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Washington TRU Solutions LLC

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August 30, 2010

ATTN: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING APPLICATION FOR REVISION 5 OF THE RH-TRU 72-B SHIPPING PACKAGE, DOCKET NO. 71-9212, TAC No. L24419

References:
1. Letter from T. E. Sellmer to Document Control Desk, dated February 12, 2010, subject: Revision 5 of the RH-TRU 72-B Shipping Package Application, Docket No. 71-9212
2. Letter from T. E. Sellmer to Document Control Desk, dated April 19, 2010, subject: Supplemental Information Regarding Application for Revision 5 of the RH-TRU 72-B Shipping Package Application, Docket No. 71-9212
3. Letter from S. I. Soto (NRC) to T.E. Sellmer, dated July 15, 2010, subject: Request for Additional Information for Review of the Model No. RH-TRU 72-B Shipping Package

Dear Sir or Madam:

Washington TRU Solutions LLC, on behalf of the U.S. Department of Energy, hereby submits an amendment to Revision 5 of the application for a Certificate of Compliance (CoC) for the RH-TRU 72-B Packaging, U.S. Nuclear Regulatory Commission (NRC) Docket No. 71-9212 (Reference 1). The amendment is to satisfy commitments made in the supplemental information request response (Reference 2) and in response to the request for additional information (RAI) (Reference 3).

The amendment consists of the following documents:

- RH-TRU 72-B Safety Analysis Report (SAR), Revision 5
- Remote-Handled Transuranic Waste Authorized Methods for Payload Control (RH-TRAMPAC), Revision 1
- RH-TRU Payload Appendices, Revision 1.

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This letter includes the following attachments:

- Attachment A – Responses to RAI
- Attachment B – Summary of Revisions
- Attachment C – Revised Documents
- Attachment D – Supplementary References
- Attachment E – Criticality Analysis Output File.

Individual responses to the RAI are provided in Attachment A. All technical changes necessary to specifically address the Supplemental Information Request and the RAI are indicated by right-bars in the margin of the documents ("|") and are summarized in Attachment B. Right-bars in the margin of the documents ("|") indicating technical changes made to the documents in the original submittal of this application have been retained.

To facilitate implementation, it is requested that the current package CoC be valid for use one year from the date of issuance of the revised CoC.

If you have any questions regarding this submittal, please contact Mr. B. A. Day of my staff at (575) 234-7414.

Sincerely,

Todd Sellmer

T. E. Sellmer, Manager
Packaging Integration

TES:clm

Enclosures

cc: C. Gadbury (CBFO)
C. Staab (NRC)

Responses to NRC Request for Additional Information (RAI) on Revision 5 of the RH-TRU 72-B Cask Safety Analysis Report (SAR), Revision 1 of the Remote-Handled Transuranic Waste Authorized Methods for Payload Control (RH-TRAMPAC), and Revision 1 of the RH-TRU Payload Appendices

Chapter 2 Structural Evaluation

1. Provide the structural material, codes, analysis, etc., and details of the construction of the package in the RH-TRU Safety Analysis report (SAR), Rev. 5, in order to qualify it for Type B(M), an exclusive use package.

   On page 1.2-7, the applicant has indicated that the package is for an "exclusive use." Elsewhere it has been claimed that the package is for "non-exclusive use" (SAR pg. 3.4-2). The staff needs this information to determine whether it will meet the requirements of the intended function.

   This information is requested by staff for compliance with 10 CFR 71.75.

   Response:

   Comment incorporated. Consistent with the statement on page 1.2-7 of the RH-TRU 72-B SAR, the RH-TRU 72-B is an exclusive use package. Chapter 3 of the SAR has been revised to consistently state that NCT package temperature evaluations are associated with an exclusive use accessible surface temperature requirement of 185°F per 10 CFR 71.43(g). References to non-exclusive use in the SAR have been deleted.

2. Explain how the structural integrity of the personnel barrier, if any, is maintained during the NCT event. Provide details regarding the deformed shape following the event and the structural analysis that was performed of the personnel barrier.

   RH-TRU SAR, Rev. 5, does not describe the deformed shape of the personnel barrier subjected to NCT loads. Modify and add details that describe the shape of the barrier into the appropriate Section of the SAR.

   This information is requested by staff for compliance with 10 CFR 71.71.

   Response:

   Due to the fact that all accessible surfaces of the RH-TRU 72-B package are conservatively in compliance with the 185°F exclusive use temperature requirements of 10 CFR 71.43(g) and the external surfaces of the package are utilized directly for exclusive use dose rate compliance measurements per 10 CFR 71.87(j), no personnel barrier is required or implemented for the package.

3. Provide structural design details of the CDX grade plywood disc. Explain how this disc is assembled and discuss the behavior of this disc inside the cask when the package is subjected to the regulatory drops for NCT and HAC events.

   The staff found the SAR inadequate in addressing the design details of this component.

   This information is requested by staff for compliance with 10 CFR 71.33.

Response:

SAR Drawing X-106-503-SNP, Flag Note 4, defines the structural design details and installation requirements for the optional CDX grade plywood disc. The CDX grade plywood disc has dimensional design requirements of 24- to 24½-inch diameter by ¼- to 1-inch stock thickness. The optional disc may be assembled above the neutron shield top end cap or below the neutron shield bottom end cap to ensure a maximum axial gap of ½ inch is maintained between the shield insert assembly and the surrounding canister. Limiting of the axial gap through the use of the optional plywood disc ensures that the neutron shield top and bottom end caps remain engaged with the neutron shield body pipe such that radiation streaming paths due to end cap disengagement from the body pipe are precluded.

During NCT and HAC end drop events, the CDX grade plywood disc is either compressed between the inner surface of the canister lid and the outer surface of the shield insert top end cap or between the inner surface of the canister base and the outer surface of the shield insert bottom end cap, depending upon the initial installation location. To ensure the SAR drawing requirements for initial axial gap and plywood disc thickness were configured to maximize the post-test resulting axial gap, a minimum initial axial gap of over ½ inch was utilized along with the maximum plywood disc size of 1-inch stock thickness. Per Appendices E and H of Petersen Engineering Report 7953-R-027, the minimum post-test thickness of the plywood disc was 0.698 inches when subject to the HAC end drops. As such, the disc performed as designed to maintain positive axial engagement of the shield insert end caps and body pipe under conditions of maximum disc compression and associated axial gap. Pages 5.1-13 and 5.1-21 and Figures 5.1-8 and 5.1-14 of RH-TRU Payload Appendix 5.1 provide additional details regarding the plywood disc purpose and performance.

4. Provide justification(s), validated by test data presented in Appendix 3.6.4 for maintaining the leak tightness of O-ring under HAC event. Reconcile results with those described in the test report.

   The current documentation provided in the SAR for justification for O-ring leak tightness of the package model is not adequate, especially since the density of the polyurethane foam material for the NS-30 neutron shielded canister is not substantiated adequately.

   This information is requested by staff for compliance with 10 CFR 71.35.

   Response:

   Comment retracted (email from B. Tripathi [NRC] to C. Staab [NRC], Subject: SAR Section Identification – RH-TRU 72B RAIs related, dated July 23, 2010).

5. Justify comparing maximum analysis displacement to the post-test deformation reported in the SAR. The implication by the applicant is that there is no elastic behavior of the impact limiter.

   The staff did not find sufficient and accurate justification for the applicant to assume a totally inelastic behavior of the impact limiter materials. A justification is required to determine the magnitude of the damage sustained by the package subjected to regulatory drops, and to verify the adequacy of the impact limiter design.

This information is requested by staff for compliance with 10 CFR 71.73(c)(1).

Response:

The Test Fixture end and side polyurethane foam impact limiters behaved primarily inelastically during both Hot and Cold 30-foot drop tests in the end and side drop orientations. The polyurethane foam impact limiters exhibited some level of elastic rebound along with the permanent plastic deformation that was observed and recorded during the post-test evaluations (see Petersen Engineering Report 7953-R-027). The residual deformations of each impact limiter, as summarized in Section 5.1.3.2.2 and Section 5.1.3.2.3 of RH-TRU Payload Appendix 5.1, were used only to *estimate* the resultant impact accelerations under a constant resistance assumption for comparison purposes with the reported impact accelerations measured during each drop event. It is acknowledged that a more conservative estimate of impact decelerations using the constant resistance assumption could have been determined by using the total maximum deformation of the impact limiters had that measurement/information been available. However, the measured impact decelerations directly provide the necessary information to ascertain that the Test Fixture design was sufficient to ensure that the NS30 test articles experienced a drop event that conservatively bounded the response of the RH-TRU 72-B package.

To summarize the data contained in RH-TRU Payload Appendix 5.1, Table 1 provides the measured Test Fixture impact decelerations and the RH-TRU 72-B SAR impact decelerations originally calculated for the packaging impact limiter design:

Table 1 – Impact Decelerations

Impact Limiter / Orientation & Temperature Condition	Average Test Fixture Measured (g's)	Maximum RH-TRU 72-B Calculated (g's)
End Drop (Cold)	375	89.70
Side Drop (Cold)	136	81.20
End Drop (Hot)	382	51.10
Side Drop (Hot)	204	68.90

As shown above, the 30-foot drop test conditions experienced by the NS30 test articles when installed in the Test Fixture were more severe (i.e., higher g-loads) than if tested in an RH-TRU 72-B package such that the NS30 test article damage was conservatively determined.

6. Provide a complete stand-alone description of the summary of damage to the various structural components for NS-30 model, under NCT and HAC events.

