Headquarters
U.S. Nuclear Regulatory Commission
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
Washington, DC 20555-0001

Attention: Pierre Saverot, Project Manager Licensing Branch

Subject: AOS Response to the NRC Request for Additional Information for the review of the Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S Packages

Reference: Amendment Request to Certificate of Compliance No. 71-9316

Application "AOS Radioactive Material Transport Packaging System Safety Analysis Report, No. AOS-FM9054 Revision G dated July 27, 2012

Docket No. 71-9316 and TAC No. L24677

Mr. Saverot.

Alpha-Omega Services, Inc. (AOS) thanks the NRC Licensing Branch and staff for the review of the referenced application and the Request for Additional Information provided in your letter dated October 31, 2012. AOS has reviewed the RAI and has provided our response to each of the requests, per the attached document.

We hope that the preceding is in accordance with your understanding. Should you have any questions, please feel free to contact us.

Best Regards,

Troy Hedger, President

Alpha-Omega Services, Inc.

Enclosures: RAI Responses, SAR Rev H, Matrix of SAR Rev H updates, Certificate Drawings and Affidavit to withhold information (1 - Hard Copy, 2 - Thumb Drives)

cc: US NRC Document Control Desk: RAI Responses, SAR Rev H, Certificate Drawings and Affidavit to withhold (1 - Hard Copy)

9156 Rose Street ● P.O. Box 789 ● Bellflower, California, U.S.A 90706
Customer Service (800) 346-7894 ● (562) 804-0604 ● Fax: (562) 804-0610 ● www.alpha-omegaserv.com

Chapter 1 – General Information

Licensing Drawings and Bill of Materials

1-1 Identify the specific changes that were made to the certificate drawings. Provide a table specifying which drawings were changed, which changes were made, and the justification for the change.

The application noted that changes to the drawings were a result of the inclusion of the cask lid elastomeric seal; the addition of a different metal alloy for certain components due to the procurement limitation of the originally selected alloys; minor dimension changes; and the reconfiguration of the central plug of the axial shielding plate for the AOS-100 model. Upon initial review, staff also identified changes due to adding or deleting items, such as those in certificate drawings 105E9722, 105E9711, and 183C8491. A complete understanding of the changes to the certificate drawings and any potential safety-significance of those changes is needed for staff to complete their review.

This information is required by staff to determine compliance with 10 CFR 71.33(a) and 71.35(a).

The changes depicted in these drawings are primarily due to fabrication operations and to reply to the current RAI's. Changes have been color coded for easy identification. Red represents the changes made at the time the submittal was made for approval, July 27, 2012. Orange are changes made post the July submittal, but not submitted to the NRC. And green are those changes made to respond to the current RAIs. The Tables below summarize the changes; and their individual justifications and are also color coded, accordingly.

TABLE OF CHANGES – AOS Transport Packaging AOS-025A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
166D8142 Rev. G	SHEET 1 NOTE 1	INTERCHANGE ABILITY	INTERCHANGEABILITY	Spelling correction.
105F9722 Rev. F	SHEET 1 NOTE 1	OTHERSWISE	OTHERWISE	Spelling correction.
	SHEET 1 NOTE 5		Revised Sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEMS 12 & 19 QTY	16	8	Component re-designed for easy of fabrication from three sub-components to one integral one.
	SHEET 1 PART LIST, ITEMS 21 & 22		DELETED The details of these changes are not shown in red on the new drawings.	Components integrated into Items 12 & 19.
	SHEET 2 ITEMS 12 & 19		Re-drawn to show the re-designed Component	Depiction of re-designed component.
	SHEET 2 ITEM 12, TACK WELD SYMBOL		REMOVED	Re-design of component.

TABLE OF CHANGES – AOS Transport Packaging AOS-025A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
	SHEET 2 G001 & G002	15^0 Dimension 3X Dia. .63 Eq. Sp. PM Ø9.00 BC	DELETED 4X Dia 2.00 Eq. Sp. PM Ø9.00 BC (Note: Dwg states "3X")	Double dimensioning with "… EQ.SP…" Note: Holes relocated to centerline; changed to Qty (4)
166D8143 Rev. F	SHEET 1 NOTE 1	INTERCHANGE ABILITY	INTERCHANGEABILITY	Spelling correction.
	SHEET 1 NOTE 5		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEMS 8 & 15 MATERIAL		Added optional Standard for mechanical properties	Availability of material in current market.
	SHEET 1 PART LIST		Added ITEM 29	Addition of elastomeric Cask Lid seal as an option.
	SHEET 2 DETAIL C		ITEMS 9, 18 & 20 changed location	Organization of the drawing layout.
	SHEET 2 DETAIL G	SEE DETAIL H FOR LID SEALS	SEE DETAIL - H & N FOR LID SEALS	Addition of elastomeric Cask Lid seal as an option.
	SHEET 2 DETAIL H	GARLOCK HELICOFLEX	TECHNETICS GROUP-COLUMBIA	To incorporate name change by seal fabricator.
	SHEET 2 DETAIL J		Detail relocated within the drawing	Organization of the drawing layout.
	SHEET 2 DETAIL K		View and Item balloon were reorganized for clarity	Organization of the drawing layout.
	SHEET 2 DETAIL L		Dimension Ø4.65 was relocated Item 21 relocated	Organization of the drawing layout.
	SHEET 2 SECTION M-M		Dimension .48 was relocated	Organization of the drawing layout.
	SHEET 2 DETAIL N		New detail added	Addition of elastomeric Cask Lid seal as an option.
	SHEET 2 DETAIL C		Callout for items 9, 18 and 20 moved	To improve drawing clarity
183C8485 Rev. E	SHEET 1 NOTE 2	KG; LB	kg; lb	To correct designation
	SHEET 1 NOTE 4	LB; KG	lb; kg	To correct designation
	SHEET 1 Item 1	TUNGSTEN ALLOY	TUNGSTEN ALLOY ATI DENSALLOY ® SD 180 PER AMS-T-21014 CLASS 3	To improve availability of material in current market
	SHEET 1 Item 2	COVER TUNGSTEN ALLOY	TOP COVER TUNGSTEN ALLOY ATI DENSALLOY ® SD 180 PER AMS-T-21014 CLASS 3	To correct part description To improve availability of material in current market
	SHEET 1 Item 3	TUNGSTEN ALLOY	TUNGSTEN ALLOY ATI DENSALLOY ® SD 180 PER AMS-T-21014 CLASS 3	To improve availability of material in current market
	SHEET 1 Item 4	COVER TUNGSTEN ALLOY	BOTTOM COVER TUNGSTEN ALLOY ATI DENSALLOY ® SD 180 PER AMS-T-21014 CLASS 3	To correct part description To improve availability of material in current market
	SHEET 2 PART 2	Ø .500	Ø .500 +.00000, -.00007	Tolerance for Clearance Fit
	SHEET 2 SECTION A-A	PART 2 Ø.500	CLEARANCE FIT Ø .500 +.00000, -.00007 PART 4 INTERFERENCE FIT	To improve fit-up of components
	SHEET 2 ZONE A-2		Added Part 4 Detail	To clarify dimensional characteristics

TABLE OF CHANGES – AOS Transport Packaging AOS-050A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9718 Rev. G	SHEET 2, ITEM 10		INCREASED VIEW SIZE	To improve view.
	SHEET 2, ITEM 11		INCREASED VIEW SIZE	To improve view.
	SHEET 2, ITEM 11	n 5/8"	Ø 5/8"	To correct typographical error.
	SHEET 2, ZONE C1 DIM.	(19.16)	(19.22)	To correct dimensional error.
	SHEET 2, ZONE E3 DIM.	(5.12) Clearance	(5.01) Clearance	To correct dimensional error.
166D8137 Rev. F	SHEET 1 NOTE 6		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEM 8	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500 OR 4602	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM15	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500 OR 4602	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 29		Added ITEM 29, an elastomeric seal.	To include an optional lid seal type.
	SHEET 2 ZONE A-1/2		ADDED DETAL I	To add an elastomeric Cask Lid seal as an alternative.
	SHEET 2 DETAIL G	SEE DETAIL H FOR LID SEALS	SEE DETAIL H & I FOR LID SEALS	To include DETAIL I as an alternative Cask Lid seal.
	SHEET 2 DETAIL J		Relocated DETAIL view	To gain space to include DETAIL I.
	SHEET 2 DETAIL H	GARLOCK HELICOFLEX	TECHNETICS GROUP-COLUMBIA	To incorporate name change by seal fabricator.
166D8138 Rev. F	SHEET 1 NOTE 3		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEM 17			Revision flag F added in error since there is no change to Material call out.
	SHEET 1 PART LIST, ITEM 18	300 SERIES STAINLESS STEEL	300 SERIES STAINLESS STEEL MUNCY PART No. 40025050	To identify new vendor component selection.
	SHEET 1 PART LIST, ITEM 19	300 SERIES STAINLESS STEEL	300 SERIES STAINLESS STEEL MUNCY PART No. 40025050	To identify new vendor component selection.
	SHEET 2 DETAIL C	TOP DIMENSION 9.86	TOP DIMENSION 9.53	To correct dimensional error.
	SHEET 2 DETAIL D	TOP DIMENSION 8.35	TOP DIMENSION 8.29	To correct dimensional error.
	SHEET 2 DETAIL E	TOP SPECIFICATION "6X19 IWRC WIRE ROPE"	TOP SPECIFICATION "7X19 IWRC WIRE ROPE" Ø .25 Depth .75 .13 x 45° .05 x 60° .82 1.38	To match current market conditions. DETAIL E was moved to improve clarity. 4 new dimensions added. Note: Ø .25 Should be Ø .125

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9711 Rev. G	SHEET 1, ITEM 5	ALUMINUM AMS 4025,AMS 4027, OR AMS-QQ-A-250/11 TYPE 6061-T651 OF T62	ASME SA-240/ASTM A240 TYPE 304 OR 316;ASME SA-479/ASTM A479 TYPE 304 OR 316; ASTM A554 TYPE 304; ASME SA312/ASTM A312 TYPE;ASME SA-182/ASTM A182 TYPE F304	To correct designation and improve availability of material in current market.
	SHEET 1, ITEM 6	CRADLE, TOP ALUMINUM AMS-4144F ALLOY 2219 T851; TURNBUCKLE ITEM 4	CRADLE, TOP ASME SA-240/ASTM A240, TYPE XM-19	To correct designation and improve availability of material in current market.
	SHEET 1 ITEM 7		TUNGSTEN ATI DENSALLOY SD 180 PER AMS-T-21014 CLASS 3	Material designation not shown on Rev. F
	SHEET 1 ITEM 9	FRAME: ASME SB-221, ALLOY A96061, TEMPER T6 MESH:ASME SA-240/ASTMA240, TYPE 304 STAINLESS STEEL	FRAME: ASME SB209, OR SB-221, ALLOY 6061, TEMPER T6 MESH:ASME SA-240/ASTM A240, TYPE 304 STAINLESS STEEL	To correct designation and improve availability of material in current market.
	SHEET 1 ITEM 11	HEX NUTS 1/2"-13 UNC	DELETED This ITEM functionality was incorporated into ITEM 5	To improve handling operations by fork truck.
	SHEET 2 ZONE E7	61.08	(60.96)	To provide better estimate of referenced dimension.
	SHEET 2 ZONE C8		Added overall height dimension of (71.65)	To provide additional detailed information.
	SHEET 2 ZONE C8	HEIGHT OF TURNBUCKLE (38.77)	HEIGHT OF TURNBUCKLE (38.85)	To provide better estimate of referenced dimension.
	SHEET 2 ZONE B6	8.47	8.75	To reflect change from a "T" cross section to a fabricated “Tee” section using 2L cross sections to form a "T."
	SHEET 2 ZONE B6	3.54	3.48	To reflect change from a "T" cross section to a fabricated “Tee” section using2L cross sections to form a "T."
	SHEET 2 ZONE E5	61.08	(60.96)	To provide better estimate of referenced dimension.
	SHEET 2 ZONE B4	12.54	12.48	To create a better distribution of bolted joints, improving fabrication.
	SHEET 2 ZONE D1	3.71	3.66	To provide better estimate of referenced dimension.
	SHEET 2 DETAIL A	AISC STRUCTURAL TEE 4X 20 (DIMENSIONS 4.13, .56, 8.07, .36 AND .25)	TWO FABRICATED ANGLES (DIMENSIONS 4.00, .50, 8.00, 1.00 AND .24)	To provide new dimensions due to the structural cross section change From a structural to a fabricated component. Refer to ATTACHMENT A for Moment of Inertia Calculations.
105E9712 Rev. F	SHEET 1 NOTE 5		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEM 30	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500 OR 4602	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 31	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION	To improve availability of material in current market.

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
		F68 AND MECHANICAL PROPERTY PER AMS 4500	PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500 OR 4602	
	SHEET 1 PART LIST, ITEM 34		Added ITEM 34, an elastomeric seal.	To include an optional lid seal type.
	SHEET 2 ZONE B1		ADDED DETAIL H	To add an elastomeric Cask Lid seal as an alternative.
	SHEET 2 ZONE F7	SEE DETAIL N FOR LID SEALS	SEE DETAIL N & H FOR LID SEALS	To include DETAIL H as an alternative Cask Lid seal.
	SHEET 2 DETAIL J		Deleted reference to DETAIL N	To correct double notation with DETAIL G.
	SHEET 2 DETAIL K		Relocated DETAIL view	To gain space to include DETAIL H.
	SHEET 2 DETAIL N	GARLOCK HELICOFLEX	TECHNETICS GROUP-COLUMBIA	To incorporate name changed by seal fabricator.
	SHEET 3 ZONE A1		ADDED Detail BB-BB	To add an elastomeric Cask Lid seal as an alternative.
	SHEET 3 ZONE F7	SEE DETAIL W FOR LID SEALS	SEE DETAIL W & BB-BB FOR LID SEALS	To include DETAIL BB-BB as an alternative Cask Lid seal.
	SHEET 3 DETAIL X		Deleted reference to DETAILW	To correct double notation with DETAIL V.
	SHEET 3 DETAIL Y		Relocated DETAIL view	To gain space to include DETAIL BB-BB.
	SHEET 3 DETAIL W	GARLOCK HELICOFLEX	TECHNETICS GROUP-COLUMBIA	To incorporate name change by seal fabricator.
105E9713 Rev. F	SHEET 1 NOTE 5		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEM 17	300 SERIES STAINLESS STEEL 6X19 IW RC	300 SERIES STAINLESS STEEL 7X19 IW RC	To match current market conditions.
	SHEET 1 PART LIST, ITEM 18	300 SERIES STAINLESS STEEL ESCO PART NO. 4057258	300 SERIES STAINLESS STEEL MUNCY PART No. 40025050	To match current market conditions.
	SHEET 1 PART LIST, ITEM 19	300 SERIES STAINLESS STEEL ESCO PART NO. 4057258	300 SERIES STAINLESS STEEL MUNCY PART No. 40025050	To match current market conditions.
105E9719 Rev. F	SHEET 1 NOTE 5		Revised sub-note (b)	Identified applicable ASME Code year and addenda.
	SHEET 1 PART LIST, ITEM 30	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500 OR 4602	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 31	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152; OR CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	To improve availability of material in current market.

