CONTENTS

8 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

This section details the requirements of the acceptance and maintenance test program for the Safkeg-HS 3977A package. The requirements of the sections below ensure compliance with Subpart G of 10 CFR Part 71[8.1].

It is the responsibility of the authorized maintenance organization to produce approved procedures which comply with the requirements of this SARP and 10 CFR 71 Subpart G with regard to all aspects of maintenance. The maintenance organization shall also have a Quality Assurance Program that meets the requirements of 10 CFR 71 Subpart H and shall maintain records that meet the requirements of 10 CFR 71.91.

The authorized maintenance organization is required to notify the SARP owner of any instance in which the packaging fails to meet the criteria of Section 8.2 during maintenance activities.

All drawings referred to in this section are included in Section 1.3.2 of the SARP.

8.1 Acceptance Tests [71.85]

This section describes the requirements for the acceptance tests to be performed prior to the initial use of the packaging. The tests shall be performed in accordance with written procedures produced by the manufacturing organization.

Initial inspection and acceptance tests are carried out during the fabrication of the packaging components by the manufacturer. These tests include dimensional, visual, liquid penetrant and radiographic inspections, structural pressure tests, and leakage tests.

8.1.1 Visual Inspections and Measurements

All components including the inserts shall be subject to visual checks to ensure that they have been fabricated and assembled in accordance with the general arrangement drawings in Section 1.3.3. The dimensions, tolerances and surface finishes shown on the drawings shall be verified by measurement of each packaging component.

Non-conforming components shall be rejected using the approved manufacturer's organization's non-conformance system. Disposition of rejected components should be reworked, used as is, or scrapped and replaced. The SARP owner should be notified of all disposition actions.

8.1.2 Weld Examinations

All keg welds shall be examined according to drawing 0C-5942. The containment vessel welds shall be examined in accordance with drawings 1C-5945 and 1C-5946. Non-conforming components shall be rejected using the approved manufacturer's organization's non-conformance system. Disposition of rejected components should be reworked, used as is, or scrapped and replaced. The SARP owner should be notified of all disposition actions.

8.1.3 Structural and Pressure Tests [71.85 (b)]

A Pressure test of the containment vessel shall be performed in accordance with the ASME B&PV Code, Subsection NB-6000[8.2]. These tests shall be conducted at 12.5 bar gauge (181 psig) which is 1.25 times the maximum design pressure of 10 bar gauge (145 psig). The pressure shall be held for a minimum of 10 minutes. The pass criteria for the test shall be no gross leakage (i.e. no visible leakage detected without use of instruments) and no permanent deformation of the lid of the containment vessel under test. This test pressure exceeds the requirements of 10 CFR 71.85(b) [8.1] which requires a test pressure of 1.5 x MNOP (7 barg) which is 10.5 bar gauge (152 psig).

Non-conforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications in the manufacturing drawings and specifications referenced in the certificate and Section 1 of the SARP.

8.1.4 Leakage Tests

Leakage testing of the containment boundary defined in Section 4 shall be carried out in accordance with ANSI N14.5 [8.3]. The containment vessel flange/cavity wall shall be leak tested after fabrication using the gas filled envelope test A.5.3 in ANSI N14.5 [8.3] as described in section 8.1.5.4. The containment vessel lid top shall be helium leak tested prior to and after machining using the gas filled envelope test A.5.3 in ANSI N14.5 as described in section 8.1.5.3. Leak rate testing of the containment vessel closure shall be performed using the evacuated envelope gas detector method A.5.4 with helium as the tracer gas and a helium leak detector. The test sensitivity shall be 5×10^{-8} ref.cm^3/s and the acceptance rate shall be 1×10^{-7} ref.cm^3/s

Leakage testing of the insert shall be carried out in accordance with ANSI N14.5 [8.3]. Leak rate testing shall be performed using the vacuum bubble method. The test sensitivity shall be 10^{-3} ref.cm^3/s and the acceptance rate shall be no visible stream of bubbles.

Non-conforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications in the manufacturing drawings and specifications referenced in the certificate and Section 1 of the SARP.

