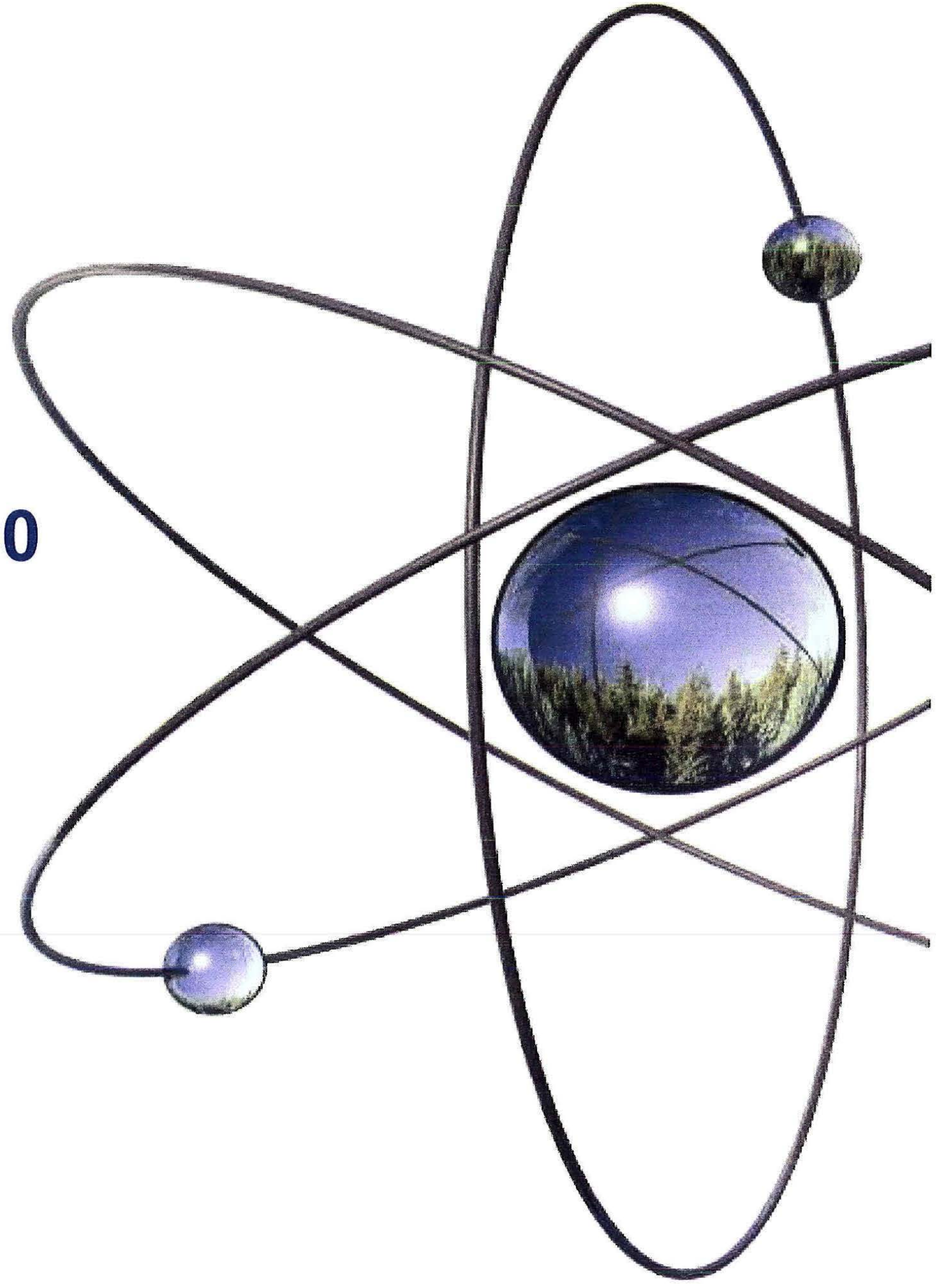
GE Hitachi Model No. 2000 Package RAI Discussion

Teleconference
July 1, 2015



HITACHI

Agenda

- Welcome & Introductions
- Purpose of Meeting
- Structural RAI discussion
- Thermal RAI discussion
- Containment RAI discussion
- Shielding study to address fabrication tolerances
- Discussion

Purpose

- Status update
- Discuss RAI response progress and approach
- Provide update on shielding evaluation that addresses fabrication tolerances

Structural RAI's

RAI 2.1:

Clarify the application statement, "[T]he material Basket has [[ ]] locations that are formed by [[ ]]to ensure it is consistent with those depicted in Drawing 001N8424.
In Section 1.2.2.2, HPI Material Basket, the drawing seems to show only [[ ]]locations for loading individual [[ ]]. Also, the [[ ]] are shown to be fabricated with [[ ]] in Drawing 001N8424.

This information is needed to determine compliance with 71.33(a).

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Structural RAI's

RAI 2.1 Proposed Response:

The material basket is constructed of [[ ]]which form a hexagon pattern and are identified as item 1 on drawing 001N8424. The center location of the basket is a developed cell which is created by the surrounding pipes. To allow for the proper insertion of a rod holder and facilitate fabrication, a 2 inch long pipe is inserted at the top and bottom of the developed cell and are identified as item 2 on drawing 001N8424 . Therefore, the exterior view of the basket shows [[ ]]. The Parts List 001N8424G001 is provided in Appendix 1.3 of the GE Model 2000 Special Authorization Request.

Structural RAI's

RAI 2.1 Proposed Response cont'd:

[[____]]

Structural RAI's

RAI 2.1 Propose Response cont'd:

[[____]]

Structural RAI's

RAI 2.1 Propose Response cont'd:

Basket Side View

[[____]]

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Structural RAI's

RAI 2.2:

Justify the uniform equivalent static pressure assumption, along the High Performance Insert (HPI) axis, to represent the inertia load produced by the loaded Material Basket in determining margins of safety. If a line load assumption is considered, identify the stress acceptance criteria and corresponding margins of safety for the inner shell of the HPI subject to the normal conditions of transport (NCT) side-drop tests and conditions.

In Section 2.6.7.5, Boundary Conditions, drawing 001N8424 shows that the Material Basket is laterally supported by [[ ]]. As such, contrary to the "area load" distribution assumption, the HPI inner shell is expected to be subject to a "line load" at each of the [[ ]].

This information is needed to determine compliance with 71.33(a) and 71.71(c)(7).

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Structural RAI's

RAI 2.2 Proposed Response:

Two study runs were performed to show the difference between 4 line loads that represent the basket in contact with the HPI inner shell and a uniformly distributed load along the length of the basket.

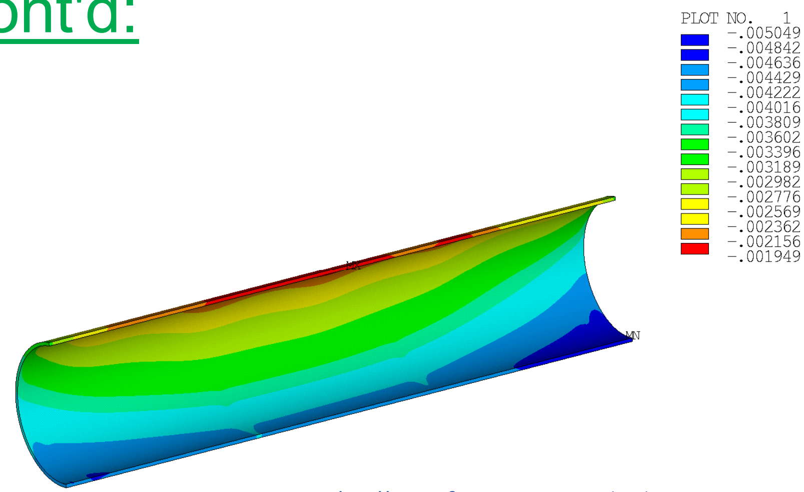
Preliminary results show that the uniform pressure case results in a slightly higher stress than the 4 line load case (7285 psi versus 7187 psi). Review of the displacement results shows that the stresses in the inner shell are following classic beam theory.

A third study run will be performed to concentrate the load further at the center of the inner shell to determine if the trend continues.

~~Contains GEH Proprietary Information~~
~~Withhold Pursuant to 10 CFR 2.390~~

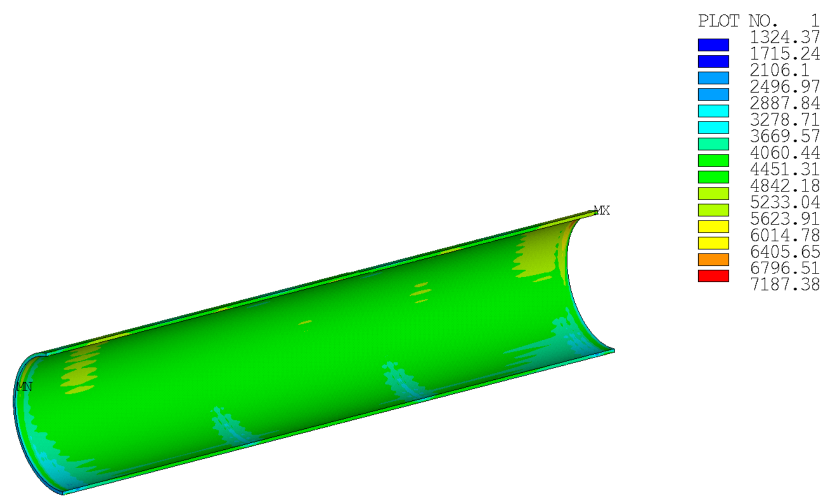
Structural RAI's

RAI 2.2 Propose Response cont'd:



Inner Shell Deformation (in)

[[ ]]



Inner Shell Stress Intensity (psi)

