Materials RAIs for AOS Application – Round 2

M1 – Make the following corrections and changes to the certificate drawings (see tables below), and modify Table 2-17 to precisely match the information in the drawings.
All components with safety classification A or B must have at least one material specified by a national consensus standard and the corresponding material grade or type. For example, '300 series stainless steel' is not an acceptable material designation, but ASME SA-240/ASTM A240 Type 304 is acceptable.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

AOS-025

Drawing	Item	Issue/Question	Note(s)
166D8143	8	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	13	Specify a national consensus material standard and material grade/type	
	14	Part reference cannot be found on manufacturer's website	
	14	Specify a national consensus material standard and material grade/type	Alloy 90 is unspecified
	14	Remove 'or equivalent'	
	16	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	23	Specify a national consensus material standard and material grade/type	
	24	Specify a national consensus material standard and material grade/type	Discrepancy between AISI type 410 (stainless steel) and ASME SA-193 grade B6 (carbon steel)
	19&29	Remove 'or equivalent'	
	6&7	Specify weld	
	7&22	Specify weld	
	1&30	Modify weld drawing	Weld between item 1 and 30 on section A-A and B-B should look like AOS-050A drawing 166D8137

105E9722	2&3	Specify weld	
	2&7	Specify weld	
	11	Drawing label	Swivel hoist ring is labeled as item 12 on drawing: should be item 11
	12	Specify a national consensus material standard and material grade/type	
	13	Specify a national consensus material standard and material grade/type	
	14	Dimensions	Provide all dimensions for the J-hook
	14	Specify a national consensus material standard and material grade/type	Discrepancy between 300 series stainless steel and ASME SA-193 grade B6 (carbon steel)
	15	Specify a national consensus material standard and material grade/type	Discrepancy between 300 series stainless steel and ASME SA-193 grade B6 (carbon steel)
	19	Specify a national consensus material standard and material grade/type	
	20	Specify a national consensus material standard and material grade/type	
	21	Specify a national consensus material standard and material grade/type	
183C8485	1&2	Dimensions	Item 1 ID is smaller than item 2 OD such that item 2 does not appear to fit into item 1

AOS-050

Drawing	**Item**	**Issue/Question**	**Note(s)**
105E9718	10	Specify a national consensus material standard and material grade/type	
	10	Provide a manufacturer and part number	
166D8137	8	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	13	Specify a national consensus material standard and material grade/type	

	14	Part reference cannot be found on manufacturer's website	
	14	Specify a national consensus material standard and material grade/type	Alloy 90 is unspecified
	14	Remove 'or equivalent'	
	16	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	23	Specify a national consensus material standard and material grade/type	
	24	Specify a national consensus material standard and material grade/type	Discrepancy between AISI type 410 (stainless steel) and ASME SA-193 grade B6 (carbon steel)
	26	Specify a national consensus material standard and material grade/type	
	32	Specify a national consensus material standard and material grade/type	
	19&29	Remove 'or equivalent'	
166D8138	2&3	Specify weld	
	2&7	Specify weld	

AOS-100

Drawing	Item	Issue/Question	Note(s)
105E9711	4	Dimensions	Provide all dimensions for the jaw & jaw turnbuckle in a drawing detail
	8	Specify a national consensus material standard and material grade/type	
	10	Safety classification	Justify why turnbuckle is not Class A
	10	Remove 'or equivalent'	
105E9719	8	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	13	Part reference cannot be found on manufacturer's website	

	13	Specify a national consensus material standard and material grade/type	Part list specifies 300 series stainless steel, while response to RAI 4.1 specifies Silver + Alloy 90
	13	Remove 'or equivalent'	
	16	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	23	Specify a national consensus material standard and material grade/type	
	24	Specify a national consensus material standard and material grade/type	Discrepancy between AISI type 410 (stainless steel) and ASME SA-193 grade B6 (carbon steel)
	26	Specify a national consensus material standard and material grade/type	
	30	Specify a national consensus material standard and material grade/type	
	31	Specify a national consensus material standard and material grade/type	
	19&29	Remove 'or equivalent'	
105E9713	2&3	Specify weld	
	2&7	Specify weld	
183C8491	3	Specify a national consensus material standard and material grade/type	
105E9712	13	Part reference cannot be found on manufacturer's website	
	13	Specify a national consensus material standard and material grade/type	Part list specifies 300 series stainless steel, while response to RAI 4.1 specifies Silver + Alloy 90
	13	Remove 'or equivalent'	
	17	Specify a national consensus material standard and material grade/type	
	21	Specify a national consensus material standard and material grade/type	
	23	Specify a national consensus material standard and material grade/type	