8.1.5 Component and Material Tests

8.1.5.1 Package weight

The package shall be weighed on a set of calibrated scales with a resolution of 10g. The weight of the package shall not exceed 163 kg (359.4 lbs). Any non-conforming packages shall be reworked or rejected.

8.1.5.2 Containment Vessel O-rings

In addition to ensuring that the EP O-ring seals meet the specification in drawing 1C-5944, two inner and two outer O-ring seals from each manufacturing batch shall be removed and tested for the ability to remain leaktight, after 1000 hours at 150°C and 24 hours at 200°C in a test rig representing the CV. These O-rings shall be sacrificial and not returned to the manufacturing batch.

One O-ring set (inner and outer) will be used for the 150°C test and another O-ring set shall be used for the 200°C test. The same O-ring set may be used for both tests but each test shall be carried out independently of the other, with each test having a separate helium leak test.

The 3978 prototype containment vessel, serial no 0002 (modified for NCT and HAC testing), may be used as the test rig or, alternatively, a dedicated test rig may be used which replicates the critical dimensions of the containment vessel, including the O-ring seal groove dimensions. The test rig shall be constructed of the same materials as the containment vessel in the vicinity of the O-ring seals.

The test equipment shall include a helium mass spectrometer leakage detector (MSLD) and fittings to connect to the test ports in the test rig lid.

The O-ring shall be lubricated and fitted in position, the closure screws shall be tightened to 10±0.5 Nm. A Thermocouple shall be fitted to the test rig in the O-ring seal interspace. Additional thermocouples may be attached to the surface of the test rig.

The O-rings shall then be tested at 150°C or 200°C depending on the required test. The test rig for both tests shall be placed into an air circulating oven. The temperature of the oven will be raised until the O-rings reach the required temperature of the test either 150°C or 200°C. The temperature of the O-rings shall be maintained for 1000 hours at 150°C to 155°C for the 150°C test or for 24 hours at 200°C to 205°C for the 200°C test. Once the O-rings have been held at the required temperature for the required amount of time the test rig shall be cooled to room temperature.

Once cooled the O-rings shall be helium leak tested using the evacuated envelope gas detector method A.5.4, with helium as the tracer gas and a helium leak detector. The test sensitivity shall be 5×10^{-8} ref.cm^3/s and the acceptance rate shall be 1×10^{-7} ref.cm^3/s.

8.1.5.3 Containment Vessel Lid Top

The containment vessel lid top shall be helium leak tested prior to machining in accordance with the gas filled envelope test A.5.3 in ANSI N14.5 [8.3], to ensure it is leak tight prior to further manufacture.

The leak test sensitivity shall be a minimum of 5×10^{-8} ref.cm^3/s air and the acceptance leak rate shall be 1×10^{-7} ref-cm^3/s. Any non-conforming components not meeting this criterion shall be reworked or rejected.

On completion of the machining operation the containment vessel lid top shall be helium leak tested in accordance with the gas filled envelope test A.5.3 in ANSI N14.5 [8.3], to ensure it is leak tight prior to further manufacture.

The leak test sensitivity shall be a minimum of 5×10^{-8} ref.cm^3/s air and the acceptance leak rate shall be 1×10^{-7} ref-cm^3/s. Any non-conforming components not meeting this criterion shall be reworked or rejected.

8.1.5.4 Containment Vessel Flange/Cavity Wall

The containment vessel flange/cavity wall shall be helium leak tested in accordance with the gas filled envelope test A.5.3 in ANSI N14.5 [8.3], to ensure it is leak tight prior to further manufacture.

The leak test sensitivity shall be a minimum of 5×10^{-8} ref.cm^3/s air and the acceptance leak rate shall be 1×10^{-7} ref-cm^3/s. Any non-conforming components not meeting this criterion shall be reworked or rejected.

8.1.5.5 Cork

Each batch of the inner, outer and top cork shall have its specific weight measured according to drawing 0C-5943(section 1.3.3) and meet the criterion of 250 to 290 kg/m^3. Any cork not meeting this criterion shall be rejected.