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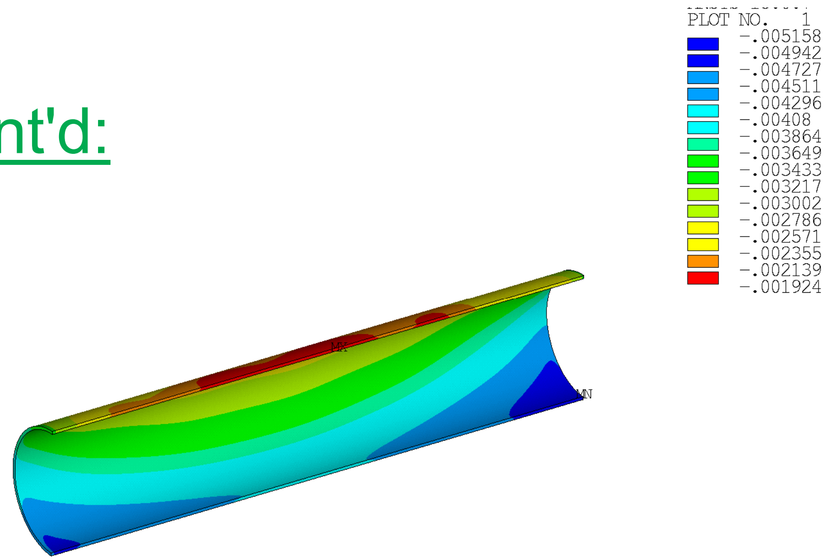
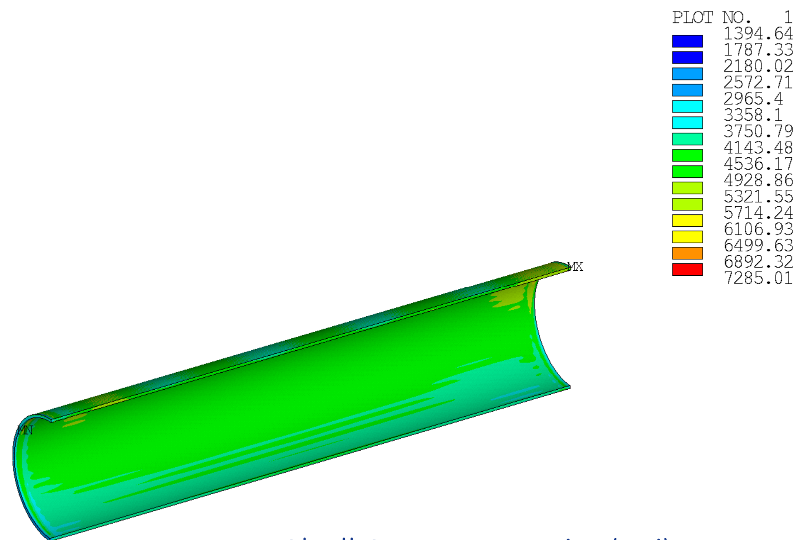
Structural RAI's

RAI 2.2 Propose Response cont'd:



Inner Shell Deformation (in)



[[____]]

Inner Shell Stress Intensity (psi)

Structural RAI's

RAI 2.3:

For the boundary conditions discussed above, if a line load assumption is to result, identify also in Section 2.1.2, Design Criteria, the stress acceptance criteria and corresponding margins of safety for the inner shell of the HPI subject to the NCT side-drop tests and conditions.

In Section 2.1.2, Design Criteria, the peak stress intensities displayed in the figures are all shown to be much larger than the reported maximum stress intensities listed in Table 2-15. It's unclear the basis for reporting the markedly lower stress intensity values in the table.

This information is needed to determine compliance with 71.33(a) and 71.71(c)(7).

Structural RAI's

RAI 2.3 Proposed Response:

The HPI body is evaluated based on the stress criterion presented in ASME III-NF. Section NF-3121.4, Peak Stress, states that the evaluation of peak stress is not required by Subsection NF. Section NF-3121.7, Membrane Stress, states that the membrane stress is uniformly distributed and equal to the average stress across the thickness of the section under consideration.

To determine the location at which to evaluate the average stress across the thickness, the peak stress is identified in ANSYS. At the peak stress location a path is defined through the thickness of the material. The linearized stress is then calculated across the path. The following plots show method in ANSYS Workbench and the resulting stresses across the section. The following slide shows the peak stress, the path across the section and resulting average stresses across the section. The stress results show that the peak stress is 7187 psi. However, the average membrane stress is 4324 psi and the membrane plus bending stress is 5010 psi. These stress values are compared to the acceptance criteria presented in ASME III-NF.

Structural RAI's

RAI 2.3 Proposed Response cont'd:

[[____]]

Location	Length [in]	Membrane [psi]	Bending [psi]	Membrane + Bending [psi]
1	0.0000	4323.6	3907.4	7155.9
2	0.0052	4323.6	3744.6	7026.9
3	0.0104	4323.6	3581.8	6897.9
4	0.0156	4323.6	3419.0	6769.0
5	0.0208	4323.6	3256.2	6640.0
6	0.0260	4323.6	3093.4	6511.2
Rows Removed for Clarity				
44	0.2240	4323.6	3093.4	4872.1
45	0.2292	4323.6	3256.2	4905.3
46	0.2344	4323.6	3419.0	4938.5
47	0.2396	4323.6	3581.8	4971.7
48	0.2448	4323.6	3744.6	5005.0
49	0.2500	4323.6	3907.4	5038.4
	AVERAGE	**4323.6**	**1922.0**	**5009.6**

[[____]]

Structural RAI's

RAI 2.4:

In Figures 2-10, -11, -12 and -13, HPI NCT Side Drop Results, regarding Peak Stress Intensity, clarify how the "peak stress intensities," shown as stress fringe plots in the figures, are calculated then post-processed for the primary membrane and the primary membrane-plus-bending stresses summarized in Table 2-15 of the application.

The peak stress intensities displayed in the figures are all shown to be much larger than the reported maximum stress intensities listed in Table 2-15. It's unclear what the basis is for reporting the markedly lower stress intensity values in the table than those shown in the stress fringe plots in the figures.

This information is needed to determine compliance with 71.71(c)(7).

Structural RAI's

RAI 2.4 Proposed Response:

See discussion presented in response to RAI 2.3.

Structural RAI's

RAI 2.5:

Revise the Material Basket side-drop evaluation to recognize that: (a) There is [[ ]] design feature described for the [[ ]] to develop composite action, thus enabling the use of the area moment of inertia, Ix, to calculate the extreme fiber stress in the outer most [[ ]], and (b) [[ ]] in contact with the [[ ]] are each subject to a concentrated inertia load at the [[ ]] location. As such, [[tube]] wall permanent deformations are likely to occur and the Subsection NF, Level A stress acceptance criteria, will cease to apply. In Section 2.6.7.8, Material Basket Evaluation, the potential for a deformed [[ ]] after the NCT free drop must be evaluated as an analyzed configuration.

This information is needed to determine compliance with 71.71(c)(7).

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Structural RAI's

RAI 2.5 Proposed Response:

The response to RAI 2.1 provides a detailed view of the actual basket configuration. As the figures show the basket is assembled with the use of stiffener/spacer plates that were added to allow for the application of full penetration welds that comply with ASME Section III-NF requirements. The addition of these plates contribute to a stiff cross-sectional profile.

To demonstrate the acceptability of the basket design, only the pipes on the periphery of the basket be credited when calculating the moment of inertia. Additionally, only the pipe moment of inertias is used without accounting for the hexagon shape of the basket (see next slide). Peak bending stresses are calculated at the junction of the alignment disk and the pipe sections and combined with the shear stresses as a stress intensity. The preliminary results show that the stress are below the ASME Section III-NF allowables. Therefore, permanent deformation of the basket is not predicted.

Structural RAI's

RAI 2.5 Proposed Response cont'd:

[[ ]]

Structural RAI's

RAI 2.5 Proposed Response cont'd:

The shear stress that develops across the section during the side drop is

$$\tau = \frac{P}{2A} \approx 893.8 \text{ psi}$$

Where,

$$P = 5822.2 \text{ lb}$$

A	=	$10\times\frac{\pi(do^2-di^2)}{4} = 3.26 \text{ in}^2$	Cross-sectional area
do	=	1.66 in	Outside diameter of pipe
di	=	1.53 in	Inside diameter of pipe

The stress intensity in the basket that results from the combination of the bending and shear stresses is

$$\sigma = \sqrt{\sigma_b^2 + 4\tau^2} = 9006.2 \text{ psi}$$

The margin of safety is

$$MS = \frac{1.5S_m}{\sigma} - 1 = \frac{23850}{9006.2} - 1 = +1.65$$

Where,

S_m	=	15900 psi	Design stress intensity, 316 stainless steel, 800°F

Structural RAI's

RAI 2.5 Proposed Response cont'd:

The elastic stability of the basket pipes is also evaluated by determining the external pressure load that will cause buckling of the pipe (Roark's). The evaluation assumes that the total payload is applied to a single pipe. The preliminary results indicate that the structure maintains elastic stability with a high margin of safety.

Structural RAI's

RAI 2.6:

Explain in detail the fabrication sequence of the High Performance Insert (HPI) assembly components containing depleted uranium (DU) shielding material.

Describe the [[ ]] utilized how contamination from capillary attraction, at the root layer will be avoided of melted DU.

HPI assembly license drawing 001N8423 section A-A shows the various components, [[ ]], containing DU material. No backing material or note to remove material in way of closure welds or gaps are identified on any of the various detailed drawings. The staff is concerned with the integrity of the welds without precautions identified to preclude contamination/oxidation.

This information is needed to ensure compliance with 10 CFR 71.33(a)(5)(iii).

Structural RAI's

RAI 2.6 Proposed Response:

The DU design was reviewed in detail to discuss fabrication practices and the sequence of assembly. Because DU is considered a nuclear product, regulations require that the DU be fully encapsulated prior to final assembly of the HPI. To facilitate the fabrication process, the HPI inner and outer shells will be assembled and welded to the base plate. The DU will then be lowered into the shell assembly and the top plate welded in place. To avoid weld contamination/melting, a small chamfer will be cut into the DU which will provide a sufficient gap between the steel and DU.