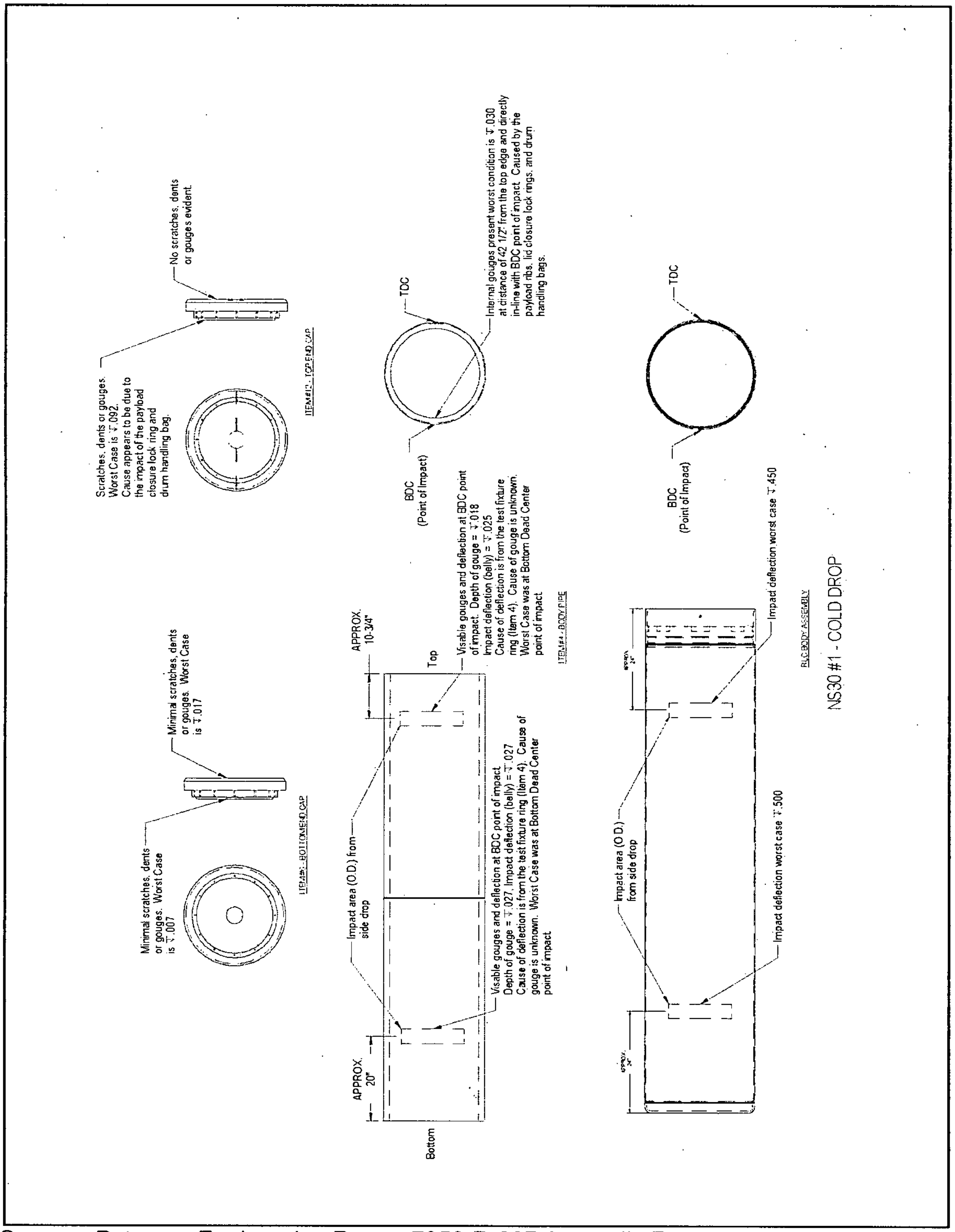
   The staff needs this information to evaluate any potential cross cutting issues with other discipline such as criticality and shielding.

   This information is needed for compliance with 10 CFR 71.35.

   This information is needed for compliance with 10 CFR 71.73(c)(1).

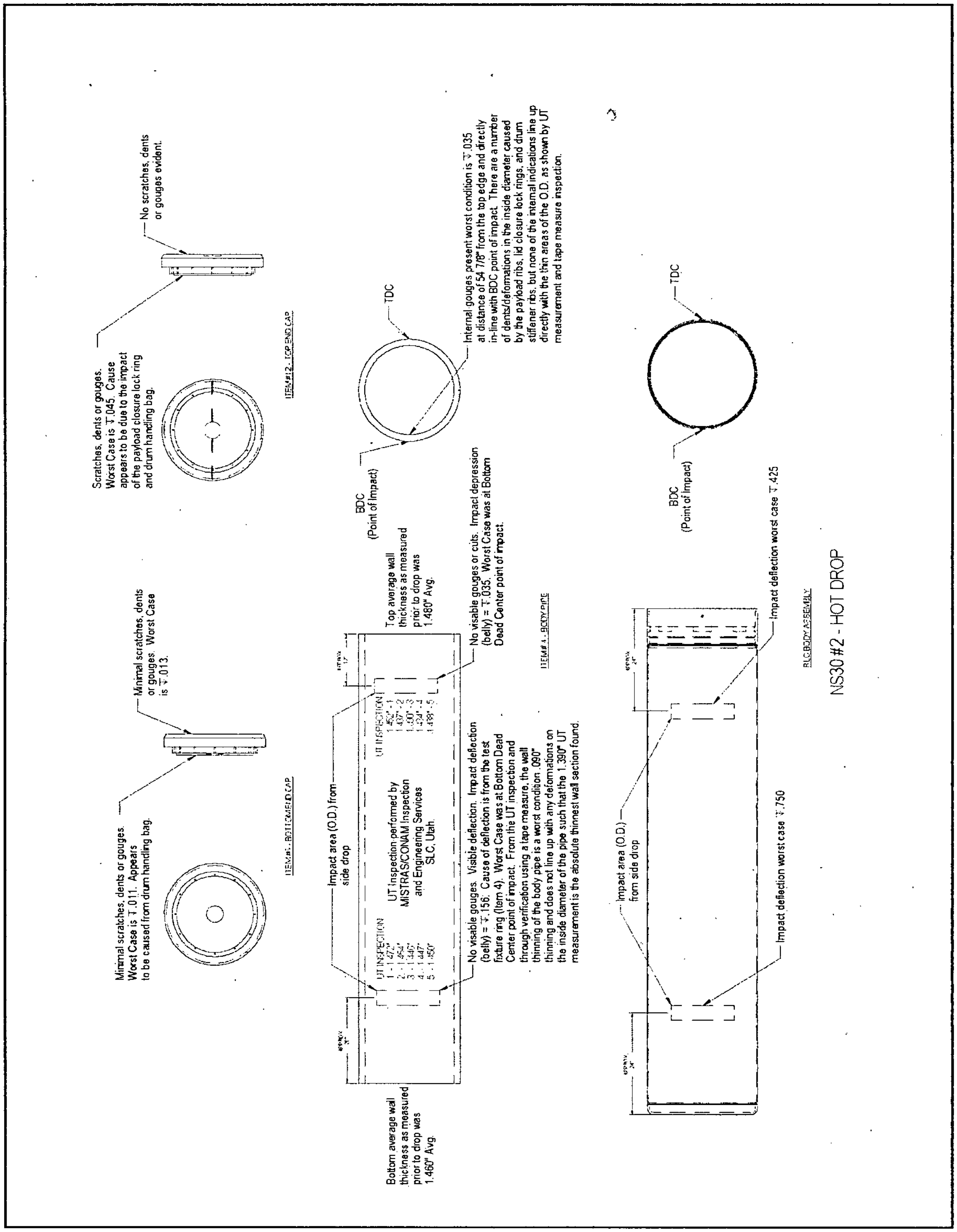
Response:

RH-TRU Payload Appendix 5.1 Sections 5.1.3.2.2 through 5.1.3.2.4 provide a summary description of the damage to the NS30 canister metallic lid and body and shield insert polyethylene top and bottom end caps and pipe body. Additionally, as repeated below in Figure 1 and Figure 2, the Petersen Engineering Report 7953-R-027 provides a detailed summary of maximum damage to these components in Appendices E and H.



Source: Petersen Engineering Report 7953-R-027 Appendix E

Figure 1 – Damage Assessment of NS30 #1 Cold Drop Test Article



Source: Petersen Engineering Report 7953-R-027 Appendix H

Figure 2 – Damage Assessment of NS30 #2 Hot Drop Test Article

Chapter 3 Thermal Evaluation

1. Indicate whether metallic waste will be placed within the shielded NS15 and NS30 canisters.

   Staff is not able to determine if metallic waste will be placed within the NS15 and NS30 canisters. For example, on page 9 of 52 of the RH-TRU SAR, Rev. 5, Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask, Section 2.5.2, Decay Heat, indicates that a paper waste stream is considered for the shielded canisters. However, page 8 of 52, second item under Section 2.3, of Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask mentions metallic waste configurations. Considering that the SAR indicates that a 300 W metallic waste stream results in a surface temperature at the regulatory limit (122°F), provide an analysis of the metallic waste stream inside the NS15 and NS30 shielded RH waste container, unless the NS15 and NS30 shielded RH waste containers will not be used to ship metallic waste stream. It should be mentioned in Section 7, Operating Procedures if metallic waste is not to be shipped in the shielded canisters.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Comment incorporated. Metallic waste may be shipped within the NS15 and NS30 canisters provided that the 50-watt maximum design decay heat limit is met. From an analysis perspective, an extremely low thermal conductivity value associated with a paper waste stream is utilized to conservatively bound all authorized contents (including metallic waste) for the NS15 and NS30 when limited to 50 watts. Section 5.0 of the RH-TRAMPAC has been revised to clarify that the NS15 and NS30 shielded canisters are each limited to 50 watts.

2. Clarify whether paper waste and metallic waste will not be shipped in the same package.

   The analyses assumed either paper waste or metallic waste. Confirm whether or not paper waste and metallic waste will be shipped in the same package.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Comment incorporated. Paper and metallic waste may be shipped in the same package. Exceeding the 50-watt limit (up to 300 watts) requires that the payload meet the additional requirement of having a minimum 65% by weight metallic content. When the payload is less than 50 watts, any mixture of authorized contents is allowed due to the fact that the analysis assumptions for the "paper based waste stream with a 50 watt limit" bound any mixture and/or chemical composition of materials through the use of an extremely low thermal conductivity assumption. Section 5.0 of the RH-TRAMPAC has been revised to clarify that shipment of greater than 50 watts per canister (up to 300 watts) decay heat in canisters without neutron shielding requires the payload to have minimum metallic content of 65% by weight.

3. Indicate whether the thermal properties used in the thermal analysis are conservative/bounding.

   RH-TRU SAR shows that properties used in the thermal analyses are often not given as a function of temperature. For example, see page 15 of 52, Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask, Table 3-2, page 3.2-3 and Table 3.6.1-1, page 3.6.1-5, RH-TRU 72-B SAR, Rev. 5, February 2010. Therefore, the text should indicate whether the thermal properties at the single temperature conservatively bound the analyses.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   A non-temperature dependent thermal property is used when either the temperature effect is deemed to be insignificant over the temperature range of interest and/or when there is insufficient data to establish a temperature dependency. For example, the thermal properties reported for HDPE plastic given in Table 3-2, page 15 of 52, *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask*, are provided as single point values since that is all that exists in the open literature and since the data source (i.e., reference 9) states that the thermal conductance remains fairly constant over the typical range of working temperatures. Values obtained from other sources (e.g., www.matbase.com) also present only single point, non-temperature dependent values.