8.1.5.6 DU Shielding

The chemical composition of each batch of depleted uranium shall be analyzed to assure that the alloy meets the specifications. The chemical composition shall meet the requirements given in drawing 1C-5946 (section 1.3.3). The density of the depleted uranium contents shall be determined using a water displacement method. The finished DU components shall be visually inspected to verify that the surfaces are free of cracks and voids. Any items not meeting the acceptance criterion will be rejected.

8.1.5.7 Stock Material Used to Manufacture the Containment Boundary

The stock material, Stainless Steel 304L, used to manufacture items that make up the containment boundary as defined in Section 4.1, shall be examined with liquid penetrant and ultrasonic tests according to drawings 1C-5945 and 1C-5946.

8.1.6 Shielding Tests

Section 8.1.5 discusses the material tests for the DU components.

8.1.7 Thermal Tests

A prototype package has been fully tested as described in Section 2 and shown to perform satisfactorily under both Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC).

The package design is such that specific tests of manufactured components are not required to prove adequate thermal performance. This package has no special thermal features other than the cork insulation. With the low heat load and the design margins on allowable material temperature, the package requires no special thermal testing as part of the post-manufacture acceptance test.

8.1.8 Miscellaneous Tests

Not applicable.

8.2 Maintenance Program

The maintenance program for the SAFKEG 3977A packaging applies to periodic maintenance, and to packagings that have failed the pre-shipment inspection specified in Section 7.1.1. It ensures the continued performance of the package throughout its lifetime.

The maintenance program includes periodic testing, inspection and replacement schedules. Criteria are also included for the repair of components and parts on an ‘as needed’ basis. A summary of the maintenance requirements is given in Table 8-1.

This section provides the minimum requirements required in order to maintain the package. From these requirements each organization, authorized to perform maintenance, shall prepare specific instructions and checklists, in accordance with that organization's Quality Assurance Program, that will ensure compliance with the requirements of Section 8.2.

Any non-conforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications in the manufacturing drawings and specifications referenced in the certificate and Section 1 of the SARP.

The maintenance organization is required to notify the SARP owner of any instance in which the packaging fails to meet the criteria of Section 8.2 is found during maintenance.

The periodic maintenance activities, as specified in Section 8.2, shall have been performed not more than 1 year prior to shipment.

8.2.1 Structural and Pressure Tests

Structural and pressure testing do not form part of the periodic maintenance requirements.

8.2.2 Leakage Tests

8.2.2.1 Containment Vessel

Maintenance leakage testing of the containment vessel shall be in accordance with the evacuated envelope (gas detector) test A.5.4 in ANSI N14.5 [8.3]. The test shall use a suitable helium leak detector. The test sensitivity shall be 5×10^{-8} ref.cm^3/s and the test pass rate shall be 1×10^{-7} ref.cm^3/s. The O-rings shall be coated with a light film of silicone O-ring lubricant for lubrication, and replaced if damaged.

The leakage rate testing shall be performed during the periodic maintenance tests, this shall not exceed 12 months prior to package use. The leakage rate test shall also be performed after the following maintenance activities:

- replacement of the containment seal
- repair of the containment sealing surface
- repair or replacement of the containment vessel lid or body

8.2.2.2 Inserts

The maintenance leakage testing of the inserts shall be in accordance with the vacuum bubble test A.5.6(b) in ANSI N14.5 [8.3]. The test sensitivity shall be 10^{-3} ref.cm^3/s and the acceptance rate shall be no visible stream of bubbles.

The leakage rate testing shall be performed during the periodic maintenance tests, this shall not exceed 12 months prior to package use. The leakage rate test shall also be performed after the following maintenance activities:

- replacement of the insert seal
- repair of the insert sealing surface
- repair or replacement of the insert lid or body

8.2.3 Component and Material Tests

The following sections describe the periodic maintenance requirements for package operation. Additional maintenance may be required on packagings that have failed the pre-shipment inspection process. Any additional maintenance requirements shall follow the periodic maintenance and its associated record keeping requirements.

8.2.3.1 Stainless Steel Surfaces

All of the stainless steel surfaces of the keg and containment vessels shall be visually inspected for corrosion. The presence of any surface corrosion on any component shall be cause for further inspection. If the corrosion can be easily wiped off, and no pitting is apparent beneath it, the component is acceptable. If the corrosion cannot be easily wiped off, or if scaling is present, or if pitting is observed, then the surface shall be reworked and the component must undergo a dimensional inspection and dye penetrant and/or radiographic testing to determine the extent of the damage.