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
			OR 4602	
	SHEET 1 PART LIST, ITEM 34		Added ITEM 34, an elastomeric seal.	To include an optional lid seal type.
	SHEET 2 ZONE A1		ADDED DETAIL LL	To add an elastomeric Cask Lid seal as an alternative.
	SHEET 2 DETAIL G	SEE DETAIL N FOR LID SEALS	SEE DETAIL N & LL FOR LID SEALS Note: DWG shows "H", correct to "L-L"	To include DETAIL H as an alternative Cask Lid seal.
	SHEET 2 DETAIL J		Deleted reference to DETAIL N	To correct double notation with DETAIL G.
	SHEET 2 DETAIL K		Relocated DETAIL view	To gain space to include DETAIL LL.
	SHEET 2 DETAIL LL	GARLOCK HELICOFLEX	TECHNETICS GROUP-COLUMBIA	To incorporate name change by seal fabricator.
183C8491 Rev. F	SHEET 1, PART LIST, ITEM 2	LINER PLATE	CENTRAL PLUG	To incorporate the ITEM name change to one that better describes its functionality.
	SHEET 1, PART LIST, ITEM 5		SHIELDING SCREW	To add a new central plug and shielding plug; this allows for an additional way to attach to the content baskets.
	SHEET 1, PART LIST, ITEM 6		CENTRALPLUG, OPTION	To add a new central plug and shielding plug; this allows for an additional way to attach to the content baskets.
	SHEET 2, DETAIL G		Added DETAIL G ITEM 5	To add a new central plug and shielding plug; this allows for an additional way to attach to the content baskets.
	SHEET 2, SECTION I - I		Added SECTION I – I ITEM 6 CENTRAL PLUG, OPTION	To add a new central plug and shielding plug; this allows for an additional way to attach to the content baskets.
	SHEET 2, DETAIL B	1.000 1.50	1.00 MIN 1.50 MIN Relocated detail view Added M12x1.75-6H by .75 deep	To gain space to include DETAIL G and SECTION I – I
	SHEET 2, ZONE D-3		Added ITEM 5 SEE DETAIL G	Clarity

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
183C8491 Rev. G	SHEET 1, PART LIST, ITEM 7		ITEM WAS ADDED	This allows for an additional method to attach the content baskets
	SHEET 2, DETAIL G, SECTION H-H	M12x1.75-6g	3/8-16 UNC-2A	To provide the component in English units for domestic users.
	SHEET 2, SECTION J-J, ITEM 7		ITEM WAS ADDED	To show detail
	SHEET 2, DETAIL B	M12x1.75-6H .75 DEEP	3/8-16 UNV-2A .75 DEEP (OR) M12x1.75-6H .75 DEEP	To provide the component in English units for domestic users
	SHEET 2, SECTION I-I	Ø .63	Ø .65	To correct error
105E9712 Rev. G	SHEET 2, DETAIL L	Ø .81	Ø .94	To correct error.
			ADDED # SIGN BEFORE THE SCREW SPECIFICATION	To clarify the information given.
	SHEET 3 DETAIL Z	Ø .81	Ø .94	To correct error.
			ADDED # SIGN BEFORE THE SCREW SPECIFICATION	To clarify the information given.
105E9719 Rev. G	SHEET 2, DETAIL L	Ø .81	Ø .94	To correct error.
			ADDED # SIGN BEFORE THE SCREW SPECIFICATION	To clarify the information given.

TABLE OF CHANGES – AOS Transport Packaging AOS-025A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9722 Rev. G	SHEET 2 SECTION A-A	PLASTIC	PLATICS	Spelling correction.
	SHEET 2 BOTTOM VIEW G001	3X	4X	Correct error.
	SHEET 2 DETAIL B	0.05	0.048	Correct error.
166D8142 Rev. H	SHEET 1 PART LIST, ITEM 4	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T651 OR T62	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T6-TYPE TEMPERS; SB-209 AND SB-211 ALLOY 6061 T6-TYPE TEMPERS	To improve availability of material in current market
	SHEET 1 PART LIST, ITEM 7	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T651 OR T62	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T6-TYPE TEMPERS; SB-209 AND SB-211 ALLOY 6061 T6-TYPE TEMPERS	To improve availability of material in current market
	SHEET 2 ZONE D-3	4 in.	4 ft	To correct designation
	SHEET 2 LEFT VIEW AND SECTION B-B		ADDED STRAP RATCHET MECHANISM	To provide complete information.
166D8143 Rev. G	SHEET 1, NOTE 14		ADDED NOTE 14: "APPLY THREAD SEALANT LOCTITE No. 5770 TO THREAD PRIOR TO INSTALLATION"	To enhance the sealing capability of pipe threads.
	SHEET 1, ITEM 15	PORT PLUG SEAL	PORT PLUG SPACER	To better describe Item functionality
	SHEET 1 PART LIST, ITEM 8	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM15	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 2 VIEW S-S		ADDED DETAIL	To provide complete information
	SHEET 2, ZONE C1	¼-28 UNF – 2A THREADS CONFORM TO ANSI B1 20.3	¼-28 UNF – 2A THREADS CONFORM TO ANSI B1 20.3 TORQUE 84 IN-LBS (LUB) AT INSTALLATION	
	SHEET 2 DETAIL E	REFERENCE TO NOTE 13	DELETED REFERENCE TO NOTE 13	To correct error.
	SHEET 2, ZONEC/D5	10.32 (CAVITY)	DELETED	
	SHEET 2, DETAIL L	(Ø .041 HOLE THRU) REF	(Ø .031 HOLE THRU) REF	
	SHEET 2, DETAIL N	SEAL CONFIGURATION; TWO O-RINGS AND TWO METAL RINGS	Seal configuration changed to two O-Rings and one metal ring	To improve seal design for its small configuration.
	SHEET 2,		ADDED DETAIL	To provide complete information

TABLE OF CHANGES – AOS Transport Packaging AOS-025A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
	DETAIL R			
	SHEET 2 DETAIL H		ADDED .250 DIMENSION	To provide complete information. .
	SHEET 2 SECTION B-B		ADDED ADDITIONAL TEXT "SEE DETAIL D FOR WELD JOINT OPTION"	
	SHEET 2 DETAIL R		ADDED DETAIL	
	SHEET 2 SECTION M-M		PROVIDED ADDITIONAL DIMENSIONS AND COMMENTS	
	SHEET 2 DETAIL N		CHANGED VARIOUS DIMENSIONS	
183C8485 Rev. F	SHEET 1 NOTE 2	6	6.6	To provide complete information.
	SHEET 2, PART LIST, ITEM 2		ADDED THE LABEL "TOP COVER"	
	SHEET 2, PART LIST, ITEM 3		ADDEDTHE LABEL 'SCREW"	
	SHEET 2, PART LIST, ITEM 4		ADDED LABEL "BOTTOM COVER"	
	SHEET 2 SECTION A-A		ADDED ITEM NUMBER 3, 2X	

TABLE OF CHANGES – AOS Transport Packaging AOS-050A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9718 Rev. H	SHEET 1, NOTE 5		Triangle symbol removed from around "5"	To correct error.
	SHEET 1, NOTE 9		ADDED TRIANGLE SYMBOL	To correct error.
	SHEET 1 PART LIST, ITEM 4 ITEM 6 ITEM 7	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T651 OR T62	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T651 OR T62; SB-209 AND SB-211 ALLOY 6061 T651 OR T62	To improve availability of material in current market
	SHEET 1 PART LIST, ITEM 5	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T651 OR T62	ALUMINUM AMS 4025, AMS 4027, OR AMS QQ-A-250/11 TYPE 6061-T6-TYPE TEMPERS; SB-211 ALLOY 6061 T6-TYPE TEMPERS (STRUCTURAL); ASME SB-209 3003 (EXPANDED METAL)	To improve availability of material in current market
	SHEET 2, ISOMETRIC VIEW		ADDED ADDITIONAL ITEMS	To provide additional details.
	SHEET 2, VIEWS LEFT, CENTRAL AND SECTION B-B		CHANGED SEVERAL DIMENSIONS	To match analytical model presented in paragraph 2.5.3.1.3, "Analysis of Shipping Cage Fasteners – AOS-050."
	SHEET 2, ZONE E3	(5.01) CLEARDENCE	(4.37) CLEARDENCE	To correct dimensional error.
	SHEET 2, SECTION B-B	REFERENCE SYMBOL NOTE 5	DELETED	To correct error.

TABLE OF CHANGES – AOS Transport Packaging AOS-050A				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
166D8137, Rev. G	SHEET 1 PART LIST, ITEM 8	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 15	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152.	To improve availability of material in current market.
	SHEET 1, PART LIST, ITEM 15	PORT PLUG SEAL	PORT PLUG SPACER	To better describe Item functionality
	SHEET 2, ZONE C1	3/8-24 UNF – 2A THREADS CONFORM TO ANSI B1 20.3	3/8 - 24 UNF – 2A THREADS CONFORM TO ANSI B1 20.3 TORQUE 288 lb-in (32.54 N-m) (LUB) AT INSTALLATION	To provide complete information.
	SHEET 2, SECTION M-M		ADDED COMMENT "SEE DETAIL R FOR GROOVE"	To provide complete information
			ADDED ADDITIONAL DIMENSIONS	
		0.35	DELETED	
	SHEET 2, DETAIL H		ADDED .335 DIMENSION	
	SHEET 2, DETAIL I		ADDED .371 DIMENSION	
		Ø5.75	Ø5.754 ID	
		Ø5.86	Ø5.920	
		Ø6.25	Ø6.250	
		Ø6.31	Ø6.353	
			Ø6.456 OD	
	SHEET 2, DETAIL R		ADDED DETAIL	
	SHEET 2 VIEW S-S		ADDED DETAIL	
166D8138, Rev. G	SHEET 1 PART LIST, ITEM 12	PLASTIC	PLASTICS	To correct error.
	SHEET 2 SECTION A-A	PLASTIC	PLASTICS	To correct error.

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9711 Rev H	SHEET 1 ITEM 9	"…TEMPER T6…"	"…T6 – TYPE TEMPERS…"	To correct designation and improve availability of material in current market.

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
105E9712 Rev. H	SHEET 1 PART LIST, ITEM 30	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 31	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 2 SECTION M-M		ADDED COMMENT “SEE DETAIL CC FOR GROOVE”	To provide complete information. .
			ADDED Ø12.899 AND Ø11.445 DIMENSIONS	
		0.727 AND 0.12	DELETED THESE DIMENSIONS	
	SHEET 2 DETAIL N		ADDED .667 DIMENSION	
		0.156	Ø.095	To correct error.
	SHEET 2 DETAIL H		ADDED (.653) DIMENSION	To provide complete information.
		Ø11.54	Ø11.538 ID	
		Ø11.644	Ø11.914	
		Ø12.702	Ø12.704	
			Ø12.843 OD	
		Ø.073	Ø.093	To correct error.
	SHEET 2 DETAIL K	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3 TORQUE: 230 lb-ft. (25.98 N-m) (LUB) AT INSTALLATON	To provide complete information
	SHEET 2, DETAIL CC		ADDED DETAIL	To provide complete information. .
	SHEET 2, VIEW EE-EE		ADDED DETAIL	
	SHEET 2, DETAIL J	GROVE	GROOVE	To correct misspelled word
	SHEET 2, DETAIL D	CAST	CASK	
	SHEET 3, SECTION AA-AA		ADDED COMMENT “SEE DETAIL DD FOR GROOVE”	*To provide complete information.* .
			ADDED Ø12.899 DIMENSION	
			ADDED Ø11.445 DIMENSION	
		0.727 AND 0.12	DELETED THESE DIMENSIONS	
	SHEET 3, DETAIL W		ADDED (.667) DIMENSION	
		0.156	Ø.095	
	SHEET 3, DETAIL BB-BB		ADDED DETAIL	
		Ø11.54	Ø11.538 ID	
		Ø11.644	Ø11.914	
		Ø12.702	Ø12.704	
			Ø12.843 OD	

TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
		Ø.073	Ø.093	
	SHEET 3. DETAIL DD		ADDED DETAIL	
	SHEET 3, VIEW FF-FF		ADDED DETAIL	
	SHEET 3 DETAIL Y	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3 TORQUE: 230 lb-ft. (25.98 N-m) (LUB) AT INSTALLATON	To provide complete information
	SHEET 3, DETAIL S	CAST	CASK	To correct misspelled word
105E9713 Rev. G	SHEET 2 SECTION A-A	PLASTIC	PLASTICS	To correct misspelled word
		0.105	.109 (IN 7 PLACES)	To correct error.
105E9719 Rev. H	SHEET 1 PART LIST, ITEM 30	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	. To improve availability of material in current market.
	SHEET 1 PART LIST, ITEM 31	C10100, C10200 OR C11000 COPPER , FOIL OR STRIP, CHEMICAL COMPOSITION PER ASTM B152 OR ASTM F68 AND MECHANICAL PROPERTY PER AMS 4500	C10100, C10200 OR C11000 COPPER - FOIL, SHEET, STRIP, PLATE OR ROLLED BAR, ASME SB-152	To improve availability of material in current market.
	SHEET 2 SECTION M-M		ADDED COMMENT "SEE DETAIL R FOR GROOVE"	To complete information.
			ADDED Ø12.899 AND Ø11.445 DIMENSIONS	
		0.727 AND 0.12	DELETED	
	SHEET 2 DETAIL N		ADDED (.667) DIMENSION	
	SHEET 2 DETAIL H		ADDED (.653) DIMENSION	
		Ø11.54, Ø11.644 AND Ø12.702	CHANGED TO Ø11.538, Ø11.914 AND Ø12.704	
			ADDED Ø12.843 OD DIMENSION	
		Ø.073	Ø.093	To correct error.
		"L-L"	CORRECTED LABEL "H"	
	SHEET 2 DETAIL R		ADDED DETAIL	To complete information.
	SHEET 2 DETAIL K	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3	1-12 UNF-2A THREADS TO CONFORM TO ANSI B1.20.3 TORQUE: 230 lb-ft. (25.98 N-m) (LUB) AT INSTALLATON	To provide complete information
	SHEET 2, DETAIL J	GROVE	GROOVE	To correct misspelled word
	SHEET 2, DETAIL L	4X 2-56 UNC – 2BX.13DP CSK DIA.16 X 82° EQ SP ON DIA 12.172 BC FS	4X 2-56 UNC – 2BX.13DP EQ SP ON DIA 12.172 BC FS	To correct error.
	SHEET 2,		ADDED DETAIL	To complete information.

