containment bottom flange, vent port and drain port cover plates, port cover bolts, outer closure lid with closure bolts, and their respective elastomeric seals (inner seals) and welds.

The staff reviewed the containment boundary shown in Figure 4.1.1 for the dual lid cask and the containment boundary shown in Figure 4.1.2 for the single lid cask and finds inconsistencies in the containment boundary.

In particular, the containment components of the vent and drain port cover plates are not marked in Figure 4.1.2; the test port cover (and its test plug seal), marked in Figure 4.1.2, is not identified as the containment boundary.

This information is required by the staff to determine compliance with 10 CFR 71.33.

Holtec Response to RAI 4-1

Figures 4.1.1 and 4.1.2 were modified to be consistent with Section 4.1 and 4.1.4.

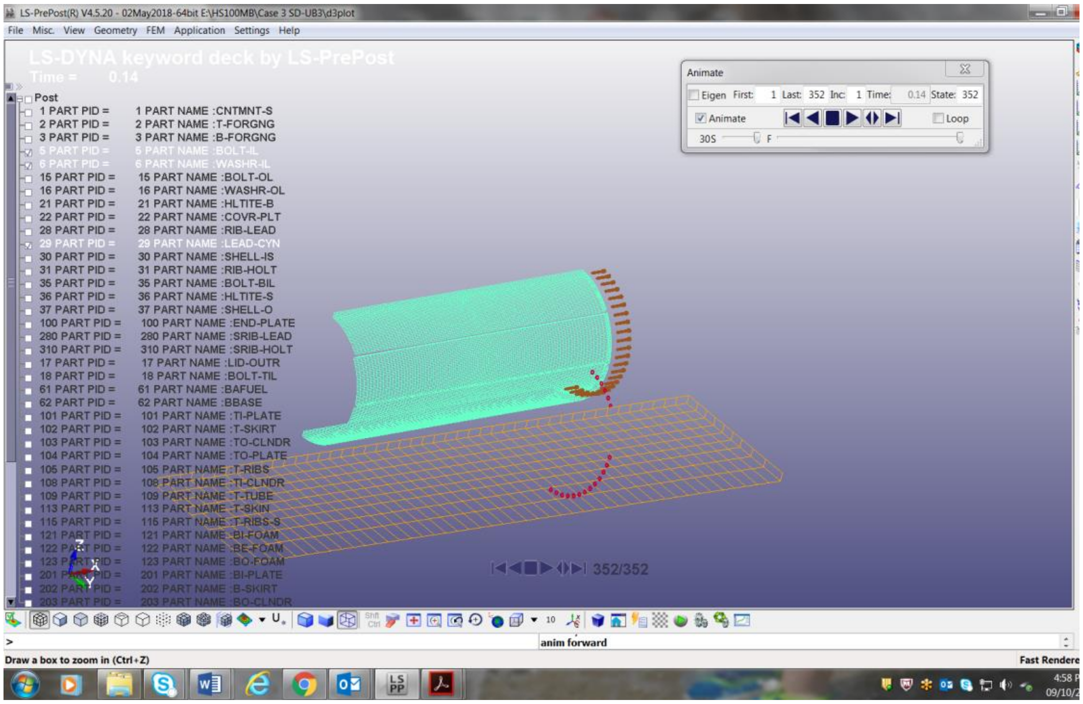
4-2 Clarify the observed behaviors of the inner lid washers in the LS-DYNA drop simulations.

The LS-DYNA results of Case 3 SD-UB3 (portrayed below), show that, at some point during the drop simulation, the inner lid washers (LS-DYNA 6 Part PID = 6 Part Name Washr-IL) seem to move separately from the bolts. It is not clear to the staff if this situation is realistic, and if containment can be maintained. The following needs to be addressed:

a. Clarify if the observed behavior is in fact expected and, if so, describe how the containment boundary is maintained with the absence of the washers.

b. If the observed behavior is not expected, revise the model for this and all simulated drop scenarios, as appropriate.