In the case of the containment vessel, a hydrostatic test shall be performed. All acceptance criteria for a newly fabricated component (drawing 1C-5944) shall apply to the reworked component. If the corrosion has compromised the structural integrity of the component (e.g. the component no longer meets dimensional criteria for a new part as specified on drawing 1C-5944), then the component shall be rejected. The inspection results and any necessary replacement or repairs, shall be recorded in the package maintenance records.

8.2.3.2 Keg

1. The model/serial numbers of the keg assembly (keg body and keg lid) shall be checked to be matched: where the model/serial numbers of the keg assembly (body and lid) do not match, these assemblies shall be removed from service.

2. The keg name plate shall be checked for legibility of the nameplate information.

3. The keg outer shell shall be visually checked for unacceptable defects. Unacceptable defects are dents greater than 8.06 mm (0.3 in.) in depth; cracking of welded joints; penetration of the keg skin; or abrasion or scratches greater than half the thickness of the keg skin [shell thickness is 2 mm (0.080 in.)].

4. The keg closure studs shall be checked for tightness of fit in the keg top flange and damage (i.e. stripped or distorted). A die nut (thread class 6g) shall be used to clear any tight threads. The closure studs shall be checked that they are positioned in accordance with drawing 0C-5942. If the stud is loose or the height is incorrect, the stud shall be removed, cleaned, and repositioned using Loctite 270.

5. The keg lid seal and respective groove shall be checked for visible damage such as splits or cuts in the lid seal and scratches in the lid seal groove. The lid seal shall

fit correctly into the seal groove. The lid seal shall be replaced as necessary; there is no requirement for periodic replacement.

6. The keg, keg lid, and keg closure nuts shall fit up freely. Any damaged nuts or washers shall be replaced according to drawing 0C-5942.

7. The fuse plug and spring washer shall be visually inspected for presence in the keg and damage and wear. A damaged or missing fuse plug or washer shall be replaced according to the specifications in drawing 0C-5942.

8. Nonconforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications in the manufacturing drawings and specifications referenced in the certificate and Section 1 of the SARP.

9. The inspection results and any necessary replacement or repairs, shall be recorded in the package maintenance records.

8.2.3.3 Containment Vessel

1. The model/serial numbers of the body and lid shall be checked to be matched: where the model/serial numbers of the containment vessel assembly (body and lid) do not match, these assemblies shall be removed from service.

2. The Containment Vessel components shall be checked for visible damage and in particular that the closure components assemble freely by hand. Any defects affecting the operation or integrity must be corrected or a part replaced.

3. The welds on the containment vessel body and lid shall be visually checked for defects and evidence of cracking.

4. The threads in the closure of the containment vessel and the closure screws shall be cleaned and the threads shall be coated with molybdenum disulfide dry film spray lubricant.

5. The surface finish of the faces against which the O-rings seat shall be visually inspected. These faces shall be circular and there shall be no scratches across the lay. Scratches shall be polished out to return the surface to the specification in the drawings or the component rejected.

6. The three O-rings marked on drawing 1C-5944 shall be replaced. These O-rings must be replaced annually. The O-rings shall be coated with a light film of silicone O-ring lubricant (Parker Super O-Lube). The O-rings shall be within the valid expiration date as specified by the manufacturer. O-rings shall be procured and tested in accordance with drawing 1C-5944.

7. Leakage testing of the containment vessel shall be carried out in accordance with ANSI N14.5 [8.3]. The test sensitivity shall be 5 x 10^{-8} ref.cm^3/s and the test pass rate shall be 1 x 10^{-7} ref.cm^3/s.

8. Nonconforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications in the manufacturing drawings and specifications referenced in the certificate and Section 1 of the SARP.

9. The inspection results and any necessary replacement or repairs, shall be recorded in the package maintenance records.

8.2.3.4 Cork Set

1. The cork packing pieces (top cork, inner cork and outer cork) shall be visually inspected for chipping and cracking. The pieces shall be checked for fit within the assembled package. They shall fit without interference.

