SAFKEG-HS 3977A

SAR Update Matrix for Inclusion of Liquid Mo-99 to be shipped in a Split Lid Containment vessel

Title	SAFKEG-LS 3977A SAR Update Matrix for Addition of Extra Contents	Number	CTR 2016/08
		Issue	A
		File Ref	CTR2016-08-v1.docx
Compiled		Checked	
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Approved		Issue Date	21 March 16
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Contents

1 Notes on methodology and content

This Update Matrix (CTR 2016/08) details the changes in the SAFKEG-HS 3977A SAR in updating from Rev 6 to Rev 7.

The update to SAR Rev 7 is to allow Mo-99 in liquid form to be carried in a new steel insert, as listed in Contents Type 8. In order to facilitate handling of Mo-99 a split lid CV has been introduced.

This Update Matrix (CTR 2016/08) provides the following.

- Justification for the changes in the SAFKEG-HS 3977A SAR in updating from Rev 6 to Rev 7
- Details of SAR changes - List of all changes to the SAR - Table 1
- Question and Response Matrix Table – Table 2 [Blank at this stage]
- List of SAR page changes [Appendix B]

It is proposed that this document (CTR 2016/08) will be updated to include responses to any further questions and will thereby fully document all issues including any questions and responses for the entire SAR update.

2 Justification for the changes in the SAFKEG-HS 3977A SAR in updating from Rev 6 to Rev 7

Croft wishes to add liquid Mo-99 to the approved contents of the HS 3977A package. In order to carry Mo-99, the contents type 8 has been changed to liquid Mo-99. The contents listed in the original application as Contents Type 8 are no longer proposed for this package. The liquid Mo-99 will be carried in a new steel insert, which will be located inside a tungsten liner. Due to handling requirements for the Mo-99 a split CV lid has also been introduced to allow the handing of the Mo-99 bottles at the loading and unloading facilities.

3 SAR Changes

This table contains notes on all the SAR Page Changes and supporting Document Changes for Rev 7 (from Rev 6).

Table 1 Summary of SAR Page Changes and Supporting Document Changes for Rev 7

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Chapter 0 - Contents			
All pages	Header	Page Rev status amended to Rev 7 All changes are shown in red and sidelined.	Changes required solely to record the current issue status of SAR pages and references.
Page 0-2	Date box	Date amended	Update.
Page 0-5	Documents in section 1.3.3	Licensing drawings added to include the split CV lid, new stainless steel insert and tungsten liner.	These drawings are required to provide the manufacturing details for the HS package used to ship the Mo-99 contents. Although a full set of drawings are provided the keg, cork and containment vessel body are identical to the current approved drawings.
Chapter 1 - General Information			
Page 1-2	Section 1.2.1.1	The split CV lid details added to the general description of the package.	Addition of Mo-99 contents requires a new split CV lid design.
Page 1-3	Section 1.2.1.3	A description of the split CV lid was added to the CV description.	Addition of Mo-99 contents requires a new split CV lid design.
Page 1-3a	Section 1.2.1.4	Extra figures listed in text.	An extra figure demonstrating the containment boundary of the split CV lid has been added to the SAR.
Page 1-3a and 1-4	Section 1.2.1.5	Extra figures listed in text.	An extra figure demonstrating the radiation shielding of the split CV lid has been added to the

