SARP REVISION STATUS

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1 GENERAL INFORMATION

1.1 Introduction

This Safety Analysis Report for Packaging (SARP) has been prepared by Croft Associates Ltd for the new approval of the Safkeg-LS 3979A package as a Type B(U) design.

The Safkeg-LS 3979A package is a general purpose container for the transport of non-fissile nuclides and limited quantities of fissile nuclides as specified under NRC general licenses, under non exclusive and exclusive use. The contents may be in solid, liquid and gaseous form. The modes of transport specified are road, rail, sea and air. A detailed list of the nuclides can be found in Section 1.2.2. The contents of the package include some nuclides in excess of 3000 A_2 and therefore the package is classified as Category I as defined in NUREG 1609 [1.1].

The Safkeg-LS 3979A package was designed in 2008 and a prototype package fabricated and tested in 2009. Analysis of the safety of the design has also been carried out: the results of the tests and the analysis are provided in this SARP.

All design, manufacturing and testing has been carried out in accordance with the Croft Quality Assurance program which complies with 10 CFR 71 subpart H [1.2] and is approved by the NRC under Approval Number 0939. This SARP has been prepared in accordance with Regulatory Guide 7.9 [1.3] and demonstrates that the package meets all the applicable requirements in 10 CFR 71 [1.2].

5.2 Summary Table of Maximum Radiation Levels

Table 5-1 shows the package maximum NCT dose rates for exclusive use. The maximum quantities of the allowable contents were derived assuming a surface dose rate of 2 mSv/hr. However due to analytical uncertainties, package tolerances and the method of calculation the surface dose rates required increasing in accordance with CTR 2015/10. Therefore the surface dose rates exceeded that of non exclusive use so they were assessed against those of Exclusive use.

Under 10 CFR 71.47(b) if a package exceeds the limits specified in 71.47(a) it shall be shipped under exclusive use and the radiation levels shall not exceed the following during shipment:

1) 2 mSv/h (200 mrem/h) on the external surface of the package, unless the following conditions are met, in which case the limit is 10 mSv/h (1000 mrem/h):

(i) The shipment is made in a closed transport vehicle;

(ii) The package is secured within the vehicle so that its position remains fixed during transportation; and

(iii) There are no loading or unloading operations between the beginning and end of the transportation;

(2) 2 mSv/h (200 mrem/h) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure, if used, and on the lower external surface of the vehicle; and

(3) 0.1 mSv/h (10 mrem/h) at any point 2 meters (80 in) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 meters (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle); and

(4) 0.02 mSv/h (2 mrem/h) in any normally occupied space, except that this provision does not apply to private carriers, if exposed personnel under their control wear radiation dosimetry devices in conformance with 10 CFR 20.1502.

The Safkeg-LS package will be transported in a closed sided truck. The smallest truck that shall be used is an 18 foot (5.5 m) truck. The minimum internal dimensions of this truck are 7'4" (2.24 m) wide and 7' (2.13 m) high. The package shall be secured in position using a transport pallet it shall secure the pallet so that it is at least 20 cm from the base, side and top of the truck.

Within Table 5-1 it has been assumed that the dose rate for each surface is the highest rate calculated. The surface dose rate of the truck has been calculated assuming that the package is only 20 cm from the surface of the truck, therefore accounting for the worst case scenario.

Table 5-1 Summary Table of Maximum Radiation Levels Under Normal Conditions of Transport Under Exclusive Use

	Total Gamma + Neutron mSv/h (mrem/h)			10 CFR 71.47(b) Limit
Location	Top	Side	Bottom	
Package Surface	2.74 (274)	2.74 (274)	2.74 (274)	10 (1000)
Truck Surface	0.4 (40)	0.4 (40)	0.4 (40)	2 (200)
2m from Edge of the Truck	0.008 (0.8)	0.008 (0.8)	0.008 (0.8)	0.1 (10)

In practice, the surface dose rate will be less than the calculated dose rates for maximum contents of 2.74 (274) mSv/h (mrem/h) because the assumptions for the calculations as summarized below are inherently conservative.

The MicroShield calculations are based on the following worst case assumptions.

- Self shielding is neglected as the contents are assumed to be a point source.
- The point source is positioned in the worst position (centre of bottom of the Insert) whereas in practice it will usually be a volume distributed throughout a significant part of the cavity.
- Shielding provided by the Product containers is neglected.

The Monte Carlo calculations for liquid contents are based on the following worst case assumptions.

- The CV Lid and CV Body (see Section 5.3.1.1) have maximum gap dimensions.
- The CV Lid has maximum offset within the CV Body.
- All the liquid has leaked from the Product Container and also from the Insert.
- The package is upside down on its lid.
- The liquid has flowed to completely fill the gap between the CV Lid and CV Body.

5.4.2 Material Properties

The material properties used for the shielding evaluations are given in the reports referenced in Section 5.3.1.

5.5 Shielding Evaluation

5.5.1 Methods

The methods used for the Monte Carlo shielding calculations are reported in SERCO/TAS/003191(Section 5.5.2).

The methods used for the MicroShield shielding calculations are reported are CTR 2009/22 (Section 5.5.2). This includes the methodology for assessing gamma emitters, beta emitters and neutron emitters.

5.5.2 Input and Output Data

The input and output data for the Monte Carlo shielding calculations are reported in SERCO/TAS/003191 (Section 5.5.2).

The input and output data for the MicroShield shielding calculations is reported are CTR 2009/22 (Section 5.5.2).

5.5.3 Flux to Dose Rate Conversion

The flux to dose rate conversion data for the Monte Carlo shielding calculations reported in SERCO/TAS/003191 (Section 5.5.2) are taken from ICRP 74 [3.2].

The flux to dose rate conversion data for the MicroShield shielding calculations reported in CTR 2009/22 (Section 5.5.2) are performed by the software using ICRP-51 [3.4], with the Anterior/Posterior values taken as these provided the highest surface dose rate. ICRP 51 provides a lower surface dose rate than using the conversion factors in ANSI/ANS 6.6.1-1977. Therefore a correction factor was applied to the results as detailed in CTR 2015/10.

5.5.4 External Radiation Levels

5.5.4.1 Monte Carlo calculations

5.5.4.1.1 Monte Carlo calculations for reference case (Ir-192)

The results of the Monte Carlo shielding calculations reported in SERCO/TAS/003191 (Section 5.5.2) for the reference case of 1kCi Ir-192 point source, with the source positioned all around the surface of the CV, are presented

5.6 Appendix

5.6.1 References

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

[3.2] ICRP Publication 74, "Conversion Coefficients for use in Radiological Protection against External Radiation", Annals of the ICRP 26 3/4, 1996

[3.3] CS 2009/14, SAFKEG-LS-3979A-Liquids shielding limits - HAC - based on TI

[3.4] ICRP Publication 51, "Data for Use in Protection against External Radiation", Annals of the ICRP, 1984

5.6.2 Supporting Documents

Document Reference	Title
CTR2009/22	SAFKEG LS 3979A: Package Activity Limits Based on Shielding
CTR2015/10	Uncertainties Associated with the Proposed Shielding Calculation Method for the SAFKEG-LS 3979A Package
SERCO/TAS/003191/001	Monte Carlo Modelling of Safkeg LS Container

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-6044) 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-6044), 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 8.9 mm (1 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-6042. If the stud is loose or the height is incorrect, the stud shall be removed, cleaned, and repositioned using Loctite 270 or Loctite 263. If any keg closure studs are damaged they shall be replaced according to drawing 0C-6042.