LTR-20000-130-03

July 14, 2021

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

Dear Director:

DAHER-TLI hereby submits the response to the Request for Additional Information (RAI), issued on June 2, 2021, for Revision 12 to the Versa-Pac Safety Analysis Report (SAR), Docket No. 71-9342. The response to the RAI is documented in Attachment 1 to this letter and Revision 12 of the Versa-Pac SAR with change pages resulting from the RAI Response are also enclosed in this submittal. Change pages in the SAR are marked 'July 2021' in the header and a summary of all changes is provided in Attachment 2 to this letter. The affidavit for withholding from public disclosure is documented in LTR-20000-130-04, submitted jointly with this application along with a redacted version of the updated SAR.

To support customer scheduling obligations, we request the approval of the certificate revision by the end of August 2021. DAHER-TLI is committed to providing timely responses to any proposed questions to support this timing.

Thank you for your attention to this license application for the Versa-Pac. This report is being submitted in accordance with 10CFR71.1, Communications and records. The enclosures of this report are being submitted through the EIE system.

Please address any questions or comments to the undersigned.

Sincerely,

Digitally signed by Philip Sewell
Date: 2021.07.14 10:57:57 -04'00'

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DAHER-TLI

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Non-Proprietary Enclosures:

Description:	File Name:
Affidavit to Withhold Proprietary Information	LTR-20000-130-04.pdf
SAR Revision 12, Non-Proprietary	VP SAR Rev 12-NP.pdf

Proprietary Enclosures:

Description:	File Name:
SAR Revision 12, Proprietary	VP SAR Rev 12-P.pdf

Attachment 1 – RAI Response

NRC RAI 3-1

Justify the heat transfer coefficient value used to perform the analysis of the 30-minute regulatory fire.

SAR Section 3.5.3.5.1 "Fire Test Conditions" states that forced convection heat transfer is used with a convection coefficient of 10 W/m-°C. This value may not be adequate for the regulatory fire as use of a lower heat transfer coefficient value may result in nonconservative predicted temperatures. The staff needs this information to determine that predicted temperatures and pressures remain below allowable limits during hypothetical accident conditions.

For reference, Sandia Report "Thermal Measurements in a Series of Large Pool Fires", Sandia Report SAND85– 0196 TTC – 0659 UC 71, (August 1971) measured a higher value of about 25.5 W/m^2-°C for this type of fire.

Note: The units used in the heat transfer coefficients on SAR Section 3.5.3.5.1 appear to be incorrect and should be revised.

This information is needed to determine compliance with 10 CFR 71.73(c)(4).

DAHER-TLI Response:

The forced convection coefficient of 10 W/m^2-°C was taken from the IAEA advisory material Specific Safety Guide No. SSG-26 (2012), Paragraph 728.30. However, to address the concern, a film coefficient of 17.4 W/m^2-°C was calculated for the cylindrical portion of the package and a value of 15.6 W/m^2-°C was calculated for the ends of the package using the method described below. Consequently, all HAC cases in the SAR were reran using the updated boundary conditions. Overall, the temperature increases are small and do not change the conclusions of the thermal evaluations presented in the SAR. As noted, the heat transfer coefficient units were corrected throughout the SAR to W/m^2-°C.

The following description is added to the boundary condition discussion in Section 3.5.4.2:

During the HAC 30-minute fire, forced convection film coefficient (h_c) are applied as boundary conditions to each external surface of the package. Temperature dependent h_c values are calculated for the range from ambient, 100°F (37.78°C), to the fire the temperature of 1472°F (800°C) based on the geometry of the surface [1]. The maximum calculated h_c values for the range are conservatively applied to the external surfaces of the ANSYS model.

The forced convection coefficient is calculated using the following equation (Equation 9.24 [1]):

$$h_c = \frac{Nu \times k}{L}$$

where, Nu = Nusselt number,
k = thermal conductivity of air at the film temperature, and
L = characteristic length of the surface.

