Staff needs further clarification for the following questions

Question provided 3/23

1) RAI 3 – 3**:** Provide the equations and the related parameters/values used to derive the maximum pressure of NCT within the 3-60B containment vessel.

The calculated pressure of 25.6 psig for NCT in SAR 3.4.3 does not include the radiolysis-induced pressure in a complete manner and its effect on the other pressure components. Specifically, the applicant did not calculate the pressure, generated by radiolysis, as a function of the effective G value, the decay heat, and the 60-day shipping period.

The maximum pressure within the 3-60B under NCT is attributed by the radiolytic gas generation, the thermal expansion of gases, and the vapor pressure of water within the package. Therefore, the applicant should perform a NCT pressure calculation based on three factors:

- Pressure generated by radiolysis (based on the decay heat, the effective G value and a 60-day shipping period),
- Pressure increase of the initial gas due to thermal expansion, and
- Vapor pressure of water.

The applicant should provide the equations, the related parameters/values, and calculations for the total pressure calculations. In addition, the applicant should show the calculation for the water vapor pressure using the formula in Ref. 3-4 of the SAR.

RESPONSE

Section 3.3.2 will be revised as shown below.

Cask Internal Pressure

The maximum internal pressure of the cask is calculated assuming that the gas within the cask, a mixture of air, water vapor, oxygen, and hydrogen, behaves as an ideal gas. To determine the maximum internal pressure under normal conditions in the cask (MNOP) the temperature of the gas mixture within the cask was evaluated. First, the pressure at ambient temperature (70°F) is determined. The cask void is filled with air at atmospheric pressure, 14.7 psi. Radiolysis will produce hydrogen and oxygen that will add to the pressure in the cavity. By limiting the amount of water and decay heat as discussed above, the maximum amount (in volume percent) of gases produced by radiolysis of water (based on the decay heat, the effective G value and a 60-day shipping period) will be 5% hydrogen and, correspondingly, 2.5% for oxygen. The addition of hydrogen and oxygen to the sealed cask cavity result in an increased cask pressure (at 70°F) of:

$$P_1 = 14.7 + (14.7 \text{ x } (5\%+2.5\%)) = 15.8 \text{ psi}$$

Second, the pressure at the maximum cavity temperature is determined. The temperature of the gas is 227.3°F (T_2) on the 100°F day (see Table 3-3). The pressure in the cask at 227.3°F due to thermal expansion, P_2, is calculated by the ideal gas relationship:

$$P_2 = \frac{T_2}{T_1} \cdot P_1$$, where T is in degrees absolute

With an increase in temperature to 227.3°F, the pressure becomes:

P_2 = 20.5 psi

Third, the additional pressure due to the vapor pressure of water at the maximum cavity temperature is determined. Since the cask cavity is assumed to also contain water, the vapor pressure of water must be added to the pressure in the cavity. The vapor pressure contributed by water in the cavity at 227.3ºF (108.65 ºC) is 19.8 psia (interpolated from the table Vapor Pressure of Water from 0 to 370 ºC , page 6-15, from Reference 3-4).

Finally, the total pressure in the cavity is determined. The total pressure (maximum normal operating pressure) is the sum of the pressure of the gas due to thermal expansion and the water vapor pressure at the maximum cavity temperature. The calculated maximum normal operating pressure (in gage pressure) is,

MNOP = 20.5 + 19.8 – 14.7 = 25.6 psig

The value used for MNOP is conservatively set at 35.0 psig.

<u>Questions provided 3/15</u>

1) RAI 4-1: The applicant responds that they will replace Lock-O-Ring with Parker Stat-O-Ring. The applicant needs to provide the description of Parker Stat-O-Ring and its characteristics.

<u>RESPONSE</u>

The section of the Parker catalog is provided that describes a Stat-O-Seal. The cask drawing specifies a Stat-O-seal, 600 series, with S/STL Retainer.

