DOCKET NO. 71-9366

REQUEST FOR ADDITIONAL INFORMATION FOR THE WMG-150B PACKAGE

By letter dated January 2, 2015, WMG, Inc. submitted an application for approval of the Model No. WMG-150B package as a Type B(U)-96 package. The staff performed an acceptance review of the application and, by letter dated April 29, 2015, WMG, Inc., responded to staff's request for supplemental information letter dated March 17, 2015.

This request for additional information (RAI) identifies information needed by the staff in connection with its review of the WMG-150B package. The requested information is listed by chapter number and title in the application. The staff reviewed the application using the guidance in NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

Each individual RAI section describes information needed by the staff to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements.

**CHAPTER 1 GENERAL INFORMATION**

1-1 Clarify the contents of the package.

Section 1.2.2.1 of the application states, "The activity of all radionuclides shall not exceed 3,000 $A_2$ and shall be less than 100 curies of Co-60 or equivalent, subject to the shielding limitations (Chapter 5) determined in accordance with Attachment 7-1 in Chapter 7."

As a content limit, 3,000 $A_2$ is ambiguous. The gamma source term in the shielding evaluation is based on 100 Ci Co-60 with equivalence to other gamma emitting nuclides, as discussed in Reference 5-7. There are no analyses for alpha, beta or neutron sources (see RAI 5-8). Since alpha and beta radiations (see RAI 5-10) are typically not challenging to the shielding employed in this package, the staff can only assume that 3,000 $A_2$ was meant for these radiation sources only.

Based on the current shielding analyses, the staff can only support the following authorized contents in a certificate of compliance (CoC): 3,000 $A_2$ for alpha and beta, with gamma sources being limited to 100 Ci Co-60 or equivalent, as determined by Reference 5-7 in the application.

Clarify the above cited language from Section 1.2.2.1, and provide additional analyses justifying the shipment of up to 3,000 $A_2$ of gamma and neutron sources, as needed.

This information is required to determine compliance with 10 CFR 71.47 and 71.51.

**LICENSING DRAWINGS**

1-2 Provide additional dimensions and details of the upper impact limiter.

The drawings do not indicate the inner diameter of the impact limiter (item 301), nor the thickness of the impact limiter over the secondary lid.

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

1-3 Clarify the details of the protection cover (item 326) on the licensing drawings.

Region C1 of sheet 7 of the drawings shows an upper impact lifting lug detail with a member that appears to be the protection cover just under the lifting lug. However, this item appears to be a solid plate rather than a raised expanded metal, as described on sheet 1.

Also, the thickness of this item, and the attachment method to the upper impact limiter, are both unclear. In addition, staff is concerned that, if this item is a solid plate, this will affect the performance of the upper impact limiter.

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

1-4 Clarify note 7 on sheet 1 of the licensing drawings.

Note 7, sheet 1, specifies general tolerances for components. Values of +/- ¼” have been cited for cask components, +/- ½” for impact limiters, and +/- $2^o$ on angular components. Taken as such, those large tolerances may require additional analyses for most, if not all, components.

For instance, a ¼” decrease in the primary lifting lug thickness would require an analysis that incorporates this change in dimension; weld callouts to the outer canister would have to be reworked as a ¼” change in the outer shell could invalidate them as specified; the impact limiter design is questionable if the steel skin thickness is increased by ½” etc.

Analyses provided should incorporate these tolerances. Note that tolerances may be indicated for each part on the drawings.

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

1-5 Provide additional dimensions and details of the lower impact limiter.

The drawings do not indicate the inner diameter of the lower impact limiter (item 401).

This information is required to determine compliance with 10 CFR 71.33

1-6 Clarify how the upper lift lug/angle items 323 and item 322, respectively, are attached to the upper impact limiter.

In response to RSI 1-3, Region C1 of sheet 7 of the drawings represents an upper impact lifting lug detail showing how items 322 and 323 are joined; a welding note indicates how these two items are joined. However, it is unclear how items 322/323 are attached to the upper impact limiter itself.

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

1-7 Indicate, on the drawings, what welding process, weld filler material, and welding notes will be used at each of the welds specified on the licensing drawings. Provide their associated welding calculations.

Base material welding calculations have been provided in the application, but the welds themselves were not. Weld filler material and welding process have not been provided. Reference to ASME code alone is insufficient.

This information is required to determine compliance with 10 CFR 71.45, 71.71, and 71.73.

1-8 Clarify the shackle lifting load, specified on the drawings, for the primary lifting lugs.

The RSI response indicated that 27 ton working load limit shackles will be used for the primary lift lugs (item 323). However, 17 ton working load limit shackles have been specified on the drawings.

This information is required to determine compliance with 10 CFR 71.45.

1-9 Clarify the weld symbol used to join the outer canister shell (item 103) to the bolt ring (item 106).

Region C2, sheet 5 of 8, shows a 5/8" groove weld (near and far side) of item 103 to 106. However, only a single bevel has been shown.

This information is required to determine compliance with the requirement of 10 CFR 71.33.

1-10 Clarify the dimensions of the lifting lugs.

The tie-down lugs (items 111-114) are indicated on sheet 7 of the licensing drawings; however, the complete dimensions of the lugs have not been shown. It is unclear where the tie-down opening is relative to the lug itself, nor where the lugs are located on the outer canister shell.

This information is required to determine compliance with the requirement of 10 CFR 71.33.

1-11 Clarify the location of the guide plates (items 121 and 122).

It is unclear where the guide plates are located along the perimeter on the outer canister shell. Also, items 108 (interior floor SST sheet) and 109 (interior wall SST sheet) are not shown on the “Cask Body and Lid Containment” detail on sheet 8, but instead are on sheet 4 of the licensing drawings, while no mention is made on sheet 4 to indicate that items 108 and 109 are not shown.

This information is required to determine compliance with the requirement of 10 CFR 71.33.

1-12 Clarify the location of the optional insulation disk (item 123).

It is unclear if the optional disk is centered relative to item 101 (bottom end of the outer canister) shown on sheet 5 of the licensing drawings.

This information is required to determine compliance with the requirement of 10 CFR 71.33.

1-13 Clarify the locations of the lifting lugs for the primary and secondary lid.

Lifting lugs (primary and secondary), as shown on the drawings, appear to be equidistant from each other; however, their position relative to the lids on which they sit is unclear. For example, the distance of the primary lifting lugs relative to the primary lid edge, as shown in Section B-B of sheet 4 of 8, is unclear, as is also the angular measurement between the other primary lifting lugs.

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

1-14 Clarify note 4, sheet 1 of 8, of the licensing drawings.

Note 4 indicates that complete joint penetration welds will be used on all rolled plates. Indicate which rolled plates (item numbers) this refers to.

