71-9302

TRANSNUCLEAR, INC.

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Mr. Chris Regan, Project Manager
Spent Fuel Project Office
Division of Industrial and Medical Nuclear Safety
Office of Nuclear Material Safety and Safeguards
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Subject: Docket No. 71-9302 (TAC No. L23328), Additional Clarification for the NUHOMS®-MP197 Transport Package Application dated October 24, 2001, and submittal of Rev. 4 SAR pages.

Dear Mr. Regan:

Enclosed for your review is an additional clarification to our RAI response submittal on January 31, 2002. They consist of the following attachments:

1. Response questions on the thermal Chapter for the NUHOMS MP197 SAR (8 copies)
2. Appendix 3.7.3, Rev. 4 pages (8 copies)
3. Appendix 3.7.5, Rev. 4 pages (8 copies)
4. CD (1 copy)

If you have any questions or comments, please call me.

Sincerely,

John Conklin for
Peter Shih
Project Manager

cc: 1093 File
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Additional questions on the Thermal Chapter for the NUHOMS - MP197 SAR

2. Boundary condition temperatures established for the cask model do not display isothermal characteristics in the circumferential direction at either end of the cask skin within the canister thermal model. Because the models have decoupled the cask and canister analyses at the cask inside surface, the cask model must first be run in order to establish the boundary condition temperatures for the canister. Temperature information is then extracted from the cask inner surface and superimposed onto a "skin" representing the interacting cask surface within the canister model. The macro "Trans_3D.mac" is used in conjunction with "xn3D.txt", "yn3D.txt", and "zn3D.txt" to perform the boundary condition temperature assignment for the canister model. It appears as if this macro is assigning the boundary condition temperatures incorrectly because the cask model results reflect the appropriate circumferential isothermal characteristics. The model thus needs to be corrected. We believe the correction will not effect the temperature distribution dramatically.

Response: The comment is absolutely correct. In the macro "Trans_3D.mac", the coordination system was set to cylindrical coordination (CSYS,1), although the node coordination in the files "xn3D.txt", "yn3D.txt", and "zn3D.txt" were in cartesian coordination. The corresponding command in the macro "Trans_3d.mac" has been corrected. The models are run with the corrected macro. As it is mentioned in the comment, this correction did not effect the temperature distribution significantly. The changes in the component temperatures are as follows:

The canister maximum temperature is increased by 1°F in Table 3.7.5-1.
The average temperature of the peripheral inserts is increased by 1°F in Table 3.7.5-2.

In Appendix 3.7.3 the maximum temperature of the cask body was not consistent with the value reported in Chapter 3, Table 3-1. This value has been corrected in Appendix 3.7.3, Rev. 4 to make the values consistent. As a consequence of this correction the maximum cavity pressure increases from 1.64 atm (9.4 psig) to 1.65 atm (9.6 psig). Since a maximum pressure of 50 psig is considered in the structural analysis, there is no adverse effect on the structural analysis due to this correction.

In addition to the above corrections, the method to calculate the average temperature of the shield plugs in Appendix 3.7.5 has been revised. Instead of using the average of the node temperatures on the outer surface of the shield plug, a volume average temperature of the corresponding elements is calculated to make the average temperature calculation mathematically correct.

Appendices 3.7.3 and 3.7.5 are revised to consider the above corrections.

APPENDIX 3.7.3

MAXIMUM INTERNAL OPERATING PRESSURES

3.7.3.1 Discussion

The following approach is used in the determination of maximum pressures within the cask body and canister during normal and hypothetical accident conditions of transport:

- First, average cavity gas temperatures are derived from component temperatures.
- Next, the amount of helium present within the canister and cask body after the initial backfilling of each is determined via the ideal gas law.
- Then, the total amount of free gas within the fuel assemblies, including both fill and fission gases, is calculated.
- Using the prescribed percentage of fuel rods that develop cladding breaches from the Standard Review Plan, the total amount of gas within the canister is determined
- Finally, the maximum cavity pressures are determined via the ideal gas law.

3.7.3.1.1 Average Cavity Gas Temperatures

For simplicity, the average cavity gas temperatures within the canister is taken to be the average of the maximum steady state or peak transient fuel cladding and canister wall temperatures. Within the cask body the average cavity gas temperature is taken to be the average of the maximum steady state or peak transient cask body and canister wall temperatures.

Component	Max. Temperature (°F)	
	Normal Conditions	Accident Conditions
Fuel Cladding	598	680
Canister Wall	388	485
Cask Body	302	535
Average Cavity Gas, Canister	493	583
Average Cavity Gas, Cask Body	345	504

3.7.3.1.2 Amount of Initial Helium Backfill

The amounts of helium present within the DSC and the cask body are calculated using the ideal gas law and a maximum initial helium fill of 3.5 psig within the canister and cask body. The initial fill temperature is assumed to be 273 °F; the value used within the NUHOMS®-MP197 Storage Application [1].

From the backfill pressure and average gas temperatures the amounts of helium backfill gas can be calculated.

$n = (PV)/(RT)$

P = initial fill pressure = 3.5 psig = 1.24 atm
V = Free volume (ft^3)
T = initial fill temperature = 273 °F = 733 R
R = universal gas constant = 0.730 atm-ft^3/lbmoles-R

	Canister	Cask Body
Free Volume, V	214.86 ft^3	9.03 ft^3
Amount of backfill, n	0.498 lbmoles	0.021 lbmoles

3.7.3.1.3 Free Gas within Fuel Assemblies

The amount of fission and fill gases within each of the fuel assembly types is taken from Reference 2. The amounts of fission gases tabulated below were determined from SAS2H/ORIGEN-S computer runs. I, Kr, and Xe gases are considered following irradiation. These numbers include the 30 percent release fraction for fission gases due to cladding breaches specified in the Standard Review Plan for Transportation (Reference 3).