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
			SAR.
Page 1-4	Section 1.2.1.6	Extra figures listed in text.	An extra figure demonstrating the energy absorbing features of the split CV lid package has been added to the SAR.
Page 1-5	Figure 1-1a	Title of figure changed.	To clarify that this figure shows the standard CV lid.
Page 1-5a	Figure 1-1b	Addition of figure.	This figure presents the package with the split CV lid.
Page 1-6	Figure 1-1c	Title changed to 1-1c from 1-1b.	Allows the addition of new figures
Page 1-7	Figure 1-2a	Title of figure changed.	To clarify that this figure shows the standard CV lid.
Page 1-7a	Figure 1-2b	Addition of figure.	This figure presents the split CV lid.
Page 1-8	Figure 1-2c	Title changed to 1-2c from 1-2b.	Allows the addition of new figures.
Page 1-9	Figure 1-3a	Title of figure changed.	To clarify that this figure shows the standard CV lid.
Page 1-9a	Figure 1-3b	Addition of figure.	This figure presents the split CV lid.
Page 1-10	Figure 1-4a	Title of figure changed.	To clarify that this figure shows the standard CV lid.
Page 1-10a	Figure 1-4b	Addition of figure.	This figure presents the split CV lid.
Page 1-11	Section 1.2.2.1	Text added to demonstrate that the standard CV lid will be used for all contents types, apart from Type 8, which will be carried in the split lid containment vessel.	Contents Type 8 is the liquid Mo-99 contents. A Split CV lid is required to handle these contents.
Page 1-12	Section 1.2.2.2	Extra figures listed in text.	An extra figure has been added to illustrate the new insert and liner design.
Page 1-12	Table 1-1	New insert and tungsten liner added to table.	A new insert and liner were required to carry the liquid Mo-99 contents.

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Page 1-13a	Figure 1-5d	Addition of figure.	This figure provides an illustration of the new insert and tungsten liner.
Page 1-14	Table 1-2	Contents Type 8 altered. CV lid arrangement added to table.	A user would like to carry Mo-99 therefore the contents category was altered from the unlicensed solid contents to liquid Mo-99. The table was expanded to clarify that only the Mo-99 may be shipped with a split CV lid.
Page 1-22	Table 1-3-8	The contents description and requirements altered to liquid Mo-99.	A user would like to carry Mo-99 therefore the contents category was altered from the unlicensed solid contents to liquid Mo-99. The special form fissile material has been removed from the SAR because these contents are not approved by the NRC.
Page 1-33	Table 1-4-8	The contents limits were altered to liquid Mo-99.	A user would like to carry Mo-99 therefore the contents category was altered from the unlicensed solid contents to liquid Mo-99. The special form fissile material has been removed from the SAR because these contents are not approved by the NRC.
Page 1-34	Section 1.2.3	Contents Type 8 added to the liquid contents listed in section 1.2.3.	Mo-99 has been added as an approved liquid contents.
Page 1-34	Section 1.2.4	The addition of the split CV lid general arrangement drawing.	The addition of Mo-99 requires a split CV lid to provide suitable handling of the contents. Therefore the drawing has been added.
Page 1-37	Section 1.3.3	Title to 1.3.3.1 altered to include standard CV lid design and section 1.3.3.2 added to list out the added drawings including the split CV lid, new steel insert and tungsten liner.	Addition of liquid Mo-99 contents. The Mo-99 user requires a split CV lid to load and unload the product. To simplify drawings a new set has been produced however the keg, CV body and cork are identical for both designs.
Chapter 2 - Structural Evaluation			

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Pages 2-1 to 2-3	Section 2.1.1	New drawing numbers for the Mo-99 contents are added to the relevant sections. A description of the split CV lid has been added along with the new insert and tungsten liner.	Addition of liquid Mo-99 contents requires a split CV lid, new insert and tungsten liner.
Page 2-3a	Section 2.1.2	Clarification that the tests were carried out using the standard CV lid.	The loading on the CV lid is worst case for the standard lid, therefore the results bound the results of the split CV lid.
Pages 2-18 to 2-19	Table 2-10	Updated the O-ring materials to Fluoroelastomer.	Corrected an error identified during review. The O-rings were altered during the last RAI process. While the drawings were correctly updated, the SAR contained this error.
Pages 2-18 to 2-19	Table 2-10	New insert and tungsten liner added to table.	The addition of insert and liner in order to carry Mo-99 liquids.
Page 2-21	Section 2.2.3	Corrected O-ring material.	Corrected an error identified during review. The O-rings were altered during the RAI process. While the drawings were correctly updated, the SAR contained this error.
Page 2-24	Table 2-15	The tungsten liner has been added to the matrix. The O-ring material has been corrected.	The tungsten liner has been added due to the inclusion of Mo-99. The O-ring material has been corrected. The O-rings were altered during the RAI process. While the drawings were correctly updated, the SAR contained this error.
Page 2-25	Section 2.3.1	Drawing numbers added to text.	This ensures the split CV lid drawings are included in the SAR.
Page 2-26	Section 2.3.2	Drawing numbers added to text. The leakage test on manufacture of the insert has been added to section.	This ensures the split CV lid drawings are included in the SAR. The leakage testing of the inserts has always been carried out however it wasn't included in this