[[____]]

For the [[ ]], the plug shells will be assemble except for the cover plate. Once the DU is inserted the cover plate will be welded into place. The weld prep for the cover plate forces the heat into the mass of the steel and avoids the DU.

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Structural RAI's

RAI 2.7:

Provide American Society for Testing & Materials (ASTM) or American Society of Mechanical Engineers (ASME) specifications for all materials identified on all HPI drawings explain why commercial specification designation is acceptable for use in fabricating the HPI assembly as identified on the various drawing parts lists, and explain the use of "or equivalent," on various drawing parts lists.

HPI assembly license drawing 001N8423 and various other HPI drawings do not provide ASTM/ASME specifications for all materials identified for use in fabrication of the HPI assembly. In addition, "commercial" specification and "or equivalent" is used in identifying material and/or specifications. The staff needs specifications to verify chemistry, mechanical properties and various other necessary details of material fabrication for the HPI assembly.

This information is needed to ensure compliance with 10 CFR 71.33(a)(5)(iii).

Structural RAI's

RAI 2.7 Proposed Response:

The drawings/parts list will be updated to include the ASME and ASTM equivalent for the stainless steel components, e.g., ASME SA240 Type 316.

The use of the term commercial indicates the part is a catalog item that is readily available. In the case of the bolts and alignment pins, typical commercially available forms of 18-8 stainless steel include Type 304 and 316.

The use of the term equivalent allows the fabricator to use a part with the same specification from a different vendor, e.g. E-Z Lok brand inserts are specifically called out in the parts list. However, equivalent product from other vendors such as Heli-Coil meet the same requirements.

Structural RAI's

RAI 2.8:

Explain the use of the weld symbol used throughout the HPI drawings.

The staff is unfamiliar with the weld symbol indicated on various drawings (e.g., drawing 001N8425 sheet 1of1, Detail C, Item 1 to 8 and Detail D, [[ ]] when utilizing the American Welding Society (AWS) A2.4, Standard Symbols for Welding.
This information is needed to ensure compliance with 10 CFR 71.33(a)(5)(iii).

Structural RAI's

RAI 2.8 Proposed Response:

Two welds shown on 001N8425 sheet 1 of 1 are clarified in this response with the application of AWS A2.4:2012 "Standard Symbols for Welding, Brazing, and Nondestructive Examination."

Weld 1: Detail C, Zone C-6, joining item 1 "OUTER SHELL" to item 8 "BOTTOM COVER RING."

[[____]]

This weld is an all-around complete joint penetration bevel groove weld. The bevel groove weld symbol is defined in Figure 1 in AWS A2.4:2012. This weld joins the .25 inch thick "OUTER SHELL" to the .25 inch thick "BOTTOM COVER RING" and is complete joint penetration per Section 7.2.2 in AWS A2.4:2012, so the weld extends through the thickness of the joint. Per Section 6.4.1 in AWS A2.4:2012, either item can be beveled in order to achieve this weld. The flat line below the bevel symbol means the face of the groove weld (arrow side) is to be approximately flush to the base material, see Figure 26 (A) in AWS A2.4:2012. This explanation applies to anywhere this weld symbol appears on the drawing.

Structural RAI's

RAI 2.8 Proposed Response (cont):

Weld 2: Detail D, Zone D-5, joining item 6 "PIPE FLANGE SLIP-ON" to item 2 "COVER RING."

[[____]]

The bevel weld symbol is defined in Figure 1 in AWS A2.4:2012. This weld is an all-around bevel groove weld, with a groove depth of ¼ inch (identified not in parentheses) and a groove weld size (identified in parentheses) of ¼ inch as per Section 7.2.1 in AWS A2.4:2012. This weld joins item 6 to item 2, with the bevel specifically applied to item 6 as shown in the tail of the welding symbol. The flat line below the bevel symbol means the face of the groove weld is to be approximately flush to the base material, see Figure 26 (A) in AWS A2.4:2012. This explanation applies to anywhere this weld symbol appears on the drawing.

Thermal RAI's

RAI 3.1:

Provide the maximum temperatures of the O-rings located at test port, vent port and drain port, separately, under NCT and HAC.

As stated in SAR 1.2.1.1, GEH-2000 package has O-rings (made of [[ ]]) installed at the test port, vent port, and drain port. Instead of listing one "single" maximum temperature of cask seal in SAR Table 3-4 for hypothetical accident conditions (HAC) and Table 3-12 for NCT, the applicant needs to provide the maximum temperatures of the O-rings located at test port, vent port and drain port, separately. This information is necessary to confirm that the temperatures are in fact below their design limits under NCT and HAC This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

Thermal RAI's

RAI 3.1 Proposed Response:

Per RAI 3.2, the 3000 watt thermal analyses previously presented in the application are updated to address the HAC analyses use of forced convection during the 30-minute fire, a radiation boundary condition emissivity of 0.9 during the 30-minute fire, and a radiation boundary condition emissivity of 0.8 during the post-fire cool-down. NCT sensitivity studies were also performed to evaluate the thermal performance of the package using boundary conditions applied as both steady-state and constant boundary conditions solved as a transient. Because the solutions are radiation-dominated, the transient solution results in better convergence and slightly higher temperatures. To achieve stead-state conditions, the transient solver is used with a simulation time of 2000 hours. The 2000-hour duration of the transient analyses is sufficiently long enough for the temperatures within the package to reach their steady-state values—that is, the temperature of a node within the package model doesn't change from one time step to the next.

Using this revised solution methodology, the maximum temperatures of the ports are determined for both NCT and HAC. Tables 3.1-1 and 3.1-2 provide the NCT and HAC results, respectively. Figure 3.1-1 shows the temperature time-history of the port during the HAC fire and cool down.

Thermal RAI's

RAI 3.1 Proposed Response (cont):

Table 3.1-1. GE 2000 Seal and Port Temperature during NCT

Item	100°F Ambient temperature, in shade		100°F Ambient temperature, with insolation	
	Max	Min	Max	Min
Cask seal	406	383	432	409
Drain port (bottom)	342	309	370	338
Test port (side)	400	383	426	409
Vent port (lid)	416	410	442	435

Table 3.1-2. GE 2000 Seal and Port Temperature during HAC

Item	Peak temperature (°F)	Time at which peak temperature occurs (hours)	Time at which temperature exceeds 600°F (minutes)
Cask seal	508	6.2	—
Drain port (bottom)	612	0.8	20.4
Test port (side)	608	0.6	10.2
Vent port (lid)	520	7.1	—

Thermal RAI's

RAI 3.1 Proposed Response (cont):

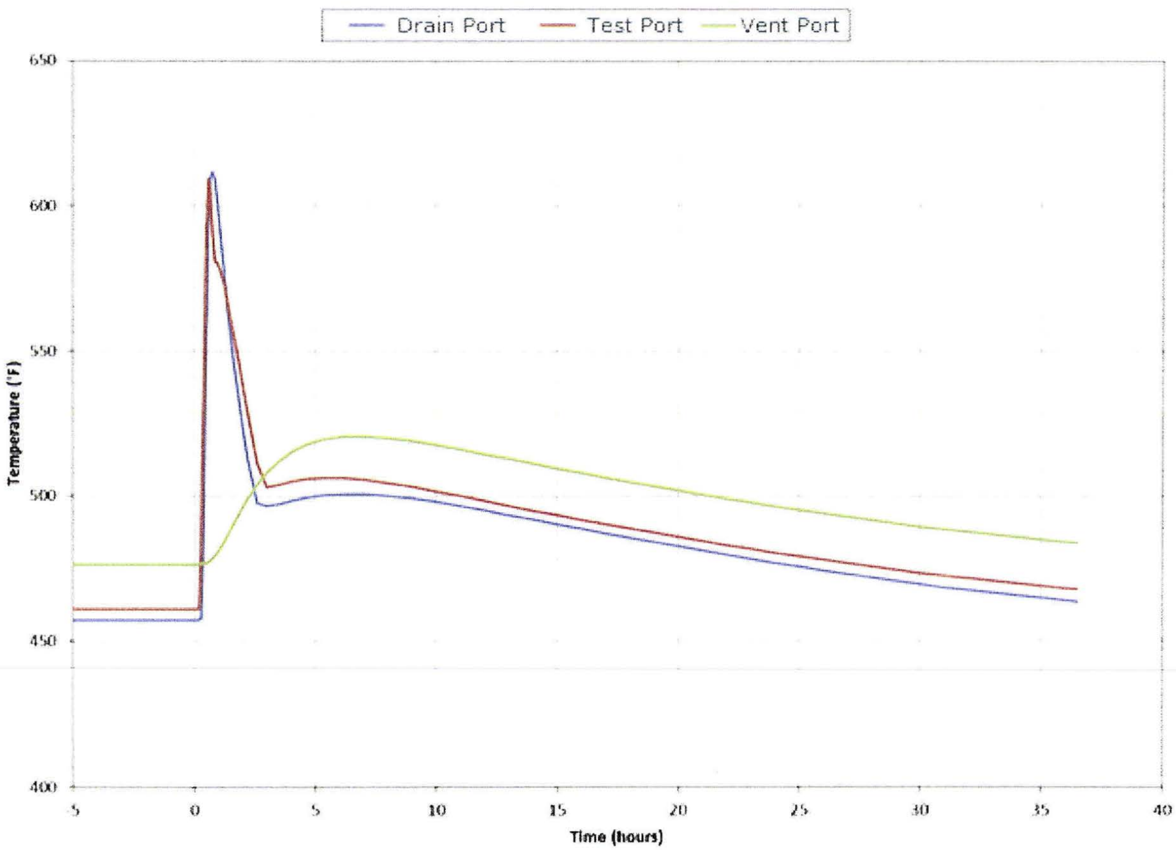

Figure 3.1-1. Temperature-history of the Cask Ports for HAC

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Unverified Information for discussion purpose only

Thermal RAI's

RAI 3.2:

Perform the thermal analysis using an average emissivity coefficient of at least 0.9 for the HAC 30-minute fire.