This information is required by the staff to demonstrate compliance with 10 CFR 71.71(c)(7) and 71.73(c)



Holtec Response to RAI 4-2

The slapdown analysis (Case 3 SD-UB3) is performed for the governing XL version of the HI-STAR 100MB cask, which is used to transport a loaded MPC so only the outer closure lid is needed. Therefore, the inner lid is removed from the LS-DYNA model of the Version XL package. The inner lid bolts and inner lid bolt washers were unintentionally left in the model, but not included in any of the contact definition. Since they do not interact with the rest of the package in the LS-DYNA model, their presence in the slapdown analysis model has no affect on the analysis results. Thus, the loose inner lid washers identified by the reviewer are of no concern and are not an indication a containment breach. Identical results would be obtained if the simulation were repeated after removing the inner lid washers from the model.

4-3 Justify that the inner lid seals of the HI-STAR 100 MB package with the F-32M basket will perform their containment function without any material degradation when experiencing temperatures exceeding the NCT or HAC limits for a period of time.

As shown in Table 3.1.1 of the application, the maximum NCT temperature of the inner lid seals is 121°C which exceeds the NCT limit of 120°C, as shown in Table 2.2.11. The maximum HAC temperature of the inner lid seals is 208°C, which exceeds the limit of 170°C for a period of time not greater than 20 hours.

The applicant should provide adequate information to justify that the inner lid seals of the HI-STAR 100 MB package with the F-32M basket will perform their containment function without material degradation when experiencing those temperatures.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Holtec Response to RAI 4-3

HI-STAR 100MB SAR revised to incorporate enhanced temperature resistance seals. The enhanced characteristics are defined in Chapter 2 and evaluated under NCT and HAC in Chapter 3.

4-4 Provide the maximum NCT and HAC temperatures of the inner seal in (i) the inner closure lid, (ii) the inner closure lid vent port, (iii) the inner closure drain port, and (iv) the outer closure lid and test plug seal at the test port in Tables 3.1.1 and 3.1.3 for the package with the F-32M fuel basket.

The applicant has only provided the maximum NCT and HAC temperatures for the inner lid seal but did not justify that the seal temperatures of the package with the F-32M fuel basket, predicted from the computer model, are consistent with the package heat removal path under NCT and HAC conditions and are below their corresponding NCT and HAC limits for containment performance. The applicant should provide the maximum NCT and HAC temperatures of the inner seal in the inner closure lid, in the inner closure lid vent port, in the inner closure drain port, in the outer closure lid and test plug seal at the test port.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73(c)(4).

Holtec Response to RAI 4-4

The cited SAR tables report bounding temperatures of inner and outer lid containment seals which include vent and drain port seals and test port seals as defined in Containment Chapter 4. Chapter 3 tables are suitably revised to incorporate above. Non-limiting seal temperatures are added to thermal calculation package for information (SAR reference [3.1.3]).

Chapter 5 SHIELDING REVIEW

5-1 Provide a justification to explain the shielding impacts of the extra 1 cm height modeled in HI-STORM 100 MB XL analyses.

The HI-STORM 100 MB XL is modeled as being 1 cm taller than the design specifications for the package. The applicant stated that this difference between the heights modeled in MCNP and that of the drawings is small and has a negligible impact on external dose rates; however, the staff finds there is insufficient information to verify this conclusion.

Staff is unable to determine if this difference is a result of an increase in thickness of a single shielding component or an aggregated effect of smaller approximations over the length of the package. The applicant's analysis relied on a conservative reduction of shielding materials, e.g., due to manufacturing tolerances, to demonstrate bounding analyses. Yet, the extra height may represent a non-conservative contradiction to the applicant's modeling simplifications. Without knowing the specific nature of this extension, it is not possible for staff to determine that the applicant's analyses remain conservative and bounding.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(2)

<u>Holtec Response to RAI 5-1</u>

The note was related to Drawing 11070R0. The following figure shows the location of the extra material. As can be seen it is not at the high dose rate areas. Nevertheless, this note is not applicable to Drawing 11070R2 since the length of the containment bottom flange is increased. The note is removed from Chapter 5.