	24	Specify a national consensus material standard and material grade/type	Discrepancy between AISI type 410 (stainless steel) and ASME SA-193 grade B6 (carbon steel)
	26	Specify a national consensus material standard and material grade/type	
	30	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	31	Specify a national consensus material standard and material grade/type	Specific copper alloy must be specified
	33	Specify a national consensus material standard and material grade/type	
	19&29	Remove 'or equivalent'	
	6&7	Specify weld (sheet 1)	The symbol indicating a 360° weld is missing (should be identical to that in sheet 2)
	1&30	Modify weld drawing (sheet 2)	Weld between cask outer shell and bottom plate should be identical toAOS-100A shown in sheet 1

M2 – Provide the detailed chemical characteristics, physical characteristics, location, and configuration of the contents of the AOS Transport Packaging System, and indicate whether the contents will be Special form or normal form. This RAI is a follow up to the first round RAI 1.2 and 2.8 responses.

The chemical and physical form shall include density and moisture content. The location and configuration of the contents within the packaging shall include secondary containers, wrapping, shoring, and other materials not defined as part of the packaging.

The staff needs to know precisely what the content materials consist of (as listed above) in order to determine if the 1000°F temperature limit is bounding for all contents that will be transported in the AOS Transport Packaging System, and to determine if any materials will be subject to chemical, galvanic, or other reactions, including the generation of combustible gases.

Section 2-10 indicates that Special form material does not apply for the AOS Transport Packaging System, but Table 1-3 indicates that Special form material is a possible content of the cask. If Special form is a content of the AOS Transport Packaging System, a note indicating: “current Certificate of Compliance, as Special form, required” must be added to Table 1-3.

This information is required by the staff to determine compliance with 10 CFR 71.33(b)(3) and 71.4.

M3 – Provide manufacturer data for the design operating range of the lid seals Helicoflex H-309854, H-309852, and H-309850. Provide a complete description of the silver and Alloy 90 materials used in the seals, and correct the AOS-100 cask certification drawings and part lists to

accurately indicate the lid seal materials. This RAI is a follow up to the first round RAI 4.1 response.
The lid seal references provided could not be found on the manufacturer's website, thus no information regarding the operating range of the seals was found. The materials composing the lid seal are not adequately defined: a complete description of the materials including composition and temperature dependent thermal and mechanical properties must be provided for the entire design temperature range.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M4 – Correct the cylinder radius and the calculated buckling critical force in Table 2-2, and correct the Young modulus values in note (b) to table 2-2. This RAI is a follow up to the first round RAI 2.1 response.
The cylinder radii reported for AOS-050 and AOS-100 are erroneous, they should be 7.0 in. and 14.0 in., respectively. This correction results in a corrected critical buckling force of 2.184e6, which is lower than the 2.78e6 reported. Furthermore, there is a factor of 10 error in the Young modulus values provided in note (b) to Table 2-2. Assess the impact of these corrections on the analyses and calculations presented in the SAR, update the analyses and calculations of the SAR as required, and address any inconsistencies in the SAR as a result of these corrections.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M5 – Clarify and justify which codes and standards are applicable for the design, fabrication and testing of the AOS Transport Packaging System, in Table 2-8.
For components of the 'other safety' group, the referenced B&PV code section is Section III, Division 1, Subsection NG, but several NF code subsections are then referenced below in the same table. Clarify and justify the use of either NF or NG code subsections.
This information is required by the staff to determine compliance with 10 CFR 71.33 and 10 CFR 71.37(a).

M6 – Justify the use of the mean coefficient of thermal expansion instead of the instantaneous coefficient of thermal expansion in Tables 2-9, 2-10, 2-12.
Table TE-1 in ASME Code Section II, Part D, provides three different values for the thermal expansion coefficient for each material group: instantaneous, mean, and linear (columns A, B, C respectively). Justify the use of the mean instead of the instantaneous coefficient of thermal expansion. If the thermal expansion coefficients are changed, assess the impact of these changes on the analyses and calculations presented in the SAR, update the analyses and calculations of the SAR as required, and address any inconsistencies in the SAR as a result of these changes.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M7 – Correct Table 2-10 to show the mechanical properties of the N07718 nickel alloy. This RAI is a follow up to the first round RAI 2.3 response.