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

1-15 Clarify how attachment lugs (item 318 and Item 409) are connected to the impact limiters.

It is not clear how attachment lugs (item 318 and Item 409) are connected to the impact limiters since they do not appear to be shown on the licensing drawings.

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

1-16 Clarify how the longitudinal complete joint penetration weld along the length of the outer and inner canister shell, as shown on regions A7 of sheet 4 the drawings, will be made.

Both inner and outer canister shells indicate that they will be prepared on both sides with a bevel prior to receiving a complete joint penetration weld. It is unclear how this will be accomplished since there does not appear to be access to the space between the two canister shells to complete the weld.

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

1-17 Clarify the items callouts used in the test port details.

Region B8 of sheet 6 of the drawings (test port detail) has a callout indicating item 204/217, 218, and 219 which correspond to the primary lid, secondary lid ring, secondary poured lead, and secondary bottom lid plate, respectively. However, the drawn-up detail itself is not representative of all these items, since all of them do not all look like the detail as shown.

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

1-18 Clarify the location of the test ports and pressure ports in the plan view and the overall section of the licensing drawings.

Details have been provided showing test ports and pressure ports in the cross section details. However, it is unclear where these items are located in the plan views of the lids themselves, nor where they are in the overall cross sections, like Section B-B of sheet 4, of the licensing drawings.

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

1-19 Clarify the note with respect to items 230 and 235 on the bill of materials.

The bill of materials indicates that item 230 is a hardened washer that corresponds to item 228 (test port cover). However, the item appears to correspond to item 229 (test port plug) according to region C1 of sheet 8.

A similar scenario exists for item 235 (pressurization port hardened washer) which is indicated to correspond to item 233 (pressurization port cover), but appears to be for item 234 (pressurization port plug) according to region C4 of sheet 8.

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

1-20 Clarify what items may have possible seams shown in region B5 of sheet 8 and what type of welding shall be done in these regions, if any.

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

1-21 Clarify the weld note shown in region B7 of sheet 6 of the drawings.

The note for the 1/8” groove weld, shown in region B7 of sheet 6 of the drawings, indicates that this weld will be performed on item 206 (primary lid seal ring) and item 221 (secondary lid seal ring); however, a weld to these items is not shown, and/or the weld callout is incomplete.

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

1-22 Clarify the height of the lifting lugs shown on sheet 7 of the drawings.

It is unclear how tall both primary and secondary lifting lugs are on sheet 7. The bill of materials indicates that, overall, these items are square; however, they appear to be rectangular.

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

1-23 Clarify note 24 of sheet 1 of the licensing drawings. Identify and specify, on the drawings, all optional fabrications.

Drawing No. WMG-150B-DW-004P71, Rev. 1, note 24, states that, in addition to item 104 (Inner Shell, 3/4-inch plate), other items may be fabricated from multiple pieces using CJP groove welds with WMG approval. Indicate what items will be welded this way and what process and filler material will be used to perform these welds.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1-24 Clarify the quantity of impact limiter guide plates (items 121 and 122) shown on the drawings.

Upper and lower guide plate details shown on region D7 of sheet 7 indicates that 16 fillet welds will be performed on items 121 and 122. However, only 12 of these items have been shown on the drawings.

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

1-25 Clarify the 4 pairs of double concentric circles shown on the detail labeled “Entire Assembly – Top View,” as shown on sheet 3 of the drawings.

It is unclear what the four pairs of double concentric circles represent on sheet 3. If these are structural details, indicate what they are, and provide additional sections/notes.

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

1-26 Clarify note 16 on sheet 1 of the drawings.

Indicate what lubricant shall be used on the bolts mentioned in note 16, along with specific material information such as ASTM standard.

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

1-27 Clarify note 23 on sheet 1 of the drawings.

Note 23 indicates that backing rings may be used for welding. Indicate whether they are to remain in place and, if so, provide dimensions and material properties on the drawings, including the bill of materials.

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

1-28 Modify the licensing drawings to show the tolerances for the features important to the shielding performance of the package.

The tolerances in the shielding evaluation should be consistent with the tolerances provided in the drawings. NUREG/CR-5502 states, in Section 3.3.1, that appropriate tolerances should be included on the package dimensions. Tolerances should be included for all features credited in either the normal or accident condition shielding analyses.

This information is required to determine compliance with 10 CFR 71.31(a)(1) and 71.33(a).

1-29 Identify the specific boundary welds according to the requirements of Subsection NB-4240, i.e., weld joint categories A, B, C, and D, as well as the welding process weld examinations and methodologies. Identify these welds on the drawings through the use of weld symbols or drawing notes.

Drawing No. WMG-150B-DW-004P71, Rev. 1, note 2, states that all containment boundary welds shall be done in accordance with ASME Code Section III, Subsection NB Division 1, except where the geometry of the joint does not allow, in which case an appropriate testing method may be substituted.

This information is required to determine compliance with 10 CFR 71.33(a) (5)(iii) and 71.39.

1-30 Identify and specify on the bill of materials the type of lubricants to be used, their corresponding specifications, and the consensus national standards.

Drawing No. WMG-150B-DW-004P71, Rev 1, Notes 16 & 17, states that items 209 and 224, i.e., Primary/Secondary Lid Socket Head Cap Screws, shall be lubricated when installed.

This information is required to determine compliance with 10 CFR 71.33(a) (5)(iii) and 71.39.

1-31 Identify and specify on the bill of materials the insulation material to be used, its corresponding specification, and the consensus national standard.

Drawing No. WMG-150B-DW-004P71, Rev. 1, note 21, states that the insulation disk is optional. Define and/or justify when the use of the insulation disk is optional.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1-32 Identify and specify on the bill of materials the backing ring material specifications and the weld symbol for the optional use of the backing bar.

Drawing No. WMG-150B-DW-004P71, Rev. 1, note 23, states that backing rings may be used between item 101 (Bottom plate outer), item 217 (Secondary Lid Ring), and item 219 (Secondary Lid Bottom Plate).

This information is required to determine compliance with 10 CFR 71.33(a) (5)(iii) and 71.39.

1-33 Identify and specify on the bill of materials (i) the critical characteristics, e.g., dimensions, mechanical properties, heat range, chemical, (ii) a manufacturer specification and (iii) a consensus national standard for the O-rings.

Material note B states that the O-rings shall meet the requirements of technical specification WMG-150-ES-003-P71. WMG-150-ES-003-P71 is not a recognized consensus national standard. The O-ring, listed as item 231 and 236 and Category “B” item, shall be listed as a supplier catalog item.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1-34 Identify and specify a method for achieving the contour of the welds.