[PROPRIETARY INFORMATION WITHHELD PER 10 CFR 2.390]

5-2 Provide the basis for allowing the cladding temperature of moderate burnup fuel to exceed 400°C during short-term drying operations.

Table 3.3.8 shows that the cladding temperature for moderate burnup fuel reaches 436°C (817°F) during vacuum drying with the F-32M bare fuel basket configuration. The footnote of the table states that the temperatures comply with ISG-11, Revision 3. Also, Table 7.1.7 states that the cladding temperature limit for moderate burnup fuel is 570°C (1058°F) under drying operations.

ISG-11, Revision 3 states that, for low burnup fuel, a cladding temperature exceeding 400°C (752°F) may be used if the applicant can show that the cladding hoop stress is equal to or less than 90MPa (13,053 psi). The application does not contain an analysis of the cladding hoop stress, and thus it is unclear if the potential for hydride reorientation may exist and, if so, whether the fuel cladding can fulfill its safety functions during transportation.

This information is required by the staff to demonstrate compliance with 10 CFR 71.51 and 71.55.

Holtec Response to RAI 5-2

The acceptability of 400°C exceedance and compliance with the 90 MPa hoop stress for moderate burnup fuel is suitably addressed by the Pacific Northwest National Laboratory study cited below:

> "Estimated Maximum Cladding Stresses for Bounding PWR Fuel Rods During Short Term Operations for Dry Cask Storage", Lanning D.D. and C.E. Beyer, Pacific Nortwest National Laboratory, January 2004.

HI-STAR 100MB SAR Chapter 3 is revised to cite the above study with a suitable evaluation. The citation and evaluation above is same as the evaluation of moderate burnup fuel in Holtec licensed applications such as the HI-STORM 100 (Docket 72-1014) and it's acceptance in the NRC SER [5-2-1, 5-2-2]. See quote excerpted from the SER below:

Ref. [5-2-1]
"The proposed FSAR stated that the Pacific Northwest National Laboratory (PNNL) has evaluated a number of bounding fuel rods for reorientation under hydride precipitation temperature for MBF delineated in PNNL White Paper "Estimated Maximum Cladding Stresses for Bounding PWR Fuel Rods During Short Term Operations for Dry Cask Storage," Lanning and Beyer, January 2004. PNNL's study concluded that hydride reorientation is not credible during short-term operations involving low to MBF (up to 45 GWD/MTU). Accordingly, a higher temperature limit is applied to MBF, as specified in Table 4.3.1 of the proposed FSAR.

The staff reviewed the component specifications and found them acceptable."

Ref. [5-2-2]
"With respect to the applicant's cladding temperature for low burn up fuel under vacuum drying operations, the staff reviewed the analysis referenced by the applicant (Lanning and Beyer, 2004) and the similar work reported by Brown et al. (2004). The staff determined that the temperatures for the low burnup fuel during drying that exceed 400°C (752°F) but remain less than 570°C (1 ,058°F) are acceptable because the estimated cladding hoop stress is equal to or less than 90 MPa (13,053 psi) and thus follows the guidance in NUREG-1536, Revision 1."

[5-2-1] "Final Safety Evaluation Report Docket No. 72-1014 Holtec International HI-STORM 100 Cask System Certificate of Compliance No. 1014 Amendment No. 5", ML082030170.

[5-2-2] "Final Safety Evaluation Report Docket No. 72-1014 Holtec International HI-STORM 100 Multipurpose Canister Storage System Certificate of Compliance No. 1014 Amendment No. 12".

CHAPTER 7 OPERATING PROCEDURES

7-1 Mark Note #2 in Tables S.6.7 and S.6.8 of Report HI-2188066 for the HAC maximum pressures of the packages containing either the F-32M basket or the MPC-32M.