2. Non-conforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the specifications drawing 0C-5943 and specifications referenced in the certificate and Section 1 of the SARP.

3. The inspection results and any necessary replacement or repairs, shall be recorded in the package maintenance records.

8.2.3.5 Inserts

1. The model/serial numbers of the body and lid shall be checked to be matched: where the model/serial numbers of the insert (body and lid) do not match, these assemblies shall be removed from service.

2. The insert components shall be checked for visible damage and in particular that the lid screws freely by hand onto the body. Any defects affecting the operation or integrity must be corrected or a part replaced.

3. The lid and body threads shall be cleaned and coated with molybdenum disulfide dry film spray lubricant.

4. The presence of the O-ring shall be checked and replaced if missing. The O-ring shall be coated with a light film of silicone O-ring lubricant.

5. The insert shall be leak tested as specified in section 8.2.2.2.

6. Non-conforming components shall be rejected and controlled for rework, or scrapped and replaced. Components that are reworked or replaced shall meet the

specifications on drawing 2C-6173, 2C-6174 and 2C-6176 and the specifications referenced in the certificate and Section 1 of the SARP.

7. The inspection results and any necessary replacement or repairs, shall be recorded in the package maintenance records.

8.2.4 Thermal Tests

This package has no special thermal features other than the cork insulation. Therefore, the package requires no special thermal testing as part of the routine maintenance. Visual inspection is sufficient to check that components are in satisfactory condition.

8.2.5 Miscellaneous Tests

This section discusses the requirements for replacing component parts on the package. These parts may be newly manufactured or substituted components from other packages. The keg which bears the serial number of the package will form the host component.

8.2.5.1 Replacement of a Closure Lid

If a closure lid is replaced, a maintenance leak rate test shall be performed in accordance with Section 8.1.4. The replacement shall be noted in the maintenance log along with the results of the leak test.

8.2.5.2 Replacement of the Containment Vessel Body

If the containment vessel body is replaced, it shall first be checked to ensure that the lid, closure screws and O-rings all fit. A maintenance leak test shall then be performed according to Section 8.1.4. The replacement shall be noted in the maintenance log along with the results of the leak test.

8.2.5.3 Replacement of a Containment Vessel

If the containment vessel is substituted the replacement shall be noted in the package maintenance log. The replacement containment vessel shall be manufactured to the requirements shown in the general arrangement drawings in Section 1.3.2.

8.2.5.4 Replacement of a Keg Lid

If the keg lid is replaced, the replacement shall be noted in the package maintenance log.

Table 8-1 Package Maintenance Summary

Item	SARP Section	Pre Shipment Action	Annual Maintenance Action	Tests on repair/replacement
Containment Vessel Surfaces	8.2.3.3	V	V	Leak Test
Containment O-ring	8.2.3.3	V, Leak Test	R, Leak Test	Leak Test
Leak test O-ring	8.2.3.3	V	R	
Test Port O-ring	8.2.3.3	V	R	
O-ring sealing surfaces	8.2.3.3	V	V	
Containment Vessel threaded inserts	8.2.3.3	O	V	
Containment vessel screws	8.2.3.3	O, V	V	
Keg surfaces	8.2.3.2	V	V	
Keg lid seal	8.2.3.2	V	V	
Lid seal sealing surfaces	8.2.3.2	V	V	
Keg Studs	8.2.3.2	O, V	V	
Keg bolts and washers	8.2.3.2	O	V	
Fuse plug	8.2.3.2		V	
Fuse plug washer	8.2.3.2		V	
Cork	8.2.3.4	V	V	

Notes: V = Visual Inspection, R = Replace, O = Operational test

8.3 Appendix

8.3.1 References

[8.1] Title 10, Code of Federal Regulations, Part 71, Office of the Federal Register, Washington D.C.

[8.2] ASME III Division 1 – Subsection NB, Class One Components, Rules for Construction of Nuclear Facility Components, ASME Boiler and Pressure Vessel Code, 2001 edition, the American Society of Mechanical Engineers, New York, New York.

[8.3] ANSI N14.5, American Standards for Radioactive Materials – Leakage Tests on Packages for Shipment, American National Standards Institute, 1997.