The Nusselt number (Nu) is a function of the Reynolds number (Re) and the Prandtl number. The Reynolds number is, in turn, a function of surface geometry, temperature, flow velocity, and properties (density and viscosity) of the surrounding air, which is calculated using the following equation (Equation 6.45 [1]):

$$Re = \frac{V \times L}{\nu}$$

where, V = air free-stream velocity,
L = characteristic length,
ν = air dynamic viscosity at T_f,
T_f = film temperature = $(T_s + T_\infty)/2$,
T_s = surface temperature, and
T_∞ = ambient temperature.

The VP-55 package surfaces are modeled using Nu correlations for a cylinder in cross flow or a flat plate with parallel flow depending on which surface and package orientation being evaluated. These Nu correlations are as follows:

Cylinder in Cross Flow

The characteristic length, L, of a cylinder is its diameter, D. The Nusselt number for a cylinder in cross flow is calculated using the following equation (Equation 7.55b [1]):

$$Nu = C\, Re_D^{\,m}\, Pr^{1/3}$$

where, Re_D = Reynolds number, and
Pr = Prandtl number.

The constants 'C' and 'm' in the previous equation are functions of the Reynolds number (Re_D) and are listed in Table 1.

Table 1. Constants 'C' and 'm' for the Nusselt number calculation of a cylinder in cross flow.

Re_D	C	m
0.4 – 4	0.989	0.330
4 – 40	0.911	0.385
40 – 4,000	0.683	0.466
4,000 – 40,000	0.193	0.618
40,000 – 400,000	0.027	0.805

Reference: [1] Table 7.2.

Flat Plate with Parallel Flow

For laminar flow ($Re_L \leq 5\times10^5$ per Equation 6.24, [1]), the Nusselt number for external flow over a flat plate is calculated using the following equation (Equation 7.31, [1]):

$$Nu = 0.664\, Re_L^{\,1/2}\, Pr^{1/3} \qquad (5\times10^5 \leq Re_L,\ Pr \leq 0.6)$$

where, Re_L = Reynolds number, and
Pr = Prandtl number.

For mixed parallel flow (laminar and turbulent), the Nusselt number for external flow over a flat plate is calculated using the following equation (Equation 7.44, [1]):

$$Nu=0.037\ Re_L^{4/5}\ Pr^{1/3} \qquad (5\times10^5 < Re_L \leq 10^8)$$

where, Re_L = Reynolds number, and
Pr = Prandtl number.

To provide maximum heat input from the fire, the package is assumed to be laying in the horizontal position. Using the equations presented above, calculated forced convection film coefficients of 15.6 and 17.4 W/m²·°C are applied to the flat ends and cylindrical side surface of the package, respectively.

Works Cited

[1] T. L. Bergman, A. S. Lavine, F. P. Incropera and D. P. DeWitt, Fundamentals of Heat and Mass Transfer, Seventh ed., New York: John Wiley & Sons, Inc., 2011.

Attachment 2 – Summary of SAR Chapter 3 Changes

In addition to the HAC case reruns for the RAI response, all NCT cases were rerun to universally update the version of ANSYS used throughout the thermal analysis to 19.1. These NCT case reruns resulted in some temperature results changing slightly. Also, the 11.4 W maximum decay heat was applied to the thermal analysis of the VP-55 with no Containment Insulation Plug (Section 3.5.3), which was previously omitted from the analysis.

The following table is provided to supplement the submittal and aid review by outlining all changes made to Chapter 3 of the SAR. Note that there are a number of instances where figures have been changed out for equivalent higher quality images. These cases are noted in the table below, but not tracked by revision bars in the SAR section. Also, the SAR revision remains Rev. 12, but the changed pages list the date of the new submittal (July 2021) rather than that of the original submittal (February 2021).