Drawing No. WMG-150B-DW-004P71, Rev. 1, shows various weld joint contours; however, no method (e.g., grinding, machining, chipping, etc.) of achieving weld contours is specified. Specify if the method is to be used for all welds showing a contour symbol.

This information is required to determine compliance with 10 CFR 71.33(a) (5)(iii) and 71.39.

## Chapter 2 Structural and Materials Evaluation

2-1 Provide additional information demonstrating that the LS-DYNA finite element analysis (FEA) model is properly benchmarked for predicting rigid body decelerations of the package under free-drop analyses.

1) Information provided in response to RSI 2-3 regarding calibration of WMG modeling techniques has been provided for the WMG-150-B package for the side drop and 15$^{o}$ slap down conditions, as per Reference 4 of Reference 2-42. This information is based on a vitrified high level waste (VHLW) cask that was physically drop-tested by BAM. However, model calibration based on end drop testing has not been provided. Staff is concerned that responses at angles other than those mentioned will not be adequately captured by the LS-DYNA modeling techniques used for the WMG-150B package without such information.

2) Provide dimensions and material properties of the impact limiters and the cask used in the VHLW package. It has been noted that some of the dimensions of the VHLW cask have been scaled from a representation of the cask rather than from actual drawings, and the impact limiter casing was assumed to be metallic in nature since the properties itself are unknown. Specify the properties and dimensions of the

impact limiters and of the cask used, provide thicknesses of the VHLW canister and the material type, describe the contents weight and configuration used in the VHLW drop testing. Staff cannot make a clear determination based on scaled dimensions alone.

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

2-2 Justify the foam density used for the impact limiter design.

Values cited on page 4 of document 2-42 (AR-131S Rev. 0) indicate that foam values are based on static loading conditions (crush values) rather than dynamic crush values. Both static and dynamic crush values for foam are found in Reference 6 of document 2-42.

Clarify why static crush values are used rather than dynamic crush values. A sample dynamic impact calculation from Reference 6 uses dynamic crush foam properties (Last-A-Foam FR-3700) for a 700 lb object falling 30’ which is akin to an impact limiter design.

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

2-3 Justify the element type and mesh size used for finite element modeling of the impact limiters.

Document 2-42 (AR-131S Rev. 0) describes the use of 8 node elements (element 164) to model the impact limiter. The stability of the results based on this element versus higher order ones is unclear. Similarly, the mesh size refinement does not appear to have been considered or compared.

The document states that no extra precautions against hour glassing were taken; however, 8 node explicit elements such as the 164 are susceptible to hour glassing. Clarify how hour glassing is not a concern.

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

2-4 Provide and update contents to canister impact calculations.

Section 1.2.2.3 of the application indicates that contents density varies from 0.5g/cc to 12g/cc. A single 55 gallon drum with these specified densities could weigh more than 10,000 lb. However, Section 2.7.1.10 of the application assumes that two 5,000 lb drums are shored.

In the HAC drop scenarios, the contents could impact a lid at a slightly oblique angle and at an off centered location, as the package overall makes contact with an unyielding surface. Lids, bolts and the bottom plate could be damaged in such a scenario, as could be also the case for any lead shielding in the vicinity. Cumulative damage should be examined, as the lids, bottom plate, and bolts may be damaged first by the package impact, followed by the impact of contents.

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

2-5 Provide details, configuration, and material specifications for the shoring material used for contents packaging.

Shoring is mentioned in 2.7.1.10 of the application with regards to the packaging of canister contents but no details have been provided with regards to the material the shoring is made of or its configuration. This information should be described in the application and on the licensing drawings.

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

2-6 Incorporate actual welded conditions into the finite element analyses.

Several components such as lifting lugs and plates appear to have been modeled in ANSYS and LS-DYNA, for both normal conditions of transport (NCT) and hypothetical accident condtions (HAC), with full penetration welds. However, drawings and calculations show otherwise, e.g., lifting lug item 201, on sheet 7.

This information is required to determine compliance with 10 CFR 71.45, 71.71, and 71.73.

2-7 Provide details and calculations on the impact of vibrations, incident to travel, on the package.

Staff is concerned with possible fatigue issues that can arise from the dynamic response of the package, incident to NCT, regarding tie down lugs, lifting lugs, bolts, and tack welds. Describe the configuration in which the package will be transported on the conveyance.

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

2-8 Provide additional analyses of the package orientations used for drop evaluations for both NCT and HAC.

Package orientations used in reference 2-7 appear to be incomplete. Reversed package orientations of those shown in Figures 1-d through 1-g should also be included in the analyses to account for the scenario where the bottom end of the package (opposite end of where the lids are located) strikes first. Both cold and hot scenarios should be examined for all package orientations.

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

2-9 Evaluate additional package components for the puncture event.

Puncture, as described in 10 CFR 71.73, was not considered with respect to the outer stainless steel shield. Specifically, a glancing blow by the bar described in the puncture test could tear the shield and create a thermal “hot spot” during HAC thermal conditions.

In addition, primary lifting lugs, secondary lift lugs, impact limiter lifting lugs, upper and lower guide plates, primary and secondary lid, and tie down lifting lugs have not been examined for a similar scenario in which these devices may be separated from the package body.

Staff is concerned that glancing blows and direct impact by the bar mentioned in the puncture test may also damage the lead shielding in those areas. Test ports and pressurization port region should also be examined for a direct impact and glancing blows, as localized stresses may be observed.

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

2-10 Perform a water immersion analysis.

Section 2.7.6 of the application states that a water immersion test (10 CFR 71.73(c)(6)) is not necessary since a value of 25 *psig* was used for the external test mentioned in Section 2.6.4 of the application. However, a value of only *20 psia* was used in both Section 2.6.4 and Reference 2-24 of the application.

As specified in 10 CFR 71.73(c)(6), an equivalent amount of water to produce *21.17 psig* is adequate, which equates to *35.87 psia,* the value that should be used in this calculation.

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

2-11 Clarify the location of the seals in items 206 and 221 in the seal rings.

Dimensions have been provided for the seal grooves in response to RSI 2-15; however, the placement of these groves within the seal rings themselves is unclear. Regions A6 and A3, sheet 6, show grooves for items 206 and 221, but the offset to the edge of the seal plate of these grooves is unclear since a center line has not been pointed out in these views. In addition, clarify the height of the seal grooves. Both dimensions of 0.319 or 0.315 inches are shown, but it is unclear when one dimension or another will be used.

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

2-12 Verify and clarify the dimensions of the impact limiters. The impact limiter analysis in Reference 2-25 does not appear to use the same impact limiter dimensions as those specified on the licensing drawings. Justify that HAC drop evaluations are not affected.