Note #2 in Tables S.6.7 and S.6.8 of Report HI-2188066 states that the HI-STAR 100MB helium backfill pressure limits are specified in Chapter 7 of Reference [3] for an HAC maximum pressure for the packages with the F-32M fuel basket and the MPC-32M. However, this statement is not correct and Note #2 is not marked in Tables S.6.7 and S.6.8.

This information is required by the staff to determine compliance with 10 CFR 71.73(c)(4).

Holtec Response to RAI 7-1

Note #2 refers to "Initial Maximum Backfill" pressure tabulated in Tables S.6.7 and S.6.8 of the cited report above. The tabulated values are supported by Chapter 7 of the HI-STAR 100MB SAR Reference [3] cited in the NRC comment as clarified below:

Table	Value Tabulated	Reference [3] Chapter 7 Support Location
S.6.7	21.8 psig	Table 7.1.8
S.6.8	31.8 psig	Table 7.1.4

The cited report Tables S.6.7 and S.6.8 are revised to incorporate Note #2 marks and Chapter 7 support locations in it.

7-2 Revise the dryness criteria of the forced helium dehydration (FHD) in Table 7.1.6.

The current dryness criteria of the FHD in Table 7.1.6 are not consistent with those mentioned in Note #3 of Table 7.1.5. Staff suggests to adopt, as FHD dryness criteria, "≤ -5°C (22.9°F)" for the gas dew point and ≤ -6.1°C (21°F) for the gas temperature" in Table 7.1.6.

This information is required by the staff to determine compliance with 10 CFR 71.81.

Holtec Response to RAI 7-2

The dryness criteria in Table 7.1.6 has been revised to state ≤ -5°C (22.9°F) for the gas dew point and ≤ -6.1°C (21°F) for the gas temperature.

7-3 Explain why a leakage test to the cask cavity is not required for the single lid cask loaded with an MPC containing moderate burnup fuel (MBF).

Section 7.1.4 specifies that, if the MPC contains high burnup fuel (HBF), then the cask cavity is leak tested to the required acceptance criteria in Chapter 8. Given that staff requires to have the leakage rate testing to the entire containment boundary of a

transportation package, the applicant shall justify why the leakage rate testing to the cask cavity is not required for the single lid cask loaded with an MPC containing MBF.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

Holtec Response to RAI 7-3

Subsection 7.1.4, Step 2's reference to leakage testing the "cask cavity" is revised to clarify leakage testing the "MPC cavity". This is changed to be consistent with Chapter 4, Confinement, and ANSI N14.5 Table 1 and Section 7.6, pre-shipment leakage rate testing. Testing of the cask cavity, when loaded with either HBF or MBF, is performed per operational step 5 in Section 7.1.4. In accordance with Chapter 4, two confinement boundaries are credited when the cask is to contain HBF, so in addition to the leakage testing of the cask cavity in Step 5, Step 2 is revised to clarify leakage testing of the MPC cavity is required.

7-4 Provide consistency between the statements in Sections 7.1.4 and 7.1.5 for periodic leakage rate tests on the overpack's containment boundary.

The applicant stated in Section 7.1.5 that a periodic leakage test of the overpack's containment boundary (cask cavity) shall be performed unless such test has been performed less than a year before. This statement requires the periodic leakage rate test on the cask cavity, not only for the MPC containing high burnup fuel, but also for the MPC containing moderate burnup fuel.

Given that a periodic leakage rate test on the overpack's containment boundary could also cover the leakage rate test on the cask cavity, the statement in Section 7.1.5 could conflict with the statement that "the cask cavity is leak tested to the required acceptance criteria if MPC contains HBF" in Section 7.1.4.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

Holtec Response to RAI 7-4

See response to RAI 7-4. Subsection 7.1.4 has been revised to clarify the "MPC cavity" is additionally leak tested when the contents include HBF. The periodic leakage test is in accordance with ANSI N14.5 Table 1 and Section 7.5 where the leakage rate testing are performed on containment boundary components subject to wear or degradation (e.g. seals, closures, valves…). As later specified in paragraph 7.1.5.1, only the ITS seals and other ITS components of the containment boundary that may be subject to wear are leak tested.