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
			section, it has now been added for completeness.
Page 2-27	Section 2.4.3	Reference to new figure in section 1.	Includes reference to split CV lid figure added in section 1.
Page 2-28	Section 2.6.1.1	Maximum pressure section updated to take into account the pressure generated by Mo-99.	This section is now linked to section 3.3.2 to ensure the correct pressure is presented in section 2.
Page 2-39	Section 2.6.7	Note added to clarify tests were carried out on the standard lid CV along with a description of why this is the worst case test condition.	The addition of Mo-99 necessitates a split lid CV. The loading on the CV lid is worst case for the standard lid, therefore the results bound the results of the split CV lid.
Page 2-47 and 2-47a	Section 2.6.1.2	Discussion added to provide argument that existing testing bounds that of the split CV lid design.	The split lid is being added to the SAR a discussion is required as to why the existing testing covers the split CV lid design.
Page 2-57	Section 2.7.4.1	Altered the maximum pressure to account for the Mo-99 contents	Radiolysis of the Mo-99 solution causes the pressure to rise in the CV above that of the existing contents. Therefore the pressure needed to reflect this, however the pressure of the CV remains within the design pressure.
Chapter 3 - Thermal Evaluation			
Page 3-11	Section 3.3	Inclusion of standard CV lid in the section.	This makes clear the thermal testing was carried out with a standard CV lid.
Page 3-15	Section 3.3.2	Gas generation calculations for liquid Mo-99 added.	The gas generation rates provide the required data to support the inclusion of Mo-99 liquid.
Pages 3-15a and 3-15b	Section 3.3.2	Extra pages added to allow for the text regarding hydrogen generation.	The gas generation rates provide the required data to support the inclusion of Mo-99 liquid.
Page 3-19	Section 3.4.3	Inclusion of hydrogen pressure in the HAC pressure calculation.	This pressure is required to demonstrate the addition of Mo-99 will not increase the pressure

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
			above the design pressure.
Page 3-22	Section 3.5.2	Mallinckrodt report added.	This report provides hydrogen generation rates for the MURR Mo-99 liquid.
Chapter 4 - Containment Evaluation			
Page 4-1	Section 4.1	Added standard and split CV lid to text, this includes a new figure which demonstrates the containment boundary of the split CV lid. New drawing numbers added.	Addition of Mo-99 contents requires a new split CV lid design.
Page 4-2	Figure 4-1	Title of figure changed.	To clarify that this figure shows the standard CV lid.
Page 4-2a	Figure 4-2	Figure added.	Figure demonstrates the containment boundary of the split CV lid. Addition of Mo-99 contents requires a new split CV lid design.
Page 4-5	Section 4.3.2	Maximum internal pressure increased to 1100 kPa.	This change to the maximum internal pressure was made during the RAI process on the last certificate application. This section however wasn't updated in accordance with the required change. Therefore this error is corrected during this application.
Chapter 5 - Shielding Evaluation			
Page 5-1	Section 5.1.1	A description of the split CV lid, tungsten liner and new steel insert added to section. Figure references updated.	Addition of Mo-99 contents requires a new split CV lid design, insert and tungsten liner.
Page 5-2	Figure 5-1	Title altered.	This clarifies that this figure is of a standard CV lid.
Page 5-3	Figure 5-2	Figure added.	This figure shows the shielding present for the liquid Mo-99 contents.