Impact limiters, as analyzed in Reference 2-7, do not appear to incorporate the lug recesses shown at the lifting lugs in the finite element analysis and on the drawings. In addition, the height of the recesses of the impact limiters at the lifting lugs on the drawings does not indicate how deep they have to be (see Primary Lift Lug Fit-Up detail sheet 7 of 8 of the drawings).

This information is required to determine compliance with 10 CFR 71.33 and 71.73.

2-13 Provide stresses in the seal components for NCT and HAC conditions.

Stress summaries are provided for several components under NCT and HAC. However, stresses found in the inner bearing rings, primary lid seal ring, secondary lid seal ring and inner O-rings, have not been provided.

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

2-14 Justify the elements used for finite element analysis for NCT and HAC conditions.

Section 2.6 of the application mentioned that the 8 node (SOLID185) element was used for performing analysis for NCT and HAC conditions. Sensitivity studies and benchmarking have not been done using elements with more nodes which typically can capture shear effects in regions where there are welds, or where changes in geometries occur such as from the bottom lid to the canister walls, etc..

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

2-15 Justify the mesh refinement used for both NCT and HAC in analyses using ANSYS.

It is unclear what the sensitivity of the results is with mesh refinement. For instance, in Figure 2-10 of the application, three elements appear to be used through the thickness of the outer shell and only two elements appear to be used for the bottom inner canister shell.

Describe how results based on the mesh in regions of larger geometric changes such as the bottom end of the inner canister to the inner canister wall, the outer canister to the bottom canister end, the bolt ring to the canister walls etc., are stable, based on the number of elements used for thickness and overall size.

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

2-16 Clarify the orientation of the package with respect to its long axis used for drop conditions specified for HAC and NCT.

Figure 1 of Reference 2-7 describes the package orientations used for the drop analyses. However, the impact limiters are not symmetric in plan view as shown in the "Entire Assembly – Top View" section described on sheet 3 of 8 of the drawings. It is unclear if the package is striking the flat portion of the impact limiter where there is less foam, or the rounded portion of the impact limiter during the corner drop, side drop etc.

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

2-17 Justify the mesh refinement used to model the impact limiters for both NCT and HAC in analyses using LS-DYNA.

It is unclear what the sensitivity of the results is with mesh refinement and with the element type used to model the impact limiters. Page 4 of 88, Section 4.0 of Reference 2-7, indicates that since element size used in modeling the impact limiters and attachments are so small, there was no need to refine mesh density near the impact region. However, results supporting this statement have not been provided.

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

2-18 Clarify content weight and configuration used for NCT and HAC conditions.

Since the density of the contents varies from 0.5g/cc to 12g/cc, a single 55 gallon drum could theoretically weigh more than 10,000 lb. However, the applicant stated in Section 2.7.1.10 of the application that two 5,000 lb drums are shored. During drop scenarios, forces transmitted from the contents pressing into the lids and side walls due to the configuration and weight of the contents could vary greatly.

In addition, the load distribution shown on pages 15-16 of Reference 2-31 does not match the configuration shown in Section 2.7.1.10. Provide analyses(s) and clarifications of transported contents weight and configuration.

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

2-19 Clarify the bolt loads observed during NCT and HAC conditions.

Reference 2-24, page 58, indicates that the bolt tightening scenario has the lowest margin of safety, i.e., 1.22, in the lid bolts for the initial conditions stated (no decay heat, at ambient temperature, balanced internal and external pressure, etc.). Reference 2-31, page 67, indicates that, from the NCT drop tests, only a top end corner drop at 100$^{o}$F will produce a factor of safety that is slightly less, i.e., 1.16, in the lid bolts.

Clarify why the bolt tightening scenario is more aggressive than practically all other cases examined (hot/cold environment, side drop, end drop, pressure increase/drop etc.) and if it is an initial condition for all NCT analyses.

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

2-20 Verify that that tie-down lugs are not engaged during the HAC side drop test.

Page 16 of Reference 2-7 indicates that the foam in the impact limiter during hot conditions may crush as much as 6.26 inches (11.25” original) during the HAC side drop test. This appears to be enough for tie-down lugs to be impacted in the side drop test. Staff notes also that the exact protruding dimensions of the tie-down lug, measured from the outer shell, have not been provided. If this is the case, describe the consequences to the package.

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

2-21 Clarify the margins of safety for the lid bolts, reported for NCT and HAC conditions in Reference 2-31.

Tables, such as Table 3.4 of Reference 2-31, summarize factors of safety for lid bolts and related combined tension and shear calculations for these bolts follow. However, it is unclear if the margins of safety, reported in those tables, such as Table 3.4, incorporate these combined tension and shear results. If they do not, please update these tables throughout the referenced document.

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

2-22 Justify the stresses found in the bolts, bolt rings, shells, lids, and seal rings observed during NCT and HAC conditions.

Margins of safety for the bolts in the package have been based on average stresses throughout Reference 2-31. These values appear to have been computed just under the bolt head (Figure 3-19 on page 50 of that reference is an example). However, it appears that other locations along the bolt appear to have more stress (on average) than just under the bolt head (midway along the shaft for instance).

Verify the stresses along the length of bolt in addition to the location examined. Similar clarification is required for the aforementioned components such as the bolt rings, shells, lids, and seal rings.

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

2-23 Justify the bolt preload used during NCT and HAC conditions.

Page 2-22 of the application indicates that a bolt preload of 550ft-lb was used in calculating forces in the 1-1/2" socket head screws. However, References 2-24 and 2-31 used for calculating NCT and HAC conditions utilize 500ft-lb of preload. Note that margins as low as1.06 have been reported for the primary lid bolts, e.g., on page 222 of reference 2-31.

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

2-24 Provide operational experience and data from lead pours on ASTM A543 material.

The response to RSI 2-1, dated March 17, 2015, did not provide sufficient information to justify that the A543 welded steel shells would not be susceptible to liquid metal embrittlement (LME). The response to RSI 2-1 did not also provide the requested pour data.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii), and 71.39.

2-25 Discuss personnel qualifications for the lead pouring process used for this package.

The ASME Code requires NDE procedures, such as a gamma scan, to meet the requirements of ASME Section V, Article 2, " Radiographic Examination," to demonstrate the ability of the procedure to detect voids. The applicant did not provide the qualifications and certifications that will be required from the NDE personnel.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii), and 71.39.