7-5 Provide conditions and criteria for the installation of the new seals on the closure lid inter-seal test port plug, closure lid port cover, and cover plate inter-seal test port plug for the preparation of the MPC for transport.

The applicant stated in item #1b of Section 7.1.5 that, if necessary, the closure lid inter-seal test port plug, closure lid port cover, cover plate inter-seal test port plug are installed with new seals. The applicant should clarify the conditions and the criteria for installing new seals, as important to safety components, in a procedure for the users to follow in preparation of the package for transport.

This information is required by the staff to determine compliance with 10 CFR 71.81, 71.87(a), and 71.87(c).

Holtec Response to RAI 7-5

This section identifies the replacement of not important to safety (NITS) seals that are visually examined during periodic leak testing of the HI-STAR 100MB overpack containment seals. Conditions and criteria of the installation of new NITS seals are not required to ensure the package is capable to perform its design safety function during NCT and HAC. Item #1a for Section 7.1.5 identifies the important to safety (ITS) seal conditions and criteria for replacement. As Section Item #1b provides additional confusion between the ITS and NITS components, the reference to NITS seals in item #1b is intentionally deleted.

7-6 Provide acceptance criteria under item #7 of Section 7.1.6, "Loading the MPC with Spent Fuel," for (a) combustible gas monitoring and (b) purging the space below the MPC lid to ensure there is no combustible mixture present in the welding area.

The applicant stated in item #7 of Section 7.1.6: "Perform combustible gas monitoring and purge the space under MPC lid with an inert gas to ensure that there is no combustible mixture present in the welding area" for loading of MPC with spent fuel.

The applicant should provide criteria, under item #7 of Section 7.1.6, for monitoring of the combustion gas and purging the space below the MPC lid. The acceptance criteria could include, but not limited to, inert gas purity level, gas pressure, limit of combustion gas concentration, etc.

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

Holtec Response to RAI 7-6

This requirement is driven by the radiolysis of water in high flux conditions, which leads to the creation of combustible gases. With the MPC lid in place, this small quantity of hydrogen may be trapped just beneath the MPC lid. Current industry operations remove this combustible gas by purging the space with inert gas prior to and during high temperature operations (i.e. MPC lid welding and cutting operations). Purging with inert gas prior to and during high temperature operations ensures combustible gas concentrations will not develop in the space beneath the MPC lid. Combustible gas monitoring provides further assurance the space beneath the MPC lid is filled with inert gas from the continuous purging. Subsection 7.1.6 of the SAR text is revised to clearly state purging operations with inert gas must occur prior to and during hot work activities to ensure combustible gases concentrations are not present. Site procedures for hot working activities provide the acceptance criteria for combustible gas concentrations during hot work activities.

7-7 Provide acceptance criteria in Section 7.2.3, “Removal of Contents from MPC,” for (a) combustible gas monitoring and (b) venting or purging the space below the MPC lid during the MPC lid cutting operations to ensure there is no combustible mixture present.

The applicant stated at item #5 of Section 7.2.3: “Appropriate monitoring for combustible gas shall be performed prior to, and during MPC lid welding operations. The space below the MPC lid shall be vented/exhausted or purged with inert gas prior to, and during MPC lid cutting operations to provide additional assurance that flammable gas concentrations will not develop in the space.” The applicant did not provide acceptance criteria for monitoring of the combustible gas and venting/purging the space below the MPC lid. The acceptance criteria could include, but are not limited to, inert gas purity level, limit of combustion gas concentrations, etc.

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

Holtec Response to RAI 7-7

See response to RAI 7-8. As specified in item #5 of Subsection 7.2.3, the space below the MPC lid shall be purged with inert gas prior to, and during operations. This requirement not only removes any combustible gases below the MPC lid but ensures any combustible gas concentrations will not develop.