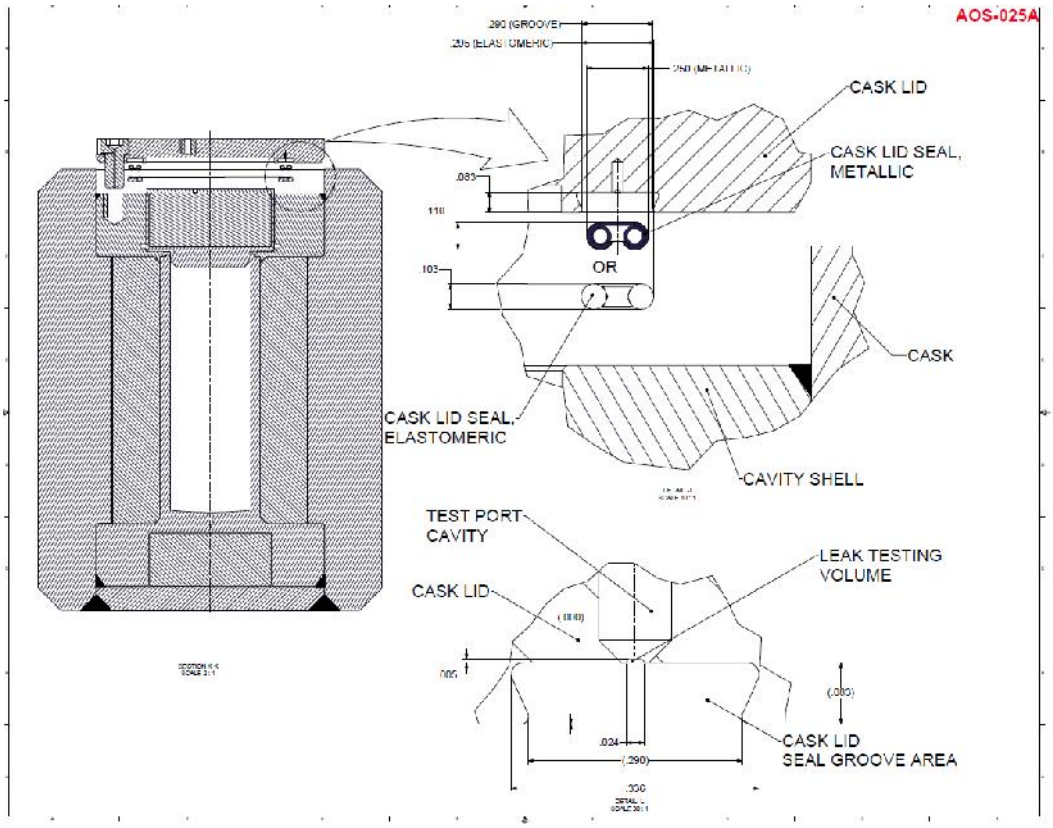
TABLE OF CHANGES – AOS Transport Packaging AOS-100				
DRAWING NO.	ITEM	CHANGES		JUSTIFICATION
		BEFORE	NOW	
	VIEW S-S			
	SHEET 2, DETAIL D	CAST	CASK	To correct misspelled word

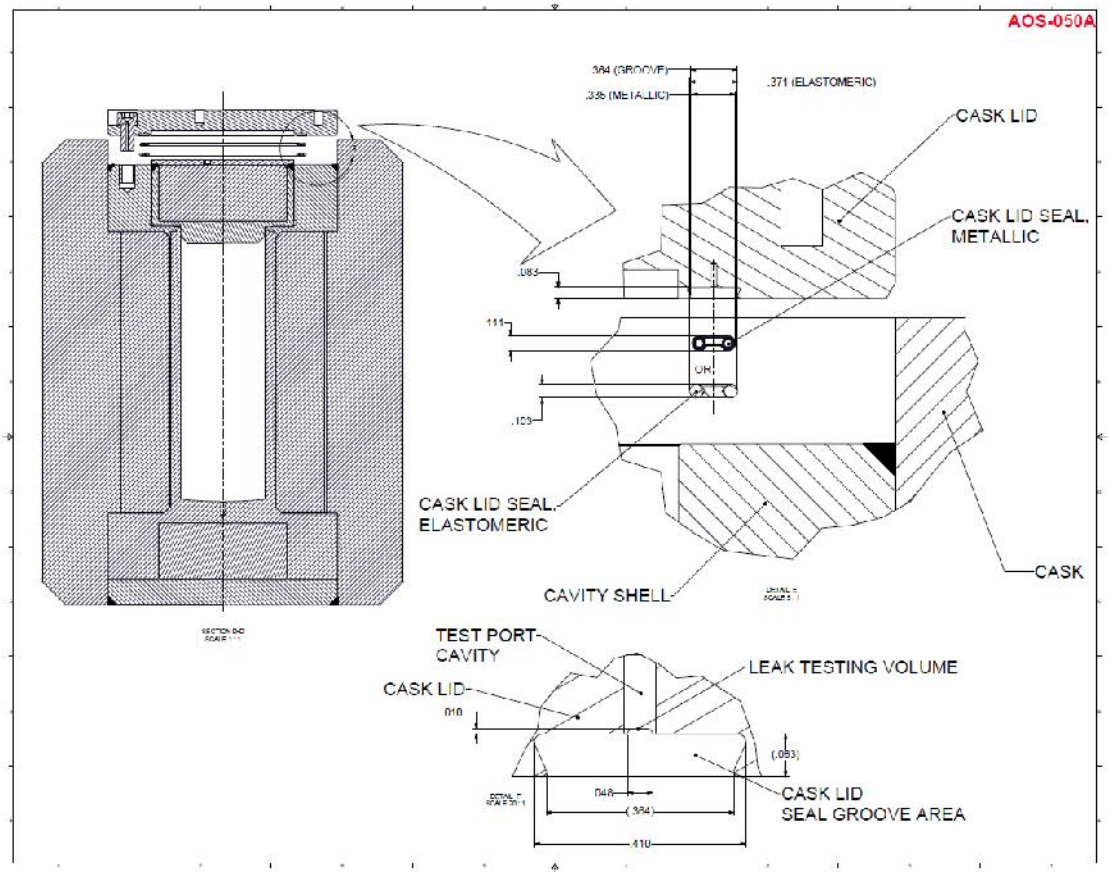
1-2 Clarify on the licensing drawings how the lid seals, including the metallic and the new elastomeric lid seal design fit in the lid seal groove shown on the licensing drawings. Also clarify on the licensing drawings the lid seal groove location on the lid by providing the inner and outer diameter of the lid seal groove, as well as specifications for straightness, roundness, flatness, and surface finish for the lid seal groove. Also provide complete design details and drawings for the new elastomeric lid seal design.

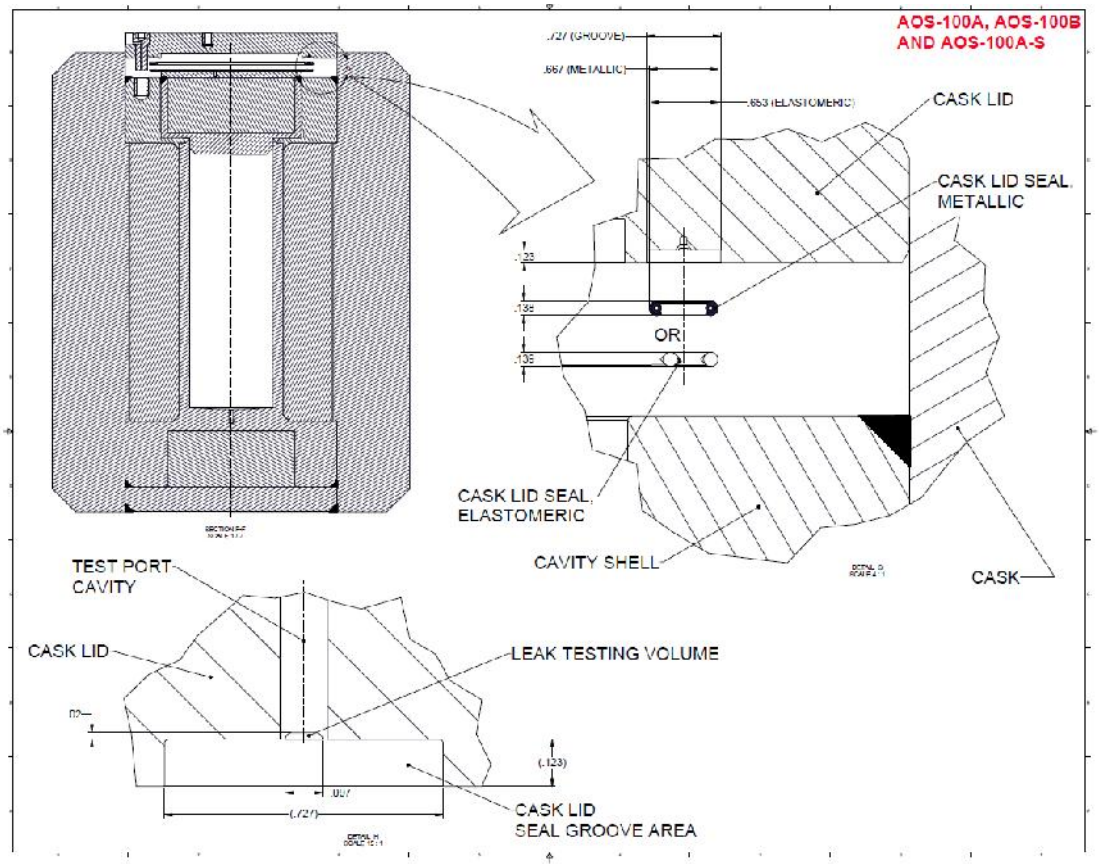
On licensing drawings 166D8143 (Section M-M compared to Details H and N), 166D8147 (Section M-M compared to Details H and I), and 105E9712 (Section M-M compared to Details H and N, and Section AA-AA compared to Details W and BB-BB), it appears that the width of the lid seal groove is significantly smaller than the dimension of the metallic seal and the dimension of the new elastomeric lid seal design and that lid seal groove would not be able to accommodate either the metallic seal or the new elastomeric lid seal design. Also the location and specifications of the lid seal groove has not been completely described on the licensing drawings. For the new elastomeric lid seal design, dimensions should be provided for the pseudo-groove materials as well as specifications for straightness, roundness, flatness, and surface finish, also ensure the materials for each individual component of the lid seal option have been completely described.

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

All seal types, elastomeric or metallic are designed to fit into the cask lid groove as shown in the sketches below. Drawings 166D8143, 166D8137, 105E9712 and 105E9719 will be revised to better illustrate this information. The geometry configuration of the model AOS-025A seal and AOS-050A grooves are different than that of the AOS-100, because their small sizes.


AOS-025A
.290 (GROOVE)
.295 (ELASTOMERIC)
.350 (METALLIC)
CASK LID
CASK LID SEAL, METALLIC
.085
.110
.103
OR
CASK
CASK LID SEAL, ELASTOMERIC
CAVITY SHELL
TEST PORT CAVITY
LEAK TESTING VOLUME
CASK LID
.005
.024
(.290)
CASK LID SEAL GROOVE AREA


AOS-050A
.384 (GROOVE)
.335 (METALLIC)
.371 (ELASTOMERIC)
CASK LID
CASK LID SEAL, METALLIC
.083
.111
OR
.103
CASK LID SEAL, ELASTOMERIC
CAVITY SHELL
CASK
TEST PORT CAVITY
CASK LID
.010
LEAK TESTING VOLUME
(.083)
.048
(.384)
.410
CASK LID SEAL GROOVE AREA

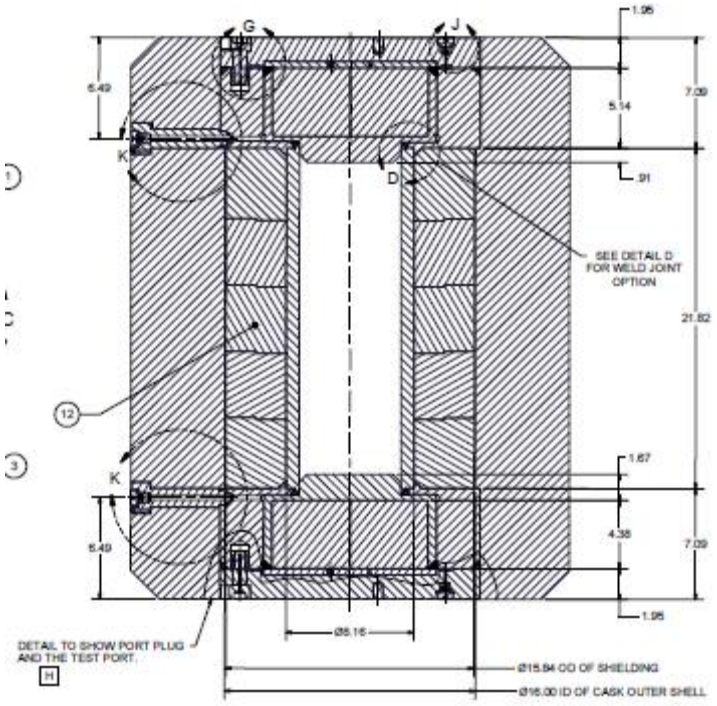

AOS-100A, AOS-100B AND AOS-100A-S
.727 (GROOVE)
.667 (METALLIC)
.653 (ELASTOMERIC)
CASK LID
CASK LID SEAL, METALLIC
.123
.135
OR
.135
CASK LID SEAL, ELASTOMERIC
CAVITY SHELL
CASK
TEST PORT CAVITY
CASK LID
.012
LEAK TESTING VOLUME
(.123)
.027
(.727)
CASK LID SEAL GROOVE AREA

1-3 On licensing drawing 105E9719, Rev. F, Section B-B, show the bottom lid seal test port that is illustrated in Detail J. This test port is shown on Section B-B for the top lid seal.

The current Section B-B does not show the bottom lid seal test port, but that test port is necessary for leak testing the bottom lid seal.