   A similar situation occurs for the thermal properties of polyurethane foam and paper/metallic payloads presented in Table 3.2-1 and Table 3.6.1-1 of RH-TRU 72-B SAR, Rev. 5, February 2010. General Plastics, the vendor of the proprietary polyurethane foam, provides only single point, non-temperature dependent values for thermal conductivity and specific heat as a function of foam density. Below 500°F, the thermal properties of the proprietary foam are essentially constant (see response to Chapter 3 Thermal Evaluation RAI No. 9). Chapter 3 Thermal Evaluation RAI Nos. 12 b) and 12 c) address the conservatism associated with the thermal properties for paper/metallic payloads.

   The single value specific heat values for stainless and carbon steel and lead are appropriate since there is little change with temperature and conservatively low values are used. Similarly, the thermal conductivity value for lead is conservatively low for NCT conditions and conservatively high for HAC conditions. The thermal conductivity value for the A516, Grade 55 carbon steel used for the canister shell is low for the NCT conditions and does not materially impact the safety analysis under HAC since the canister shell is not near its temperature limit and its 'thru-wall' temperature difference is essentially zero because of its thickness.

   The thermal conductivity of Type 304 stainless steel will vary from about 8 Btu/hr-ft-°F at the 100 to 150°F temperatures seen under NCT conditions to 11 Btu/hr-ft-°F at the peak 611°F temperature seen under HAC conditions. Although the thermal shield reaches a higher temperature, its thinness yields a 'thru-wall' thermal resistance that is vanishingly small. While the use of a fixed thermal conductivity value of 10 Btu/hr-ft-°F will tend to under predict the peak OC outer shell temperature and, to a lesser degree, the OC inner shell, the effect will be relatively slight since the non-conservative thermal conductivity occurs over the last half of the fire event and since the heat flow into the OC outer shell is principally controlled by the thermal resistance between the thermal shield and the OC outer shell and not the conductivity of the OC outer shell. The thermal margins available for the OC inner and outer shells and the lead shield under HAC conditions are sufficient to prevent the less-than-bounding thermal conductivity for Type 304 stainless steel under HAC conditions from creating a safety issue.

4. Discuss the results of the sensitivity analyses for waste placement.

   On page 17 of 52, page 31 of 52, pages 48-50, Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask, Section 4.1, it is mentioned that there were evaluations of sensitivity analyses for waste payload placement and centered/eccentric placement. Explain the extent of the differences in temperature in order to put in perspective the final arrangement chosen for analysis, such as shown in Figure 4-1 and Figure 4-2.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Comment incorporated. A discussion of the sensitivity analyses has been added to Section 4.2.1 of *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask*. The evaluation showed that the temperature results are essentially insensitive to the stacking arrangement with the middle positioning yielding the lowest peak payload temperature and the bottom positioning yielding the highest. The difference in the peak payload temperature between these two positions is only 2°F. See the response to Chapter 3 Thermal Evaluation RAI No. 14 b) for a discussion of the effects of eccentric placement of the components within a horizontal cask.

5. Provide the allowable temperatures of the components used in the RH-TRU 72-B package.

   On page 3.1-3 and page 3.1-4, Table 3.1-1 and Table 3.1-2, of the RH-TRU 72-B SAR, Rev. 5, the allowable limits (not N/A) need to be provided for the items listed in the tables.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Comment incorporated. The requested allowable temperature limits have been provided in the RH-TRU 72-B SAR, Table 3.1-1 and Table 3.1-2. Additionally, RH-TRU Payload Appendix 5.1 Tables 5.1-1 thru 5.1-4 have been revised to incorporate allowable temperature limits.

6. Explain the disparate temperature differentials between the OC thermal shield and OC outer shell under NCT and HAC conditions.

   On page 3.4-12, Table 3.4-2 of the RH-TRU 72-B SAR, Rev. 5, February 2010, the temperatures of the OC thermal shield and OC outer shell are very similar, 142°F and 143°F respectively, for the NCT condition, implying a small resistance between the two components, but there is a very large temperature difference between the OC thermal shield (1231°F) and OC outer shell (611°F) for the HAC condition. For a given thermal resistance of the thermal shield, staff is not able to verify why the 1°F temperature increase between the thermal shield and outer shell for NCT should suddenly increase to 620°F for HAC [Temperature differences between the shell and thermal shield of approximately 350°F have been previously seen.]

This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

The temperature differentials between the OC thermal shield and OC outer shell under NCT and HAC conditions are a function of both the thermal resistance AND the heat flux between these two components. Since the heat flux is vastly different under the two conditions, the temperature difference is also expected to be vastly different. The NCT evaluation is conducted as a steady-state analysis with decay heat loads of 50 and 300 watts (W). As such, the temperature differential is purely a function of the thermal resistance and the decay heat load. In contrast, the HAC evaluation is conducted as a transient analysis where, in addition to thermal resistance and decay heat, the temperature differential is a function of thermal mass of the thermal shield and OC outer shell and the heat flux from the fire.

The validity of the noted HAC temperature differential can be confirmed from the presented temperatures. Per the RH-TRU 72-B SAR, Table 3.5-1, the temperature of the OC thermal shield at the end of the 30-minute fire for the 300 W payload is 1,231°F, while the temperature of the OC outer shell is 611°F. The transient temperature of a component is a function of its heat balance, which can be summarized as: Heat In - Heat Out + Heat Stored (or lost) = 0. Since the thermal mass of the thermal shield is relatively small, the amount of heat stored/lost within the thermal shield during the fire event is insignificant compared to the overall heat flow. As such, at any point during the 30-minute fire, the heat into the thermal shield from the fire is essentially equal to the heat flow between the thermal shield and the OC outer shell.

Given a flame temperature of 1,475°F and an OC thermal shield surface emissivity of 0.8, the heat flux on the thermal shield from radiation and convection heat transfer (see RH-TRU 72-B SAR, Section 3.6.1.2.1.1) at the end of the 30-minute fire is:

$$q = 1.714E\text{-}09 \text{ Btu/hr-ft}^2\text{-°F}^4 * 0.8 * [(1475°F + 460°F)^4 - (1231°F + 460°F)^4] + 2.5 \text{ Btu/hr-ft}^2\text{-°F} * (1475°F - 1231°F)$$

$$= 8{,}621 \text{ Btu/hr-ft}^2$$

In contrast, the equivalent heat flux under NCT conditions would be (300 W * 3.412 Btu/hr/W) / 86.9 ft^2 = 11.8 Btu/hr-ft^2 (based on approximately 86.9 ft^2 of thermal shield surface area and conservatively assuming that all of the payload's decay heat passes through the thermal shield). For a constant thermal resistance, the ratio of the temperature difference between two components is equal to the ratio of the heat flux between the components. Under this assumption, the expected ratio of temperature difference between the HAC and NCT conditions would be 8,621/11.8 = 730.6, which bounds the actual 620 ratio noted in the analysis (i.e., [1231°F-611°F]/[143°F-142°F]). The lower temperature ratio occurs because the thermal resistance between the OC thermal shield and OC outer shell is not constant with temperature due to the inclusion of radiation exchange between the components and the change in the thermal conductance across the air gap with temperature.

Since the temperature differential is highly dependent on the design and NCT heat load, the staff's previously seen temperature differential of 350°F could be explained by differences in thermal mass, surface emissivity, etc.

7. Clarify the amount of decay heat and distribution of the payload within the RH-TRU 72-B package.

   On page 3.4-13, Table 3.4-5 of RH-TRU 72-B SAR, Rev. 5, it is stated that the canister and container can hold 300 W metallic waste or 21.7 W paper waste. However, clarifications on the canister and container terms are needed. For example, page 39 of 52 of the thermal analysis uses the term *canister* to describe NS15 and NS30 and also mentions that they can hold, for example, six 8-gallon *containers*. Revise Table 3.4-5 to clarify whether the entire package will hold 300 W metallic waste or 21.7 W paper waste.

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

   Response:

   Comment incorporated. Table 3.4-5 of the RH-TRU 72-B SAR has been revised to delete the last row referencing the decay heat per payload container as the two rows present duplicate information. The decay heat values shown in Table 3.4-5 of the RH-TRU 72-B SAR apply per "payload canister." For the RH-TRU 72-B packaging, the term "payload container" is equivalent to the term "payload canister." Additionally, as stated in RH-TRAMPAC Section 2.1.1, "the terms 'payload container' and 'RH-TRU waste canister' are interchangeable." The RH-TRU waste payload canister may be a: a) fixed lid canister, b) removable lid canister, c) NS15 shielded canister or d) NS30 shielded canister. The fixed and removable lid canisters may either be direct-loaded with inner containers of varying sizes or contain up to three 30-gallon drums or up to three 55-gallon drums; contents within the drums may be further configured within inner containers of varying sizes. The NS15 and NS30 shielded canisters are removable lid canisters with the addition of internal high-density polyethylene neutron shield inserts designed to accommodate up to three approximately 15-gallon drums or up to three approximately 30-gallon drums, respectively; contents within the drums may be further configured within inner containers of varying sizes.

   All thermal analyses assume an even distribution of decay heat within an inner container where the volumetric heat generation is reasonably concentrated. Analysis assumptions, which due to the relatively low decay heat (≤50 W and/or ≤300 W) have little effect on packaging temperatures, are summarized from Appendix 3.6.1 of the RH-TRU 72-B SAR and Section 7.4.2 of *Thermal Analysis of the RH Shielded Canisters in RH-TRU 72-B Cask* as follows:

   a) Fixed lid canister – loaded with three 30-gallon drums having decay heat evenly distributed within six 7½-gallon inner containers (two 7½-gallon containers per drum)
   b) Removable lid canister – same as fixed lid
   c) NS15 – loaded with three 16-gallon drums having decay heat evenly distributed within the drums

d) NS30 – loaded with three 30-gallon drums having decay heat evenly distributed within six 8-gallon inner containers (two 8-gallon containers per drum)

From a thermal perspective, the NewMet and NewPaper wattage limits are 300 and 50 watts, respectively. Compliance with related RH-TRAMPAC requirements (e.g., nuclear criticality, flammable gas) will likely result in decay heat values well below the 50-watt maximum design decay heat limit for paper waste and the 300-watt maximum design decay heat limit for metallic waste. For additional clarification of the pressure and flammable gas wattage requirements, see response to Chapter 3 Thermal Evaluation RAI No. 16.

8. Justify the accuracy of Figure 3.4-1 and Figure 3.4-2 of the RH-TRU 72-B SAR. In addition, discuss why the 50 W paper waste temperature is higher than the 300 W metallic waste temperature.