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Page 5-5	Figure 5-6	Figure added.	This figure shows the new steel insert design for the Mo-99 contents.
Page 5-8	Section 5.3.1	Addition of shielding report for Mo-99 in a steel insert and tungsten liner.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Pages 5-9 to 5-10	Section 5.4.1	Addition of Mo-99 shielding calculation.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Pages 5-10 to 5-11	Table 5-5	Addition of Mo-99 to the table along with clarification of the CV type used in the calculation.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Page 5-15	Figure 5-10	Figure added.	Demonstrates the source location for the Mo-99 content shielding evaluation.
Page 5-16	Figure 5-11	Figure added	Demonstrates the source location for the Mo-99 content shielding evaluation.
Page 5-17	Figure 5-12	Figure added	Demonstrates the source location for the Mo-99 content shielding evaluation.
Page 5-19	Section 5.4.2	Addition of Mo-99 contents.	Allows the shipment of liquid Mo-99 in the HS package.
Page 5-20	Section 5.5.1	Addition of Mo-99 shielding calculation.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Page 5-20	Section 5.5.2	Addition of Mo-99 shielding calculation.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Page 5-21	Section 5.5.3	Addition of Mo-99 shielding calculation.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Page 5-24	Section 5.5.4.2	Addition of section.	This section discusses the shielding calculations carried out for liquid Mo-99 and the subsequent results.

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Pages 5-24 to 5-25	Table 5-12 and Table 5-13	Addition of Mo-99 shielding calculation results.	This provides the shielding data to allow the inclusion of Mo-99 onto the approved contents list.
Page 5-28	Section 5.5.6	Addition of Mo-99 shielding report to supporting documents list.	Added on this application to allow the addition of Mo-99 to the approved contents list.
Chapter 6 - Criticality Evaluation			
None		None	
Chapter 7 - Operating Procedure			
Pages 7-2 to 7-3	Section 7.1.1	Standard and split CV lid added to title and section. Extra steps added to describe the removal of the split lid. Drawing numbers added for the split CV lid.	Addition of Mo-99 contents requires a new split CV lid design. This section now includes operational requirements for this split lid.
Page 7-4	Section 7.1.2	Standard lid added to title. Clarification added that the standard lid shall only be used with the existing tungsten and steel inserts.	Shielding calculations have only been carried out with the existing inserts and the standard lid, this operational description ensures existing contents will not be loaded with the split lid or new insert.
Pages 7-4 to 7-5	Section 7.1.3	Extra section added.	This section describes the loading of the split CV lid design.
Page 7-5	Section 7.1.4	Standard and split CV lid added to title and section.	Addition of Mo-99 contents requires a new split CV lid design. This section now includes instruction for the preparation of transport for the split lid containment vessel.
Page 7-7	Section 7.2.2	Standard lid added to title.	This ensures the operators remove the contents correctly for the standard lid containment vessel.
Page 7-8	Section 7.2.3	Extra section added.	This section describes the removal of the contents for the split CV lid design.

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Page 7-9	Section 7.3.1	Standard lid added to title.	This ensures the operators remove the contents correctly for the standard lid containment vessel.
Pages 7-10 to 7-11	Section 7.3.2	Extra section added.	This section describes the preparation of an empty package for shipment with the split CV lid design.
Chapter 8 - Acceptance Tests & Maintenance Program			
Page 8-2	Section 8.1.2	Split CV lid drawing numbers added to section.	Addition of liquid Mo-99 contents require the split CV lid, new insert and tungsten liner. The new drawings are therefore added to the section.
Page 8-2	Section 8.1.4	Helium leakage test of lid component clarified for the split CV lid.	The helium leakage test for the lid component is only carried out after machining and not also prior to machining as with the standard lid. This is because the plug is not welded to the lid.
Page 8-3	Section 8.1.5.2	Standard and split lid added to section	This provides clarification these tests are required for both lid designs.
Page 8-3	Section 8.1.5.4	Drawing numbers added to text.	This ensures the split CV lid drawings are included in the SAR.
Page 8-4	Section 8.1.5.5	Drawing numbers added to text.	This ensures the split CV lid drawings are included in the SAR.
Page 8-4	Section 8.1.5.6	Drawing numbers added to text.	This ensures the split CV lid drawings are included in the SAR.
Page 8-4	Section 8.1.6	Inclusion of tungsten liner into the shielding test requirements. Addition of ultrasonic testing of the DU to determine the performance of the DU finished component.	The addition of Mo-99 requires the addition of the tungsten liner for shielding purposes. The ultrasonic test has been added as an alternative to the gamma scan to allow flexibility during manufacture.
Page 8-6	Section 8.2.3.1	Drawing numbers added to text.	This ensures the split CV lid drawings are included in the SAR.

