'SAFPAK' AND 'SAFKEG' PACKAGES – A NEW RANGE OF HIGH INTEGRITY PACKAGES FOR Pu AND U IN SOLID OR LIQUID FORM

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Abstract

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The paper outlines the need for new designs to replace existing designs and indicates the main problem areas and design philosophy adopted in arriving at new designs. Some novel design features are described and the range of designs currently developed are listed with their licensing status.

1. REQUIREMENT FOR NEW DESIGNS

Most packages currently available for transporting Pu and U were designed before the introduction of the IAEA 1973 Regulations for the Safe Transport of Radioactive Materials. The adoption of the IAEA 1973 Regulations resulted in a re-examination of the leaktightness criteria for all packages. The regulations established an allowable activity leakage criteria but gave little advice on how this could be achieved and what degree of engineering leaktightness is required to meet the activity leakage requirement.

The IAEA 1973 Regulations also introduced the requirement for a degree of Quality Assurance which was applied to the leaktightness criteria by the introduction of post-loading leak testing as required practice.

The new IAEA 1985 Regulations introduce the requirement for a high standard of Quality Assurance of design, licensing and manufacture; a standard which most existing designs do not meet because of the difficulty of retrospective quality control.

The packages described in this paper were designed specifically to overcome the problems noted above, as well as meeting all other requirements of the IAEA 1973 and 1985 Regulations.

2. TECHNICAL DEVELOPMENT

A number of technical problems had to be investigated to find practical solutions which would not make packages excessively expensive or difficult to use. The main considerations in the design (in arbitrary order) were:

Quality Assurance of design, manufacture and operation
High containment integrity
Provision of post-loading leak testing facility
Simplicity of design and operation
Safety of the package to be inherent in the design and not in the operating procedures
Ease of manufacture and reasonable cost
Minimisation of maintenance
Ease of use
Ease of decontamination
Design style suitable for covering a range of sizes

In developing the new SAFPAK & SAFKEG package designs, it was necessary to investigate acceptable leaktightness standards for powders, methods of leak testing capable of achieving the desired standard, and a design solution to the problem of providing virtually absolute leaktightness for Pu as liquid.

2.1 Pu powders are produced in a wide variety of particle sizes and it is necessary to consider the particle size when determining what standard of gas leaktightness is required for a particular seal configuration in order to achieve containment of the Pu powder within the regulatory limits. After studying the experimental evidence and considering the theoretical leakage rates from seals, the weight of evidence suggested that Pu powders would be completely contained by a containment vessel having a leaktightness of 10^{-5} bar cm^3/s SLR*. This has been accepted by the UK Competent Authority for all but superfine powders produced by special techniques.

2.2 The IAEA Regulations for the Safe Transport of Radioactive Materials are being interpreted in the UK as requiring post-loading, pre-shipment leaktightness tests for containment vessels. Where the requirement is a

FIG. 1. SAFKEG package design No. 2799E with the containment vessel being leak tested using a CALT pressure drop leak tester.

leaktightness of 10^{-5} bar cm^3/s SLR*, sophisticated methods such as helium mass spectrometry are normally required. However, pressure transducers and electronic digital pressure indicators are now sufficiently accurate to enable this level of leaktightness to be measured using pressure drop techniques, although this is dependent on the containment seal design providing a small test volume; usually by the use of double 'O' ring seals. Leak testing equipment (named CALT) and procedures were developed specifically to enable post-loading, pre-shipment leaktightness tests of the containment vessels incorporated in the SAFPAK & SAFKEG packages. The CALT leak tester is shown in Figure 1 attached to a containment can for a leak test.