   On page 3.4-12, Table 3.4-2 RH-TRU 72-B SAR, Rev. 5 the charts illustrated in Figure 3.4-1 and Figure 3.4-2 show that the average payload temperature is the same for both waste types. In addition, they also show that the waste centerline temperature is higher for the 50 W waste than for the 300 W waste. Higher decay heats tend to result in a larger source temperature. Therefore, Figures 3.4-1 and 3.4-2 need to be revised.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Figures 3.4-1 and 3.4-2 of the RH-TRU 72-B SAR are accurate and reflect the results of the NCT thermal analyses for both the paper and metallic payload cases as reported in Tables 3.4-3 and 3.4-4 of the RH-TRU 72-B SAR. Considering the 50-watt-based data point plotted in each figure, it is seen that the low-conductivity paper payload has a higher waste temperature than the high-conductivity metallic payload, yet the packaging temperatures are nearly identical for both payloads, as expected. It is coincidental that the average payload temperatures for the 50-watt paper case and 300-watt metallic case are nearly identical.

9. Provide further discussion on the properties of crushed polyurethane foam and charred polyurethane foam.

   On page 3.5-2 RH-TRU 72-B SAR, Rev. 5, it is not clear how the polyurethane foam's thermal conductivity was changed to reflect the crushed foam. In addition, considering that the morphology of the foam is different between uncharred and charred foam provide the basis for stating that the charred foam's thermal conductivity does not change appreciably from the uncharred foam.

   This information is requested by staff to determine compliance with 10 CFR 71.71.

   Response:

   Comment incorporated. The statement on page 3.5-2 of the RH-TRU 72-B SAR regarding the charred foam's thermal conductivity not changing appreciably from that of un-charred foam is incorrect and has been removed. Thermal properties of charred foam do not exist because the mechanisms behind the observed variations in the thermal properties and behavior of the FR-3700 foam at elevated temperatures are varied and complex. Accurate analytical modeling of the foam's thermal properties at temperatures above 500°F is therefore very difficult. Not only do the foam's effective conductivity and specific heat change as it undergoes thermal decomposition, but its density drops and the decomposition is accompanied by vigorous out-gassing, which removes a significant amount of heat from the package via mass transport. This same out-gassing can carry portions of the char layer with it and result in a non-homogenous char layer. Below 300°F, the thermal properties of the foam are essentially constant.

What has been successfully correlated is the thickness of foam that undergoes thermal decomposition during the 30-minute fire event as a function of density [see *Williamson, C., and Iams, Z., Thermal Assault and Polyurethane Foam - Evaluating Protective Mechanisms, General Plastics Manufacturing Company, Tacoma, WA, presented at PATRAM International Symposium, Berlin, Germany, 2004*]. To conservatively bound the change in thermal properties within this char layer, the thermal modeling assumes the charred foam is removed instantaneously at the start of the fire event. RH-TRU 72-B SAR Section 3.5.2, *Package Conditions and Environment*, has been revised to correct the modeling methodology explanation.

10. Include a Prg calculation that assumes the hypothetical accident condition at the end of the maximum 60 day transport period.

Page 3.5-3 RH-TRU 72-B SAR, Rev. 5. The Prg component of the IV pressure is based on 125.9°F. However, if the hypothetical accident condition occurred at the end of the 60 day transport period, the pressure would have to reflect the 295°F HAC temperature. The pressure values that make up Pmax should reflect the higher temperature associated with the hypothetical accident condition. This would raise the maximum pressure beyond 178.8 psig.

This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

Comment incorporated. The calculation of radiolytic gas pressure, P_{rg}, for bounding content code NewPaper has been revised to assume the hypothetical accident condition (HAC) at the end of the maximum 60-day transport period. The revised calculation reflects the use of the HAC gas temperature of 295°F (instead of the normal conditions of transport gas temperature of 125.9°F). The use of the HAC gas temperature results in a P_{max} value of 217.9 psig, which is well below the HAC analysis pressure of 300 psig. Section 3.5.4.1 (page 3.5-3) of the RH-TRU 72-B SAR has been revised to present the revised P_{rg} and P_{max} calculations for hypothetical accident conditions.

11. Provide the basis for the O-ring compression dimensions.

On page 3.6.4-1 RH-TRU 72-B SAR, Rev. 5, the basis for the 26.3 inch dimension on the last sentence of the page was not provided. Similarly, on page 3.6.4-2, the basis for the 31.000 inch dimension on the last sentence of the page was not provided. Confirm the gland (O-ring notch) dimensions are appropriate for the O-ring dimensions provided in the Chapter 1 drawings.

This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

The 26.30-inch dimension is the inner vessel containment O-ring inside diameter as delineated in Section P-P, Zone C-7/8, Sheet 5 of RH-TRU 72-B SAR Drawing X-106-500-SNP, Revision 5. The 31.00-inch dimension is the outer cask containment O-ring inside diameter as delineated in Section K-K, Zone C/D-8, Sheet 4 of RH-TRU 72-B SAR Drawing X-106-500-SNP, Revision 5. The sealing geometries utilized in the RH-TRU 72-B packaging design are appropriate for the O-ring dimensions as confirmed by the O-ring seal material testing documented in Appendix 3.6.4 of the RH-TRU 72-B SAR. The extreme tolerances of the RH-TRU 72-B sealing geometries are determined and applied, along with bounding temperature extremes, to demonstrate that the qualified O-ring seal material is capable of maintaining a leaktight seal when subjected to the bounding conditions (minimum O-ring compression and minimum and maximum temperatures) associated with the packaging design.

12. Discuss how the weighted thermal conductivity of the metallic waste in the analysis is conservative/bounding. Likewise, the procedure for combining the waste and cementitious material should be provided in the SAR.

    On page 3.2-1, RH-TRU 72-B SAR, Rev. 5, the third paragraph states: "A weighted conductivity of the metallic waste is calculated assuming the metal is encased in a cementitious material. The relative amount of these materials is determined by adjusting the portions to achieve a maximum allowable payload weight with three completely filled 55-gallon drums. The heat generation is assumed to be *evenly distributed* throughout the drums."

    a) Since the mixture thermal property may affect package temperature, a procedure for adjusting the metal and cementitious material in the correct proportions needs to be provided in the SAR.

    b) An "evenly distributed" heat generation could result in a non-conservative analysis. As a result, the analysis needs to indicate the sensitivity of the results to a non-uniform heat generation assumption (i.e., localized 'hot spots') especially considering that the surface temperature is equal to the regulatory limit of 122°F.

    c) On page 3.6.1-4 RH-TRU 72-B SAR, Rev. 5, the thermal conductivity of the metallic payload is listed as 9.47 Btu/hr ft °F. However, there is no calculation or basis for that value mentioned. Additional discussion is warranted to ensure the 9.47 Btu/hr ft °F thermal conductivity value is bounding for NCT and HAC.

    This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

a) Comment incorporated. Section 5.0 of the RH-TRAMPAC has been revised to clarify that shipment of greater than 50 watts per canister (up to 300 watts) requires the payload to be comprised of at least 65% by weight metallic content. Also see response to Chapter 3 Thermal Evaluation RAI No. 2.

b) Comment incorporated. The RH-TRU 72-B is an exclusive use package with an accessible surface temperature limitation of 185°F. As such, a significant thermal margin exists for both the 50 W and 300 W payloads for the criteria specified in 10 CFR 71.43(g). Given the waste classification of the RH-TRU 72-B payloads, a definitive analytical definition of the payload cannot be made. It was for this reason that the choice was made to simulate the 'paper' waste stream as having the thermal conductivity of 'still' air and to ignore heat transfer via radiation internal to the payload. The conservatism of these two assumptions accounts for both the variety of waste material and the potential for non-uniform loading. Since nearly all materials (other than insulations) have thermal conductivities that are an order of magnitude or greater than that of air, any credible concentration of the heat load should also be accompanied by an associated increase in thermal conductivity to a more realistic level. When combined with the existing large thermal margins under the current set of conservative modeling assumptions and the fact that a localized 'hot spot' would primarily affect the peak payload temperature with an insignificant impact on the packaging temperatures, it is the applicant's position that the addition of non-uniform loading represents a redundant and unnecessary conservatism.

A similar situation exists for the 300 W metallic payload in that the assumed thermal conductivity is based on a uniform packing fraction of 36% steel and 64% (by volume) concrete. A non-uniform decay heat distribution would imply a higher packing fraction in the 'hot spots' with a correspondingly higher local thermal conductivity (see response c), below). As with the paper payload, the 300 W metallic payload exhibits large thermal margins that are sufficient to offset any credible non-uniform payload distribution.

An insight into the sensitivity of non-uniform heat distribution within the packaging can be garnered by comparing the results presented in Table 3.4-2 of the RH-TRU 72-B SAR for the 50 W and 300 W payloads. Both payloads are distributed over approximately the same axial length of the packaging, with the 300 W payload exhibiting about twice the volumetric heat generation as the 50 W payload (i.e., 300 W/22.95 ft^3 versus 50 W/7.56 ft^3) and about 6 times the decay heat on an axial length basis. Since, as seen from the table values, the combination of both a change in the local decay heat loading plus the increase in the total heat load results in less than a 20°F increase within any packaging component, the effect of changing only the local decay heat loading and maintaining a constant total decay heat load would easily be limited to 20°F or less for the 50 W payload. A similar limiting effect on the packaging temperatures would occur for a doubling of the decay heat loadings for the 300 W payload.

RH-TRU 72-B SAR Section 3.6.1.7, *Payload Model*, has been revised to include the justifications for using evenly distributed decay heat loading.

c) Comment incorporated. As indicated in RH-TRU 72-B SAR Section 3.6.1.7.2, *Metallic Payload*, the thermal conductivity of the metallic payload is based on a mixture of steel and concrete in a ratio (i.e., 36% steel and 64% concrete by volume) that yields the maximum allowable payload canister total weight of 8000 lb. RH-TRU 72-B SAR Section 3.6.1.7.2 has been revised to present the calculational basis of the 9.47 Btu/hr-ft-°F thermal conductivity value and the justification of its use.

13. Confirm the gap dimensions and that the modeling arrangement of the HDPE insert results in conservative NCT and HAC temperatures.

    a) On page 5.1-30: RH-TRU Payload Appendices, Rev. 1, the fourth paragraph states: "Maintaining a tight contact between the bases of the insert and canister shell will yield *lower* NCT temperatures for the insert and payload and *lower* HAC temperatures ...." Confirm the modeling arrangement is such that NCT and HAC temperatures are conservative.

    b) On page 5.1-30: RH-TRU Payload Appendices, Rev. 1, February 2010, the fourth paragraph refers to 0.125 inch and 0.375 inch axial gaps for the base and lid ends of the canister. However, on page 37 of 52, Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask, the second to last sentence describes 0.125 inch and 0.5 inch gaps. Confirm that the gaps modeled are consistent and conservative/bounding values.

    This information is requested by staff to determine compliance with 10 CFR 71.71.

