SAFKEG - A Modern Family of Packages

R A Vaughan

Croft Associates Ltd, B2 North Culham Estate, Abingdon
Oxon OX14 13GY, United Kingdom

SUMMARY

The SAFKEG family of packages were developed specifically to replace existing fissile material packages designs which are based on 30 year old design concepts. The SAFKEG replaces 2 design concepts: the wood cadmium rectilinear packages used in the UK and 6M drum packages commonly used in the USA.

The design principles used in the SAFKEG are relatively novel, but were adopted specifically to provide a large design margin at a reasonable cost. The design features were chosen to facilitate the licensing process and to provide operational convenience.

The current designs, including those just about to be brought into service, are summarized.

USAGE

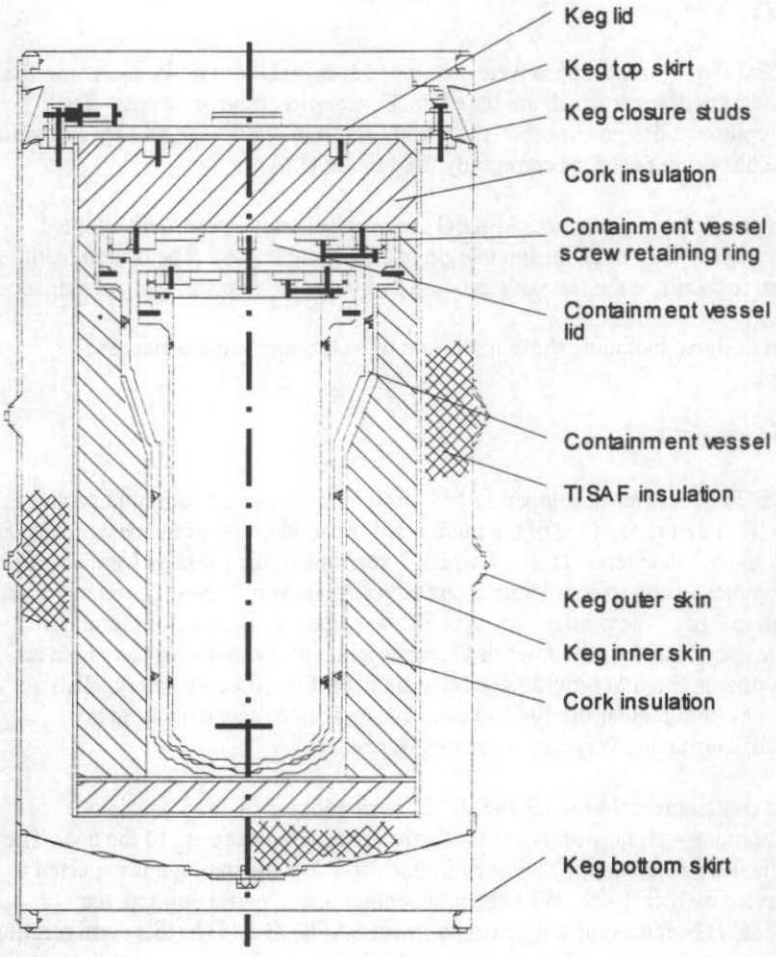
The SAFKEG 2816G was developed in 1987 to replace the wood cadmium packages in use in the UK at that time. One of the main reasons for adoption of the design was that it had been shown, in extended tests in which 2 versions of the package were dropped from a helicopter to impact a concrete target at > 80% terminal velocity, to have a very large design margin. The primary use was for the shipment of 18 kg of plutonium oxide: other usage was for any other fissile material up to about 4.6 kg for which an aluminium liner is fitted to provide a smaller diameter for criticality safety. This package has been in regular use for 10 years, during which there have been no operation difficulties and very little repair work needed.

The double containment SAFKEG 2863B has been adopted by the Los Alamos National Laboratory as the workhorse for the future as a replacement of the 6M. The DOE certificate is scheduled to be issued in mid 1998 and the package is expected to be put into service early in 1999. With the inner containment vessel omitted, the SAFKEG 2863B becomes the single containment SAFKEG 2863A: this configuration is also expected to be used widely in place of the 6M as this is phased out of use in the USA.

The large cavity single containment SAFKEG PC2 is being developed for components fabricated from fissile metals and should be available for general purpose usage within 1 to 2 years.

DESIGN FEATURES

The SAFKEG packagings consist of an outer keg, an insulating cork liner, and one or two containment vessels. The keg consists of a double skinned stainless steel body fitted with a flat lid secured by studs. The cavity between the double skin is filled with an insulating and shock absorbing foam (TISAF - a special formulation from Croft). The stainless steel containment vessel design utilizes standard pipe and pipe fittings and has a machined head having a flange type closure with the lid held in position using a screw retaining ring. All components meet the appropriate requirements of the ASME B&PV Code as referenced by NRC Regulatory Guides and Recommendation papers.



SAFETY FEATURES

The SAFKEG package design provides a large margin of safety as demonstrated by the performance in a large number of drop and fire tests as specified in the IAEA SS6 regulations, and in extended drop tests in which 2 different SAFKEGs were dropped from a helicopter to impact a concrete target at > 80% terminal velocity, after which the package remained intact with the containment vessels being leaktight.