This information is required by staff to determine compliance with 10 CFR 71.33.

The bottom lid test port is identical to the top lid test port, as both of the lids are symmetrical. Drawing 105E9719, Sheet 2, SECTION B-B will be revised to show the test port detail in both lids as shown below:

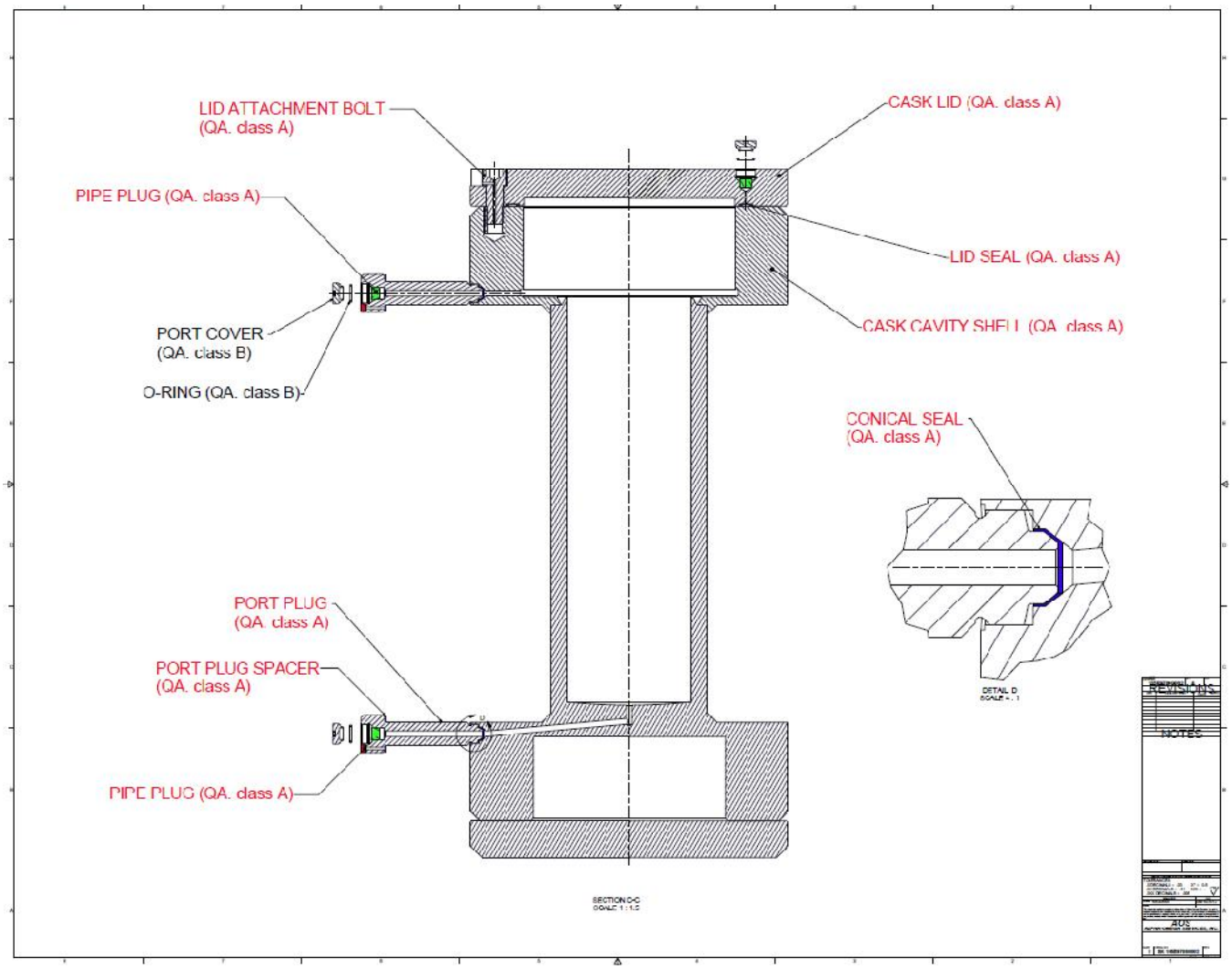


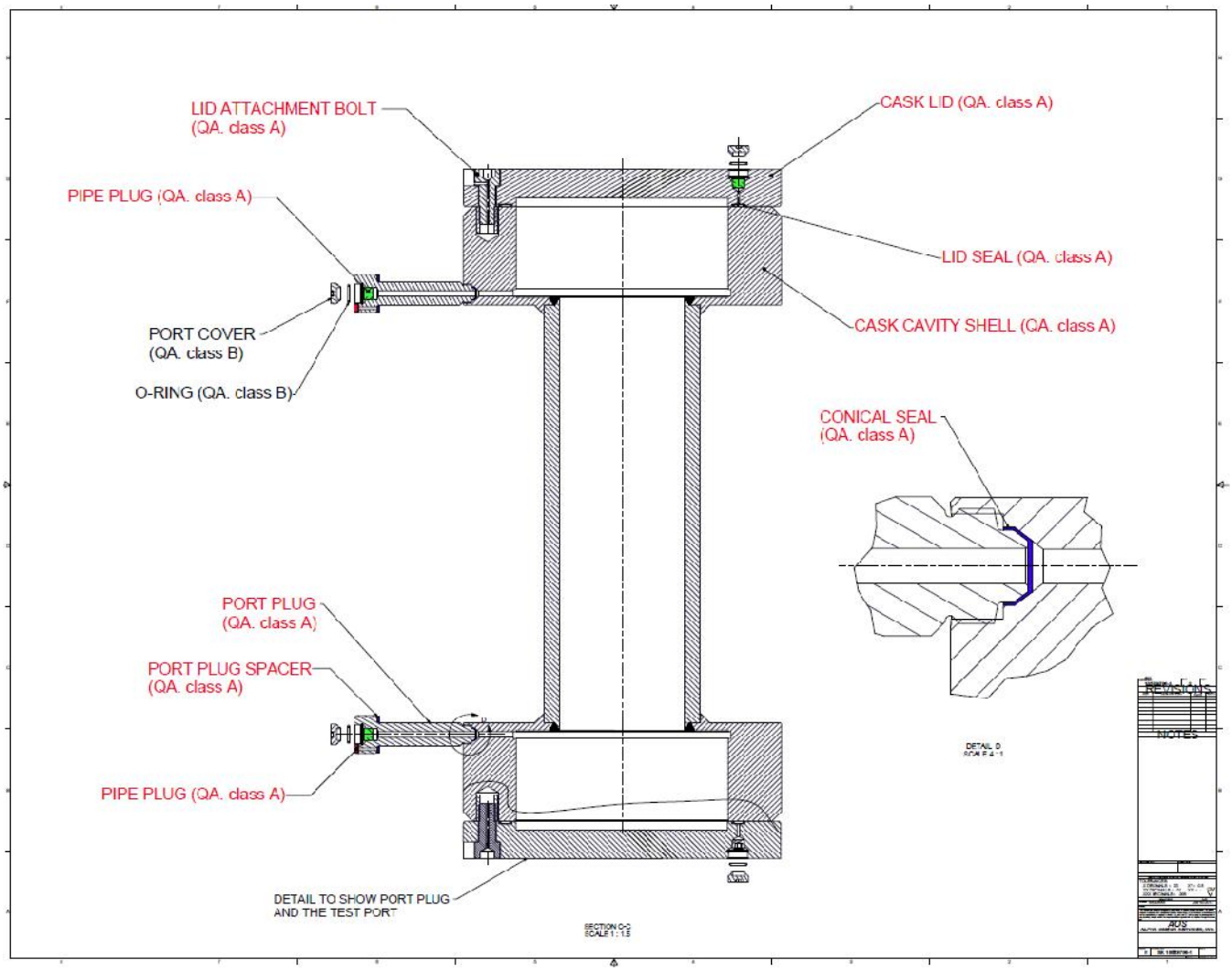
1-4 Revise the licensing drawings to ensure that all containment boundary components are Safety Classification A.

For example, on licensing drawing 166D8143, Rev. F, item numbers 27 and 28, the port cover and O-ring are category B components, but it appears to the staff that those components could potentially be part of the containment boundary. The response to RAI 4-1 should be used in the development of the response to this RAI.

This information is required by staff to determine compliance with 10 CFR 71.101 and 71.107.

The Safety Classification assigned all components of the containment boundary meet the requirements of NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety." The Figure below shows all components of the containment boundary and their Safety Classification as given in the Certification drawings. The Model AOS 100A and the Model AOS 100A-S are used to illustrate the boundaries. The components labeled in red are those components of the containment boundary.


LID ATTACHMENT BOLT
(QA. class A)
CASK LID (QA. class A)
PIPE PLUG (QA. class A)
LID SEAL (QA. class A)
CASK CAVITY SHELL (QA. class A)
PORT COVER
(QA. class B)
O-RING (QA. class B)
CONICAL SEAL
(QA. class A)
PORT PLUG
(QA. class A)
PORT PLUG SPACER
(QA. class A)
PIPE PLUG (QA. class A)
REVISIONS
NOTES


LID ATTACHMENT BOLT
(QA. class A)
CASK LID (QA. class A)
PIPE PLUG (QA. class A)
LID SEAL (QA. class A)
CASK CAVITY SHELL (QA. class A)
PORT COVER
(QA. class B)
O-RING (QA. class B)
CONICAL SEAL
(QA. class A)
PORT PLUG
(QA. class A)
PORT PLUG SPACER
(QA. class A)
PIPE PLUG (QA. class A)
DETAIL TO SHOW PORT PLUG
AND THE TEST PORT
DETAIL D
REVISIONS
NOTES

Chapter 2 – Materials Evaluation

2-1 Justify the unlimited use of the elastomeric seals based on the critical characteristics of the seals, including: compression and decompression characteristics over the operating temperature, springback adequacy, radiation resistance, and suitability for impact loads. Alternatively, define the useful life of the elastomeric seals for the AOS Transport Packaging System, considering the critical characteristics of the seals, expected and extreme operating temperatures, and maximum radiation exposure.

The elastomeric seals provide an essential safety function of the AOS Transport Packaging System, establishing and maintaining radioactive material containment.

In order to ensure that the containment boundary is maintained, degradation mechanisms must be appropriately addressed, such that the seals will be replaced before this safety function is compromised.

This information is required by the staff to determine compliance with 10 CFR 71.51(a).

It was never AOS's intention for unlimited use of the elastomeric seals. The proposed usage cycle is for replacement every year or every twelve usages whichever comes first. This proposed usage, assures that the physical properties of the seal material will not be affected by the operating environment due to the short usage period. Seals will also be inspected prior to use, to assure operating condition is maintained. The proposed usage cycle is added to Sub-section 4.1.2 of SAR's Chapter 4 as follow:

*"*The seal replacement schedule is as follows:

- Metallic Seal – Single use only.
- Elastomeric Seal – Once every twelve uses or every twelve (12) months, whichever comes first, or if damaged.
- 37° Conical Seal – Only when damaged. This…"

2-2 Clarify the dynamic testing requirements for the impact limiter foam formulation. Specify how many samples will be tested and what the strain rate will be. Reference an appropriate testing standard or clarify the applicability of ASTM D1621-10.

Dynamic testing of the impact limiter foam is needed to ensure that the formulation results in material properties that are consistent with the properties used in the impact limiter structural analysis. This testing will define the correlation between the material response during dynamic loading and the material response during quasi-static batch and pour acceptance testing. ASTM D1621-10 specifies a crosshead displacement rate required to maintain quasi-static loading conditions. Quasi-static loading conditions are not applicable to the dynamic loading of interest.

This information is required by staff to determine compliance with 10 CFR 71.51.

AOS is not testing at the quasi-static load rates listed in the specification. Instead, the test is performed at a controlled dynamic rate of 60 s^{-1}. This strain rate provides the proper data for verifying the dynamic performance of the material as used in the analysis. The designated test practices, the equipment used, and the data reduction, etc. are all consistent with ASTM D1621-10, but the rate is dynamic rather than static. Five (5) samples each were tested at each of the temperature values as required by the ASTM D1621-10 Standard. ***Note c*** *of Table 8-5, "LAST-A-FOAM FR3700 Series Foams – Testing Program," Chapter 8 of the SAR is revised to clarify the strain rate used during the test as follows:*

"The dynamic test shall be per ASTM D1621-10, and will follow the recommendation of this Standard, with the exception of the strain rate. The test will use a controlled dynamic strain rate of $60s^{-1}$. The values obtained from this test…"

Chapter 3 Thermal Evaluation

3-1 Provide the minimum and maximum allowable temperature limits for normal conditions of transport (NCT) and hypothetical accident conditions (HAC) for each material, including any adhesive if used that is part of the new elastomeric lid seal design.

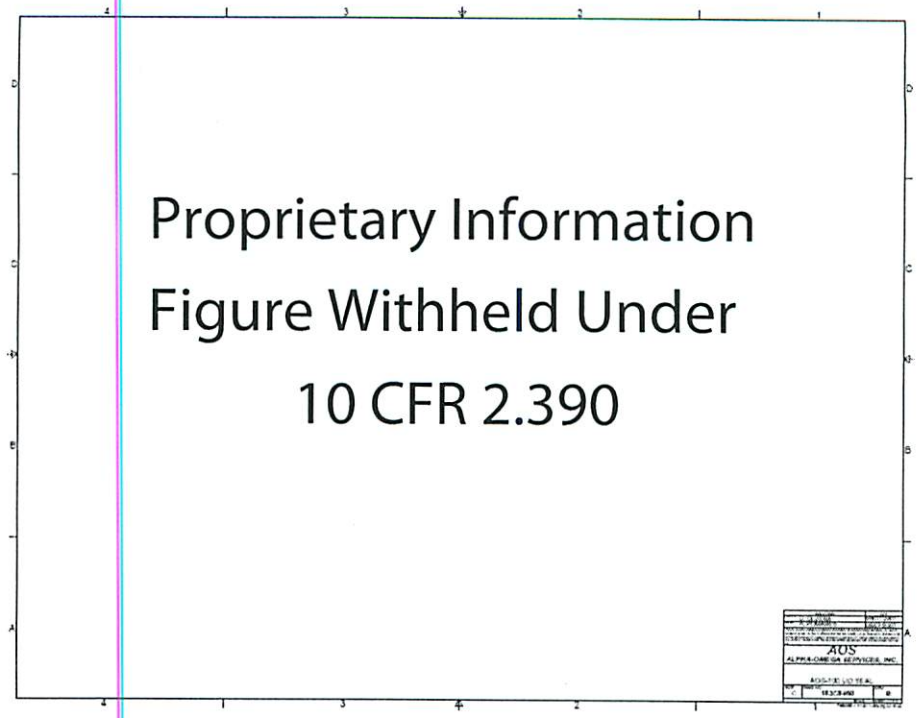
It is not clear from the licensing drawings how the new elastomeric lid seal has been assembled considering it is comprised of multiple materials. Allowable temperature limits for NCT and HAC for each material used in the new elastomeric lid seal design need to be provided for the staff to determine if the individual components of the new elastomeric lid seal design meet those limits. The staff acknowledges that minimum and maximum temperature limits have been provided in Chapter 3 of the SAR for the elastomeric seal material, but those limits may not be bounding for all materials that make up the new elastomeric lid seal design.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.71 and 71.73.