    Response:

    a) Comment incorporated. The modeling arrangement of assuming gaps between the payload and the HDPE insert and between the HDPE insert and the canister does yield conservatively predicted temperatures under both NCT and HAC conditions. The logic behind this conclusion is as follows: The alternative arrangement of assuming a tight contact between the bases of the insert and canister shell will yield lower temperatures under the steady-state NCT conditions for the insert and payload since the thermal resistance would be lower. The alternative modeling arrangement would also yield lower transient peak temperatures under HAC conditions for the base of the canister shell since the thermal mass of the HDPE insert would be closely coupled to the canister base and thus help absorb the transient heat flux during the fire event yielding a lower peak canister base temperature than would be achieved with no contact. Therefore, the peak canister temperature achieved under HAC conditions without contact with the HDPE insert will bound that achieved with contact and will also bound the peak HDPE insert temperature achieved with and without contact. This latter criterion was pointed to in *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask* as an alternative, conservative demonstration that the HDPE insert will remain below its allowable temperature under HAC.

       The *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask* and RH-TRU 72-B SAR have been revised to capture the above extended clarification.

    b) The axial gaps being referenced on page 5.1-30 of RH-TRU Payload Appendix 5.1 are associated with those between the neutron shield insert and the surrounding canister structure, whereas the gaps being referenced on page 37 of 52 of the *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask* are associated with those between the canister and the packaging inner vessel. The modeled gaps are consistent and appropriate values for both the inner vessel-to-canister and canister-to-shield insert interfaces.

14. Considering that there is no "Margin of Error" section in the RH-TRU 72B SAR, Rev. 5, discuss and provide quantification of the conservative nature of the thermal analyses.

Some issues that should be addressed include:

a) Averaging the insolation over 24 hours (page 3.6.1-1 RH-TRU 72-B SAR, Rev. 5, February 2010) tends to result in package surface temperatures that are not conservative (per "Thermal Modeling of Packages for Normal Conditions of Transport with Insolation", J.C. Anderson and M.R. Feldman, CONF-951135-28, Proceedings of the ASME Heat Transfer Division, HTD-Vol. 317-2 International Mechanical Engineering Congress and Exposition, November 1995). Applying a transient insolation boundary condition (e.g., 12 hours "on" and 12 hours "off") would result in the 300 W package surface temperatures being above the 122°F limit.

b) Another potentially non-conservative assumption is a uniform radial gap. Page 38 of 52, *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask*, Section 7.4.2 states, "The use of a uniform radial gap is appropriate for NCT and HAC evaluations even though the RH-TRU 72-B package is transported horizontally since the increase in the radial gap on one side of the HDPE insert will be offset by a corresponding smaller gap on the opposing side." This would indicate the actual situation is not axisymmetric. Therefore, the highest expected temperatures of the package components under NCT and HAC, whether for a "large" gap situation and/or a "small" gap situation, needs to be provided.

c) Confirm that a node sensitivity analysis was performed and results are grid independent.

This information is requested by staff to determine compliance with 10 CFR 71.71.

<u>Response:</u>

a) Comment incorporated. The surface temperature limit of 122°F applies to a non-exclusive use package and only without insolation. The RH-TRU 72-B is an exclusive use package with accessible surface temperature limitation of 185°F. As such, a significant thermal margin exists for both the 50 W and 300 W payloads for the criteria specified in 10 CFR 71.43(g).

While the use of averaged solar does provide non-conservative peak surface temperatures for NCT conditions with insolation, the internal package temperatures are relatively unaffected by the method used to apply the solar load (per the conclusions drawn in "Thermal Modeling of Packages for Normal Conditions of Transport with Insolation", J.C. Anderson and M.R. Feldman, CONF-951135-28, Proceedings of the ASME Heat Transfer Division, HTD-Vol. 317-2 International Mechanical Engineering Congress and Exposition, November 1995).

The thermal model used constant, 12-hour averaged insolation values and the projected area of the curved surfaces to arrive at the steady-state solar loads to be applied at each of the package surfaces. The use of a constant 12-hour averaged steady-state insolation loading conservatively bounds the results obtained using a transient insolation boundary condition (e.g., either a 12 hours "on" and 12 hours "off" or a sinusoidal method). The method for determining the solar loading used in the thermal modeling was described in Section 2.5.1 of *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask*. RH-TRU 72-B SAR Section 3.6.1.1 has been updated to include this clarification.

b) Comment incorporated. The potential thermal impact arising from eccentric placement of the payload within the cask was addressed by *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask* (see third paragraph from the end of Section 7.4.2). The noted impact was a slight (i.e., ≤ 0.2°F) decrease in the peak payload and HDPE temperatures, indicating that, given the low decay heat considered for the shielded canisters, the reduction in thermal resistance over the bottom half of the payload and HDPE insert offsets the increased thermal resistance over the upper half. Section 4.2.1 of *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask* has been updated to include this result.

It should be noted that the cask design includes a support structure to limit the eccentric offset of the canister when the cask is in the horizontal position such that a minimum radial gap of 2.375 inches would exist. This gap is only 0.25 inch smaller than that existing for the concentric placement of a canister with the nominal diameter.

c) A grid sensitivity analysis was not conducted for the RH-TRU 72-B package thermal analysis for the following reasons:
   - the model is constructed using finite difference surfaces and solids, and the finite difference methodology is fundamentally less vulnerable to grid induced errors than is the finite element method.
   - high mesh counts are generally necessitated to capture large 3-dimensional thermal gradients and the thermal gradients within the RH-TRU 72-B package under NCT and HAC conditions are either small and/or primarily in one direction only (radial).
   - for consistency with the RH-TRU 72-B SAR thermal analysis, the analysis of the NS15 and NS30 shield canisters utilized the same thermal modeling for RH-TRU 72-B package. The computational grid for that modeling was hand generated and the modeling captured only by text based input. As such, a grid revision would require extensive model re-work.

   Given the effort required to conduct a grid sensitivity study, the expectation that an insignificant impact on the predicted peak temperatures would be seen, and the large demonstrated thermal margins existing within the model, it is the applicant's position that a grid sensitivity study is not necessary to ensure the safety basis of the design.

15. Resolve the inconsistency upon the surface emissivity and absorbtivity values were used in the analyses.

    Page 3.2-4 of RH-TRU 72-B SAR, Rev. 5, lists emissivity and absorbtivity values that are different than those listed on page 3.6.1-1 and page 3.6.1-7.

    This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

Comment incorporated. The solar absorptivity value of 0.3 listed on page 3.6.1-1 of the RH-TRU 72-B SAR has been corrected to 0.52. The emissivity value of 0.3 listed on page 3.6.1-7 is consistent with the values on page 3.2-4 of the RH-TRU 72-B SAR in that all of the listed model nodes are associated with surfaces representing the thermal shield, impact limiter shells, and the trunnions.

16. Clarify the maximum allowable decay heats of paper waste and metallic waste that are expected to be shipped. This will then put into context the decay heat values used in the calculations.

    a) On page 3.4-1 RH-TRU 72-B SAR, Rev. 5, the last sentence states: "The two payload models represent the bounding conditions for all payloads, because the established payload parameter limits *do not approach the conditions represented by the models*." This sentence should be expanded to indicate the maximum decay heats that will be allowed in practice versus the decay heat values used in the calculations. As an example, the modeling of the metallic waste was based on a 300 decay heat. From the quoted sentence above, it would appear that a 300 W decay heat package will not be shipped. Staff is unable to determine if a package will not contain 300 W of metallic waste decay heat and what is the maximum metallic waste decay heat that is allowed to be shipped.

    b) There are a series of statements concerning the allowable decay heats based on a flammable gas generation consideration and vessel design pressure consideration. For example, on page 3.4-3 RH-TRU 72-B SAR, Rev. 5, at the top of page states: "Included in the evaluation is a demonstration that accumulation of potentially flammable gas is precluded." Page 3.4-8 of the SAR states that hydrogen gas generation will be the controlling factor for decay heats of organic material that are below 21.7 W. Pages 5.3-1 to 5.3-3 of the TRAMPAC indicate that the flammable gas limit will be reached if the paper waste decay heat reaches 5.149 W whereas the RH-TRU Payload Appendices (page 2.5-32) indicate that the maximum allowable decay heat is 0.8347W. However, pages 3.4-8 and 3.4-9 then show that a decay heat of 21.7 W generates a pressure that reaches the vessel design pressure. Staff is unable to determine whether the maximum paper waste decay heat that is allowed to be shipped is 0.8347 W, 5.149 W, or 21.7 W.

This information is requested by staff to determine compliance with 10 CFR 71.71.

Response:

a) Comment incorporated. The quoted sentence on page 3.4-1 of the RH-TRU 72-B SAR has been revised as follows: "The two payload models represent the bounding conditions for all payloads. Compliance with the RH-TRAMPAC requirements will likely result in decay heat values well below the 50-watt maximum design decay heat limit for paper waste and the 300-watt maximum design decay heat limit for metallic waste."

The maximum design decay heat limits for RH-TRU 72-B authorized payloads are as follows:

- 50 watts per NS15 or NS30 canister
- 50 watts per canister without neutron shielding
- 300 watts per canister without neutron shielding with a minimum metallic content of 65% by weight.

RH-TRAMPAC Section 5.0 has been revised to clearly state the above canister limits as the maximum design decay heat limits for RH-TRU 72-B authorized payloads.

The maximum decay heat values of paper waste and metallic waste payloads are expected to be below the 50-watt limit due to the requirements structure that specifies compliance with multiple limits that control the allowable activity per canister and the waste profile at the shipping sites. No payloads meeting the criteria for the 300-watt limit (i.e., predominantly metallic waste) have been shipped to date. Of the 402 RH-TRU 72-B shipments completed as of August 23, 2010, the highest wattage value per canister was 13.83 watts (without error), and 93 percent of these shipments contained less than 1 watt per canister. The average decay heat value per canister shipped to date is 0.3189 watts.

b) The pressure analysis detailed in Section 3.4.4 of the RH-TRU 72-B SAR shows through theoretical analysis that a decay heat of 21.7 W could potentially generate a pressure equal to the vessel design pressure. This is the wattage value at which the RH-TRU 72-B design pressure limit of 138.8 psig is met assuming a total gas generation rate at the theoretical maximum. The decay heat value of 21.7 watts is the theoretical bounding decay heat load for organic waste (corresponding to the maximum allowable pressure increase of 138.8 psig) and is not a "limit." As summarized in Section 3.4.4.3 of the RH-TRU 72-B SAR, "Beyond this theoretical pressure analysis, compliance with the flammable gas generation rate limits will ensure compliance with the total gas generation rate [pressure] for all cases."