The applicant stated in SAR Section 3.4 that thermal radiation exchange is between the fire (emissivity 0.9) and the package external surfaces (emissivity 0.8). The applicant noted in the RSI response that an emissivity of 0.7347 was calculated by using the equation for diffuse, gray, two-surface enclosure for infinite parallel plates and was then used in the ANSYS thermal analysis for the HAC 30-minute fire. The staff points out that for HAC 30-minute fire, the radiation feature between package surface and flame is different from the radiation feature between two "parallel" plates.

Given the fact that only one emissivity value "ε" was used as input into the ANSYS code for radiation heat transfer between the fire and the package surface, the applicant should use an average emissivity coefficient of at least 0.9 in the HAC 30-minute fire and an average emissivity coefficient of less than 0.8 in the post-fire cool down.

Thermal RAI's

RAI 3.2 Proposed Response:

During NCT and HAC pre-fire, the external surfaces of the package are assumed to have an emissivity consistent with the material of construction at temperature (0.22). During the HAC, the fire is modeled with an emissivity of 0.9 per regulations. During HAC post-fire cool-down, the package is assumed to have an emissivity of 0.8 (which is consistent with a heavily oxidized steel surface). These emissivity values are summarized in Table 3.2-1.

Table 3.2-1. Summary of emissivity values used in the thermal analyses

Conditions	Emissivity used for boundary condition
NCT (shade)	0.22
NCT (insolation)	0.22
HAC (pre-fire)	0.22
HAC (fire)	0.9
HAC (post-fire)	0.8

The advantage of assuming that the radiation between package surface and flame occurs between two "parallel" infinite plates is the view factor is 1, which results in 100% of radiation transfer between the two surfaces during the fire. View factors for other geometries block or prevent some of the radiation from reaching the package. The temperature results for NCT and HAC are presented in Tables 3.2-2 and 3.2-3, respectively.

Thermal RAI's

Table 3.2-2. Temperature results, NCT (in shade and with insolation)

Item	100°F Ambient temperature, in shade			100°F Ambient temperature, with insolation		
	Max	Min	Avg	Max	Min	Avg
Basket	989	465	801	1,001	490	815
HPI	581	360	---	604	388	---
HPI shielding (top)	517	506	513	539	529	535
HPI shielding (sides)	581	435	544	601	460	565
HPI shielding (bottom)	477	427	451	501	452	475
Cask (bottom, shells, top, lid)	430	309	---	455	338	---
Cask shielding (lid)	424	408	414	449	433	440
Cask shielding (sides)	405	341	385	431	370	412
Cask seal	406	383	---	432	409	---
Cask port (bottom)	342	309	---	370	338	---
Cask port (top)	400	383	---	426	409	---
Cask port (lid)	416	410	---	442	435	---
Overpack base	335	159	---	364	184	---
Overpack cover	272	108	---	308	174	---
Overpack toroidal shell (top)	159	110	125	207	165	179
Overpack toroidal shell (bottom)	215	114	139	249	136	176
Overpack honeycomb impact limiter (top)	220	205	215	263	249	258
Overpack honeycomb (bottom)	330	275	304	359	305	334
HPI fill gas	971	460	672	983	485	689
Cask fill gas	574	346	462	594	374	486
HPI and Cask fill gas, combined	971	346	481	983	374	505

Thermal RAI's

Table 3.2-3. Temperature results, HAC)

Item	Peak temperature (°F)	Time at which peak temperature occurs (hours)
Basket	1,045	13.0
HPI shielding (side)	670	11.0
HPI shielding (top)	599	9.0
HPI shielding (bottom)	618	11.0
Cask seal	508	6.2
Cask shielding (side)	570	0.6
Cask shielding (top)	529	7.1
Cask shell, puncture location	782	0.5
Cask shell, opposite side to puncture location	512	4.0
Overpack outer shell, puncture location	1,103	0.5
Overpack outer shell, opposite side to puncture location	1,337	0.5
Cask bottom port	612	0.8
Cask top port	608	0.6
Cask lid port	520	7.1
HPI fill gas (average)	740	11.0
Cask fill gas (average)	571	7.1
HPI and Cask fill gas, combined (average)	585	8.0

Thermal RAI's

RAI 3.3:

Revise the thermal analysis to use the forced convection coefficients between the fire and the package surface in the HAC 30-minute fire.

In SAR Section 3.4, under subsection 30-minute fire (transient analysis), the applicant assumed natural convection from the package external surfaces to the 100°F environment and used the calculated "natural" convection coefficients, displayed in SAR Figure 3-16, for the thermal analysis of the HAC 30-minute fire. With the fire temperature up to 1475°F (800°C), and the air under high fluctuation, the heat transfer from the fire to the package surface is in the mode of forced convection (not natural convection in the still air). Therefore, the applicant should revise the analysis with the forced convection coefficient used in the HAC 30-minute fire.

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

Thermal RAI's

RAI 3.3 Proposed Response:

The thermal evaluation for hypothetical accident conditions presented is updated to use forced convection rather than natural convection for the fire analysis. The boundary conditions applied to the finite element model are summarized in Table 3.3-1. Temperature results are provided in the response to RAI 3.2.

Table 3.3-1. Summary of Boundary Conditions

Conditions	Package orientation	Environment temperature	Insolation?	Convection	Emissivity for radiation boundary condition
NCT (shade)	Upright	100°F	No	Natural	0.22
NCT	Upright	100°F	Yes	Natural	0.22
HAC (pre-fire)	Horizontal	100°F	Yes	Natural	0.22
HAC (fire)	Horizontal	1475°F	No	Forced	0.9
HAC (post-fire)	Horizontal	100°F	Yes	Natural	0.8

Thermal RAI's

RAI 3.4:

Explain the heat transfer features on the overpack outer shell and the package shell, as well as the temperature variation inconsistencies between the two, during the HAC 30-minute fire.

The applicant stated in SAR Section 3.4.1 that the drop onto the pin causes the overpack outer and inner shells to come in contact, thus creating a path for the heat from the fire to more easily reach the package shielding.

In SAR Table 3-13 and Figure 3-18, it is identified that the overpack outer shell has a lower temperature at the site with puncture-damage than the site opposite from puncture damage, but the package shell has a higher temperature at the site with puncture-damage than the site opposite from puncture damage, during HAC 30-minute fire. Therefore the applicant should address in detail the heat transfer features on the overpack outer shell and the package shell and explain the inconsistency in the temperature features between the overpack outer shell and the package shell, during the HAC 30-minute fire.

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

Thermal RAI's

RAI 3.4 Proposed Response:

The puncture damage provides a path for the heat (represented as arrows in the Figure 3.4-1 on the next slide) from the fire to enter the package (at location B). The location opposite this puncture damage (represented by location A) is undamaged. Because there is a heat transfer path at location B that offers less resistance, the Overpack will have a lower temperature while the Cask will have a higher temperature at this location (when compared to location A). Since there is no damage at location A, the Overpack shell has rather large air gaps (between the Overpack shells and between the Overpack and Cask) that will impede the heat from getting to the Cask—thus causing the Overpack to have a higher temperature and the Cask to have a lower temperature at this location when compared to location B.

Thermal RAI's

RAI 3.4 Proposed Response cont'd:

Figure 3.4-1. Heat Path during HAC Fire

[[____]]

Thermal RAI's

RAI 3.5:

Provide information of the personnel barrier to ensure that the airflow cooling during transport will not be blocked.

SAR Section 3.3.1 states that the overpack in the region of the bolting ring exceeds the allowable temperature of 185°F and therefore, a protective personnel barrier will be used to block access to the region when ready for transport, in compliance with 10 CFR 71.43(g).

The applicant should provide a more detailed discussion of the personnel barrier so that the staff can verify what it will encompass and that it will not affect the heat removal performance of the package

This information is needed to determine compliance with 10 CFR 71.71 and 10 CFR 71.43(g).

Thermal RAI's

RAI 3.5 Proposed Response:

A personnel barrier will be added to the flat bed trailer as part of the routine transport of the GE 2000 cask. The personnel barrier will not be part of the package.

Thermal RAI's

RAI 3.6:

Provide references 28, 31, and 32, listed in Table 3-8 of SAR Section 3.3 (and SAR Section 1.3.3), for typical thermal contact conductance values, and (2) perform the thermal tests to verify that the thermal contact resistance levels assigned to the model contact elements are acceptable for the thermal analysis

The applicant determined the thermal contact conductance (TCC) values based on the open literatures 28, 31, and 32, listed in Table 3-8 of SAR Section 3.3 (and SAR Section 1.3.3 References). The applicant should provide these references to support the TCC values used in the thermal analysis.

The applicant should also perform the thermal tests to verify that the thermal contact resistance levels assigned to the modeled contact elements, as shown in SAR Table 3-10, exactly represent the thermal contact conditions between the components and are acceptable for the thermal analysis. The test results should be addressed in SAR Chapter 8.

Otherwise, the applicant should apply the "perfect contact (TCC = 1000 Btu/hr-in^2-°F)" to the model contact elements in the thermal analysis.

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

Thermal RAI's

RAI 3.6 Proposed Response:

A sensitivity study was performed that compares the temperature results (NCT with insolation and HAC) for mixed thermal contact resistance versus perfect contact. In general, using perfect contact in the analyses results in lower package temperatures (except for the Cask ports during HAC).

In order to assess the impact that using the mixed thermal resistance levels have on package temperatures, the analyses for NCT (with insolation) and HAC are repeated with all of the thermal resistance levels set to "low" (i.e., perfect contact). The results of these analyses are presented in Table 3.6-1 for NCT and Table 3.6-2 for HAC.

In general, the package temperatures are lower when modeling the thermal contact as perfect as opposed to the mixed thermal contact levels. This is because the mixed thermal contact resistances impede the flow of the heat generated by the contents from getting out of the package where it is rejected to the surroundings.

However, the Cask bottom port and the Cask top port have peak temperatures that are higher when modeling the thermal contact as perfect. This is due to their proximity to the modeled puncture damage which allows the heat from the fire to more readily enter the package.