7-8 Define the conditions to allow an alternate torque onto the outer closure lid access port plug for the dual lid cask (bare basket fuel package).

The applicant tabulated torque requirements for the dual lid cask (bare basket fuel configuration) in Table 7.1.3 and recommended a torque of “Snug Tight” to the outer closure lid access port plug with the additional comment that “alternative torque may be permitted with Holtec approval.” The applicant did not define and did not justify the conditions allowing an alternate torque to the outer closure lid access port plug.

This information is required by the staff to determine compliance with 10 CFR 71.87(a).

Holtec Response to RAI 7-8

The outer closure lid access port plug is a NITS component that does not provide a safety function or reduce the capability of HI-STAR 100MB from performing its design safety function. The containment boundary in the outer closure lid includes the port cover plate and its seals, and these components of the containment boundary are ITS component. Due to the safety classification of the closure lid access port plug, an alternate torque value does not have defined or specific conditions in the SAR.

7-9 Provide acceptance criteria on gas sampling for removal of contents from the dual lid cask (bare basket configuration) to assess the conditions of the fuel cladding and determine the special actions needed to vent the cask cavity.

The applicant stated, in Section 7.2.4 “Removal of Contents from Bare Basket Cask,” that gas sampling is performed to assess the condition of the fuel cladding and the user’s Radiation Control organization may require special actions to vent the cask cavity. The applicant did not provide the acceptance criteria in Section 7.2.4 for these conditions or actions.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.81.

Holtec Response to RAI 7-9

The gas sampling, including acceptance criteria of the conditions of fuel cladding, is performed following the site’s Radiation Program (i.e. Radiation Control organization). Subsection 7.2.4 is revised to state the gas sample analysis to assess the fuel cladding condition is performed by the site’s Radiation Protection or Chemistry Department.

CHAPTER 8 MAINTENANCE PROCEDURES

8-1 Revise Table 8.1.2 to list separately the containment components of the single lid cask and those of the dual lid cask leak-tested at the fabrication facility.

The applicant summarized the helium leakage rate tests in Table 8.1.2 for the HI-STAR 100MB and MPC containment systems. The applicant listed the tested components without identifying the containment components of the single lid cask or of the dual lid cask.

The applicant should revise Table 8.1.2 to list the containment components of the single lid and dual lid casks, separately, leak-tested at the fabrication facility.

(a) Information in the revised Table 8.1.2 should include, but not limited to, test location (shop or field), components tested, type of leakage test, allowable leakage rate, and

(b) Tested components listed in the revised Table 8.1.2 should be consistent with the containment components specified in Sections 4.1 and 4.1.4 for the single lid cask and with the containment components specified in Sections 4.1 and 4.1.5 for the dual lid cask.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.51(a)(1) and 71.51(a)(2).

Holtec Response to RAI 8-1

Table 8.1.2 has been revised as Table 8.1.2.A and Table 8.1.2.B for leak test requirements of a single lid cask and a dual lid cask. The components tested in the initial table are clarified across Table 8.1.2.A and 8.1.2.B to clearly identify the containment components related to both single lid cask and dual lid cask.

a. *Each table provides information on the test location, components tested, type of leakage test, and allowable leakage rate.*

b. *The tested components for both the single lid cask and dual lid cask are consistent with all confinement components specified in Chapter 4 during the applicable leakage test per ANSI N14.6 Table 1 requirements.*

8-2 Clarify the containment components of the single lid and dual lid casks tested for pre-shipment, maintenance, and periodic leakage rate tests.

In Table 8.1.2, the applicant listed both the HI-STAR 100MB Cask and the MPC system as being tested for both the pre-shipment leakage rate test and the periodic leakage rate test, but listed the HI-STAR 100MB Cask only for the maintenance leakage rate test.