2-26 Justify why ASTM A543, Type B, Classes 1 and 2 materials, are not susceptible to LME when in contact with liquid lead. Operational experience and laboratory studies indicate that low-alloy quenched and tempered steels comparable to ASTM A543 are susceptible to LME (L.C.F Canale, R.A. Mesquita, and G.E. Totten, *Failure Analysis of Heat Treated Steel Components*, ASM International, Materials Park, OH, 2008, pp. 66-67, 302-303. *and its supporting references*)

The applicant, in its response to RSI 2-1, dated March 17, 2015, identified prerequisites for LME such as (i) liquid metal wetting of the steel surface, (ii) the presence of a tensile stress, and (iii) stress concentrators or obstacles to dislocation motion (i.e., obstacles that prevent the material from yielding in a ductile manner in front of a crack tip). The applicant claimed that none of these prerequisites are met. Staff offers the following observations regarding such claims:

*(i) The chromium in A543 creates surface oxides in the as-received plate that prevent liquid metal wetting.* Observations of LME in 4145 steels do not support the applicant's position that the chromium content of ASTM A543 steel prohibits wetting. The allowable range of chromium content for A543, Type B, overlaps those of 4145. In addition, the welding process would be expected to disturb the as-received surface oxides at the weld joints.

*(ii) Tensile stresses on the shells created by the weight of the lead are low, below 1000 psi.* Staff notes that residual stresses in shell plate welds would likely be significantly greater than those created by the lead pour. Nevertheless, available literature indicates that LME requires only very low tensile stresses. The RSI response did not provide information on estimated weld residual stresses and why these would not be sufficient to cause LME.

*(iii) There are no holes or attachments to cause obstacles to dislocation motion.* The quenched and tempered steel microstructure contains a high concentration of obstacles to dislocation motion, which gives this microstructure its high strength, but also makes it difficult to yield in the presence of an advancing crack. The available literature indicates that macro-scale stress concentrators (e.g. holes, visible cracks) are not necessary to initiate LME.

Additional information is required to justify that ASTM A543 would not share similar LME susceptibility to other quenched and tempered low-alloy steels.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii), and 71.39.

2-27 Provide qualified procedures, applicable codes, standards, and inspection criteria to justify that the ASTM A-543, Type B, Class 1, steel will remain crack-free and that the corrosion resistant oxide layer will remain intact prior to, and during, the lead pour.

Paragraphs 4.0 and 6.0 of the WMG-150B-AR129S-P71 report cite minimum conditions required to be maintained, or to be met, in order to ensure LME does not occur.

Typically, no steel of this thickness is flaw free, when inspected to the ASME Code Section III, Subsection NB requirements. The Code inspection criterion has been established to ensure material structural integrity. The Code does not address surface conditions such as the presence of micro fissures which may provide a pathway for LME to occur. The corrosion resistant oxidized surfaces, typically removed during fabrication in preparation for welding (e.g., grinding), during the welding process, pre and post weld heat treatments, may provide a pathway for LME.

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

2-28 Provide procedures written in compliance with a consensus national code or standard, other than military specifications, to address inspection requirements for “as-received” Class A & B materials.

Drawing No. WMG-150B-DW-004P71, Rev. 1, note 28, states that ASTM A-543, Type B, Class 1, material surfaces shall be inspected per [MIL] T9074-BD-GIB-010/0300 B.3.6 prior to fabrication.

B.3.6 states for surface quality that the depth of rolled-in scale, pits, windrowed condition, or other defects shall not exceed 0.015 inch (0.38 mm) and shall not result in an under gauge (less than minimum thickness) condition. Isolated, individual pits not over 0.030 inch (0.76 mm) deep are acceptable, provided plate thickness is not reduced to an under gauge condition.

Surface imperfections maybe removed by grinding, provided the thickness is not reduced to an under gauge condition and the width of the ground area is three times its depth and radially tapered into the defect.

This inspection requirement does not support the statements made in paragraphs 4.0, 6.0, and 7.0 of the WMG-150B-AR129S-P71 report on the WMG-150B Cask “Liquid Metal Embrittlement.”

This information is required to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

## CHAPTER 3 THERMAL EVALUATION

3-1 Clarify how the use of arbitrarily large values of contact resistance assumed at the interface between lead and steel will result in bounding maximum temperatures for both NCT and HAC.

Page 3-5 of the application states that the lead shielding in the cask body and the lid is not bonded to the steel, it is free to slide over the steel surface. Accordingly, the interface between the lead and the steel is modeled by pairs of 2-d 3-node thermal contact elements (CONTA172) and 2-d target segments (TARGE169). Heat transfer through contact pair is realized by only heat radiation, i.e., arbitrarily large value of contact resistance is assumed at these interfaces. This approach may result in non-conservative temperatures during HAC conditions.

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

3-2 Clarify how assuming only radiation heat transfer in fire-shield air gap will result in bounding maximum temperatures for both NCT and HAC.

Page 3.5 of the application states that the mode of heat transfer in the fire-shield air gap is by radiation heat transfer only. This approach may result in non-conservative temperatures during HAC conditions because it neglects convection and conduction through the air gap.

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

3-3 Provide details of the correlation or measured data used to obtain the forced convection heat transfer coefficient applied during HAC thermal evaluation.

Page 3-11 of the application states that heat transfer to the ambient by forced convection is included in the analysis. However, details of how the heat transfer coefficient is obtained are not provided in the application. Details of the correlation used and justification for its applicability are needed in order to make a determination of the adequacy of the heat transfer coefficient applied during HAC conditions.

The information is required to determine compliance with 10 CFR 71.73.

## CHAPTER 4 CONTAINMENT EVALUATION

4-1. Provide the American Society of Nondestructive Testing (ASNT) certification level of the examiner for development and approval of helium and pressure change leakage rate testing procedures.

The applicant described the leakage tests in Section 8.1.4 for acceptance leak tests and Section 8.2.2 for periodic and maintenance leak test, without identifying the ANST level of the examiner.

This information is required to determine compliance with 10 CFR 71.37, 71.87, and 71.119.

4-2 Clarify the scope of the containment boundary.

The applicant stated: (i) in Section 1.2.1.3 of the application that the containment boundary consists of the inner steel shell of the cask body together with closure features comprised of the primary and secondary bearing and seal rings, inner O-rings, pressurization port, cask lids and cap screws, and (ii) in Section 4.1.1 of the application, that the package “containment vessel” is defined as the inner shell of the cask and the primary and secondary lids, together with the associated O-rings.

1) The applicant should (i) clarify whether the containment boundary includes the baseplate and the joining welds, (ii) specify the locations of the inner O-rings, (iii) clarify if the cap screws are part of the containment boundary, and (iv) provide a complete and clear description of the containment boundary.

2) Revise Figure 2-1 to clearly delineate the containment boundary to ensure that it completely encloses the package cavity.

This information is required to determine compliance with 10 CFR 71.33 and 71.51.

4-3 Provide descriptions of (i) the characteristics of the sealed metal cavity-filler canister, (ii) the corresponding installation and removal procedures, and (iii) the metals suitable as the cavity-filler canister in the leak test.