As described in RH-TRAMPAC Section 5.3, because total gas (corresponding to pressure) and flammable gas are generated predominantly through radiolysis, compliance with the flammable gas (hydrogen) generation limits implies low flammable gas generation, which means low total gas generation. In order to demonstrate this point, RH-TRAMPAC Section 5.3 derives the theoretical maximum allowable FGGR and decay heat per canister by assuming no layers of confinement exist, the waste occupies no volume (maximizes the void volume), and the waste has the gas generation potential of cellulose (highest total-to-flammable gas G value ratio). The calculation of the theoretical maximum decay heat corresponding to the theoretical maximum FGGR is summarized on pages 5.3-1 to 5.3-3 of Section 5.3 of the RH-TRAMPAC and is 5.149 watts. The decay heat value of 5.149 watts is the theoretical maximum decay heat load (corresponding to the maximum allowable FGGR) and is not a "limit." Its calculation is intended to show that a canister payload will reach the 5% hydrogen concentration limit before it reaches the RH-TRU 72-B design pressure limit.

As specified by RH-TRAMPAC Section 5.0, "the hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume of the innermost layer of confinement." As such, RH-TRU 72-B payloads are restricted so that no flammable mixtures can occur in any layer of confinement during shipment. As detailed in RH-TRAMPAC Section 5.1.2, compliance with the flammable gas limit must be demonstrated through the evaluation of compliance with either:

- Decay heat limit per canister
- Flammable gas generation rate limit (FGGR) per canister.

The hydrogen-generation-based decay heat limit is determined per canister based on the packaging configuration and the gas generation potential of the waste. Sections 2.5.5 and 2.5.6 of RH-TRU Payload Appendix 2.5 present an example of the implementation of the hydrogen gas generation limit calculation methodology. The example presents the limit calculations for a specific Idaho National Laboratory solid organic RH-TRU waste form packaged in two bag layers of confinement in a 30-gallon drum inside an RH-TRU canister (described as RH-TRUCON Code ID 325B). Page 2.5-32 of RH-TRU Payload Appendix 2.5 specifies a decay heat limit of 0.8347 watt per canister, which is the unique hydrogen-generation-based decay heat limit for an RH-TRU canister with this particular waste and packaging configuration. The 0.8347-watt value is the decay heat limit only for waste described by the RH-TRUCON Code ID 325B example. This decay heat limit may only be exceeded if the FGGR limit also specified by the code is met. As stated in RH-TRAMPAC Section 5.1.2, for all canisters, either the decay heat limit or the FGGR limit must be met to ensure ≤5% hydrogen concentration in the innermost layer of confinement.

17. Confirm the free convection heat transfer correlations that were used in the analyses.

    On Page 3.4-1 RH-TRU 72-B SAR, Rev. 5, the fifth paragraph implies that the heat transfer coefficient correlation provided on page 3.6.1-2,based on *turbulent* flow, is appropriate for *free* convection. Justify, the appropriateness of using a turbulent flow correlation for free convection.

    This information is requested by staff to determine compliance with 10 CFR 71.71.

    Response:

    The convective heat transfer coefficient correlation provided on page 3.6.1-2 of the RH-TRU 72-B SAR is used only during the 30-minute fire event (see section heading). The use of a turbulent convective correlation conservatively maximizes the heat transfer between the fire and the package. The convective heat transfer prior to and following the 30-minute fire is based on a separate correlation that is valid for laminar and turbulent free convection over a range of Rayleigh numbers between 1 and 1×10^{12} [see *Rohsenow, Hartnett, and Choi, Handbook of Heat Transfer, 3rd edition, McGraw-Hill, 1998, equations 4-13, 4-24, 4-31, and 4-33*].

18. Clarify whether helium formation due to alpha decay was considered in the pressure analysis.

    On page 3.4-3 RH-TRU 72-B SAR, Rev. 5, section 3.4.4.2, staff is unable to identify the effects of the formation of helium due to alpha decay (e.g., decay of Pu) on the pressure analysis.

This information is requested by staff to determine compliance with 10 CFR 71.71.

Note: Editorial comment/clarification. Page 6 of 52, Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask, Section 1.2, Purpose states that NUREG-1617 was used for guidance, although the references (page 32 or 52) list NUREG-1609. Clarify if NUREG-1609 was used for guidance and make the appropriate corrections.

Response:

Helium generation due to alpha decay is insignificant in TRU waste shipments and does not contribute to the total pressure. Generally, the small masses (i.e., gram or less quantities) of TRU radionuclides in a payload and the long half-lives of TRU radionuclides (such as Pu-239 with a half-life of 24,000 years) combine to present very small activities of TRU radionuclides in the payload. In addition, the relative RH-TRU 72-B package void volume will be much larger than any helium volume generated through radioactive decay and alpha emission.

For example, Pu-238 with a half-life of 87.7 years is one of the shorter-lived, alpha emitting TRU radionuclides; therefore, it has a relatively high specific activity (17.3 Ci/g). As shown below even relatively large amounts of Pu-238 do not contribute significant quantities of helium.

The maximum theoretically possible decay heat limit per canister is 300 watts (W). Converting this limit to curies (Ci) results in 300 W Pu-238 / 5.73E-01 W/g * 1.73E+01 Ci/g Pu-238 = 9058 Ci Pu-238.

Converting to disintegrations per second (d/s) gives an estimate of Pu-238 decay: 9058 Ci Pu-238 * 3.7E+10 d/s = 3.35E+14 d/s.

The decay rate for the 60-day maximum shipping period associated with the transport of the RH-TRU 72-B package is calculated as follows: 1 alpha/d * 1 helium atom/alpha * 3.35E+14 d/s * 60 s/minute * 60 minutes/hour * 24 hours/day * 60 days = 1.74E+21 helium atoms in 60 days.

Converting to moles results in: 1.74E+21 helium atoms / 6.023E+23 helium atoms/mol = 2.89E-03 mol.

Assuming 22.4 L per mole of helium results in the maximum generation of 6.47E-02 L of helium during the 60-day shipping period.

The total volume of helium that is potentially generated due to the alpha decay of Pu-238 during the 60-day shipping period is 6.47E-02 L. When compared to the void volume of the RH-TRU 72-B package, which is 450 L, contribution to total pressure from helium is insignificant. Similar analyses apply to other alpha-emitting radionuclides.

Note Response:

Comment incorporated. The *Thermal Analysis of RH Shielded Canisters in RH-TRU 72-B Cask*, Section 1.2 Purpose, has been revised to clarify that NUREG-1609 was used for guidance in preparation of the calculation.

Chapter 4 Containment Evaluation

1. Clarify the O-ring test procedure.

   Page 3.6.4-4 to 3.6.4-6 RH-TRU 72-B SAR, Rev. 5, Section 3.6.4.3 Formulation Qualification Test Fixture and Procedure RH-TRU 72-B SAR, Rev. 5, February 2010:

   a) Page 3.6.4-5 discusses 'rapid' permeation and saturation of helium at high temperatures. Explain why the small test volume of the O-ring annulus (and hence, time for the test) would not allow helium leak testing at the NCT and HAC O-ring temperatures (approximately 150°F).

   b) Explain what a "rapid, hard vacuum" and the time period that it is "maintained" mean.

   c) In order to minimize the permeation effects during measurement is it possible for a helium atmosphere to be applied after the eight hours at high temperature and then apply Section A.5.3, Gas Filled Envelope – Gas Detector of ANSI N14.5? It is understood that the answer is dependent on the available experimental setup.

   This information is requested by staff to determine compliance with 10 CFR 71.35.

   Response:

   a) The reference in Section 3.6.4.3 of Appendix 3.6.4 of the RH-TRU 72-B SAR to "rapid permeation and saturation of helium gas through elastomeric material at high temperatures" is regarding the HAC Fire condition temperature of ≥360°F. The O-ring formulation qualification test evaluates the O-rings at temperature extremes that bound both NCT and HAC (≤-40°F to ≥360°F). The dwell time for the helium leak tests performed on the O-rings is a minimum of 3 minutes with the O-rings exposed to a helium-rich atmosphere for a minimum of 6 minutes subject to an acceptance criterion of 8.8×10^{-8} atm cc/sec of helium. Performing helium leak testing of the butyl O-ring materials at an elevated temperature (≈150°F) would result in a permeation rate through the material that exceeded the acceptance criteria of the O-ring material per *ASNT Volume 1, Leak Testing, Third Edition, Page 65, Figure 16*.

   b) A "rapid, hard vacuum" between the O-ring seals is defined by attaining a pressure of less than or equal to 1 torr that is "maintained" for a minimum of 5 minutes.

   c) Please refer to response a), above.

2. Discuss the appropriateness of using the low end of the pressure transducer range and sensitivity to measure the leak tightness criteria, as described in Containment RSI response 1.

   Containment RSI response 1, from the applicant (April 2010) indicated that the preshipment leak test will be based on using the low end of the pressure transducer range and sensitivity. Discuss the appropriateness of using the low end of the pressure transducer range and sensitivity, considering that transducers are usually accurate to a certain percentage (say 1%) of full scale. Operating at the low end of a wide measurement range is not desirable.

This information is requested by staff to determine compliance with 10 CFR 71.35 and 71.41.

Response:

The pressure transducers are calibrated at several points across the full scale, where each calibration point is individually required to be accurate to within 1%. A benefit of operating the pressure transducer in the lower end of the calibrated pressure range is the corresponding increase in sensitivity that is achieved for the testing process.

3. Discuss the package venting procedure.

   Page 7.1-1 and 7.2-1 RH-TRU 72-B SAR, Rev. 5, mentions package venting. The venting procedure and the appropriate controls should be mentioned in the SAR.

   This information is requested by staff to determine compliance with 10 CFR 71.89.

Response:

The RH-TRU 72-B Chapter 7.0 Operating Procedures are implemented by detailed operating procedures (inclusive of venting operations) delineated in the DOE/CBFO RH Packaging Operations Manual (DOE/WIPP 02-3284). Users of the RH-TRU 72-B package are required to use the DOE/CBFO RH Packaging Operations Manual for operation of the package. Surveillances of the package users are performed in accordance with Section 9.3.4.1 of the RH-TRU 72-B SAR to verify proper use of the package as well as implementation of the applicable DOE/CBFO RH Packaging Operations Manual.

Chapter 5 Shielding Evaluation

1. Provide an analysis of the effect of lead slumping on dose rate. Show that this is bounded by the effect of lead thinning due to impacts, which is the hypothetical accident condition (HAC) in the SAR.

   On page 4.3-2 of RH-TRU SAR, Rev. 5, the applicant states that "a conservatively maximum bounding lead slump of 0.513 inches is estimated." However, an analysis of the effect of lead slumping on dose was not included. Nor was a justification that leads slumping is bounded by the current HAC provided. Include in the response the output files of any shielding models used to analyze the dose effect of lead slumping.

   This information is requested by staff to show compliance with 10 CFR 71.51(a)(2) and 71.73.