Thermal RAI's

RAI 3.6 Proposed Response cont'd:

Table 3.6-1. Comparison of mixed and perfect thermal contact for NCT with insolation

Item	100°F Ambient temperature, with insolation, mixed thermal contact resistance*			100°F Ambient temperature, with insolation, perfect contact		
	Max	Min	Avg	Max	Min	Avg
Basket	1,001	490	815	998	482	811
HPI	604	388	---	598	379	---
HPI shielding (top)	539	529	535	534	523	530
HPI shielding (sides)	601	460	565	596	452	559
HPI shielding (bottom)	501	452	475	494	444	468
Cask (bottom, shells, top, lid)	455	338	---	450	327	---
Cask shielding (lid)	449	433	440	443	428	434
Cask shielding (sides)	431	370	412	426	361	407
Cask seal	432	409	---	428	405	---
Cask port (bottom)	370	338	---	362	327	---
Cask port (top)	426	409	---	422	405	---
Cask port (lid)	442	435	---	436	430	---
Overpack base	364	184	---	356	184	---
Overpack cover	308	174	---	305	174	---
Overpack toroidal shell (top)	207	165	179	206	165	179
Overpack toroidal shell (bottom)	249	136	176	250	136	177
Overpack honeycomb impact limiter (top)	263	249	258	259	243	254
Overpack honeycomb impact limiter (bottom)	359	305	334	355	298	329
HPI fill gas	983	485	689	979	477	684
Cask fill gas	594	374	486	589	366	480
HPI and Cask fill gas, combined	983	374	505	979	366	499

Thermal RAI's

RAI 3.6 Proposed Response cont'd:

Table 3.6-2. Comparison of mixed and perfect thermal contact for HAC

Item	Peak temperature (°F)	
	Mixed thermal contact resistance	Perfect thermal contact
Basket	1,045	1,043
HPI shielding (side)	670	668
HPI shielding (top)	599	596
HPI shielding (bottom)	618	617
Cask seal	508	506
Cask shielding (side)	570	576
Cask shielding (top)	529	527
Cask shell, puncture location	782	795
Cask shell, opposite side to puncture location	512	511
Cask bottom port	612	655
Cask top port	609	613
Cask lid port	520	518
Overpack outer shell, puncture location	1,103	1,094
Overpack outer shell, opposite side to puncture location	1,337	1,336
HPI fill gas (average)	740	738
Cask fill gas (average)	571	569
HPI and Cask fill gases, combined (average)	585	584

Thermal RAI's

RAI 3.7:

Clarify the temperatures and use of insolation in the HAC fire model.

It is not clear what initial component temperatures were used in the model to start the HAC 30-minute fire analysis. Explain whether the initial temperatures for HAC are obtained from the NCT analysis with solar heat included or from the NCT analysis without solar heat.

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

Thermal RAI's

RAI 3.7 Proposed Response:

Table 3.7-1 below is provided to clarify the boundary conditions used in this application. All case were analyzed to determine the worst case thermal conditions.

Table 3.7-1. Summary of Boundary Conditions

Conditions	Package orientation	Environment temperature	Insolation?	Convection	Emissivity for radiation boundary condition
NCT (shade)	Upright	100°F	No	Natural	0.22
NCT	Upright	100°F	Yes	Natural	0.22
HAC (pre-fire)	Horizontal	100°F	Yes	Natural	0.22
HAC (fire)	Horizontal	1475°F	No	Forced	0.9
HAC (post-fire)	Horizontal	100°F	Yes	Natural	0.8

Containment RAI's

RAI 4.1:

Provide the basis for the O-ring compression and O-ring groove dimensions in the drawings (i.e., from manufacturer data sheets).

The staff needs to verify the appropriateness of the seal for the containment system, therefore the basis for the O-ring compression and O-ring groove dimensions, such as from manufacturer data sheets, should be provided for the seals and the manufacturer and part number of the O-rings should be provided on the drawings.
The drawings should indicate both the dimensions and tolerances of the groove dimensions and the O-rings to ensure compression of the O-rings.

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

Containment RAI's

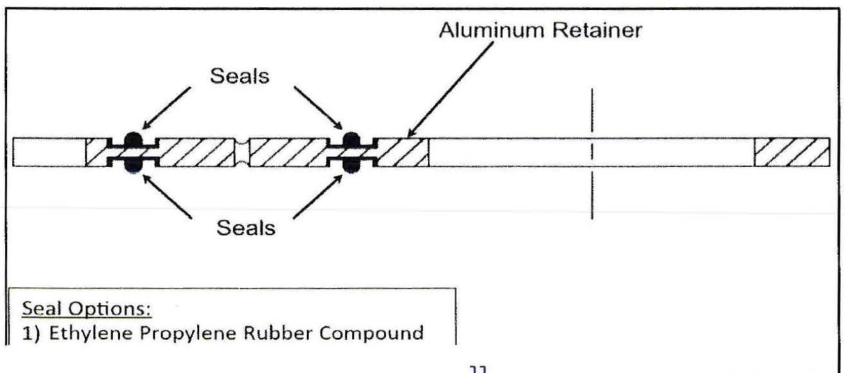
RAI 4.1 Proposed Response:

The dimensions and design for the "new" seals are identical to that of the seals that are currently licensed for the cask. For this application, the only change to the licensed seal design is a change of the [[ ]] material in the gasket seal and O-rings from the EPDM compound to the [[ ]] compound to accommodate the higher temperatures from the greater heat load. The information on the following two slides describes the gasket seal and O-ring designs that apply to both the old EPDM compound and the new [[ ]] compound.

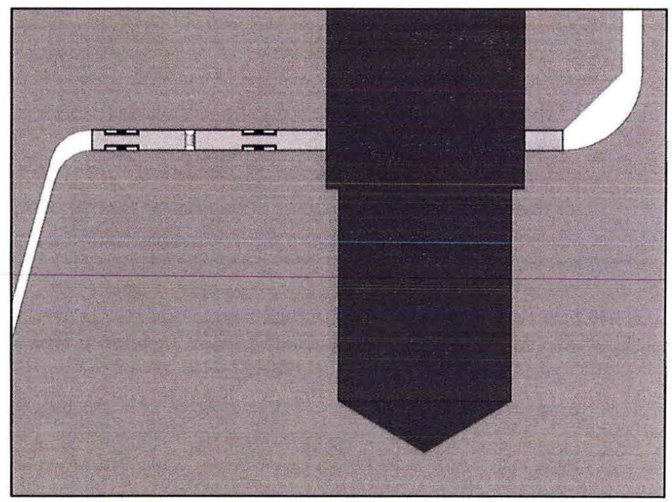
Containment RAI's

RAI 4.1 Proposed Response cont'd:

In the currently approved Model 2000 seal design, there are no machined O-ring grooves in the Model 2000 cask body, but the cask is sealed using the Parker Gask-O-Seal design on the highly polished, flat-faced surfaces of the flanges on the cask body and lid. The Gask-O-Seal design for the cask consists of a 1/8 in. thick 6061-T6 aluminum retainer with two concentric [[ ]] seals on the top and two concentric [[ ]] seals on the bottom (4 total). The surfaces of the Model 2000 cask body and the lid flanges have an electropolished finish to ensure that they are clean sealing surfaces for the Gasket-O-Seal. The calculation inputs and results of preload requirements for gasket seating are included in NEDO-31581 in Sections 2.10.12.3 and 2.10.12.4, where it is determined that the preload is sufficient to seat the aluminum retainer of the Gask-O-Seal per the formulation presented in NUREG/CR-6007.



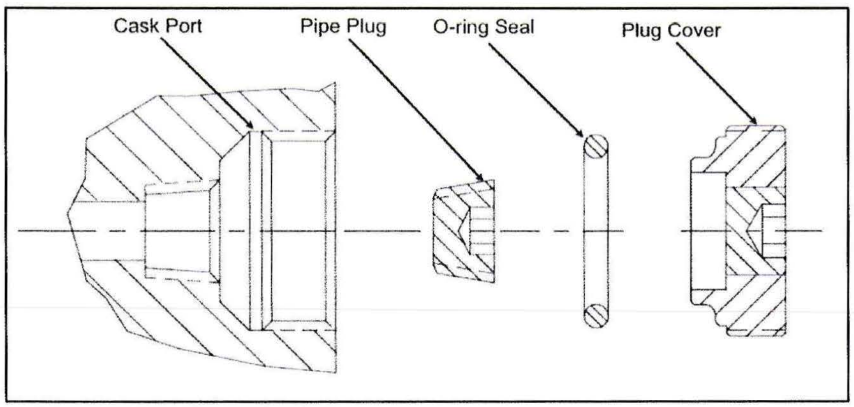
[[ ]]

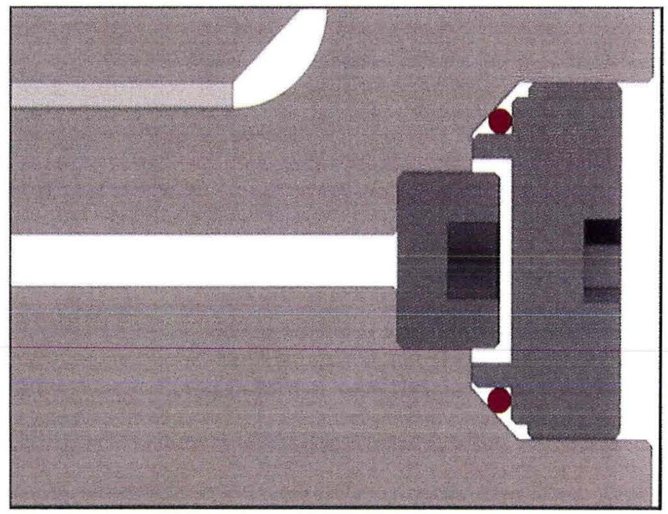


Containment RAI's

RAI 4.1 Proposed Response cont'd:

For sealing the Drain, Vent, and Test ports in the Model 2000 cask, a 1/2 NPT socket head pipe plug is screwed into place using an applied Gore-Tex sealant. The containment boundary is at the respective port O-ring (Size 2-218 in the [[ ]]), which is sealed into place using a 1-3/4-12 UNC cap. Machining dimensions and details of the cask ports, plugs, O-rings, and plug covers are provided in the GE Drawing 101E8748.