The applicant stated in Section 8.1.4.2, “Test Procedure,” of the application that (optional) the sealed metal cavity-filler canister may be inserted into the package cavity in the leakage tests to reduce the volume of tracer test gas required to conduct the tests. The applicant noted that the cavity-filler canister should not obstruct the pressurization port penetration. The canister metal must be chemically compatible with the cask liner and the test gas.

Additional information is required on (1) the characteristics of this sealed metal cavity-filler canister, (2) the installation and removal procedures, and (3) the list of the canister materials to ensure that the canister material will not interact with or be penetrated by the test gases (helium) and will not thermally expand to cover the drain opening during the leak tests.

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

4-4 Provide information on the containment O-ring (Seal & Design Viton GLTS) to verify its operating range of -49°F to 400°F as well as its properties against radiation damage.

The applicant stated in Section 4.1.3 of the application that the primary lid contains two solid, high temperature elastomer O-rings (Seal & Design Viton GLTS) in machined grooves. The Seal & Design Viton GLTS is a fluoro-elastomer (Viton) compound with working temperature range of -49°F to 400°F. The applicant needs to provide verifiable and reliable sources or references to show the O-ring seal is usable in a range of -49°F to 400°F and is not damaged by radiation.

This information is required to determine compliance with 10 CFR 71.33 and 71.51.

4-5 Provide information on calculations of the minimum hold time for the pre-shipment leak tests on the closure lid and pressurization ports.

The applicant used the leakage rate of $1.0 \times 10^{-3}$ ref-$cm^3$/s (air) to derive the minimum hold time for the pre-shipment leak tests on the closure lid and pressurization ports. To clarify the calculations, the applicant needs to:

(a) Provide geometry and dimensions of the manifold and show how the manifold volume of 20 $cm^3$ is derived.

(b) Explain how the gas pressures in the annulus between two O-rings (18.1 psig at start of test and 18.0 psig at end of test) are determined.

(c) Provide Equation 4.7-1 in the application, and

(d) Correct the typo "$V_{ann} = 1.663 \times 10^0$ $V_{ann} = 2.725 \times 10^1$ $cm^3$" to "$V_{ann} = 1.663$ $in^3 = 2.725 \times 10^1$ $cm^3$" (page 4-8 of the application).

This information is required to determine compliance with 10 CFR 71.51.

4-6 Clarify the type of pressurization port seal and its permeation to helium.

The applicant stated, in Section 2.2.1 of the application, that the pressurization port seal is fluoro-elastomer (Viton) and has a usable temperature range that meets or exceeds the temperature ranges required for NCT. The staff reviewed the drawing WMG-150B-DW-004-P71 (sheet 2 of 8) and found that the pressurization port seal is described as Stat –O-Seal which is a Seal Compound S604-70 Silicone, i.e., not the fluoro-elastomer.

The applicant needs to clarify whether the pressurization port seal is a fluorocarbon elastomer or a silicone elastomer. For a silicone elastomer, the applicant needs to provide information and references to show that the silicone elastomer is not permeable to helium.

This information is required to determine compliance with 10 CFR 71.33 and 71.51.

4-7 Provide calculations of hydrogen generation by radiolysis, based on the contents allowed in the WMG-150B package

The application states: "WMG-150 users will ensure that the total amount of hydrogen gas in the secondary container generated during previous storage and during twice the expected shipping time will be limited to a molar quantity less than 5% of the volume of the cask cavity at STP conditions."

The applicant must estimate the maximum quantity of hydrogen generated by radiolysis, based on the contents allowed in the package.

This information is required to determine compliance with 10 CFR 71.35 and 71.43(d).

4-8 Show the derivation of the water vapor pressure in the MNOP's calculation.

The applicant stated, in Section 3.3.2 of the application, that the maximum normal operating pressure (MNOP) is the sum of three components: the pressure due to gas generation by radiolysis, the pressure due to increased temperature of the gas in the cavity, and the pressure due to water in the cavity.

The applicant needs to provide references to show how the water vapor pressure of 6.77 psia is derived in the MNOP's calculation.

This information is required to determine compliance with 10 CFR 71.35 and 71.71.

4-9 Clarify the difference, or similarity, between air and nitrogen on the minimum hold time and the test operations for the pre-shipment leak tests.

The applicant states, in Section 4.4, that the pre-shipment leak tests on the closure lid and pressurization ports can be performed by using air or nitrogen. The applicant derived a minimum hold time of 13 minutes for a pre-shipment leak test on both the closure lid and pressurization ports, per an air leakage rate of 1 $x10^{-3}$ ref-$cm^3$/sec. The applicant needs to clarify the difference, or similarity, of the operations between air and nitrogen on the minimum hold time and the test operation, if nitrogen is used as the tracer gas in the pre-shipment leak test.

This information is required to determine compliance with 10 CFR 71.51.

4-10 Clarify the distinction between the vent port and the pressurization port in the application.

The applicant mentioned the vent port in Section 4.4 (page 4-8) for the pre-shipment leak test and in Section 7.1.2 (page 7-4) for loading of contents. However, the staff reviewed the application, including the drawings, and found that the vent port does not exist in the design configuration of the WMG-150B package.

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

4-11 Include a note in the licensing drawings to summarize the technical specifications pertaining to the primary and secondary lid inner and outer O-rings.

The applicant provided the dimensions of the seal plate groove and the diameters of the primary and secondary lid inner and outer O-rings in the drawing WMG-150B-DW-004-P71, sheet 6 and sheet 2 respectively.

To ensure that each O-ring will properly fit into the groove, the following data is needed: tolerances for dimensions, material type and properties (e.g., hardness, tensile strength, elongation break, heating/aging, etc.), and the compression ratio of the O-ring into the groove for each of the primary and secondary lid inner and outer O-rings.

This information is required to determine compliance with 10 CFR 71.33(a) and 71.51.

4-12 Provide more information for acceptance of the high temperature elastomer O-rings (Seal & Design Viton GLTS) used in both primary and secondary lids.

In response to RSI 8-3, the applicant provided the document WMG-150B-ES-003-P71 and proposed to use its own Commercial Grade Dedication (CGD) process to procure the seals. The applicant stated that the O-rings are the high temperature elastomer O-ring (Seal & Design Viton GLTS), made of 75 durometer Viton GLTS fluoroelastomer compound, meeting the requirements specified by Seal and Design, Inc., via V71C Ultra-low temperature fluoroelastomer Product Data Sheet (Appendix A of WMG-150B-ES-003-P71).

The staff reviewed the document WMG-150B-ES-003-P71 and has no assurance that the V71C ultra-low temperature fluoroelastomer is identical to the 75 durometer Viton GLTS fluoroelastomer compound, nor that it is appropriate for use as a substitute for developing a CGD process for 75 durometer Viton GLTS fluoroelastomer compound to be used in WMG-150B package.