2) RAI 4-2: Staff understands that the preshipment leak test is not required for LSA or SCO contents (a general case), but the applicant needs to provide an explanation whether LSA or SCO may be authorized contents in the 3-60B? If allowed, which contents below can be identified/categorized LSA or SCO from the content's description i.e. "By-product, source, or special nuclear material, in the form of de-watered inorganic solids, including powdered or dispersible solids, or inorganic solidified material, or - de-watered inorganic resins, or - activated and/or contaminated non-fuel-bearing reactor or accelerator components or segments of components." Which can be categorized as to LSA or SCO? How ?

<u>RESPONSE</u>

Any of the contents might be classified by the shipper as LSA or SCO. Classification is performed per the definitions of LSA and SCO in 10 CFR 71.4 following the guidance of NUREG 1608. Per 49 CFR 173.427(b)(3), the packages in which LSA or SCO must be packaged includes Type B packages.

3) RAI 4-5: the applicant increased the backfill pressure from 25 psig to 42 psig for halogen test gases (R-12 and R-134a) in the leak tests. But Table 8-1 and SAR 8.1.4.8 has not been updated with 42 psig.

RESPONSE

Table 8-1 and Step 8.1.4.8 have been corrected.

4) RAI 4-6: The applicant does not simplify the equations of allowable test leakage and allowable test leakage sensitivity as a function of temperature for staff to check the figures.

RESPONSE

The calculational method and equations are taken from ANSI N14.5 following Example 10, page 35. The allowable leakage rate equations in Section 4.5.1, 4.5.2, and 4.5.3 have been simplified using the data provided in the chapter for the three gases, R12, R134a, and helium. The simplified equations are as follows:

For R12

The allowable test leakage in oz/yr as a function of temperature in degrees Fahrenheit, $L(T_F)$, is given by the equation below.

$$L(T_F) = 27.59 + (0.06853 \text{ x } (0.556T_F + 255.2)^{0.5}) \div (0.556T_F + 255.2)$$

The allowable test leakage sensitivity in oz/yr as a function of temperature in degrees Fahrenheit , $S(T_F)$, is given by the equation below.

$$S(T_F) = 27.59 + (0.06853 \text{ x } (0.556T_F + 255.2)^{0.5}) \div 2 \text{ x } (0.556T_F + 255.2)$$

For R134a

The allowable test leakage in oz/yr as a function of temperature in degrees Fahrenheit, $L(T_F)$, is given by the equation below.

$$L(T_F) = 23.93 + (0.06278 \text{ x } (0.556T_F + 255.2)^{0.5}) \div (0.556T_F + 255.2)$$

The allowable test leakage sensitivity in oz/yr as a function of temperature in degrees Fahrenheit , $S(T_F)$, is given by the equation below.

$$S(T_F) = 23.93 + (0.06278 \text{ x } (0.556T_F + 255.2)^{0.5}) \div 2 \text{ x } (0.556T_F + 255.2)$$

For Helium
The allowable test leakage in cm^3/sec as a function of temperature in degrees Fahrenheit, $L(T_F)$, is given by the equation below.

$$L(T_F) = 7.123 \times 10^{-7} + (3.70 \times 10^{-8} \times (0.556T_F + 255.2)^{0.5})$$

The allowable test leakage sensitivity in cm^3/sec as a function of temperature in degrees Fahrenheit , $S(T_F)$, is given by the equation below.

$$S(T_F) = 7.123 \times 10^{-7} + (3.70 \times 10^{-8} \times (0.556T_F + 255.2)^{0.5}) \div 2$$

5) RAI 7-1: The applicant stated that the dewatering process can be done by suspending the cask over the pool with the vent and drain port open until no water is visible exiting the drain port. This process does not ensure the free standing water will be less than 1% in package. Please provide assurance on that topic.

<u>RESPONSE</u>
1% free standing water is not a packaging or transportation requirement. The shipper must determine the amount of water in the package and cavity to determine the amount of hydrogen that may be generated during transport.