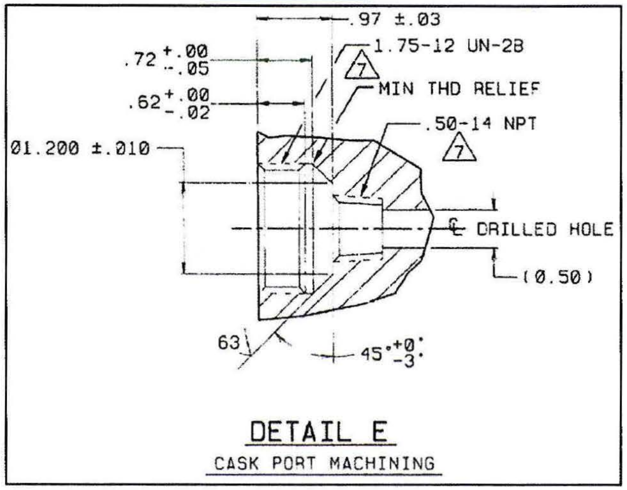




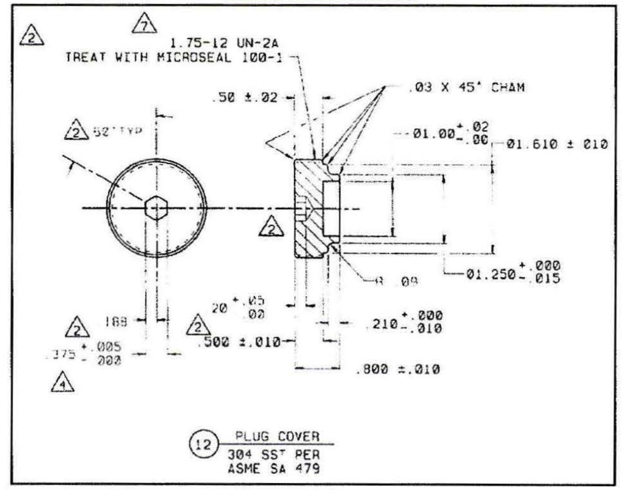
Containment RAI's

RAI 4.1 Proposed Response cont'd:

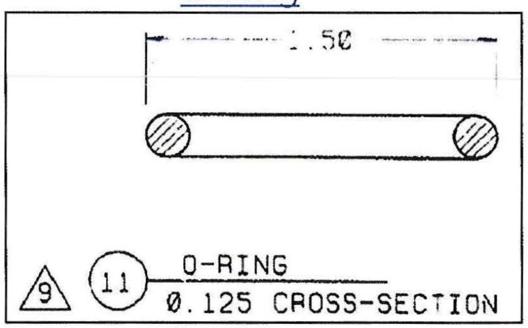
Cask Port



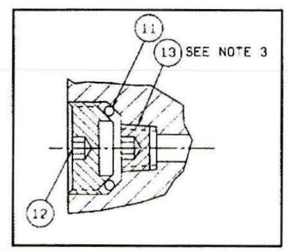
Plug Cover



O-Ring



Pipe Plug



3. PIPE PLUGS TO BE 304 SST PER ASME SA 182 AND THREAD TO CONFORM TO ANSI B1.20.3.

HITACHI

Containment RAI's

RAI 4.2:

Identify seal and O-ring importance to safety category.

SAR Section 1.2.4 and 1.3.2 state that a new [[ ]] seals and O-rings will be used for the package but the seals and O-rings are not identified in a parts list.

All seals and O-rings should be identified on a parts list and their importance to safety category should be specified per NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety."

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

Containment RAI's

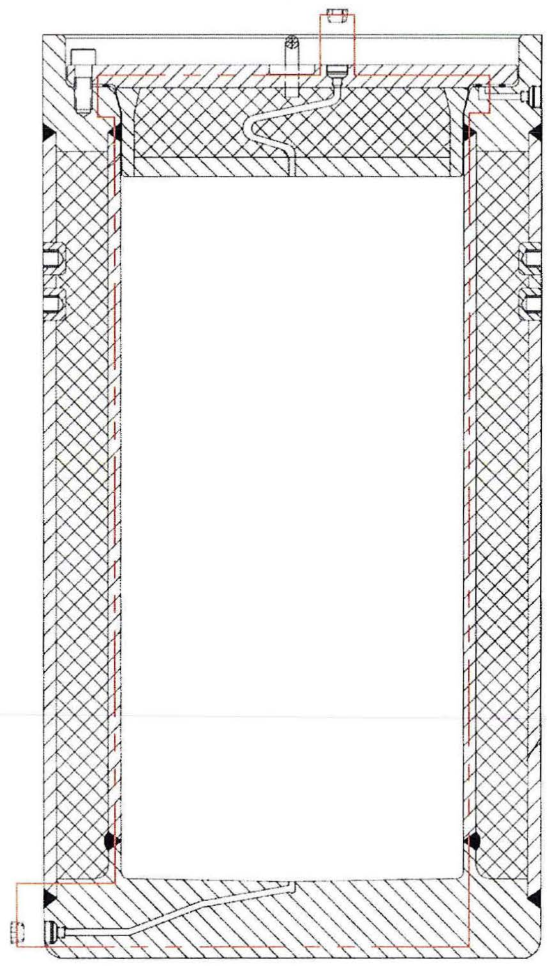
RAI 4.2 Proposed Response:

The gasket seal and port O-rings are all safety category A components.

The new [[ ]] seal option is for the cask gasket seal and the O-rings in each of the 3 ports in the cask (vent, drain, and test ports). Per NUREG/CR-6407 the gasket seal and the O-rings used in the vent port and the drain port are classified as safety category A, as each are significant to maintaining the primary containment boundary. The image on the following slide shows the containment boundary, as outlined in drawing 101E8718, highlighted in red. The Test Port O-ring is outside of the inner seal of the gasket, making it outside of the primary containment boundary. Although this seal could be classified as safety category C, all port O-rings are safety category A as the O-rings are identical between the ports so the appropriate Quality records for safety category A components will be kept for all O-rings used for the cask.

Containment RAI's

RAI 4.2 Propose Response (Cont'd):



Containment RAI's

RAI 4.3:

Provide Appendix 4.5.1 which was not in the application.

The applicant has noted Appendix 4.5.1 "Cask Penetration Leaktightness test procedure and results" on SAR page 4-2, but the section is empty. The applicant should provide this appendix for review.

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI's

RAI 4.3 Propose Response:

Appendix 4.5.1 was intended to include the procedure and results from the acceptance testing for the Commercial Grade Dedication of the [[ ]] gasket seals and O-rings. As these seals and O-rings have not yet been acquired, there hasn't been any testing to date to include in this Appendix. These acceptance tests will be performed upon receipt of the new O-rings, and the ASNT Level III approved procedures and final test results will be provided upon completion of all testing.

Containment RAI's

RAI 4.4:

Provide the American Society for Nondestructive Testing (ASNT) certification level of the examiner for development and approval of helium leakage rate testing procedures considering that industry standards indicate that this should be performed by a Level III examiner.

The applicant described the leakages tests in SAR Section 7.1.3.3, for assembly verification leakage testing and 8.1.4 for acceptance leak tests and 8.2.2 for periodic and maintenance leak test, without identifying the ANST certification level of the examiner.

American National Standards Institute (ANSI)/ASNT CP-189-2006, "Standard for Qualification and Certification of Nondestructive Testing Personnel," states that a nondestructive testing personnel Level III examiner has the qualifications to develop and approve written instructions for conducting the leak testing.

This information is needed to determine compliance with 10 CFR 71.43(f), 71.51, and 71.87.

Containment RAI's

RAI 4.4 Propose Response:

For approval of any leak testing procedures an ASNT certification Level III examiner is required. For the current authorization, a Level III examiner from Leak Testing Specialists Inc. (LTS) will be providing any leak testing procedure approvals that are required. The pre-shipment leak test procedure for the Model 2000 has already been developed and approved by LTS in Procedure number MSLT-EE-GE revision 5500-1021-01.

Containment RAI's

RAI 4.5:

Demonstrate that the [[ ]] O-rings can maintain containment function, leak tight, in a -40°F cold environment under normal and hypothetical accident conditions.

The applicant stated in SAR Section 4.1.3, that a new [[ ]] O-ring seal, made of [[ ]], designed to operate at a low -15°F based on information from the [[ ]], will be used in the package. The applicant noted that a performance test of this material at -40°F will be performed to demonstrate that the material maintains leaktightness under these temperature conditions. The safety basis of the seals must be justified in the application. In light of the design limits specified in the [[ ]], the applicant should demonstrate that the [[ ]] O-rings can maintain leaktightness in a -40F cold environment under normal and hypothetical accident conditions.

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

HITACHI

Containment RAI's

RAI 4.5 Propose Response:

Due to the minimum wattage limit set for use of the [[ ]] seals and O-rings (500W), the internal generated heat load will always be sufficient to ensure that even for the cold case (-40°F ambient temperature) the seals will remain at temperatures >0°F, however the acceptance testing for these seals will still span the entire design temperature range of the seals (-15°F to ~620°F). The results of the ANSYS calculations for the thermal evaluation establishing the minimum seal temperatures with an ambient temperature of -40°F can be found in the table below. It can be noted that the minimum seal temperature, at the cask drain port, calculated for the lowest internal wattage (500W) is 21°F. With a lower limit of 500W set for the [[ ]] seal and O-ring options, by testing the new seals to the minimum design temperature of -15°F, the true range of temperatures that the seals may experience during transport are bounded.