The Young modulus shown in Table 2-11 is that of the wrong material (Material Group B Nickel Steel). The Young modulus must be provided for N07718 Nickel alloy (Table TM-4 in Section II, Part D of the ASME code). The design stress intensity is also wrong by a factor of about 2, and should be corrected to show the correct design stress intensity for the N07718 Nickel alloy. Assess the impact of these corrections on the analyses and calculations presented in the SAR, update the analyses and calculations of the SAR as required, and address any inconsistencies in the SAR as a result of these corrections.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M8 – Provide temperature dependent properties for the tungsten alloy mechanical properties in Table 2-11. This RAI is a follow up to the first round RAI 3.1 response.
Table 2-11 should resemble Tables 2-9, 2-10 and 2-12. Assess the impact of these changes on the analyses and calculations presented in the SAR, update the analyses and calculations of the SAR as required, and address any inconsistencies in the SAR as a result of these changes.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M9 – Modify Table 2-14 so as to provide the mechanical properties of the different grades of LAST-A-FOAM FR-3700 foams used for the AOS Transport Packaging System as a function of temperature for temperatures ranging from -40°F to 279°F (the component temperature range specified in Table 3-3). For the AOS-050, justify the use of the FR-3710 foam at temperatures within 3°F of the glass transition temperature of 279°F. This RAI is a follow up to the first round RAI 2.21 response.
Based on the manufacturer data found via the link provided below, the properties of FR-3710, FR-3712 and FR-3720 change by more than a factor of two between -75°F and 250°F. These changes in material properties as a function of temperature must be taken into account in the structural models of the impact limiters. For AOS-050, the maximum temperature of the foam for the impact limiter is 276°F, while the glass transition temperature of FR-3710 is 279°F (maximum operating temperature range). It is expected that the mechanical properties of FR-3700 series foams will decrease rapidly above the glass transition temperature. The 3°F temperature margin is very small, and should be justified.
http://www.generalplastics.com/products/idatasheets.php?pfoamname=FR-3700&
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M10 – Provide a complete description of the copper alloy used to fabricate the port plug seals and the conical seals on the AOS Transport Packaging System. Provide mechanical and thermal properties for the copper alloy used to make the seals. This RAI is a follow up to the first round RAI 2.4 response.
The copper alloy C10100 is referenced in section 2.2.2. A national consensus standard should be provided for this material, as well as the corresponding material properties (mechanical and thermal). The material specification should be consistent with that specified in certification drawings.

This information is required by the staff to determine compliance with 10 CFR 71.43(d), 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M11 – Specify the exact type of foam used in the impact limiters for the AOS-165 cask drop tests.
Provide the density, mechanical, and thermal properties of the foam used in the AOS-165 test cask and compare these properties with those of the foams used for the other cask sizes in the AOS Transport Packaging System SAR. The staff needs this information to assess the validity of the structural and thermal models and analyses described in the SAR.
This information is required by the staff to determine compliance with 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M12 – Justify the use of SA-193 Grade B8RA and SA-564 Type 630-H1100 as bolting materials (Table 8-3). If these materials are to be used, provide all corresponding temperature dependent mechanical and thermal material properties.
SA-193 Grade B8RA and SA-564 Type 630-H1100 are not mentioned anywhere in the drawings or SAR, except in Table 8-3. Explain this discrepancy.
This information is required by the staff to determine compliance with 10 CFR 71.43(d), 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).

M13 – Make the following corrections in the Safety Analysis Report, and assess the impact of these changes on any analyses that may be affected, if any:

- Page 2-36: change “21mm” to “21 microns” to match the notes in the certificate drawings.
- Page 2-37: delete “per hour” in the statement “when subjected to a maximum cumulative dose of $2x10^8$ rads *per hour*.”
- Page 2-39 in table 2-17: drawing number 105E9712G001 does not exist: replace with drawing number 105E9712.
- Section 2.6.2: “Low-temperature service does not affect the AOS Transport Packaging System, because all containment and non-containment structural components are fabricated of SS300, a material that does not undergo ductile-to-brittle transition in the temperature range of interest, down to -40°C (-40°F). Therefore, it is safe from brittle fracture.” Modify this statement to take into account (1) the lid attachment bolts made of nickel alloy N07718, and (2) the impact limiters containing FR-3700 series foam. Both the lid attachment bolts and the impact limiters are structural components

This information is required by the staff to determine compliance with 10 CFR 71.33, 10 CFR 71.51(a)(1) and 10 CFR 71.51(a)(2).