Tables 3-3 and 3-4 provide the maximum allowable temperature limits for NCT and HAC for each material of the elastomeric seal components. As described in paragraph 1.2.1.3, Chapter 1 of the SAR, Rev. G, there are only two components in the elastomeric cask lid seal design:

- ***O-Rings** – Silicone, Parker Compound S1224-70, ASTM D2000*
- ***Retainer Rings** – ASME SA-240/ ASTM A240, Type 304 or 316 Stainless Steel*

The O-rings are captured by the V-grooves on the side of the metal rings. In the case of the Models AOS -025 and AOS-050, one metal ring is used. In the case of the AOS-100 designs, two metal rings are used. No adhesives or additional materials are used. Drawings of the elastomeric cask lid seal for each package model will be included in Appendix 4.5.1 of the SAR, Rev. G. Below is the elastomeric seal drawing of the Model AOS 100 attached as a sample for illustration.



3-2 Provide the temperature of the AOS100A-S bottom lid seal by specifically performing a thermal analysis for the AOS100A-S package under NCT and HAC conditions, or only use metallic lid seals for the top and bottom lid seals of the Model No. AOS-100A-S package.

The thermal model for the AOS-100A-S does not model the bottom lid or lid seal design. The maximum NCT and HAC temperature limits of the elastomeric lid seal are significantly lower than the maximum temperature limits of the metallic lid seal. In order to ensure containment is maintained the staff suggests performing a complete thermal analysis of the AOS-100A-S package under NCT and HAC conditions. Alternatively, only use metallic lid seals for both the top and bottom lid seals of the AOS-100A-S package.

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

Section 3.3, "THERMAL EVALUATION UNDER NORMAL CONDITIONS OF TRANSPORT," of the SAR is revised to include the following discussion on the AOS-100A-S evaluation:

"The analytical model developed represents the standard configuration of the cask component (only the A version of the cask). Therefore, the Model AOS-100A-S was not analyzed. This approach is justified, based on the cask component symmetry, in geometry and material selection. The cask lid/cask lid plug combination is similar to the bottom area of the "A" version of the cask. Furthermore, when the cask vent port pipe plug (top of cask) and cask drain port pipe plug (bottom of cask) area temperature results on the "A" versions of the casks are compared, it can be concluded that these areas have similar temperature results in Normal and Hypothetical Accident conditions of transport environments."

Chapter 4 – Containment Evaluation

4-1 Draw the containment boundary in Figure 4-1 of the SAR to make a contiguous boundary that does not have any gaps. List all components that are part of the containment boundary in Section 4.1.1 of the SAR. Clarify if the inner or outer lid seals are part of the containment boundary in the metallic lid seal and new elastomeric lid seal design.

The staff notes that the containment boundary in Figure 4-1 stops at the lid inner seal and does not create a continuous boundary along the lid. There also appears to be multiple penetrations to the containment boundary that create gaps between components in the containment boundary. There should not be gaps in the containment boundary for the boundary to function properly. From Figure 4-1, it appears to staff the containment boundary components could potentially include the cask cavity shell, inner lid seal, cask lid, and the following from both the vent and drain port: conical seal, port plug, port plug seal, O-ring, and port cover. The new elastomeric lid seal option metal retainer rings may also be part of the containment boundary. The individual components that make up the new elastomeric lid seal need to be considered when determining which components of the design are part of the containment boundary. The staff and AOS need to clearly understand which components are part of the containment boundary to ensure containment is maintained.

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

Figure 4-1, "Containment Boundary (Cask Lid Metallic Seal Shown)" will be modified, as shown below, to close all gaps in the boundary line depicting the Containment Boundary. Also, a similar figure will be added to show the containment boundary in the Model AOS-100A-S. Only the inner seal on the lid is part of the containment boundary. Refer to RAI 1-3 for a depiction of the containment boundary components.

Proprietary Information
Figure Withheld Under 10 CFR 2.390

Figure 4-1. Containment Boundary (Cask Lid Metallic Seal Shown)

4-2 Draw the containment boundary for each of the following package models: AOS-25, AOS-50, AOS-100A, AOS-100B, and AOS-100A-S.

Each model should have a clearly drawn containment boundary in Chapter 4 of the SAR. If the containment boundaries for the AOS-25A, AOS-50A, AOS-100A, and AOS-100B are determined to be similar/scaled (e.g., all containment boundary components are in the same location for each model and one model does not have different/additional containment boundary components from the others), briefly state that in Section 4.1.1 of the SAR and illustrate one containment boundary for that set of models. A separate figure should be drawn for the AOS-100A-S illustrating its containment boundary with a two lid design. The new elastomeric lid seal option metal retainer rings may also be part of the containment boundary. The individual components that make up the new elastomeric lid seal need to be considered when determining which components of the design are part of the containment boundary. The staff and AOS need to clearly understand which components are part of the containment boundary to ensure containment is maintained.

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

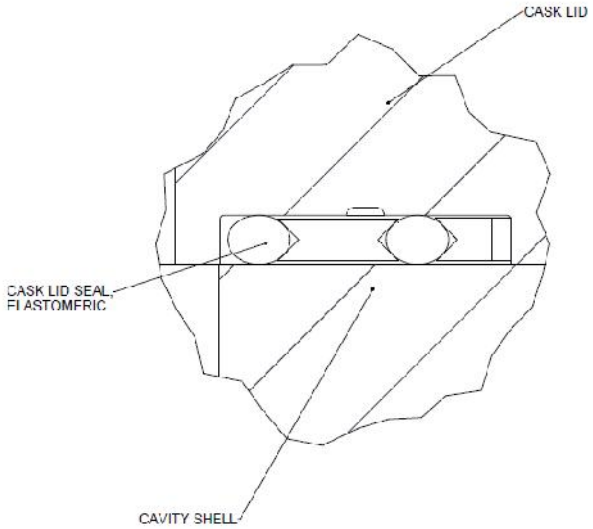
Figure 4-1, "Containment Boundary (Cask Lid Metallic Seal Shown)" is modified, as shown in RAI 4-1 response, to close all gaps in the boundary line depicting the Containment Boundary. Also a second configuration will be added to the figure to show the containment boundary in the Model AOS-100A-S. Only one configuration is shown to represent Models AOS-25A, AOS-50A, AOS-100A, and AOS-100B because of these models geometrical similarity. Please refer to RAI 4-1.

4-3 Provide design details and address concerns regarding the new elastomeric lid seal design.

Typically a complete seal design can be referenced in a seal manufacturer catalog; in this case the new elastomeric lid seal appears to be a unique design. Typically a seal and groove combination is designed by a seal manufacturer after discussions with a customer based on the customer needs. The seal manufacturer for the entire new elastomeric lid seal design was not provided in this application. The materials for each individual component of the lid seal option have not been clearly described and the use of any adhesives has not been addressed. It is not clear if the seal has been designed for the lid groove or how it will interact with the lid groove. It is also not clear if the pseudo-groove, created by the metal retainer rings and the material between the silicone lid seals and on one side of the inner silicone seal, is appropriate for the silicone seals or how the pseudo-groove will interact with the silicone seals. It appears that the pseudo-groove design will possibly pinch or damage the seals during use. It is also not clear how the silicone lid seals can be visually inspected to ensure they are properly installed, secured, and free of defects due to the enclosure created by the rest of the new elastomeric lid seal design. These concerns above need to be addressed by the applicant.

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

Drawings of the elastomeric cask lid seal for each package model will be included in Appendix 4.5.1 of the SAR, Rev. G. Refer to RAI 3-1 response for a drawing of Model 100 elastomeric seal. Once the O-rings and metal rings are assembled the seal behaves as a unit. The seal assembly is installed in the cask lid seal groove. Refer to RAIs 1-2 and 3-1 responses as well as the sketch below showing the elastomeric seal joint with the cask lid and cask body.



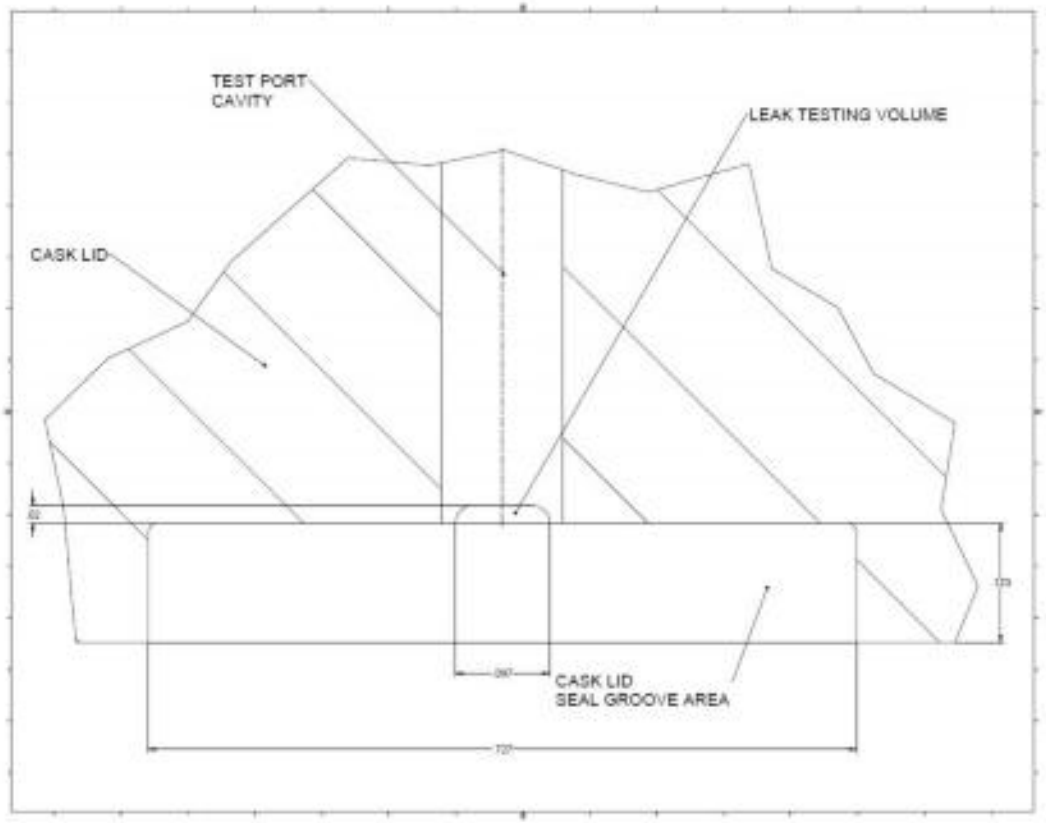
4-4 Describe how the new elastomeric lid seal option is leak tested.

It is not clear to the staff if the new elastomeric lid seal option is designed to be leak tested.

On the licensing drawings there appears to be a solid material between the inner and outer lid seals and retainer rings. Also, the metal retainer rings and material on the inside edge of the inner seal appear to block the passage of the cavity gas to the inner seal such that those materials are also providing a seal-like containment function. Section 7.1.3.3.d of the SAR states, "… check the package containment, by sniffing with the test instrument, through the test port, the volume between seal O-rings and retainer rings (elastomeric seal) …" Leak testing is necessary to ensure containment is maintained.

This information is required by staff to determine compliance with 10 CFR 71.51(a) and 71.85(a).

There is no difference, procedure wise, between the leak testing of either seal, metallic or elastomeric. The profile of the lid seal groove has a circular depression to create a small volume over the solid metal volume of either seal. This is the volume that is tested for the presence of helium during the pre-shipment or annual inspections. Any helium which escapes the inner ring of the seal will be detected in this volume. See Figure below. Dimensions given in the figure are those of the Model AOS-100.



4-5 Show how the new elastomeric lid seal design demonstrates compliance with the containment design criterion by proving that the new elastomeric lid seal design will hold together after closure and also prove that the new elastomeric lid seal design will remain leaktight during NCT and after HAC.

It is not clear to the staff if the flat metal retainer rings, the material between the two silicone lid seals, or the material on the inside edge of the inner seal could alter/impact the elastomeric seal properties including: compression and decompression characteristics over the operating temperature, springback adequacy, and suitability for impact loads, therefore the elastomeric lid seals will not remain leaktight after the lid bolts are torqued during closure. The staff needs to confirm that the application demonstrates that each package (AOS-25, AOS-50, AOS-100A, AOS-100B, and AOS-100A-S) meets the containment requirements of 10 CFR 71.51(a)(1) under NCT.

If compliance is demonstrated by test, it must be verified that the leakage rate of a package subjected to the tests of 10 CFR 71.71 does not exceed the maximum allowable leakage rate for normal conditions. Scale model testing is not a reliable or acceptable method for quantifying the leakage rate of a full-scale package. If compliance is demonstrated by analysis, it must be verified that the structural evaluation shows that the containment boundary, seal region, and closure bolts do not undergo any inelastic deformation and that the materials of the containment system (e.g., seals) do not exceed their maximum allowable temperature limits when subjected to the conditions in 10 CFR 71.71. Demonstration that each package (AOS-25, AOS-50, AOS-100A, AOS-100B, and AOS-100A-S) meets the containment requirements of 10 CFR 71.51(a)(2) under HAC is similar to the above, except that the package should be subjected to the tests of 10 CFR 71.73 and the containment criterion is the maximum allowable leakage rate for HAC.

This information is required by staff to determine compliance with 10 CFR 71.51(a).