The main safety features are:

Margin of safety	The SAFKEG has a large margin of safety to mechanical impacts. Unlike drum or birdcage designs, there is no >cliff edge= failure mode which could cause catastrophic failure at just above the regulatory test levels.
Keg insulation	The SAFKEG has a large margin of safety to fire accidents due to the double insulation (TISAF and cork) separated by a steel shell (inner skin of keg). There is no possibility of shine paths opening up in the insulation between the outer shell and the containment vessel. SAFKEGs are likely to provide compete protection to the containment vessel even in a fire much more severe than the regulatory test.
Dynamic crush	Even though this test is not required on all SAFKEGs (where the density >1), the SAFKEG design has been shown to be able to withstand such a test without catastrophic failure as can occur with drums fitted with closing bands.
Keg closure	In the SAFKEG, the outer closure is not directly impacted in any attitude drop test. The SAFKEG keg closure is fitted with multiple fasteners, therefore the security of the closure is not dependant on a single feature as is the case with drums. Any impact in closure region of the SAFKEG causes the keg lid to be trapped in place. The keg nuts specified in the SAFKEGs are the lowest grade commonly available and therefore the package would be safe if the wrong specification nuts were to be used in error.
Keg body	The body of the keg is formed from thin sheet with minimum discontinuities, with all critical welds away from impact points and configured such that they are not likely to be subject to high bending strain. The keg shell design provides high mechanical integrity - no tearing or cracking has ever been found in IAEA SS6 tests.

Simple assembly	Both the containment vessel and the keg have a minimum number of parts and are designed so that they can only be assembled in the correct configuration. The post closure (pre-shipment) leakage test required on the containment vessel provides assurance of correct assembly, as well as leaktightness.
Keg - containment vessel interactio	The keg is designed to provide protection to the containment vessel to ensure that the containment vessel is not plastically deformed under regulatory test conditions. The keg is designed to plastically deform to provide protection by absorbing energy in the drop tests. The keg inner shell provides thermal smoothing for heat coming from any damaged parts of the outer insulation.
Shielding	The SAFKEG packages provides enough shielding for maximum actinide loading by the steel in the containment vessel and keg.
Containment	The containment vessel incorporates a closure that becomes tighter if impacted: the flange lid cannot shear off.

OPERATIONAL FEATURES

The main operational features are:

Materials	The keg and containment vessels in the SAFKEG are manufactured from stainless steel which ensures low maintenance, with no uncertainty of material degradation from corrosion.
Handling	The SAFKEG design is easy to handle, sling and tie down. The aspect ratio provides for stability, yet will permit manual movement by one person if needed.
Maintenance	The SAFKEG has been designed to have very low maintenance costs and this has been borne out by experience. The keg body and containment vessels are very robust and the cork packing/insulation is resilient.
Number of parts	The SAFKEG packagings are designed for ease of use: this is partly due to the small number of parts in the packaging.
Containment vessel	The containment vessels are designed for foolproof operation. The closure consists of only two parts (lid and screw retaining ring), consequently the closure can be assemble (with proper torque applied) in less than a minute.
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As the screw retaining ring has to specially fabricated, possible use of counterfeit fasteners is not a problem.

Leak testing — The containment vessels only require a single leak test by either pressure drop or pressure rise methods. The small test volume between the double OBring seals in the closure of the containment vessel, results in a short testing time.

Keg studs — The keg studs are designed to have a larger diameter where they screw into the keg body to ensure that any damage is only to the stud, and not to the keg. Damaged studs can be replaced readily.

Cleanliness — The container design is such that the containment vessels are not exposed to dust and debris from other container components or the environment. The foam material is completely encapsulated by the stainless steel keg. The cork is extremely resistant to chafing and so does not produce particles that can become lodged in the containment vessel closure during assembly and disassembly, as can happen with containers that utilize "Celotex" type materials.

Robotic operation — The SAFKEG has been independently judged to be a robotic friendly design: all operations of both containment vessel and keg have been assessed as being capable of being carried out by a robot.

CURRENT DESIGNS

Technical data for some of the current SAFKEG packages is given in the following table:

Design #	Weight	Outside dimensions		Cavity dimensions	
	kg	mm	mm	mm	mm
2816G	111	425	1000	157	645
2863A	89	425	760	154	402
2863B	104	425	760	128	366
PC2	240	559	1097	336	750

DESIGN LIFE

The combination of inherently robust safety features, design for low maintenance and design for operational convenience, has resulted in a style which is not only applicable to current designs, but can also be used to produce new designs within the family which will provide all the benefits listed above.

User experience has shown that the SAFKEG packagings should have a long life with very little maintenance.

The large margin of safety provided by the SAFKEG provides confidence that the packages will be able to be used through several cycles of changes in the regulations: the designs are not affected by changes in the new IAEA ST-1 regulations which due to be in use in 2001 and will be unchanged for10 years.

REFERENCES

Regulations for the Safe Transport of Radioactive Material 1985 Edition (As Amended 1990), Safety Series N° 6, Vienna 1990, IAEA

Regulations for the Safe Transport of Radioactive Material 1996 Edition, ST-1, Vienna 1996, IAEA

Criticality and Shielding