Response:

Comment incorporated. Section 5.1 of the RH-TRU 72-B SAR has been revised to clarify and state that lead slump has been determined to not occur and is therefore not modeled or considered in the shielding analyses. Sections 2.1, 2.6.7.1(9), 2.7.1.1(9), 2.7.8, and 4.3.3 of the RH-TRU 72-B SAR discuss the evaluation of NCT and HAC induced lead slump in the package, concluding in each instance that lead slump would not occur under either condition due to design similarity (essentially a 2/3 scale model) to the NuPac 125-B. The 125-B package was demonstrated by test to not undergo measurable lead slump under HAC drop conditions. An upper-bound of lead slump equal to 0.008 inches under NCT and 0.513 inches under HAC was analytically determined for the RH-TRU 72-B to further support that lead slump would not be a problem were it to occur in the package. The location of the ends of the lead shield columns in the packaging are such that even the upper-bound of lead slump would not provide sufficient streaming paths to impact its dose rate compliance capability. This is primarily due to the additional distance attenuation provided by the non-credited impact limiters that overlap the ends of the lead column and the non-direct shine path between the canister payload and the ends of the lead column. In summary, design similarity between the 125-B and 72-B supports the conclusion that lead slump will not occur in the RH-TRU 72-B package for either the NCT or HAC free drop conditions.

2. Provide NCT activity limits similar to the HAC limits in Table 3.2-2 of the RH-TRAMPAC document.

   Prior to loading the package the shipper needs to rely on the calculated allowable source terms for all isotopes under normal and accident conditions. The pre-shipment radiological survey should be used only for confirming the regulatory dose limit. Also provide the composition and density of the compressed transuranic waste to be shipped in the RH-TRU 72-B. Of particular interest is the amount of hydrogen and other light elements. Staff performed scoping calculations to investigate the amount of self-shielding required to load up to the new curie limits without exceeding the NCT dose limits. To achieve acceptable dose rates for NCT a significant amount of self-shielding is needed. The NRC staff needs this information to determine whether there is enough self shielding to allow shipment of the higher activity waste.

   This information is requested by staff to show compliance with 10 CFR 71.47.

   Response:

   Consistent with the currently authorized TRU waste packages holding an NRC certificate (i.e., RH-TRU 72-B, TRUPACT-II, HalfPACT, and TRUPACT-III), it is proposed in the current amendment request that compliance with the 10 CFR 71.47 dose rate requirements for NCT continue to be satisfied through the application of preshipment radiological surveys. For exclusive use shipments, a combined gamma and neutron dose rate survey of the package surface (≤200 mrem/hr) and at 2 meters from the package surface (≤10 mrem/hr) is performed to ensure that the regulatory dose rate requirements for NCT are met. The following factors contribute to the assertion that preshipment radiological surveys are sufficient to ensure compliance with 10 CFR 71.47:

   - The preshipment radiological surveys of the package are performed by users under a Quality Assurance program that is approved and audited by the U.S. Department of Energy. An independent preshipment radiological survey of the package is also performed by a representative of the state from which the shipment originates as part of the Commercial Vehicle Safety Alliance (CVSA) vehicle inspection. Further, the shipment is randomly subjected to additional radiological surveys at points-of-entry into states through which the shipment travels.
   - The robust design of the package shielding components is such that damage to the shielding features of the RH-TRU 72-B package is negligible under NCT, and no significant increase in dose rate resulting from shield degradation would occur.

- Section 3.2 of the RH-TRAMPAC requires that additional payload container shielding beyond that defined by Section 2.8 of the RH-TRAMPAC as an integral component of the payload container not be used to meet the preshipment radiological survey limits. As such, any potential loss of self-shielding in the waste resulting from slippage of waste contents from behind supplemental shielding is accounted for, and no significant increase in dose rate would occur under NCT. Other possible causes of loss of internal self-shielding are considered incredible under NCT as multiple waste handling operations associated with waste characterization and loading activities pre-subject the waste materials to significant levels of jostling, vibration, and reorientation prior to execution of the package radiological surveys.
- A receipt radiological survey of the package is performed at the receiving site under a Quality Assurance program that is approved and audited by the U.S. Department of Energy. Received shipments that are determined by the WIPP Radiological Control Manager to exhibit dose rates that deviate significantly from the Package Transport Index are procedurally required to be logged and the shipping site Radiological Control Representative notified of the condition. Experience with approximately 400 RH-TRU 72-B shipments to date has resulted in no abnormal conditions requiring notification.

The preshipment survey is an appropriate and efficient method of ensuring NCT dose rate compliance, through measurement, which intrinsically evaluates and considers the activity distribution and self-shielding of each waste form.

Note: It is acknowledged that non-TRU waste nuclear transport packages typically have both an NCT- and HAC-based shielding analysis to establish activity limits for the payload where the NCT activity limits are typically the most limiting. Due to the varying nature of form, density, chemical composition, and radionuclide constituency of TRU waste, the development of a bounding NCT analysis, similar to the HAC analysis implemented for the RH-TRU 72-B, is not possible. The RH-TRU 72-B HAC analysis, in order to bound the complete inventory of TRU waste, assumes no self-shielding of the contents, complete reconfiguration of the contents to a single point source with minimum distance to the 1-meter detector, and maximum shield damage due to the puncture bar to establish activity limits that ensure compliance the 1 rem/hr at 1 meter dose rate requirement. Defining realistic bounds for the NCT condition is not possible due to the variations inherent to TRU waste payloads.

Chapter 6 Criticality Evaluation

1. Provide the output file for the most reactive (highest k_{eff}) Case C model.

   NRC staff frequently needs to request additional sample input/output files to cover what is described in the applicant's document. Submit the bounding or most reactive configurations.

   This information is requested by staff to determine compliance with 10 CFR 71.33 and 71.55.

   Response:

   Comment incorporated. Chapter 6 of the RH-TRU 72-B SAR has been revised to add an appendix that provides a listing of the most reactive Case A, B, C, and D criticality analysis input files. Additionally, the Case C output file is provided as Attachment E of this RAI response.

Note: There is an error in the equation for the mass of Carbon on Page 6.3-7 of the SAR. The MwO term should be MwC.

Note Response:

Comment incorporated. The equation for mass of Carbon in RH-TRU 72-B SAR Section 6.3.5 has been revised to correct the molecular weight term.

Chapter 7 Operating Procedures

1. A temperature survey should be included in the operating procedures during loading.

   A temperature survey should be performed, considering that the 300 W payload results in a package surface temperature equal to the 122 °F regulatory limit.

   This information is requested by staff to determine compliance with 10 CFR 71.87.

   Response:

   Due to the fact that RH-TRU 72-B shipments will be made subject to exclusive-use requirements with a surface temperature limit of 185°F, the large temperature margin is credited to not require preshipment temperature surveys. Also see response to Chapter 2 Structural Evaluation RAI No. 1.

2. Clarify the preshipment leakage rate test procedure.

   Revise pages 7.4.1-1 and 7.4.1-2, RH-TRU 72-B SAR, Rev. 5, to clarify the following items:

   a) Provide the basis of the 1.32 factor in the equation under item 9 of Section 7.4.1.2. Confirm that it is based on converting the 1 E-3 scc/s to leak rate sensitivity in torr cc/s.

   b) Explain the reason for choosing the sensitivity on the digital readout of the calibrated pressure transducer as the DP value. See Containment RAI Item 2 above.

   c) Discuss the connection between the time determined from page 7.4.1-1 and the statement that the time of the Section 7.4.1.3 leakage rate tests.

   d) Clarify whether using Equation B.14 of ANSI N14.5 will provide the same conclusion as the leak rate procedure discussed in 7.4.1.3.

   This information is requested by staff to determine compliance with 10 CFR 71.87.

   Response:

   a) Comment incorporated. The 1.32 factor is used to convert the pressure readings from torr to atmospheres for a preshipment leakage rate sensitivity of 1×10^{-3} atm-cm^3/sec, air. The 1.32 factor is derived as follows, where L_R = leakage rate sensitivity (1 x 10^{-3} atm-cm^3/sec), ΔP = indicated sensitivity of the pressure transducer digital readout (torr), V_t = test volume (cm^3), and t = test time (sec):

$$L_R = \frac{\Delta P \times V_t}{t}$$

Solving for t and simplifying, yields:

$$t = \frac{\Delta P \times V_t}{L_R} = \frac{\Delta P \times V_t}{1 \times 10^{-3} \frac{\text{atm–cm}^3}{\text{sec}}} \times \frac{1\ \text{atm}}{760\ \text{torr}}$$
$$= 1.32 \times \Delta P \times V_t$$

Section 7.4.1.2 of the RH-TRU 72-B SAR has been revised to clarify the required units of each term in the equation. Note that the Section 7.4.1 process for performing the preshipment leakage rate test meets the requirements of Section 7.6 of ANSI N14.5-1997.

b) The sensitivity on the digital readout of the calibrated pressure transducer is utilized as the DP value because it is used to establish the sensitivity of the leak test system. Once the sensitivity of the system has been established, the applicable test time for the test volume can be accurately calculated.

c) The "test time" calculated in step 9 of Section 7.4.1.2 is used in step 3 of Section 7.4.1.3 as the dwell time for performance of the preshipment leak test.

d) The formulae used in Section 7.4.1.2 are based on equation B.14 of ANSI N14.5-1997, but are used to verify that the requirements of Section 7.6 of ANSI N14.5-1997 are satisfied rather than to explicitly calculate a leak rate. The acceptance criteria in Section 7.6 of ANSI N14.5-1997 for the pre-shipment leakage rate test is "no detected leakage when tested to a sensitivity of at least 1 x 10^{-3} ref•cm^3/s." The testing steps identified in Sections 7.4.1.2 and 7.4.1.3 satisfy those requirements.

3. Revise Chapter 7 of RH-TRU SAR, Rev. 5, to add the shipping time restriction of 60 days.

Per Chapter 7 of NUREG-1609, procedures for special operational controls, such as the 60 day shipping limit, should be written.

This information is requested by staff to determine compliance with 10 CFR 71.87.

Response:

Payload controls applicable to the shipping duration are implemented in the RH-TRAMPAC. Step 7 of Section 5.1.2 of the RH-TRAMPAC imposes the applicable 10-day or 60-day shipping duration controls.

Chapter 8 Acceptance Tests and Maintenance Program

1. Verify that the vessels should be dried after performing the hydrostatic pressure testing and prior to the leakage rate tests.

   Page 8.1-2 RH-TRU 72-B SAR, Rev. 5, February 2010: Verify the vessels should be dried after performing the pressure testing and prior to the leakage rate tests.

   This information is requested by staff to determine compliance with 10 CFR 71.35.