As discussed in Paragraph 1.2.1.3, Chapter 1 of the SAR, Rev. G, the elastomeric lid seal consists of two (2) elastomeric O-rings captured between two (2) flat metal rings to form a unit. The metal rings have a "V" groove on their edge to capture the O-rings in place. When these components are assembled they become a unit; and this unit is installed in the cask lid seal groove and attached by four (4) screws to the lid. Because of the limited usage of the seals, twelve (12) usages or twelve months, whichever comes first, the mechanical properties will not be affected during the brief period of use. In addition, the seal will be visually inspected prior to each use. The seal will be changed if any defect is found. Further, this seal, as designed was tested during the 30 ft. drop test of the AOS 165 prototype, and the test showed no adverse effect to the drop event. Refer to RAI 4-3 figure which shows the elastomeric seal contained within the lid groove. Notice the sealing of the joint is solely provided by the deformation of the O-rings and that metal rings of the seal unit does not contact the groove cavity surface.

4-6 Clarify how the port plug / conical seal is attached to the cask cavity shell and if a torque value is necessary to ensure the port plug / conical seal remains attached and creates a leaktight containment boundary. If a torque value for the port plug / conical seal is necessary, that value should be specified on the licensing drawings for each model.

The port plug and conical seal penetrate the containment boundary. The staff needs to understand how the port plug / conical seal remains attached to the cask cavity shell and creates a leaktight containment boundary to ensure containment is maintained.

This information is required by staff to determine compliance with 10 CFR 71.51(a).

The flat and conical copper seals in the port plug assemblies are held by the compressive forces generated by torqueing of port plug threads during installation to the cask inner cavity shell. The torque value in the case of the Model 100 is 230 ±23 lb-ft. The torque value applied to each Model has been added to each Certification Drawing. The port plug is then welded to the cask outer shell after confirmation of the leak tightness of both sealed joints. The leak tightness of this joint will be tested annually. If a leak is detected, the plug port will be removed and both copper gaskets replaced. The required torque values for each cask Model is added to the Certification drawings.

4-7 Describe how the lid bolt torque values calculated for the metallic lid seal will potentially impact the new elastomeric lid seal design. Describe the effects of applying too much torque to the lid bolts on the new elastomeric lid seal design and how this would impact the compression and decompression characteristics over the operating temperature, springback adequacy, and suitability for impact loads of the lid seal, and the overall containment performance of the elastomeric lid seal design during NCT and HAC.

The new elastomeric lid seal design (if it only contained an elastomeric seal, not including metal retainer rings or other material between the seals or to the side of the seals) would have significantly lower bolt torque values if they were calculated compared to a metallic seal. The impact of the significantly higher bolt torque value on the elastomeric lid seal design compression and decompression characteristics over the operating temperature, springback adequacy, and suitability for impact loads of the lid elastomeric seal design, as well as the impact on the overall containment performance of the elastomeric lid seal design during NCT and HAC has not been described. This is necessary to ensure containment is maintained. Alternatively, calculate the bolt torque values for the new lid elastomeric seal.

This information is required by staff to determine compliance with 10 CFR 71.51(a).

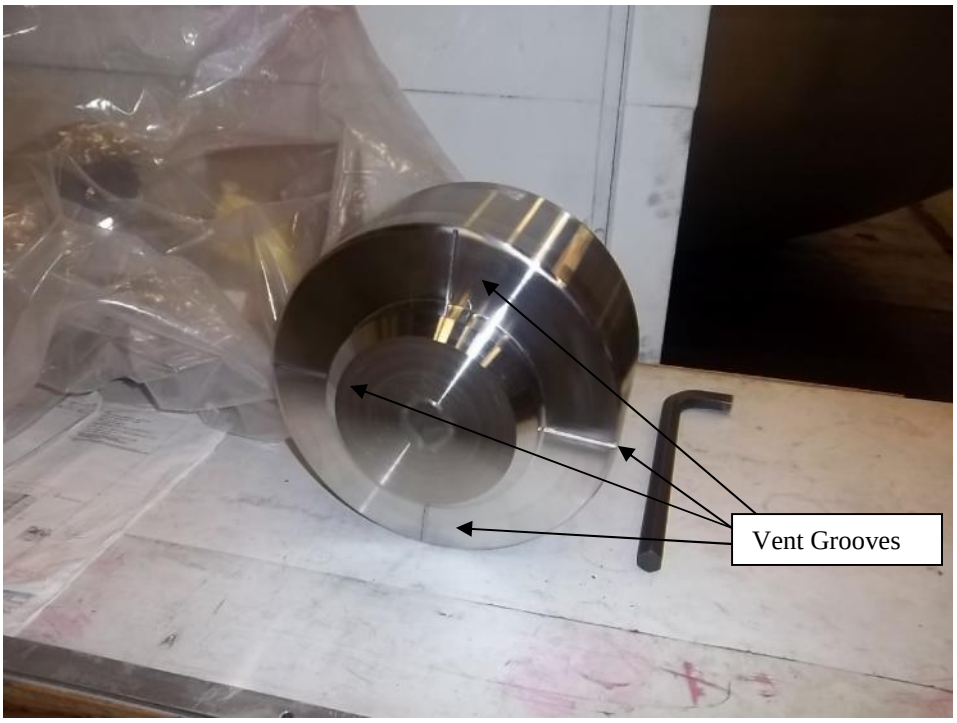
The lid bolt torque value applied to the metallic cask lid seal is more than adequate to seal the elastomeric cask lid seal. The torque excess is reacted by the lid/cask body joint, outside the sealing surface. The deformation of the O-rings is contained within the seal groove volume. Refer to RAI 4-3 figure. From the operational point of view it is better to have one constant torque value based on the most demanding seal type, the metallic seal. Because of the limited usage of the elastomeric seals, twelve (12) usages or twelve months, whichever comes first, the mechanical properties will not be affected during the brief period in use. In addition, the seals will be visually inspected prior to each use. The seal will be changed if any defect is found.

4-8 Describe how the vent port will adequately vent the package during vacuum drying. Describe the orientation of the package in greater detail during the vacuum drying draining process in Chapter 7 of the SAR. Also clarify in Chapter 7 of the SAR the method of isolating the vacuum pump from the package to ensure the cask cavity remains at or below 1 torr, for at least 30 minutes to ensure water is removed from the package.

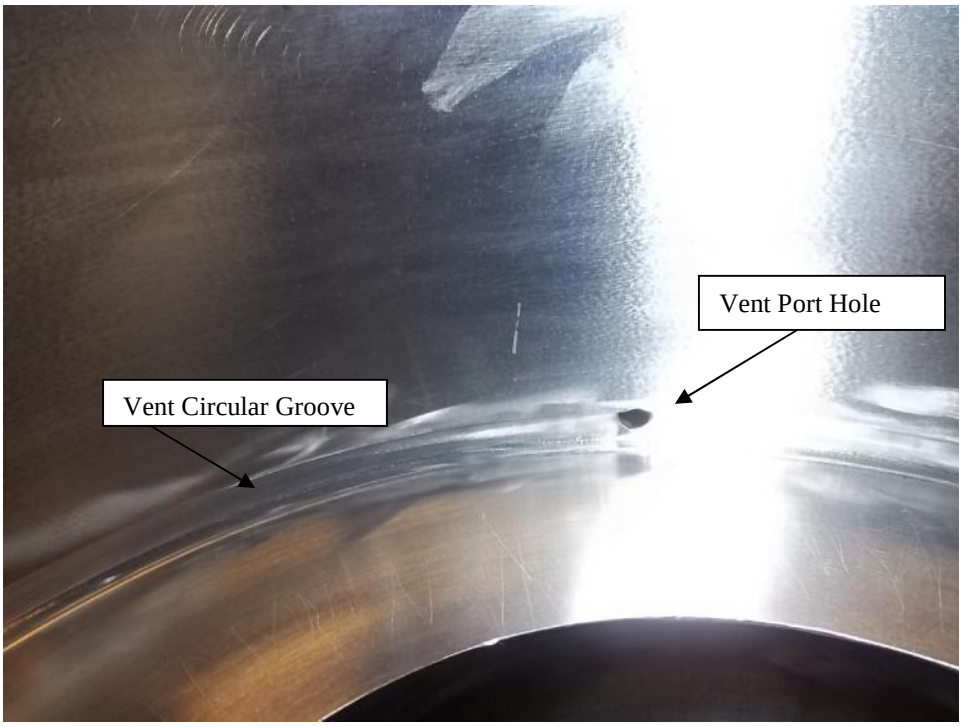
It is not clear to the staff if the vent port will function as intended due to what appears to be a restricted passage between the cask cavity shell and the lid plug assembly that can be seen on the licensing drawings. The orientation of the package should be described in greater detail during the draining process (i.e., top lid up). Also note that simply closing the valve between the package and the vacuum pump is not sufficient to isolate the vacuum pump from the package, as a faulty valve allows the vacuum pump to continue to draw a vacuum on the package. Turning off the pump, or opening the suction side of the pump to atmosphere are examples of ways to assure that the pump is not continuing to draw a vacuum on the package. This is necessary to ensure water is removed from the package.

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

The design of lid plug and cask cavity shell components provides a groove on their surface to allow the escape of gasses for the purpose of venting the cask. See photos below of these features. A detail of these groove features in assembly will be added to the Certification drawings at the next revision for all Models. Figure 7-4 of the SAR shows the vacuum drying operation setup. In this figure the cask orientation is "vertical." Therefore, all cask models requiring vacuum drying will be oriented in the vertical position.



Cask Lid Plug Assembly



Cask Cavity Shell

Chapter 7 – Package Operations

7-1 Describe throughout Chapter 7 of the SAR how the AOS-100A-S dual lid design is operated.

It appears that the operating procedures in Chapter 7 of the SAR are not written for the AOS-100A-S dual lid design, but for the AOS models that have one lid. The staff needs to understand how the AOS-100A-S dual lid design is used during preparation for loading, loading of contents, preparation for transport, package unloading, preparation of empty package for transport, and other procedures. The staff also needs to ensure that ANSI N14.5 periodic, and pre-shipment leakage rate testing is performed on the second lid and containment boundary seal for the dual lid design to ensure containment is maintained.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(a),(b),(c), and (f).

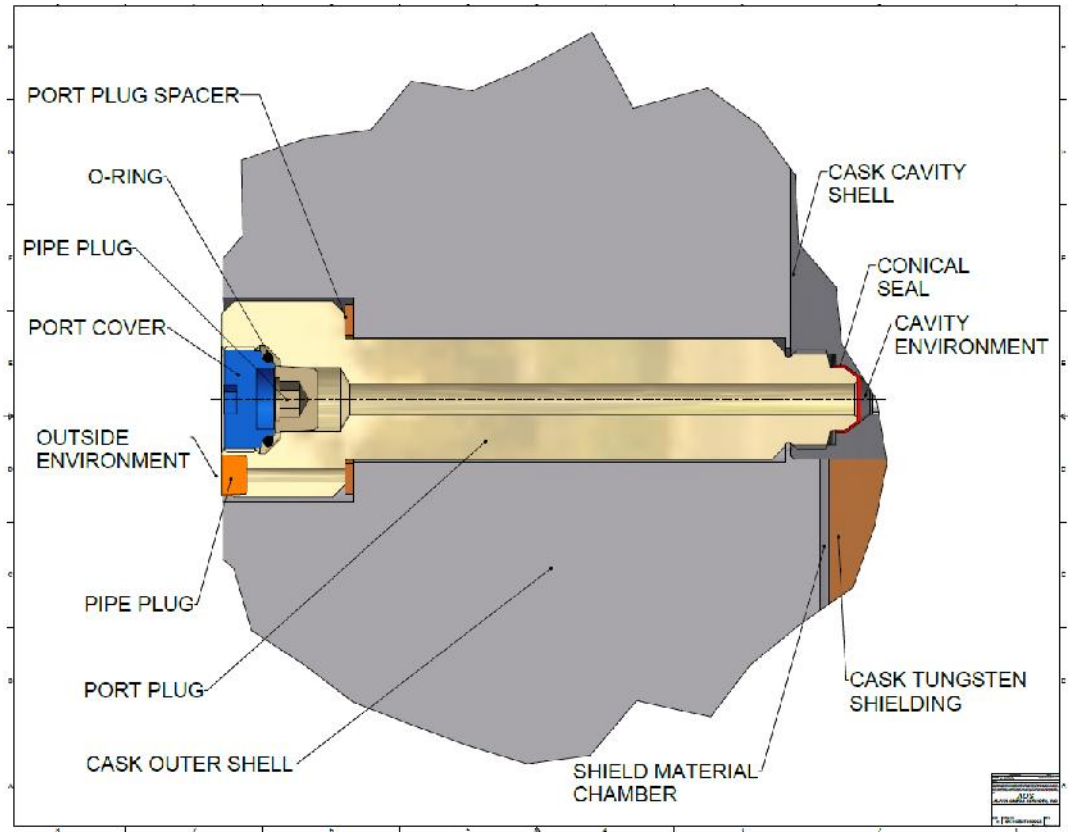
Chapters 7 and 8 provide the activities necessary to maintain, operate and test all Models of the AOS Transport Package System. These SAR Chapters are revised to identify any of those activities uniquely to any specific model.

7-2 Clarify if the port plug / conical seal will be opened, removed, or replaced at any time during package operations. Also ensure the necessary ANSI N14.5 fabrication, maintenance, periodic, and pre-shipment leakage rate tests in Chapters 7 and 8 of the SAR are appropriate for those components or describe ANSI N14.5 fabrication, maintenance, periodic, and pre-shipment leakage rate tests for those components within Chapters 7 or 8 of the SAR.

The staff needs to ensure containment is maintained after opening, removal, and replacement of containment boundary components through the use of ANSI N14.5 leakage rate testing.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(b) and (c).

The conical copper seal isolates the cavity environment from the shield material chamber. This seal is installed during manufacturing and is not opened during package operations. The seal is tested during the periodic inspection, together with the cask lid seal and pipe plug threaded joint. In addition, during fabrication, the conical copper joint will be tested by the pneumatic test prescribed by the ASME Code, paragraph NB-6300 and by a leak test in accordance with ANSI N14.5 to demonstrate compliance to the leak tightness criteria of the standard. The second copper flat spacer assures that the conical seal joint has positive frontal pressure for additional support to the joint. All leak tests must meet the ANSI N14.5 criteria for leak tightness during fabrication and periodic inspections. See the figure below of the typical port plug assembly



7-3 Describe the inspection of the elastomeric O-rings in Sections 7.1.2.1.f and 7.1.2.1.g of the SAR

Section 7.1.2.1 of the SAR does not currently mention inspection of the containment boundary seals. Based on guidance from NUREG-1609, Section 7.5.1.2, in Sections 7.1.2.1.f and 7.1.2.1.g of the SAR add the following sentence, "Elastomeric O-rings shall be visually inspected for any cuts, blemishes, debris or permanent local deformation on the sealing surface and damaged seals shall be replaced." This sentence is suggested to ensure elastomeric O-rings are replaced if necessary in order to maintain containment.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(b) and (c).