Location	Temperature (°F)											
	$Q_{contents}$ = 500 W			$Q_{contents}$ = 1,000 W			$Q_{contents}$ = 2,000 W			$Q_{contents}$ = 3,000 W		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Cask seal	50	45	---	122	113	---	237	221	---	328	304	---
Cask port (Drain)	31	21	---	88	69	---	178	147	---	250	209	---
Cask port (Test)	48	45	---	119	113	---	232	221	---	321	304	---
Cask port (Vent)	52	51	---	127	124	---	246	241	---	339	332	---

HITACHI

Containment RAI's

RAI 4.6:

Demonstrate that there will not be any chemical, galvanic, or other reactions with the new seal and O-ring material.

SAR Section 1.2.4 and 1.3.2 states that a new [[ ]] cask seal and port O-ring is used in the package.

The application should address whether this new material will cause any chemical, galvanic or other reactions to occur between the seal and the packaging or its contents, and that the seal will not degrade due to irradiation.

This information is required by the staff to determine compliance with 10 CFR 71.33 and 71.43(d).

Containment RAI's

RAI 4.6 Propose Response:

There are no chemical or galvanic reactions between the cask material (stainless steel) and the [[ ]] seals. This has been verified in discussions with the seal vendor and will be demonstrated in the acceptance testing for the seals, where the seal material will be exposed to the steel test fixture for an extended period of time at the full range of temperatures that the seals may experience in operation.

It has been determined that there will be no degradation of the seals due to irradiation. The [[ ]] indicates that there are no effects to [[ ]] through radiation levels of 10^6 rad. The maximum absorbed dose rates that the [[ ]] seals could be exposed to through a year of use is on the order of 10^2 to 10^4 rad. This range of absorbed doses was calculated using the MCNP models from the shielding analysis with tallies at the seal locations, assuming the cask is continuously loaded with 193,500 Ci of Co-60 for a full year.

Containment RAI's

RAI 4.7:

Clarify the extent to which the system is isolated during vacuum-drying processes described in SAR Section 7.1.3.1.

SAR Section 7.1.3.1 briefly describes the vacuum-drying process used if the cask was loaded under water. This description states that "the system shall be isolated." The staff needs to verify that the system reaches 1 torr pressure due to no liquid in the system instead of the vacuum pump pulling past a valve that isn't completely closed. Therefore, the applicant should provide additional clarification of the drying operation to assure that the pressure measurement is reliable (turning vacuum pump off, etc.).

This information is required by the staff to determine compliance with 10 CFR 71.33 and 71.87(f).

Containment RAI's

RAI 4.7 Propose Response:

The vacuum drying procedure used for the letter authorization will not deviate from the procedure that is currently used for the Model 2000 cask (GE Specification No. 22A9380 Rev. 8). The statement that "the system shall be isolated" refers to the use of the vacuum pump gas ballast, if it is necessary. Step 11 in the vacuum drying procedure indicates that the gas ballast should be turned off during the vacuum drying operation, however if it is needed to drive off moisture from the oil during the operation, the vacuum pump should be isolated from the cask while the gas ballast device is in use.

Containment RAI's

RAI 4.8:

Clarify the use of fabrication, maintenance, and periodic and pre-shipment leakage rate tests in SAR Chapter 7 and Chapter 8.

SAR Section 4.4 does not reference the ANSI N14.5 standard when discussing the fabrication, maintenance, periodic, and pre-shipment tests. It should be stated in SAR Chapter 7 and Chapter 8 that "the fabrication, maintenance, periodic, and pre-shipment tests are performed in accordance with ANSI N14.5".
The leakage tests described in Chapter 7 and Chapter 8 should be called out as "fabrication, maintenance, periodic, or pre-shipment" tests in reference to ANSI N14.5.
The appropriate leakage rate test and sensitivity criteria should be explicitly listed in SAR Chapter 7 and Chapter 8 for the fabrication, maintenance, periodic, and pre-shipment leakage tests per ANSI N14.5 standards.

This information is needed to determine compliance with 10 CFR 71.43(f) and 71.51.

Containment RAI's

RAI 4.8 Propose Response:

All leakage tests for operations and maintenance on the Model 2000 cask are to be performed in accordance with ANSI N14.5. The table below shows the leakage rate testing criteria and sensitivities for each of the leakage tests. It should be noted that, due to the short timeframe of this special authorization, the Fabrication, Maintenance, and Periodic leakage rate tests are likely not relevant. However, the acceptance testing for the new [[ ]] seals will verify leaktightness of the seal designs per the ANSI N14.5 definition (1×10^{-7} ref•cm^3/s).

Leakage Rate Test	Frequency	Criterion (ref•cm^3/s)	Sensitivity (ref•cm^3/s)
Fabrication	Prior to first use of each packaging.	1×10^{-7}	5×10^{-8}
Maintenance	After maintenance, repair, or replacement of components	1×10^{-7}	5×10^{-8}
Periodic	Within 12 months prior to each shipment	1×10^{-7}	5×10^{-8}
Pre-shipment	Prior to each shipment after the contents are loaded and the package is closed	1×10^{-7}	5×10^{-8}

Containment RAI's

RAI 4.9:

Confirm the extent of the containment boundary for the fabrication helium leakage test. The applicant does not reference ANSI N14.5 in SAR Section 8.1.4 and does not include welds, joints and base material in the leakage tests.

ANSI N14.5 indicates that the entire containment boundary, which includes welds, joints, base material, valves, etc., should be part of the fabrication helium leakage test. The extent of the containment boundary that is helium leak tested should be stated in SAR Section 8.1.4.

This information is needed to determine compliance with 10 CFR 71.43(f) and 10 CFR 71.51.

Containment RAI's

RAI 4.9 Propose Response:

The containment boundary is shown in the Figure for the response to RAI 4.2. Regarding welds, joints and base material, it is stated on page 1-21 of the Model 2000 SAR (NEDO-31581) that:

"A series of tests are performed during fabrication and upon completion of the Model 2000 package to establish its acceptance: visual and dimensional inspections of welds, NDE examinations of welds per ASME Code Section III, leak test of the containment boundary prior to lead pouring and of the cask, leak test of the case seal surrogate test coupon per ANSI N14.5..."

Weld inspections are further discussed in Section 8.1:

"Visual examinations of all welds and dimensions are conducted during fabrication. In addition all welds within the cask containment boundary are liquid penetrant tested (root and final passes); also, the welds forming the toroidal shell are 100% radiographed. These inspections are performed to ensure no cracks, incomplete fusion or lack of penetration exist. Parts that do no meet the established criteria are repaired or replaced in accordance with written procedures."

Containment RAI's

RAI 4.10:

Clarify the seal replacement period discussed on SAR page 8-6.

SAR Section 8.2.2 indicates that the cask closure seal and vent and drain plugs will be leak checked after every 12 usages. The replacement period should reflect the 12 month period described in ANSI N14.5.

This information is needed to determine compliance with 10 CFR 71.43(f) and 71.51.

Containment RAI's

RAI 4.10 Propose Response:

This is a typo in the letter authorization. To match the Model 2000 SAR (NEDO-31581), and comply with ANSI N14.5, this section should state:

"After every 12 usages or a year, whichever comes first, the cask closure seal and vent and drain plugs will be leak checked with a He MSLD."

Containment RAI's

RAI 4.11:

Clarify the content limits applicable to each seal material option.

SAR Sections 1.2.1 and 1.2.4 state that the cask has new cask seal and port O-ring "options." Additionally, SAR Drawings Nos. 105E9520 and 101E8718 call out two seal options with Option 1 being a "Gask-O-Seal Configuration Both Sides, Parker Compound" and Option 2 being a [[ ]] SAR Section 2.1.1 states that "for content loads up to 3000 watts," the cask seal and O-rings have this new [[ ]] material. It is not explicit what the content limit is for Option 1.

The applicant should explicitly state the content limits applicable to each option.

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

Containment RAI's

RAI 4.11 Propose Response:

The wattage limits for each seal option are listed in the table below. Seal option 1 is the Ethylene Propylene (EPDM) parker compound licensed in the current Model 2000 SAR, and option 2 is the new high temperature [[ ]] compound. The allowable wattage ranges are determined based on the allowable temperature ranges of the seal materials. The wattage range for the ethylene propylene rubber compound is based on the current Model 2000 SAR.

Seal Option	Minimum Internal Wattage	Maximum Internal Wattage
Ethylene Propylene Rubber Compound	0	2000
[[ ]]	500	3000

Containment RAI's

RAI 4.12:

Clarify leaktightness criteria for containment boundary leak testing.

SAR Section 4.1.3 states that performance tests of the seals will be performed to demonstrate leaktightness but the leakage criteria are not specified. The applicant should clarify if this leaktightness refers to the definition from ANSI N14.5 and provide the leaktightness criteria.

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI's

RAI 4.12 Propose Response:

Any mention of "leaktight" made in the special authorization request refers to the ANSI N14.5 definition of leak tight (1×10^{-7} ref•cm^3/s).

(See proposed response to RAI 4.8)

Containment RAI's

RAI 4.13:

Specify the leakage rate criteria for routine maintenance leak testing.

SAR Section 8.2.2.1 states that the cask closure seal and vent and drain plugs are leak tested using an instrument calibrated to a sensitivity of 1×10^{-5} atm. cm^3/sec (He) and if leakage greater than 1×10^{-3} atm. cm^3/sec is detected, offending components will be repaired or replaced and retested. SAR Section 4.1.3 states that tests will be performed on seals to demonstrate leaktightness.

Routine maintenance leak test criteria should be consistent with "leaktightness" terminology used and match with ANSI N14.5 standards of 1×10^{-7} ref. cm^3/s.

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI’s

RAI 4.13 Propose Response:

This error is due to the outdated language pulled from the current Model 2000 SAR. Section 8.2 in NEDO-31581 states “Routine inspections are performed prior to each assembly and prior to each shipment”, indicating that the “routine” leakage rate test does not refer to the routine maintenance leakage rate test but to the pre-shipment leakage rate test.