   Response:

   Per Section 8.1.2.2, *Inner Vessel and Outer Cask Pressure Testing*, of the RH-TRU 72-B SAR, a liquid penetrant inspection of all accessible welds and adjacent base material shall be performed after the pressure test in accordance with ASME Section V, Article 6. ASME Section V, Article 6, Sub-Section T-642(b) requires that "Prior to each liquid penetrant examination, the surface to be examined and adjacent areas within 1 in. (25mm) shall be dry and free of all dirt, grease, lint,...interfere with the examination."

   As described in Section 8.1.3 of the RH-TRU 72-B SAR, following the required liquid penetrant examination, a helium mass spectrometer leak test is performed using a procedure that meets the requirements of ANSI N14.5-1997. The specific procedure(s) implemented require that prior to performing the leak test all surfaces must be dry and free of any contaminants that could mask a leak.

2. Clarify the method that is used to determine the leakage rate.

   On page 8.1-5 of RH-TRU SAR, Rev. 5, paragraph 8.1.3.2.12 and page 8.1-7, paragraph 8.1.3.5.8 etc., states: "Determine the leakage rate of the system using the leak detector." Clarify if the leakage rate is determined by equation or by comparing the response time with the calibration standard response time.

   This information is requested by staff to determine compliance with 10 CFR 71.35.

   Response:

   The leakage rate of the system is calculated using the data recorded from the helium mass spectrometer (leak detector) during the performance of the test. All required data is recorded on an approved test report form and then the actual leak rate of the system under test is calculated using the data recorded.

   It should be noted that the procedures used to perform helium leakage rate testing on the RH-TRU 72-B package have been qualified in accordance with ANSI N14.5-1997. A procedure qualification was performed to determine the applicable dwell time to be used for the tests.

3. Explain how a calibration standard leak is used in the small annular region between O-ring seals.

   On page 8.1-6, item 8.1.3.4.6 of RH-TRU SAR, Rev. 5: staff is unable to identify how a calibration standard leak is utilized (per page 8.1-2, paragraph 8.1.3.0.2) for the region associated with the small volume between the containment O-ring seal and backfill O-ring seal. Confirm whether a calibration standard leak is used in the small annular region between O-ring seals.

This information is requested by staff to determine compliance with 10 CFR 71.35.

Response:

In step 8.1.3.0.2, the calibrated standard leak referenced is used to calibrate the helium mass spectrometer leak detector to ensure it is tuned, calibrated, and operating properly. The calibrated standard leak is not used in the small annular region between the O-ring seals. Instead, for the test described in Section 8.1.3.4, a helium-rich atmosphere (minimum of 90% helium concentration) is established in the annular space that communicates with the IV backfill port closure bolt in steps 8.1.3.2.3 through 8.1.3.2.8.

4. Clarify the helium testing between O-ring seals in Section 8.1.3.3.

Section 8.1.3.3 of RH-TRU SAR, Rev. 5, item 8.1.3.3.3 refers to paragraphs 8.1.3.2.3 through 8.1.3.2.8 as having a helium atmosphere *below* the Gas Sampling Port O-ring seals. However, paragraphs 8.1.3.2.3 through 8.1.3.2.8 refer to a helium atmosphere in the annular region *between* the containment O-ring and the backfill O-ring; not within the inner vessel. It would appear that there would be a helium atmosphere below the top gas sampling port O-ring seals and not the lower gas sampling port O-ring seal.

a) Per Figure 4.1-1, there are two gas sampling port O-ring seals. Confirm that the testing of the gas sampling port is associated with only the upper gas sampling port O-ring seal.

b) Explain the purpose of the lower gas sampling port O-ring seal.

c) A test port tool diagram is not shown. Explain if it allows the space above the port closure bolt to be evacuated and for that vacuum to be sustained when the helium detector is in operation.

This information is requested by staff to determine compliance with 10 CFR 71.35.

Response:

a) The top (upper) O-ring on the IV gas sampling port bolt is the containment seal O-ring, and testing of the gas sampling port is associated with only this sampling port O-ring seal.

b) The bottom (lower) O-ring on the IV gas sampling port bolt is used to establish a seal boundary that enables a vacuum to be established and sustained for performance of the required helium leak test.

c) The test port tool used for performance of the required helium leak test incorporates O-rings on the outside diameter of a gland that interfaces with the internal diameter of the applicable port insert on the top of the IV lid (seal test, gas sampling or backfill). The O-ring interface between the test port tool gland and the port insert allows for the establishment of a vacuum above the port bolt that is sufficient to operate the helium mass spectrometer.

RH-TRU 72-B SAR, Revision 5, August 2010			
Section	**Page**	**Change Description**	**Justification**
General		Revised header for date.	Administrative change. No impact to safety basis.
3.1	3.1-3 & 3.1-4	Revised Tables 3.1-1 and 3.1-2 to include allowable temperature limits for applicable materials.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 5. No impact to safety basis.
3.2	3.2-1	Revised 3rd sentence of 3rd paragraph from "…maximum allowable payload weight with three…" to "…maximum allowable payload canister weight when loaded with three…"	Editorial correction for consistency with Section 3.6.1.7.2. No impact to safety basis.
3.2	3.2-3	Revised Table 3.2-1 to correct specific heat value for Payload (paper) from 0.55 to 0.25.	Editorial correction for consistency with actual value utilized in the analysis. No impact to safety basis.
3.3	3.3-1	Added 4th paragraph to clarify the allowable temperature for stainless steel.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 5. No impact to safety basis.
3.4.1.1	3.4-1	Added the following sentence to the end of the 1st paragraph: "See Section 3.6.1.7, Payload Model, for further discussion of this assumption."	Editorial for clarification. No impact to safety basis.
3.4.1.1	3.4-1 & 3.4-2	Revised last sentence of 6th paragraph and added an additional sentence to clarify decay heat limits.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 16 a). No impact to safety basis.
3.4.2	3.4-2	Revised last sentence of 2nd paragraph to change "122" to "185" and "a non-exclusive" to "an exclusive."	Provided in response to Chapter 2 Structural Evaluation RAI No. 1. No impact to safety basis.
3.4.4.3	3.4-13	Revised Table 3.4-5 to delete the last row.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 7. No impact to safety basis.

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Section	**Page**	**Change Description**	**Justification**
3.5.2	3.5-2 & 3.5-3	Deleted last 4 sentences of 1st paragraph and replaced with 3 new paragraphs discussing thermal performance of the rigid urethane foam.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 9. No impact to safety basis.
3.5.4.1	3.5-4	Revised the 1st sentence of the 5th paragraph to correct the calculated radiolytic gas pressure and maximum IV pressure at the end of the 60-day shipping duration for NewPaper waste.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 10. No impact to safety basis.
3.6.1.1	3.6.1-1	Added a sentence to the end of item (6) as follows: "The Table 3.4-1 insolation values are averaged over 12 hours to obtain the steady-state solar loads applied in the thermal model."	Editorial addition provided in response to Chapter 3 Thermal Evaluation RAI No. 14 a). No impact to safety basis.
3.6.1.1	3.6.1-1	Revised item (7) to change "full" to "projected" and "0.3" to "0.52".	Editorial corrections provided in response to Chapter 3 Thermal Evaluation RAI No. 15. No impact to safety basis.
3.6.1.7.1	3.6.1-4 & 3.6.1-5	Added paragraph to further discuss the paper payload modeling assumptions.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 12 b). No impact to safety basis.
3.6.1.7.2	3.6.1-5 & 3.6.1-6	Revised 1st paragraph and added 3 new paragraphs to further discuss the metallic payload modeling assumptions.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 12 b) and 12 c). No impact to safety basis.
3.6.1.7.2	3.6.1-9	Added Table 3.6.1-5.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 12 c). No impact to safety basis.
5.1	5.1-1	Added a sentence to the end of the 2nd paragraph to clarify whether lead slump is considered in the shielding evaluation.	Provided in response to Chapter 5 Shielding Evaluation RAI No. 1. No impact to safety basis.

RH-TRU 72-B SAR, Revision 5, August 2010			
Section	**Page**	**Change Description**	**Justification**
5.1	5.1-3	Added a bullet under "Hypothetical Accident Conditions" to clarify that lead slump will not occur and is therefore not modeled under HAC.	Provided in response to Chapter 5 Shielding Evaluation RAI No. 1. No impact to safety basis.
5.3.2	5.3-2	Added notes to Table 5.3-1 to clarify material densities utilized in the MCNP neutron shielding analyses.	Provided consistent with the agreed response to Shielding Observation 2 in the Request for Supplemental Information. No impacts to safety basis as the slightly dissimilar densities are associated with materials (lead and stainless steel) which negligibly attenuate neutrons.
6.3.5	6.3-7	Revised first equation on the page for mC to correct MwO to MwC.	Provided in response to Chapter 6 Criticality Evaluation RAI No. 1 Note. No impact to safety basis.
6.6	6.6-1 thru 6.6-2 and 6.6.1-1 thru 6.6.1-14	Added appendix to provide criticality analysis input decks for most reactive cases.	Provided in response to Chapter 6 Criticality Evaluation RAI No. 1. No impact to safety basis.
7.4.1.2	7.4.1-2	Revised Item 9 to clarify units of each term in the test time equation.	Provided in response to Chapter 7 Operating Procedures RAI No. 2 a). No impact to safety basis.

RH-TRAMPAC, Revision 1, August 2010			
Section	**Page**	**Change Description**	**Justification**
General		Revised header for date.	Administrative change. No impact to safety basis.
5.0	5.1-1	Added a paragraph and bullet list to clarify the decay heat limits.	Provided in response to Chapter 3 Thermal Evaluation RAI Nos. 1, 2, 12 a), and 16. No impact to safety basis.

RH-TRU Payload Appendices, Revision 1, August 2010			
Section	**Page**	**Change Description**	**Justification**
General		Revised header for date.	Administrative change. No impact to safety basis.
5.1.4	5.1-30	Revised reference 4 for date and revision number.	Administrative change. No impact to safety basis.
5.1.4.1	5.1-32 & 5.1-33	Revised Tables 5.1-1 and 5.1-2 to include allowable temperature limits for applicable materials and revise applicable temperature limits consistent with the associated RH-TRU 72-B SAR revisions.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 5. No impact to safety basis.
5.1.4.2	5.1-34 & 5.1-35	Revised Tables 5.1-3 and 5.1-4 to include allowable temperature limits for applicable materials and revise applicable temperature limits consistent with the associated RH-TRU 72-B SAR revisions.	Provided in response to Chapter 3 Thermal Evaluation RAI No. 5. No impact to safety basis.

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(Five Hard Copies and One CD[1] – C. Staab)

- RH-TRU 72-B SAR, Revision 5
- RH-TRAMPAC, Revision 1
- RH-TRU Payload Appendices, Revision 1.

[1] CD contains a PDF version of each document listed in Attachments C, D, and E.