The sentence was added to Subsection 8.2.2 of SAR's Chapter 8, for a general application rather than Paragraph 7.1.2.1. However, a Note was added to in Paragraph 7.1.2.3 to refer to Subsection 8.2.2 for detail inspection of these components. Subsection 8.2.2 is changed as follows:

"Note: Elastomeric O-Rings must be visually inspected for cuts, blemishes, debris, and/or permanent local deformation on the sealing surface. Damaged seals must be replaced."

7-4 Reference the ANSI N14.5 maintenance and periodic leakage rate tests in Section 7.1.2.1 of the SAR

In Section 7.1.2.1 of the SAR the staff recommends adding the following sentences as Section 7.1.2.1.i of the SAR: "If a containment boundary seal is replaced or a containment boundary seal has not been leak tested within 12 months prior to the shipment, a helium leak test shall be performed in accordance with ANSI N14.5 maintenance and periodic leakage rate tests described in Section 8.2.2. Note: completion of a helium leak test does not relieve the need to perform the ANSI N14.5 pre-shipment leakage rate test in Section 7.1.3.3." This is necessary in order to ensure containment is maintained.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

The following sentence was added to Section 7.1.2.1.b to comply with this request:

"Replacement or repair of any component requires that all original examinations and tests initially prescribed be performed."

7-5 Specify the helium backfill pressure for the cask cavity in Section 7.1.3.1.a.2.g.

The helium backfill pressure should be provided to ensure the maximum normal operating procedure is not exceeded during the vacuum drying process.

This information is required by staff to determine compliance with 10 CFR 71.33(b)(5).

The helium backfill pressure value is added to paragraph 7.1.3.1.a.2.g as follows:

"…with helium, to 2 psig ±0.5 psig."

7-6 In Section 7.1.3.3.d of the SAR specify that after a repair or replacement of suspected containment boundary component(s), re-test for leakage is done in accordance with Section 8.2.2 of the SAR to ANSI N14.5 leaktight criteria. Also specify in Section 7.1.3.3 that the pre-shipment leakage rate testing is performed in accordance with ANSI N14.5.

The staff needs to ensure retesting of repaired or replaced containment boundary elastomeric seals is not performed to the ANSI N14.5 pre-shipment leakage rate, but to ANSI N14.5 leaktight criteria. Also, Sections 7.1.3.3.c and 7.1.3.3.d of the SAR appears to be written in a manner that addresses the lid seal and should consistently address all containment boundary seals.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

ANSI N14.5 Standard is added as Reference [7.8] in Chapter 7 of the SAR, and is cited at pertinent locations within the Chapter.

Chapter 8 – Acceptance Tests and Maintenance Program

8-1 Clarify in Section 8.1.4 of the SAR that an ANSI N14.5 fabrication leakage rate test is performed on the entire containment boundary. That includes leakage rate testing of the base material, (e.g., cask cavity shell, cask lid(s)) and all containment boundary components. The fabrication leakage rate test also needs to be clearly described or referenced in Section 4.4 of the SAR, currently Section 4.4 of the SAR only references periodic and pre-shipment leakage rate testing. Also in Section 8.1.4, the use of the term maintenance leakage rate test to describe a test that occurs every 12 months is in disagreement with ANSI N14.5 and should be revised to state that it is a periodic leakage rate test.

Section 8.1.4 of the SAR should describe the ANSI N14.5 fabrication leakage rate test that is to be performed on the entire containment boundary to demonstrate that each packaging, as fabricated, provides the required level of containment. The fabrication leakage rate test should be performed prior to the first use of each packaging. This testing is necessary to ensure the required level of containment is provided. Section 8.1.4 of the SAR describes helium leakage rate testing at critical locations within the AOS Transport Packaging System including the cask lid seal joint, cask drain port, and cask vent port, which does not include the entire containment boundary. The fabrication leakage rate test should be referenced in Section 4.4 of the SAR.

Section 8.1.4 of the SAR also references a maintenance leakage rate test to describe a test that occurs every 12 months. The ANSI N14.5 maintenance leakage rate test is performed to confirm that maintenance, repair, or replacement of components has not degraded the containment system performance and is performed after maintenance repair, or replacement of components of a containment system. The ANSI N14.5 maintenance leakage rate test is performed on the portion of the containment system affected by the maintenance, repair, or component replacement. The leakage criteria for the ANSI N14.5 maintenance leakage rate test is a leakage rate less than the reference air leakage rate, in the case of the AOS packages, that would be leaktight as defined by ANSI N14.5. The ANSI N14.5 periodic leakage rate test is performed to confirm that the containment capabilities have not deteriorated over an extended period of use and is performed within 12 months prior to each shipment. The ANSI N14.5 periodic leakage rate test is performed on all containment boundary seals, closures, valves, rupture disks, etc. The ANSI N14.5 maintenance leakage rate test and periodic leakage rate test should be described in Section 8.2.2 of the SAR and referenced in Section 4.4 of the SAR.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

Table 8-8, "Fabrication Examination Program" is added to SAR's Chapter 8 to clearly define those examinations and tests performed during fabrication. The containment boundary is tested during fabrication by two distinct methods: one method meets the requirements of the ASME Code, paragraph NB-6300; the second one is by a leak test in accordance with ANSI N14.5 to demonstrate compliance to the leak tightness criteria of the standard.

8-2 In Section 8.2.2 of the SAR describe the ANSI N14.5 maintenance leakage rate test.

Section 8.2.2 of the SAR describes or references ANSI N14.5 periodic and pre-shipment leakage rate tests, but does not describe the ANSI N14.5 maintenance leakage rate test. This test should be described in Section 8.2.2 of the SAR and referenced in Section 4.4 of the SAR. The ANSI N14.5 maintenance leakage rate test is performed to confirm that maintenance, repair, or replacement of components has not degraded the containment system performance and is performed after maintenance repair, or replacement of components of a containment system. The ANSI N14.5 maintenance leakage rate test is performed on the portion of the containment system affected by the maintenance, repair, or component replacement. The leakage criteria for the ANSI N14.5 maintenance leakage rate test is a leakage rate less than the reference air leakage rate, in the case of the AOS packages, that would be leaktight as defined by ANSI N14.5.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

Subsection 8.2.2 of the SAR is revised to clarify what is entailed and to what criteria the Pre-shipment and Periodic leak testing is performed.

.

8-3 State, in Section 8.2.2 of the SAR, that elastomeric seals should be replaced within the 12 month period prior to shipment and the maintenance leakage rate test should be performed after seal replacement.

NUREG 1609, Section 8.5.2.2, states that elastomeric seals should be replaced and leak tested within the 12 month period prior to shipment. This should be described in Section 8.2.2 of the SAR to ensure containment is maintained.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

Sub-sections 4.1.2 and 8.2.2 of the SAR are revised to include the replacement schedule of the elastomeric seal as: "Elastomeric seal must be replaced every twelve usages or twelve months whichever comes first."

8-4 Describe how helium permeation through the silicone seals will be addressed during all leakage rate testing to ensure accurate leakage rate testing.

ANSI N14.5-1997 Section B.11 states, “If a containment system includes elastomeric materials, such as rubber O-rings, permeation can be a problem when leakage test procedures are being used to demonstrate that the system is leaktight. The degree of permeation is affected by seal material, seal surface area, time, and temperature.” Methods for eliminating permeation as a factor in leakage rate are further discussed in Section B.11 of ANSI N14.5. The staff needs to understand how helium permeation through silicone will be addressed during leakage rate testing to ensure accurate leakage rate testing.

This information is required by staff to determine compliance with 10 CFR 71.51(a), 71.85(a), and 71.87(c).

The helium permutation phenomenon is controlled by the leak test procedure by limiting the soaking time.

ATTACHMENT A.

Letter to Pierre Saverot, Project Manager Licensing Branch,

AOS Response to the NRC Request for Additional Information for the review of the Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S Packages.

"Comparison of moments of inertia between a standard transversal section and a composed by two angles."

Comparison of moments of inertia between a standard transversal section and a composed by two angles.

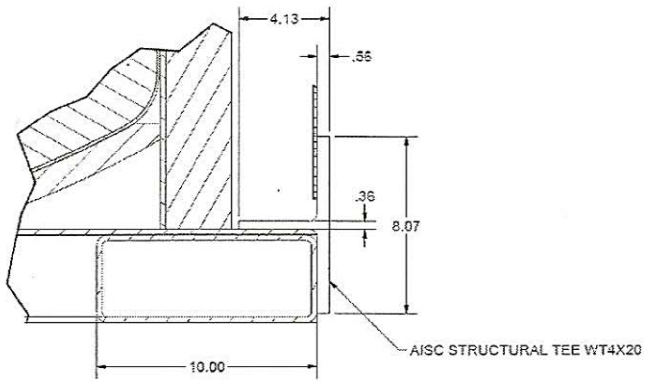


Fig. 1. Case 1 Tee

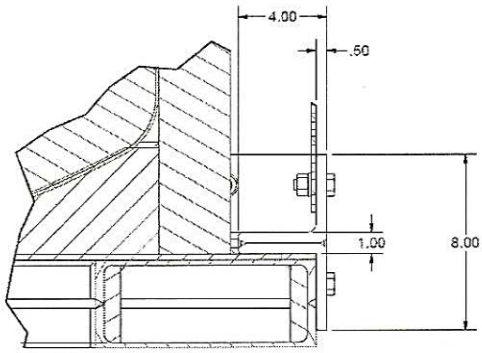
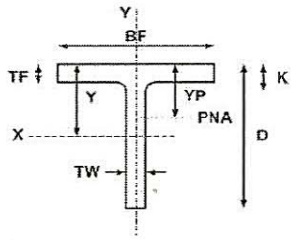


Fig. 2. Case 2 Double angles

For the first case, values were obtained by the next page of web:

http://www.cecalc.com/SteelShapes/Tables/WTShapeTables.pdf

And the values are:



WT & MT Shapes

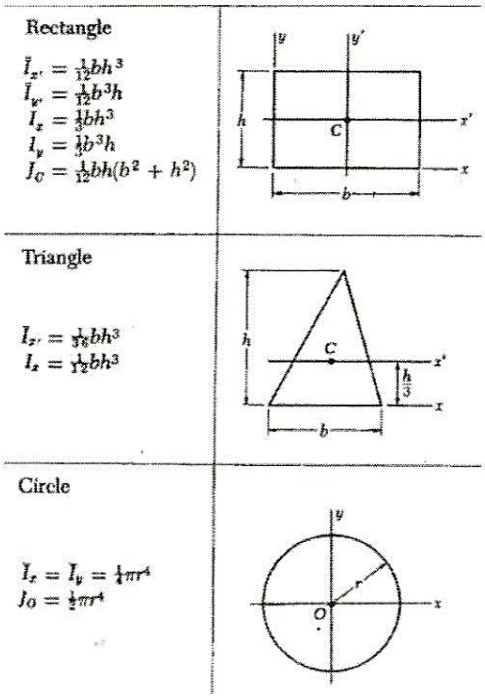
WT Shapes - US Standard Units

AISC_Shape	W	A	d	d_{clr}	b_f	b_{clr}	t_w	t_{wclr}	$t_{wclr}/2$	t_f	t_{fclr}	k_{des}	k_{det}	y	y_p	$b_f/2t_f$	D/t	I_x	Z_x	S_x	r_x	I_y
WT4X33.5	33.5	9.84	4.50	4 1/2	8.28	8 1/4	0.570	9/16	5/16	0.935	15/16	1.33	1 5/8	0.936	0.594	4.43	7.89	10.9	6.29	3.05	1.05	44.3
WT4X29	29.0	8.54	4.38	4 3/8	8.22	8 1/4	0.510	1/2	1/4	0.810	13/16	1.20	1 1/2	0.874	0.520	5.07	8.59	9.12	5.25	2.61	1.03	37.5
WT4X24	24.0	7.05	4.25	4 1/4	8.11	8 1/8	0.400	3/8	3/16	0.685	11/16	1.08	1 3/8	0.777	0.435	5.92	10.6	6.83	3.94	1.97	0.986	30.5
WT4X20	20.0	5.87	4.13	4 1/8	8.07	8 1/8	0.360	3/8	3/16	0.560	9/16	0.954	1 1/4	0.735	0.364	7.21	11.5	5.73	3.25	1.69	0.988	24.5
WT4X17.5	17.5	5.14	4.06	4	8.02	8	0.310	5/16	3/16	0.495	1/2	0.889	1 3/16	0.688	0.321	8.10	13.1	4.82	2.71	1.43	0.968	21.3
WT4X15.5	15.5	4.56	4.00	4	8.00	8	0.265	5/16	3/16	0.435	7/16	0.829	1 1/8	0.668	0.285	9.19	14.0	4.28	2.39	1.28	0.969	18.5
WT4X14	14.0	4.12	4.03	4	6.54	6 1/2	0.265	5/16	3/16	0.465	7/16	0.859	15/16	0.734	0.315	7.03	14.1	4.23	2.38	1.28	1.01	10.8
WT4X12	12.0	3.54	3.97	4	6.50	6 1/2	0.245	1/4	1/8	0.400	3/8	0.794	7/8	0.695	0.272	8.12	16.2	3.53	1.98	1.08	0.999	9.14
WT4X10.5	10.5	3.08	4.14	4 1/8	5.27	5 1/4	0.250	1/4	1/8	0.400	3/8	0.700	7/8	0.531	0.292	6.59	16.6	3.90	2.11	1.16	1.12	4.68
WT4X9	9.00	2.63	4.07	4 1/8	5.25	5 1/4	0.230	1/4	1/8	0.330	5/16	0.630	13/16	0.834	0.251	7.95	17.7	3.41	1.86	1.05	1.14	3.98

From the table:

$$Ix = 5.73\ in^4 \qquad Iy = 24.5\ in^4$$

To evaluated these results, is used *"The moments of inertia of composite areas"* (Reference *VECTOR MECHANICAL for ENGINEERS Statics, Eighth Edition, author: Beer, Jhonston & Eisenber, pag. 483-487*). Considering a composed area *A,* made of several component areas A_1, A_2, A_3, . . ., the moment of inertia of A with respect to a given axis is obtained by adding the moments of inertia of the areas A_1, A_2, A_3, . . ., respect to the same axis. The moment of inertia of an area consisting of several of the common shapes shown in the next figure:



can thus be obtained by using the formulas given in that figure. Before adding the moments of inertia of the component areas, however, that parallel-axis theorem may to be used to transfer of each moment of inertia to the desired axis.