Fuel Design	Fill Gas [5]	Fission Gas [6]	Total	Total
(---)	(kg moles/rod)	(kg moles/rod)	(kg moles/rod)	(lb moles/assy)
7x7-49-0	5.489E-06	6.640E-05	7.189E-05	7.767E-03
8x8-63-1	3.842E-06	4.889E-05	5.273E-05	7.325E-03
8x8-62-2	8.176E-06	4.923E-05	5.741E-05	7.848E-03
8x8-60-4	8.177E-06	5.016E-05	5.834E-05	7.718E-03
8x8-60-1	8.247E-06	5.041E-05	5.866E-05	7.760E-03
9x9-74-2	1.800E-05	3.927E-05	5.727E-05	9.345E-03
10x10-92-2	1.492E-05	3.318E-05	4.810E-05	9.758E-03

The General Electric 10x10 fuel assembly is the bounding case and is used in the determination of the cavity pressures.

3.7.3.1.4 Total Amount of Gases within Canister

The total amount of gas within the canister is equal to the amount of initial helium fill plus any free gases within the assemblies that are released.

The Standard Review Plan for Transportation prescribes the percentage of fuel rods that develop cladding breaches during normal conditions of transport and hypothetical accident conditions. All free gases within fuel rods that develop breaches will be released into the canister.

n_{total} = 0.498 lbmoles + (f_B)(61 assemblies)(9.758E-03 lb moles/assy)

n_{total} = total amount of gases
f_B = fraction of fuel rods that develop cladding breaches
= 0.03 for Normal Conditions of Transport [3]
= 1.00 for Hypothetical Accident Conditions [3]

	Normal Conditions	Accident Conditions
f_B	0.03	1.00
n_{total}	0.516 lbmoles	1.093 lbmoles

3.7.3.2 Maximum Pressures

Maximum cavity pressures are determined via the ideal gas law:

$P = (nRT)/V$

P = pressure (atm)
V = Free volume (ft^3)
T = average cavity gas temperature (R)
R = universal gas constant = 0.730 (atm-ft^3/lbmoles-R)
n_{total} = total amount of gases (lbmoles)

	Canister		Cask Body	
	N.C.T.	H.A.C	N.C.T.	H.A.C.
n_{total} (lbmoles)	0.516	1.093	0.021	0.021
T (R)	953	1043	805	964
V (ft^3)	214.86	214.86	9.03	9.03
Cavity Pressure (atm)	1.67	3.87	1.37	1.65

3.7.3.3 Results and Conclusions

During normal operating conditions the maximum pressure within the canister is 1.67 atm (9.8 psig). Within the cask body the maximum normal operating pressure is 1.37 atm (5.4 psig).

During hypothetical accident conditions the maximum pressure within the canister is 3.87 atm (42.2 psig). Within the cask body the maximum accident operating pressure is 1.65 atm (9.6 psig).

3.7.3.4 References

1. NUHOMS COC 1004 Amendment No. 3, 2000
2. *TN-68 Dry Storage Cask Final Safety Analysis Report*, Transnuclear Inc., Revision 0, Hawthorne, NY, 2000.
3. *Standard Review Plan for Transportation Packages for Spent Nuclear Fuel*, NUREG-1617, 2000.
4. ANSYS Engineering Analysis System, *User's Manual for ANSYS Revision 6*, ANSYS, Inc., Houston, PA.

TABLE 3.7.5-1

Maximum Temperatures Normal Conditions of Transport
(Comparison of the modified and original models)

Component	Maximum Temperature Modified model with conduction and radiation in DSC, ε =0.5	Maximum Temperature Original model, ε =0.8	Temperature Difference (Modified – Original)	Thermal Limits
(---)	(°F)	(°F)	(°F)	(°F)
Shield Shell	241	227	+14	---
Resin	263	249	+14	300
Lead	312	299	+13	---
Cask Body	315	302	+13	---
Outer Surface of Outer Shell	272	258	+14	
Impact Limiters	198	195	+3	---
Cask Lid	201	199	+2	---
Thermal Shield	192	186	+6	---
Flourocarbon Seals, Lid	206	204	+2	400
Flourocarbon Seals, Ram Plate	231	217	+14	400
Canister	393	388	+5	---
Peripheral Inserts	477	482	-5	---
Basket	568	578	-10	---
Fuel Cladding	588	598	-10	1058

TABLE 3.7.5-2

Maximum Average Temperatures Compared to the Temperatures used in the Structural Analysis

Component	Maximum Temperature Modified model with conduction and radiation in DSC, ε =0.5	Maximum Temperature Original model, ε =0.8	Temperature used for Structural Analysis Limits
---	(°F)	(°F)	(°F)
Cask Body, $T_{avg,max}$ *	294	280	300
Peripheral Insetrs, $T_{avg,max}$	435	435	500
Canister Shell, $T_{avg,max}$	379	372	500
Basket, $T_{avg,max}$	523	530	600
Front Shield Plug, T_{avg} **	227	204	400
Rear Shield Plug, T_{avg}	260	223	400

* $T_{avg,max}$ is the average temperature at the hottest cross section for the Cask body, Peripheral Inserts, Canister Shell, and Basket.

** For the shield plugs, T_{avg}, is the volume average temperature of the corresponding elements.