In addition, information on the seal surface finish and the potential of chemical, galvanic, or other reactions of 75 durometer Viton GLTS fluoroelastomer compound is not provided for review.

A standard specification from an approved manufacturer is required for O-ring seals which are important to safety components.

This information is required to determine compliance with 10 CFR 71.33(a) and 71.51.

4-13 Correct several typographical errors under Section 8.2.2 “Leakage Tests.”

The applicant should in particular revise the headings 8.3.2.1 to 8.2.2.1 (page 8-5) and 8.3.2.2 to 8.2.2.2 (page 8-6) and revise the unit “atm-cm$^3$/sec” to “ref-cm$^3$/sec” in Section 8.2.2 (page 8-6).

This information is required to determine compliance with 10 CFR 71.51.

## CHAPTER 5 SHIELDING EVALUATION

5-1 Provide an analysis that shows modeling A543 steel as carbon steel is conservative.

As stated in Section 5.3.2 of the application, “It was assumed that the A543 could be modeled using the standard carbon steel composition and this assumption was tested with a sensitivity analysis that showed the shielding results for the WMG-150B cask, when modeled with the detailed A543 composition, are bounded by the results for standard carbon steel and are within 0.2%.” This analysis was not provided in the supporting shielding analysis (Reference 5-7, WMG-150B-AR-132S-P71).

This information is required to determine compliance with 10 CFR 71.47 and 71.51.

5-2 Provide drawings and specifications for the disposable metal or polyethylene containers identified in Section 1.1 of the application. Also, provide revised activity limits when polyethylene containers are used in place of the disposable metal containers.

Section 1.1 states: “The package is designed to transport Type B quantities of solid radioactive materials in the form of dewatered or solidified resins, solidified or dewatered filter assemblies, or activated metals components placed in disposable metal or polyethylene containers that, in the absence of shoring, essentially fill the package cavity."

The supporting shielding analysis states "Steel disposal liners were modeled because polyethylene high integrity containers are becoming obsolete now that the newer disposal sites no longer accept poly hics as stable containers. A sensitivity analysis was performed to compare model dose results using a 0.25 inch steel liner vs using 0.625 inch high density polyethylene. The poly hics provide slightly less shielding and the results were about 14% higher than the steel liner results."

Since the shielding analyses credit the presence of the steel disposal liners, the drawings specifying the geometry, material, and density of these liners will be part of the licensing drawings referenced in the CoC. Specifications may be variable but need to be bounded by the assumptions used in the shielding analyses.

It is less conservative, for the shielding analysis, to assume steel liners rather than the polyethylene containers. Provide revised activity limits when using a high density polyethylene HIC or discuss how regulatory dose rate limits are met under normal and accident conditions when the high density polyethylene HIC is used.

This information is required to determine compliance with 10 CFR 71.47 and 71.51.

5-3 Provide an analysis showing that cartridge filter elements are the bounding contents for shielding.

As stated in Section 5.0, "Design basis source terms were considered for waste forms consisting of irradiated hardware, ion exchange resin and cartridge filter elements. The filter source term was found to be limiting due to the low density which provides relatively little self-shielding." No analysis was provided in the supporting shielding analysis showing that cartridge filter elements provide the maximum dose compared to the other two allowable contents.

This information is required to confirm compliance with 10 CFR 71.47 and 71.51.

5-4 Revise the calculation using dose conversion factors from ANSI/ANS 6.1.1-1977.

Section 5.4.3 of the application states that dose conversion factors were used from ANSI/ANS 6.1.1-1991. The Standard Review Plan states, in Chapter 5.5.4.3, that ANSI/ANS 6.1.1-1977 should be used for dose conversion factors in the shielding analysis. Use of the conversion factors in ANSI/ANS 6.1.1-1991 can result in a significant underestimation of external dose rates (as defined by 49 CFR 173.403 and 10 CFR 20.1004). In addition, the dose rates determined with the 1991 standard do not correspond physically to dose rates measured by typical radiation monitoring instruments.

This information is required to confirm compliance with 10 CFR 71.47 and 71.51.

5-5 Justify that a 12% margin to dose rate limit is enough to account for all intended uncertainties associated with the loading of this package.

Section 5.4.4 of the application states: "The analysis results tabulated in Table 5-1 show the packaging effectively shields the design basis source term with margin to spare relative to the limits in 10 CFR Part 71. The limiting dose rate is the contact reading on the bottom which is 88% of the limit at 175.8 mrem/hr." However, Section 9.0 of application, Reference 5-7, states: "The final sensitivity analysis performed under NCT was to estimate the effects of the manufacturing tolerances on the minimum shield thickness and the impact on the dose rates. Based on the dimensional tolerances the lead shield thickness could be reduced by 0.125 inches. This results in a 10% increase on the dose rates on the side of the package relative to the nominal dimensions."

Although no mention is made on the effect of dimensional tolerances on the lead shielding at the bottom of the package, there is no reason not to expect a similar increase in the dose rate. In addition to the effects from manufacturing tolerances, increasing the source concentration during NCT could further increase the external dose rate. For HAC, Section 9.0 of the application, Reference 5-7, states that increasing the source concentration by a factor of 2 increases the external dose rates by 30 to 40 percent.

Further, there is no basis identified in the application for not having some source concentration during NCT, which could have similar increases in the external dose rates as identified for HAC. Justify that the 12% margin shown in Section 5.4.4 of the application is adequate to cover all intended uncertainties such as manufacturing tolerances and the possibility of source redistribution during transport.

This information is required to confirm compliance with 10 CFR 71.47 and 71.51.

5-6 Discuss the possibility of source concentration under NCT.

Section 9.0 of the application, Reference 5-7, states that under HAC increasing the source concentration by a factor of 2 increases the external dose rates by 30 to 40 percent. There is no basis identified in the application for not having some source concentration during NCT, which could have similar increases in the external dose rates as identified for HAC. Source concentration is expected to some degree given that the package may be loaded to 85% of full volume. Discuss how source concentration is precluded under NCT or how it is bounded by the 12% margin in the presence of other uncertainties.

This information is required to confirm compliance with 10 CFR 71.47 and 71.51.

5-7 Justify the use of the package nominal values for the MCNP model used to perform the shielding evaluation.

The shielding evaluation was performed using nominal package dimensions. Justify the use of nominal dimensions rather than accounting for manufacturing tolerances.

This information is required to determine compliance with 10 CFR 71.41(a).

5-8 Provide an evaluation for neutron sources or justify why an evaluation is not needed.