Parallel-Axis theorem

Consider the moment of inertia *I* of an area *A* with respect to an axis *AA'* next figure:

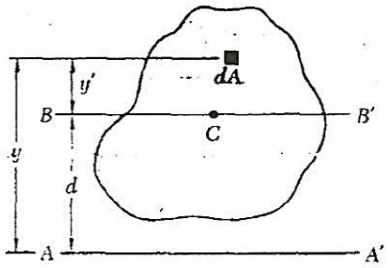


Fig. 9.9

Denoting by *y* the distance from an element of area *dA* to *AA',* we write:

$$I = \int y^2 dA$$

Let us now draw through the centroid C of the areas an axis BB' parallel to AA'; this axis is called a *centroidal axis*. Denoting by y' the distance from the element dA to BB', we write $y = y' + d$, where d is the distance between the axis AA' and BB'. Substituting for y in the above integral, we write

$$I = \int y^2 dA = \int (y' + d)^2 dA$$

$$= \int y'^2 dA + 2d \int y' dA + d^2 \int dA$$

The first integral represents the moment of inertia $\bar{I}$ of the area with respect to the centroidal axis BB'. The second integral represents the first moment of the area with respect to BB'; since the centroid C of the area is located on that axis, the second integral must be zero. Finally, we observe that the last integral is equal to the total of area A.

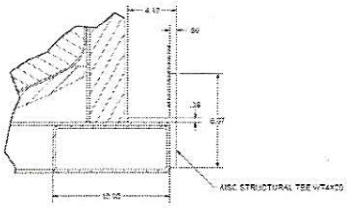
Therefore, we have:

$$I = \bar{I} + Ad^2$$

This formula expresses that the moment of inertia I of an area with respect to any given axis AA' is equal to the moment of inertia $\bar{I}$ of the area with respect to the centroidal axis BB' parallel to AA' *plus* the product of the area A and the square of the distance d between the two axis. This theorem is known as the *parallel-axis theorem.*

Analytical solution:

Dividing the Tee in two areas, from the figures 1, case for I_X:



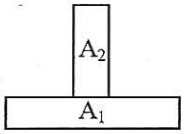


Fig. 3

$A_1 = 8.07 * .56 = 4.5192\ in^2$

$A_2 = .36 * 3.565 = 1.2834\ in^2$

$\bar{Y} = .56/2 = .28\ in$

$\bar{Y} = .56 + (3.565/2) = 2.3425\ in$

	A	$\bar{Y}$	$A\bar{Y}$
	4.5192	.28	1.26537
	1.2834	2.3425	3.00636
$\sum$	5.8026		4.27173

$A_T\bar{Y} = \sum(A_i + \bar{Y}_i)$

$5.8026\bar{Y} = 4.27173$

$\therefore \quad \bar{Y} = 4.27173/5.8026 = .73467\ in \approx .7362\ in$

$I = {}^{1}/_{12}\, bh^3 + Ad^2$

$I_1 = {}^{1}/_{12}\,(8.07 * .56^3) + [4.5192 * (.28 - .7362)^2]$

$I_1 = .1181 + .9405 = 1.05862\ in^4$

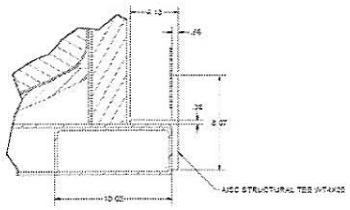
$I_2 = {}^{1}/_{12}\,(.36 * 3.565^3) + [1.2834 * (2.3425 - .7362)^2]$

$I_2 = 1.3593 + 3.3114 = 4.6707\ in^4$

For the composed area,

$I_X = 1.05862 + 4.6707 = \mathbf{5.729\ in^4 \approx 5.73\ in^4}$

Dividing the Tee in two areas, from the figures 1, case for I_Y:



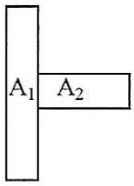


Fig. 4

$A_1 = 8.07 * .56 = 4.5192\ in^2$ $\qquad$ $A_2 = .36 * 3.565 = 1.2834\ in^2$

$\bar{Y} = 8.07/2 = 4.035\ in$ $\qquad$ $\bar{Y} = 3.855 + (.36/2) = 4.035\ in$

	A	$\bar{Y}$	$A\bar{Y}$
	4.5192	4.035	18.23497
	1.2834	4.035	5.17852
$\sum$	5.8026		23.41349

$A_T\bar{Y} = \sum(A_i + \bar{Y}_i)$

$5.8026\bar{Y} = 23.41349$

$\therefore \quad \bar{Y} = 23.41349/5.8026 = 4.03499\ in \approx 4.035$

$I = {}^{1}/_{12}\, bh^3 + Ad^2$

$I_1 = {}^{1}/_{12}\,(.56 * 8.07^3)$

$I_1 = 24.5260\ in^4$

$I_2 = {}^1/_{12}\,(3.565 * .36^3)$

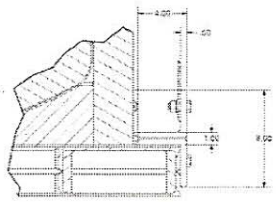
$I_2 = .01386\ in^4$

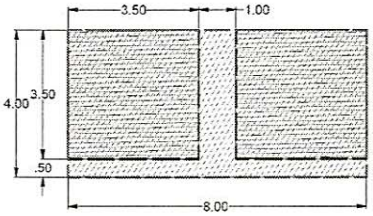
For the composed area,

$I_Y = 24.5260 + .01386 = \mathbf{24.5398\ in^4} \cong \mathbf{24.5\ in^4}$

Dividing the Tee in two areas, from the figures 1, case for I_X:

We have





A_1 Area total in red

$A_2 = A_3$ Area in blue

$A_1 = 8 * 4 = 32\ in^2$ $\qquad A_2 = 3.5 * 3.5 = 12.25\ in^2 = A_3$

$\bar{Y} = 4/2 = 2\ in$ $\qquad \bar{Y} = 3.5/2 + .5 = 2.25\ in$

	A	$\bar{Y}$	$A\bar{Y}$
	32	2	64
	-12.25	2.25	-27.5625
	-12.25	2.25	-27.5625
$\sum$	7.5		8.875

$A_T\bar{Y} = \sum(A_i + \bar{Y}_i)$

$7.5\bar{Y} = 8.875$

$\therefore \qquad \bar{Y} = 8.875/7.5 = 1.1833\ in$

$I = {}^1/_{12}\,bh^3 + Ad^2$

$I_1 = {}^1/_{12}\,(8 * 4^3) + [32 * (2 - 1.1833)^2]$

$I_1 = 42.6667 + 21.3440 = 64.0107\ in^4$

$I_2 = {}^1/_{12}\,(3.5 * 3.5^3) + [12.25 * (2.25 \quad 1.18333)^2]$

$I_2 = 12.5052 + 13.9386 = 26.4438\ in^4$

$I_3 = {}^1/_{12}\,(3.5 * 3.5^3) + [12.25 * (4 - 6.25)^2]$

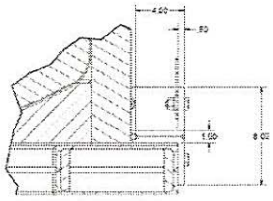
$I_2 = 12.5052 + 13.9386 = 26.4438\ in^4$

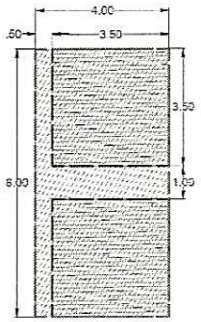
For the composite area,

$I_X = 64.0107 - 26.4438 - 26.4438 = \mathbf{11.1231}\boldsymbol{in^4}$

For the two angles:

We have





A_1 Area total in red

A_2= A_3 Area in blue

$A_1 = 8 * 4 = 32\ in^2$

$A_2 = 3.5 * 3.5 = 12.25\ in^2 = A_3$

$\bar{Y} = 8/2 = 4\ in$

$\bar{Y} = 3.5/2 = 1.75\ in$

$\bar{Y} = 3.5/2 + 4.5 = 6.25\ in$

	A	$\bar{Y}$	$A\bar{Y}$
	32	4	128
	-12.25	1.75	-21.4375
	-12.25	6.25	-76.5625
$\sum$	7.5		30

$A_T\bar{Y} = \sum(A_i + \bar{Y}_i)$

$7.5\bar{Y} = 30$

$\therefore \quad \bar{Y} = 30/7.5 = 4\ in$

$I = {}^1/_{12}\,bh^3 + Ad^2$

$I_1 = {}^1/_{12}\,(4 * 8^3) + [32 * (4 - 4)^2]$

$I_1 = 170.6667 + 0 = 170.6667\ in^4$

$I_2 = {}^1/_{12}\,(3.5 * 3.5^3) + [12.25 * (4 - 1.75)^2]$

$I_2 = 12.5052 + 62.0156 = 74.5208\ in^4$

$I_3 = {}^1/_{12}\,(3.5 * 3.5^3) + [12.25 * (4 - 6.25)^2]$

$I_2 = 12.5052 + 62.0156 = 74.5208\ in^4$

For the composed area,

$I_Y = 170.6667 - 74.5208 - 74.5208 = \mathbf{21.6251}\boldsymbol{in^4}$

Juan Sergio Ávila Cruz

Performer

Jaime Magdaleno Rubalcaba

Reviewed and verified the analysis and deem to be correct.

ATTACHMENT B.

Letter to Pierre Saverot, Project Manager Licensing Branch,
AOS Response to the NRC Request for Additional Information for the review of the Model Nos. AOS-025A, AOS-050A, AOS-100A, AOS-100B, and AOS-100A-S Packages.

AOS-165 TRANSPORT PACKAGE FREE DROP TEST ACTIVITY RECORD

7

HBA 4-4-07

Step No.	Activity	Completed	Date
B.0	*Pre-Drop Test; Orientation:* Side Drop *Date:* 3-24-07 *Time:* 4:50 pm		
.1	Instrumentation		
.1.1	• Accelerometers checked and calibrated.	DAK	3/21/07
.1.2	• Accelerometers installed.	DAK	3/21/07
.1.3	• Accelerometers cabling installed.	DAK	3/24/07
.1.4	• Accelerometers and cabling tested after installation.	DAK	3/24/07
.1.6	• Cable assignment recorded.	DAK	3/21/07
.1.7	• Date tape recorder calibrated and tested.	DAK	3/21/07

Activities Completed: David A. Kienholz — **Project/Test Engineering**; Howard Bunker — **QA/QC Engineering**; BCA AOS QA

.2	Scales and Videotape		
.2.1	• Length scales re-painted and set	DAK	3/24/07
2.2	• Time scales re-painted, calibrated and set..	DAK	3/24/07
2.3	• Videotape system tested	DAK	3/24/07

Activities Completed: David A. Kienholz — **Project/Test Engineering**; Howard Bunker — **QA/QC Engineering**; BCA AOS QA

.3	Setup equipment and instrumentation		
.3.1	• Rigging setup for the particular drop. See SK's 07012, 07009 & 07013.	DAK	3/24/07
.3.2	• External accelerometer cable numbered.	DAK	3/21/07
.3.3	• Cable supports in place.	DAK	3/24/07
.3.4	• Impact limiter accelerometer installs and checks.	DAK	3/24/07
.3.5	• Data tape recorder setup, cabled, and checked.	DAK	3/24/07
.3.6	• Channel gain settings checked and recorded.	DAK	3/24/07
.3.7	• Videotape cameras placed in position and tested.	DAK	3/24/07
.3.8	• Accelerometers installed in dummy payload.	N/A DAK	3/21/07

Activities Completed: David A. Kienholz — **Project/Test Engineering**; Howard Bunker — **QA/QC Engineering**; BCA AOS QA

.4	Package preparation and miscellaneous.		
.4.1	• Dummy payload installed in cask and accelerometers cable routed to the outside. HBA 3-21-07	N/A	
.4.2	• Cask seal installed. Seal ID No. #1 EPDM O Ring		
.4.3	• Cask lid installed and torque to 550 ft-lb. Torque wrench ID No. 1469 Cal. Date: 7-20-06, Cal. Due Date: 7-20-07		
.4.4	• Pre-test leak test performed.	HBA	3/22/07

TEST EQUIPMENT:
MSLD: Mfr: Ateates Model: 180T S/N
Calibrated Leak (CL) S/N: ~~23219-3~~ 3437 HBA 3/23/07 Leak Rate: 2.61×10^{-9} Cal. Due: 11-02-07

Metal Seal Gaskets: * Leak test failed with S/N 2 gasket. S/N 2 was replaced with S/N 003, also failed.

** 1 EPDM O-Ring gasket used for side drop

AOS-165 TRANSPORT PACKAGE FREE DROP TEST ACTIVITY RECORD

9 HBA 4.4.0C

Step No.	Activity	Completed	Date

.4.4 • Pre-test leak test performed (continue).
Temp. of CL: 58.8 C(F) Temp. Corrected Leak Rate: 1.97×10^{-7}
Thermometer Type: Digital S/N: 4894 Cal. Due: 05/15/2007
2105348 HBA 4-3.07
TEST PARAMETERS:
Tracer Gas: Helium Concentration of Cylinder welding grade % Cylinder ID: 102-227-5-HE-5
Ambient Temp: 63.3 C(F) Acceptance Criteria: 1.58×10^{-7}
TEST RESULTS: (Seal Joint)
Pre-Cal. Rate: 2.4×10^{-9} Leak Rate 2.6×10^{-9} Post-Cal Rate: 2.6×10^{-9}
Test Results: Accept/Reject. Performer: R/P Level: III Cert. No. 0260
COMMENTS:

TEST RESULTS: (Vent Port Plug)
Pre-Cal. Rate: 2.6×10^{-9} Leak Rate 2.1×10^{-7} Post-Cal Rate: 2.1×10^{-7}
Test Results: Accept/Reject. Performer: R/P Level: III Cert. No. 0260
COMMENTS: Orbel model 180T

TEST RESULTS: (Drain Port Plug)
Pre-Cal. Rate: 2.1×10^{-7} Leak Rate ~~2.1×10^{-7}~~ 1.8×10^{-8} HP 4.4.07 Post-Cal Rate: 2.1×10^{-7}
Test Results: Accept/Reject. Performer: RJP Level: III Cert. No. 0260
COMMENTS: Varian Model 979

Additional Comments:
Front side of gasket Pressurize To 15 PSI Helium and held for 5 minute with no leakage.

Pressure Gauges S/N 003 and S/N 004 are both due for Calibration the 33rd week of 2007.

Activities Completed:

L. Pombres
Project/Test Engineering

Howard Pinderson
QA/QC Engineering