For clarity, and consistency with ANSI N14.5 terminology, it should be considered that all leakage rate test criteria are as listed in table in the response to RAI 4.8.

Containment RAI's

RAI 4.14:

Justify that the thermal conductivity leakage test method procedure would provide a qualitative and integrated measurement to show that the leakage acceptance criteria are met.

SAR Sections 7.1.3.3 and 8.2.2.1 provide information on leakage tests using thermal conductivity sensing instruments. It appears that the leakage test method relies on a sniffer method, which is typically a qualitative technique. Therefore, this method is not appropriate for leak testing the entire containment boundary (welds, base material, seals, etc.) for leak tests which must meet a quantifiable allowable leak rate (as stated in SAR Section 7.1.3.3 and 8.2.2.1) around the test boundary.

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI's

RAI 4.14 Propose Response:

As a result of the pre-shipment leakage test procedure being updated recently by LTS (in 09/2014), this piece of equipment is no longer used. All leak testing is done using a MSLD (see RAI 4.17 proposed response and in LTS Procedure number MSLT-EE-GE revision 5500-1021-01).

Containment RAI's

RAI 4.15:

Justify that the scaled test method used for seal testing is acceptable.

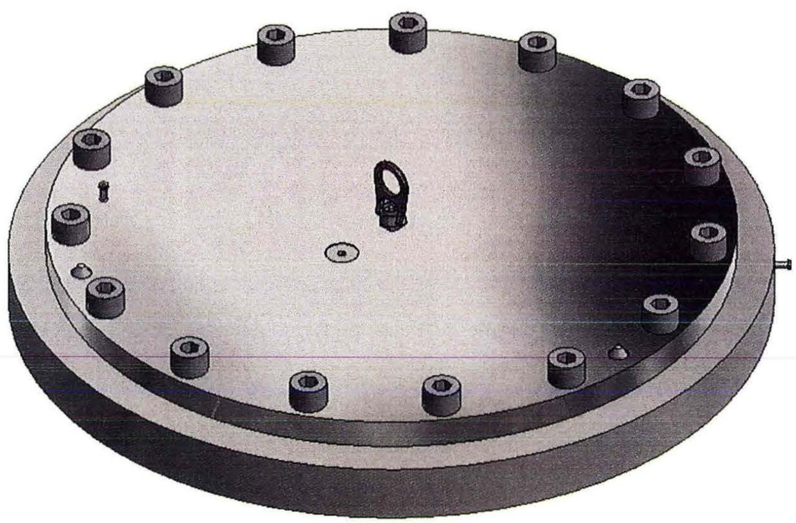
Research has shown that "Scale-model testing is not a reliable or acceptable method for quantifying the leakage rate of a full scale package" as noted in NUREG-1609 "Standard Review Plan for Transportation Packages for Radioactive Material" Section 4.5.3.2. The staff needs to verify that the seal testing method used in SAR Section 8.1.5.2 is acceptable.

This information is needed to determine compliance with 10 CFR 71.43(f), 71.51, 71.71, and 71.73.

Containment RAI's

RAI 4.15 Propose Response:

The acceptance testing for the Commercial Grade Dedication of the [[ ]] Gask-O-Seal and O-rings will be on a full-scale model (in terms of seal and flange diameter), rather than a scale model as indicated in the letter authorization request, to ensure results are representative of the actual Model 2000 cask. Details of the seal acceptance tests will be provided upon completion of all tests.



Containment RAI's

RAI 4.16:

Provide information on permeation of the new [[ ]] seal material.

Permeation is known to be an issue with some [[ ]] seal materials. The staff needs to know if the new [[ ]] seal material is permeable to helium. Permeation can be a problem when a leakage test procedure is being used to demonstrate that the system is leaktight. The degree of permeation is affected by seal material, seal surface area, time and temperature. If the new [[ ]] seal material is permeable to helium, the staff needs to determine if permeation will be accurately differentiated from leakage when leak testing the [[ ]] seals with helium to leaktight criterion on a repeatable basis.

Revise SAR Section 4.1.3.1, "Seals and Welds," of the application to include information on permeation related to the new [[ ]] seal material.

This information is needed to determine compliance with 10 CFR 71.43(d), 71.51(a)(1), 71.85(a) and 71.87 (c).

Containment RAI's

RAI 4.16 Propose Response:

It is stated in the Parker "Gask-O-Seal and Integral Seal Design Handbook" that the Gask-O-Seal is designed to yield an "extremely low permeability rate in vacuum and other gaseous applications with controlled percent squeeze and volume/void ratio". Similar to the methods in the current Model 2000 SAR, for the acceptance testing, permeation will be considered in one of two ways.

Either:

a) The leak test will take place a short period of time after helium is introduced to the test assembly, before the helium can saturate the O-ring.

b) Wait and allow the test to reach steady state permeation, then calculate and subtract the steady state permeation for the seals from the test leakage rates.

Containment RAI's

RAI 4.17:

Provide information on the mass spectrometer leak detector (MSLD) leakage test method and instruments being used.

SAR Sections 8.1.4, 8.1.5.2 and 8.2.2.2 reference leakage tests being performed with MSLD. The staff needs to verify that the test method and instrument are appropriate. Provide information on the MSLD leak test instrument being used (sniffer, evacuated envelope such as ANSI N14.5 test description A.5.5, etc.)

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI's

RAI 4.17 Propose Response:

The leakage rate testing method and equipment used are outlined in the pre-shipment leak test procedure developed and approved by LTS in Procedure number MSLT-EE-GE revision 5500-1021-01. In this procedure it is stated that:

The MSLD shall be a Varian Model 979 leak detector, or model deemed equivalent and qualified by the Level III, that is capable of sensing and measuring helium leakage rates of 1×10^{-9} or smaller.

1. The lid containment closure (gasket seal) is tested by a hood technique.
2. The vent port closure is tested by an evacuated envelope technique.
3. The drain port closure is tested by a vacuum technique.

Containment RAI's

RAI 4.18:

Provide the acceptable leakage rate for seal testing.

SAR Section 8.1.5.2 describes seal leak testing based on ANSI N14.5. The staff needs to verify that the test method is appropriate; therefore the applicant should provide the acceptable leakage rate for the test based on ANSI N14.5.

This information is needed to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Containment RAI's

RAI 4.18 Propose Response:

All leakage rate tests will comply with ANSI N14.5. The leakage rate criteria are as listed in the proposed response to RAI 4.8. For the acceptance testing of the [[ ]] gasket seals and O-rings, the acceptance criteria leakage rate will be equal to the fabrication/maintenance criteria of 1×10^{-7} ref•cm^3/s. The detailed Level III approved procedure and test results will be provided upon completion of the acceptance testing for the seals.

Fabrication Tolerance Shielding Study

Discussion:

Uncertainties in the calculated dose rates from the HPI DU shield fabrication have been considered through some additional MCNP sensitivity studies. Two aspects of the fabrication of the HPI DU shields are considered:

1) Due to the potential formation [[ ]], the minimum DU density in the HPI shields that the fabricator can guarantee is [[ ]].

2) The side shield will be fabricated [[ ]] From the fabrication tolerances at the interface of the [[ ]]

Results from the dose rate calculations analyzing the effect of both of these fabrication uncertainties are included on the following slides.

Fabrication Tolerance Shielding Study

Depleted Uranium Density:

The most restrictive MCNP case, in terms of [[ ]] were rerun with varying DU densities between [[ ]] The dose rates listed below are for 193,500 Ci of Co-60 loaded in the cask.

DU Density (g/cm^3)	NCT Top Surface		
	DR/Ci (mrem/hr/Ci)	DR (mrem/hr)	Margin
	3.60E-04	69.60	65.2%
	3.60E-04	69.75	65.1%
	3.67E-04	71.05	64.5%
	3.73E-04	72.20	63.9%
	3.77E-04	72.95	63.5%

DU Density (g/cm^3)	NCT Bottom Surface **		
	DR/Ci (mrem/hr/Ci)	DR (mrem/hr)	Margin
	8.12E-04	157.07	21.5%
	8.52E-04	164.89	17.6%
	8.90E-04	172.18	13.9%
	9.47E-04	183.23	8.4%
	9.64E-04	186.57	6.7%
	2.91E-04	56.36	71.8%

DU Density (g/cm^3)	NCT Side Surface			NCT Side 2m			NCT Side Cab		
	DR/Ci (mrem/hr/Ci)	DR (mrem/hr)	Margin	DR/Ci (mrem/hr/Ci)	DR (mrem/hr)	Margin	DR/Ci (mrem/hr/Ci)	DR (mrem/hr)	Margin
	8.19E-04	158.55	20.7%	3.00E-05	5.80	42.0%	6.24E-06	1.21	39.6%
	8.41E-04	162.75	18.6%	3.08E-05	5.96	40.4%	6.51E-06	1.26	37.0%
	8.75E-04	169.36	15.3%	3.20E-05	6.20	38.0%	6.77E-06	1.31	34.5%
	9.09E-04	175.91	12.0%	3.31E-05	6.41	35.9%	7.01E-06	1.36	32.2%
	9.28E-04	179.62	10.2%	3.39E-05	6.56	34.4%	7.16E-06	1.39	30.7%

**For the NCT Bottom surface, at lower densities the dose rate margin drops below 10%, however when the [[ ]] are considered, the calculated dose rate drops significantly.

Fabrication Tolerance Shielding Study

Fabrication tolerances in the DU side shield:

The HPI DU side shields are assembled [[ ]] From the fabrication tolerances to ensure that the pieces fit together during assembly, there may be [[ ]]

An MCNP analysis incorporating these potential gaps in the shield at the minimum DU density, and including the [[ ]] from the Model 2000 overpack calculated Side NCT dose rates of:

Surface – 86.1 mrem/hr
2-meter – 2.8 mrem/hr
Cab – 0.6 mrem/hr

The additional shielding analyses show that any uncertainty in the calculated dose rates from fabrication tolerances is sufficiently covered by the additional margin provided by the Model 2000 overpack.

[[ ]]

Discussion