Section 3.0 of the application, Reference 5-7, states: "Since the package will only be licensed to carry byproduct radioactive materials, only gamma shielding was performed. There were no neutron shielding cases performed for the package. While the contents may include trace amounts of transuranic nuclides, the contents are limited to fissile excepted per 10 CFR 71.15. This ensures that any neutron emissions due to decay will be negligible." Section 5.2.2 of the application states: "Since the cask will be licensed for byproduct material and not spent fuel or neutron sources, a neutron source term was not considered for this application. While the contents may include trace amounts of transuranic nuclides, the contents are limited to fissile excepted per 10 CFR 71.15 (Reference 5-1)." The applicant seems to be relying on 10 CFR 71.15 to preclude neutron sources being present in the package. However, 10 CFR 71.15 is solely intended for criticality safety purposes and has nothing to do with shielding and whether or not neutron sources are present.

The currently proposed contents descriptions include neutron sources. Some nuclides are gamma and neutron emitters. The current shielding evaluation and package loading operations do not address neutron emitters. An appropriate evaluation or justification (quantitative as well as qualitative) for not needing an evaluation should be provided. Any evaluation or justification should address important factors such as the radionuclides that may be present, distribution of the radionuclides (including non-uniformity and point sources) and contents compositions. Alpha-n reactions in the contents should also be addressed.

This information is required to determine compliance with 10 CFR 71.33(b), 71.35(a), 71.47, and 71.51.

5-9 Justify that the contents of the package cannot enter the chamfered region between the lid and cask under NCT and HAC.

Section 5.0 of the application states: "The top is comprised of a primary lid and a secondary lid, or fill-port, as shown in Figure 5.1. The primary lid is comprised of 5.25 inches of steel." Based on a review of the drawings, there is a chamfered region and a slight gap between the lid and cask. Also, there is no lead in the top in the ring outside the fill port. Justify that, under NCT and HAC, the contents cannot redistribute up to the top of the package where there is a streaming path between the package lid and body.

This information is required to determine compliance with 10 CFR 71.47 and 71.51(a)(2).

5-10 Justify, with an evaluation, that 3,000 $A_2$ is an acceptable content quantity limit for beta-emitting nuclides addressing the potential for significant generation of Bremsstrahlung.

For at least some beta-emitting nuclides, Bremsstrahlung may be significant as a source of radiation exposure from the package. This concern is particularly for those nuclides that emit high energy betas and the proposed content quantity limit allows for significant quantities of those nuclides to be transported. An example is P-32 with a maximum beta energy of 1.71 MeV (the average is 695 keV), emitted with each decay, and an $A_2$ value comparable to that of Co-60 (14 curies vs. 11 curies). A quantitative, as well as a qualitative, justification is needed.

This information is required to determine compliance with 10 CFR 71.35(a), 71.47, and 71.51.

5-11 Justify the rationale for concentrating the source only by a factor of two under HAC.

Section 5.4.4 of the application states: “The effects of concentrating the source material at the cask top, bottom, or side adjacent to the slump were considered. However, when considering the source material types (i.e., spent ion exchange resins and sludges, solidified waste, cartridge filters, irradiated hardware and dry active waste), it is very difficult to concentrate the waste material to increase the source concentrations locally by more than a factor of two. As long as the free flowable materials, such as resin, meet the 85% percent fill criteria and more discrete items, such as filters or irradiated components, are packaged so they are physically full or shored to prevent shifting of contents, the source cannot be concentrated appreciably. Since the dose rates under hypothetical accident conditions were less than 10% of the limits, if the source were to concentrate by a factor of two it would still be well within the limits. It should be noted that, for many waste forms, physical concentration of the source material results in an increase in the source density and the increased self-shielding tends to cancel out much of the increased dose rate.”

The arguments provided are not substantial enough to demonstrate that this material cannot concentrate by more than a factor of 2. Provide additional information or an analysis, as necessary, demonstrating that the source cannot concentrate more than a factor of 2.

This information is required to determine compliance with 10 CFR 71.51.

5-12 Justify that the representation of the cartridge filter elements accurately or conservatively (with respect to shielding) represents such contents.

Section 5.2 states: “The source densities were homogenized over the 150 cubic foot source volume. The irradiated hardware source was modeled as 1.205 g/cc of stainless steel, while the ion exchange resin and cartridge filter elements were modeled as water with densities of 0.8 g/cc and 0.16 g/cc respectively.”

Justify that the material assumptions for the cartridge filter elements (0.16 g/cc of water) represent this content accurately, or conservatively, such that there would be no less self-shielding from the actual contents.

This information is required to determine compliance with 10 CFR 71.47 and 71.51.

5-13 Address the potential for streaming for both NCT (lid and side) and HAC (lid only).

Table 5-4 of the application shows the detector (tally) locations for the shielding analyses. These are all located on the cask centerline for each surface. Section 5.3.1 states “It should be noted that numerous detector locations were evaluated to identify the maximum exposure locations on and around the cask before selecting the locations in Table 5-4 as limiting.”

In Reference 5-7, Figure Nos. 6 and 7 show that dose rate tallies at the top of the cask were evaluated up to about 70 cm from the centerline in the “well” of the impact limiter. The discussion on page 19 and figure 10 shows that streaming over the lead on the side of the cask was addressed under HAC only.

The staff believes that there may be streaming from the top of the cask outside of lead shielding in the lid, i.e., radius greater than 70 cm, and on the side above the lead shielding.

Evaluate the dose rates in these areas under NCT to demonstrate that dose rates would not increase beyond regulatory limits as a result of streaming. Evaluate the dose rates in the lid under HAC as the potential streaming above the lead under HAC was evaluated.

This information is required to determine compliance with 10 CFR 71.47 and 71.51(a)(2).

**CHAPTER 7 OPERATING PROCEDURES**

7-1 Indicate when the welds and the exterior parts of the package are inspected prior to each pre-loading.

The application indicates when lid bolts, seals, and interior portions of the package are inspected for each pre-loading, but does not mention the inspection of the exterior parts of the package and of all accessible welds.

This information is required to determine compliance with 10 CFR71.85 and 71.87.

7-2 Include, in the operating procedures, methods for determining the allowable contents quantities for neutron-emitting contents, beta-emitting contents, and mixtures of gamma, beta, and/or neutron-emitting contents, that are supported by the shielding evaluation.

If neutron-emitting contents, beta-emitting contents and/or mixtures of gamma-, beta- and/or neutron-emitting contents are shipped, the application should describe the method used for determining the allowable quantities for such contents.

This information is required to determine compliance with 10 CFR 71.33, 71.47, and 71.51.

7-3 Clarify how the tie-down lugs will be rendered inoperable during lifting operations.

Staff is concerned that the wrong lug may be used for lifting operations. Describe how tie down lugs will be rendered inoperable during lifting operations.

This information is required to determine compliance with 10 CFR 71.33 and 71.45(a).