Summary of SAR Page Changes and Supporting Document Changes for Rev 7			
SAR Page	**Location**	**Change**	**Reason for Change**
Pages 8-7a to 8-8	Section 8.2.3.3	Standard and split CV lid added to title and section. Reference to split CV lid drawings added.	Addition of Mo-99 contents requires a new split CV lid design.
Page 8-10	Section 8.2.3.7	Section added.	Addition of the Mo-99 contents requires a new tungsten liner to provide shielding. This section presents the checks to be carried out on the liner during maintenance.
Page 8-11	Table 8-1	Tungsten liner added to table.	Addition of the Mo-99 contents requires a new tungsten liner to provide shielding.

4 NRC Questions and Croft Responses

This section is provided to document all NRC Questions and Croft Responses.

Table 2 - Question and Response Matrix Table

Q#	Review Question	Croft Response	Changed Item
	None at this stage.		

Appendix A New or edited SAR pages provided in the SAR at Rev 7

Chapter	Pages
0	0-2 to 0-14
1	1-2 to 1-12, 1-13a , 1-14, 1-22, 1-33 to 1-35, 1-37, 1-38
2	2-1 to 2-5, 2-18 to 2-19a, 2-21, 2-24 to 2-28, 2-39, 2-47, 2-47a, 2-57, 2-58
3	3-11, 3-15, 3-15a, 3-15b, 3-19, 3-22
4	4-1 to 4-2a, 4-5
5	All
7	All
8	8-2 to 8-4a, 8-6, 8-7a, 8-8, 8-10, 8-11

Appendix B New or edited Supporting Documents provided in the SAR at Rev 7

Related SAR Section or Doc	Document Reference		Title
Chapter 1 - General Information			
Documents in Section 1.3.3, Licensing Drawings			
Addition	1C-7500	A	Cover sheet for Safkeg-HS design No. 3977A – Mallinckrodt Version
Addition	0C-7501	A	Safkeg HS design no.3977A – Mallinckrodt Version
Addition	0C-7502	A	Keg Design No.3977 – Mallinckrodt Version
Addition	0C-7503	A	Cork Set for Safkeg HS – Mallinckrodt Version
Addition	1C-7504	A	Containment Vessel Design No 3978 – Mallinckrodt Version
Addition	1C-7505	A	Containment vessel lid – Mallinckrodt Version
Addition	1C-7506	A	Containment vessel body – Mallinckrodt Version
Addition	1C-7507	A	Containment Vessel Plug – Mallinckrodt Version
Addition	2C-7508	A	HS-50x85-SS insert design no 4081
Addition	2C-7509	A	Snap Ring
Addition	2C-7510	A	Tungsten Liner
Documents in Section 1.3.4 Supporting Documents			
Update	PCS 036	F	Package Contents Specification for Safkeg-HS - Package Design No 3977A
Chapter 3 – Thermal			
Documents in Section 3.5.2			
Addition		V2.2	Radiolytic Gas Formation in Mallinckrodt Produced Mo99 Solutions
Chapter 5 – Shielding Evaluation			
Documents in Section 5.5.2			
Addition	AMEC/CRM42622 /TN_001	1	HS Container Shielding Assessment with Mo-99