SAR Page	Change Description
i	- Bullet added to the record of revisions to note that pages dated July 2021 in the header are change pages for the RAI response. (not marked)
Iii	- List of Effective Pages revised to update revision levels for Chapter 3 (not marked)
3-1	- Maximum temperatures listed in paragraph updated based on new HAC results - Figure 3-1 updated for higher quality image. (not marked)
3-4	- NCT results and average air volume temperature row added to Table 3-2.
3-5	- Maximum temperature updated in Table 3-3, with updated convection coefficients. - Maximum pressures updated in Section 3.1.4 based on revised maximum temperatures.
3-9	- Section 3.2.2 text revised to remove language describing the Versa-Pac cavity as "not a sealed system".
3-11	- Section 3.3 revised to update ANSYS version to 19.1 (updated with reruns), state that ANSYS Workbench was used, and cross-reference Figure 3-2.
3-12	- Figure 3-2 was changed out for a higher quality image with side-by-side views with and without ANSYS meshing. (not marked)
3-14 to 3-17	- Figure 3-3 through Figure 3-6 replaced with higher quality images. (not marked)
3-18	- Updated NCT results due to reruns with ANSYS 19.1. Average air volume temperature also added to Table 3-13 for pressure calculation.
3-19 to 3-20	- Figure 3-7 through Figure 3-10 updated to reflect reruns. Air volume hidden from figures to better show temperature contours in the VP packaging. (not marked)
3-21	- Maximum NCT pressure updated based on average NCT air volume temperature rather than the maximum cavity surface temperature. Minimal change in pressure.
3-22	- Figure 3-11 replaced with higher quality image. (not marked)

3-23	- Paragraph text and Figure 3-12 updated to reflect new HAC boundary conditions based on RAI resolution.
3-24	- Section header changed to 3.4.2.1 (was 3.4.3 previously) to better align with Reg Guide 7.9 format. - Replaced Figure 3-13 with higher quality image. (not marked)
3-25 to 3-28	- Results updated throughout section 3.4.3 to show updated temperature and pressure results.
3-28A	- No changes to content, new Figure 3-17 pushed Sections 3.4.4 and 3.4.5 to a new page. Page numbered '3-28A' to retain following page numbers.
3-30	- Updated ANSYS reference to version 19.1
3-31	- Maximum temperature values updated to reflect new HAC results.
3-32	- Updated text in Section 3.5.2.2 to list the ANSYS version used as 19.1
3-33	- Text revised to update ANSYS version to 19.1 (updated with reruns), state that ANSYS Workbench was used, and cross-reference Figure 3-20.
3-34	- Figure 3-20 was changed out for a higher quality image with side-by-side views with and without ANSYS meshing. (not marked)
3-35	- Figure 3-21 replaced with higher quality image. (not marked)
3-36	- Updated NCT results due to reruns with ANSYS 19.1.
3-37 to 3-38:	- Figure 3-22 through Figure 3-24 updated to reflect reruns and provide higher quality images. (not marked)
3-39	- Paragraph text and Figure 3-25 updated to reflect new HAC boundary conditions based on RAI resolution.
3-40	- Replaced Figure 3-26 with higher quality image. (not marked)
3-41 to 3-44	- HAC results updated throughout to show updated temperature results. Changes throughout are minimal.
3-45	- Figure 3-32 replaced with higher quality image. (not marked)
3-46	- Section 3.5.3.1 text and 'Internal Heat Generation' values in Table 3-19 updated to include the 11.4 W decay heat to the thermal case.
3-47	- Figure 3-33 replaced with higher quality image. (not marked)
3-48	- Figure 3-34 replaced with higher quality image. (not marked)
3-49 to 3-50	- NCT results updated throughout to show updated temperature results.
3-51	- Paragraph text and Figure 3-37 updated to reflect new HAC boundary conditions based on RAI resolution.
3-52	- Figure 3-38 replaced with higher quality image. (not marked)
3-53 to 3-56	- HAC results updated throughout to show updated temperature results. Changes throughout are minimal.
3-58 to 3-60	- HAC convection discussion and calculations changed based on RAI response
3-61 to 3-62	- No changes to content. The page numbers of content are shifted due to added text on prior pages.