2.3 The leaktightness requirement for a single containment vessel carrying Pu in liquid form is typically 10^{-10} bar cm^3/s SLR* (depending on the concentration of the liquid). This standard of leaktightness is not practically achievable using 'O' ring seals in a single containment vessel. To overcome this problem, double

TABLE 1 SAFPAK and SAFKEG PACKAGES for Pu & U

Package Design No	Approval Type	Certificate No	Validation Certificates	Overall Dia (mm)	Overall Length (mm)	Total Weight (kg)	Inner Design	Inner-most Design	Cavity Dia	Cavity Length (mm)	Degree of contain-ment	Maximum Contents (g Pu FC I)
2767B	B(U) B(U)F	GB/2767B/B(U) GB/2767B/B(U)F	Italy, USA	260	270	11.1	2775	----	84	121	Single	15 (Solids) 90 (Solids)
2767C	B(U) B(U)F	GB/2767B/B(U) GB/2767B/B(U)F	Italy, USA	260	270	12.7	2775	2800	54	90	Double	15 (Solids) 90 (Solids)
2781E	B(U)	GB/2781E/B(U)		425	460	45	2808	2807	75	109	Double	15 (Liquids)
2799E	B(U)F	GB/2799E/B(U)F		425	540	49.5	2812	----	116	200	Single	4600 (Solids)
2799F	B(U)F	UK Approval Pending		425	540	53	2815	----	180	255	Single	4600 (Solids)
2799H	B(U) B(U)F	GB/2799H/B(U) GB/2799E/B(U)F		425	540	55	2812	2783	75	155	Double	15 (Liquids) 4600 (Solids)
2799K	B(U)F	UK Approval Pending		425	540	59.4	2815	2812	116	200	Double	4600 (Solids)
2816A	B(U)F	GB/2816A/B(U)F		425	910	90	2817	----	115	602	Single	4600 (Solids)
2816C	B(U)F	UK Approval Pending		425	910	112.5	2851	----	157	630	Single	4600 (Solids)
2845A	B(U)F	UK Approval Pending		620	755	164	2846	----	157	320	Single	4600 (Solids)
2849A	B(U)F	UK Approval Pending		425	642	90	2846	----	157	320	Single	4600 (Solids)
2849B	B(U)F	UK Approval Pending		425	642	108	2846	2850	128	280	Double	4600 (Solids)

FIG. 2. SAFPAK package design No. 2767B.

containment is used in vessels for liquids. The inner containment vessel is completely separate from the outer containment vessel. Each vessel is fitted with double 'O' ring seals which are tested after loading with radioactive materials. When the inner vessel is placed within the outer containment vessel, the space between the two vessels is filled with an absorber (suitable for the liquid being carried) and a deflector cup fitted which would ensure that any liquid leaking from the inner vessel would have to pass over the surface of a large area of absorber before it could reach the seals of the outer containment vessel. The outer containment vessel when sealed is also leak tested via the interspace of the double 'O' ring seal. This combination of leaktight vessels and absorber has been accepted by the UK Competent Authority as providing absolute leaktightness for Pu liquids where both the containment vessels are subject to post-loading, pre-shipment leaktightness tests and where the standard of leaktightness for each vessel is 10^{-5} bar cm^3/s SLR*.

3. DEVELOPED PACKAGE DESIGNS

A range of packages has been fully developed with most designs having been fully tested and approved by the UK Competent Authority (see Table I). Package Designs No's 2767B and 2781E have been adopted by the IAEA for the shipment of small Safeguards samples in solid and liquid form respectively. Other designs are being used in the UK by the UKAEA and CEGB and in the USA by the DOE.

Figure 1 shows the components of a SAFKEG Package Design No 2799E with the containment can being leak tested using a CALT leak tester and Figure 2 shows the components of a SAFPAK Package Design No 2767B.

A number of the designs are provided with two 'nested' containment cans so that they meet the US NRC requirement for double containment for solid Pu contents. US DOE and NRC approval of Package Design No's 2767C and 2799H are currently being sought.

***Standardised Leak Rate (SLR)**

The **Standardised Leak Rate (SLR)** is the Leak Rate (evaluated under known conditions) normalised to reference conditions of air (at 25°C) leaking from an upstream pressure of 1 bar (abs) to a downstream pressure of 0 bar (abs).