To ensure that the required containment components are being tested for pre-shipment, maintenance, and periodic testing of the containment integrity, the applicant should clarify whether

a) the pre-shipment leakage rate test on the HI-STAR 100MB is required only for the single lid cask and the pre-shipment leakage rate test on both the HI-STAR 100MB and MPC are required for the dual lid cask?

b) the periodic leakage rate test on the HI-STAR 100MB is required only for the single lid cask and the periodic leakage rate test on both the HI-STAR 100MB and MPC is required for the dual lid cask?

c) the maintenance leakage rate test on the HI-STAR 100MB is required for both the single lid and dual lid casks and there is no maintenance leakage rate test required for the "empty" MPC in the single lid cask configuration.

The applicant should clarify items (a), (b) and (c) above, and may revise Table 8.1.2 to summarize each type of leakage rate tests separately for the single lid and dual lid cask configurations.

This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 71.51(a)(2).

Holtec Response to RAI 8-2

Table has been revised as stated in 8-1 above. Per SAR Subsection 8.1.2, the leakage rate testing is performed as required in Chapter 7. This is also as described in Chapter 4 for the containment boundaries based on whether the cask is loaded with MBF or HBF.

a) Pre-shipment testing is always performed on the outer containment boundary, as it is the credited containment boundary for both MBF and HBF shipments. For HBF, the pre-shipment leakage rate test is performed on both containment boundaries of the shipment; i.e. inner and outer closure lids of the dual lid system, and MPC and outer lid of the single lid system. The testing is performed per ANSI N14.5 Table 1 which identifies the testing is to confirm the containment system is properly assembled for shipment and performed only after the opened package has been loaded and closed.

b) Periodic leakage rate test is performed in compliance with ANSI N14.5, and the test conditional requirements are provided in ANSI's Table 1 and Section 7.5. Periodic leakage testing is only required on components that are subject to wear or degradation, which corresponds to the HI-STAR 100MB's closure lid seals. The material of construction and weldment of the MPC excludes the MPC from Periodic leakage rate test.

c) As defined in Table 1 and Section 7.4 of ANSI N14.5, maintenance leakage rate test is required to confirm that maintenance, repair, or replacement of components has not degraded the containment system performance. The MPC is only leak tested when containing HBF, and after the closure lid seal weldment is confirmed to meet ASME requirements. Thus, only maintenance that will be performed on the cask system is to the cask closure lids (single lid cask and dual lid cask) and their seals, and maintenance leak testing would be performed on their respective components.

8-3 Provide the nondestructive examination requirements of the welds in the fuel basket drawings.

Section 8.1.2 states: “[b]asket welds shall be examined and repaired in accordance with NDE specified in the drawing package and with written and approved procedures….” The staff notes that the drawings for the MPC-32M, and the F-32M, and F-24M baskets, do not include NDE requirements.

This information is required by the staff to demonstrate compliance with 10 CFR 71.33.

Holtec Response to RAI 8-3

Basket drawings (11084, 11082, and 11083) have been updated to include NDE requirements of welds.

8-4 Justify that the proposed approach for eddy current testing of MPCs will adequately sample MPCs considered to be most susceptible to aging degradation.

Table 8.1.6 provides the approach for selecting MPCs for eddy current testing prior to transportation. The proposed sampling approach tests a percentage of MPCs containing high burnup fuel and stored for greater than 5 years under 10 CFR Part 72. However, the staff notes that there are no guidelines for the selection of the specific MPCs to test at an ISFSI, and thus it is unclear to the staff whether MPCs that may be most susceptible to degradation will be adequately sampled.

This information is required by the staff to demonstrate compliance with 10 CFR 71.87.

Holtec Response to RAI 8-4

To strengthen the selection of the MPCs most susceptible to degradation and strengthen the sampling process, we propose to perform eddy current testing on all ISFSI lead canisters identified by the ISFSI’s Part 72 aging management program. If an aging management program has yet to be established, the ISFSI lead canister shall be identified based on a written and approved lead canister selection procedure. The proposed changes have been incorporated in the SAR revision.