

## **Type-A Radioactive Liquid Sample Packaging Family**

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### **INTRODUCTION**

Westinghouse Hanford Company (WHC) has developed two packagings that can be used to ship Type A quantities of radioactive liquids. WHC designed these packagings to take advantage of commercially available items where feasible to reduce the overall packaging cost. The Hedgehog packaging can ship up to one liter of Type A radioactive liquid with no shielding and 15 cm of distance between the liquid and the package exterior, or 30 ml of liquid with 3.8 cm of stainless steel shielding and 19 cm of distance between the liquid and the package exterior. The One Liter Liquid Shipper can ship up to one liter of Type A radioactive liquid that does not require shielding.

### **BACKGROUND**

As a result of environmental management and remediation activities at U. S. Department of Energy (DOE) facilities, many of those facilities have increased the number of environmental sample shipments to off-site laboratories. Many of these samples are liquids with radioactive contamination levels that require use of Type A packaging. In 1994, only one packaging existed in the DOE community that could be used to ship more than 200 ml of Type A liquids, and that packaging was very difficult to fabricate, cumbersome to use, and was not reusable. During 1994, sampling personnel from WHC and several other DOE facilities identified a need for new Type A liquid packagings to representatives from WHC Transportation and Packaging. The most widespread need was for packagings with a liquid capacity of one liter or less. Therefore, in mid-1994, Transportation and Packaging began a packaging development program with the goal of developing an inexpensive family of Type A liquid packagings.

The 3M Company developed the SafeSend<sup>1</sup> SP-1LR Super Pack combination packaging to satisfy U. S. Department of Transportation (DOT) regulations that will require the use

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<sup>1</sup>SafeSend is a trademark of 3M Corporation.

of performance-oriented packagings by October 1996. This packaging was designed as a reusable hazardous materials packaging that can accommodate multiple inner packagings to ship up to one liter of materials with a specific gravity of 2.0 or less (Alvarez and Insley 1992). The one liter SafeSend has outer dimensions of 31.5 cm in height by 16.5 cm in diameter, is fabricated from high-density polyethylene, and has a powersorb lining the inside of the cylinder. That powersorb lining acts as a cushioning to the inner packagings and can absorb approximately 1.9 liters of water in the event the inner bottle breaks or leaks. The one liter SafeSend has a internal pressure rating of 100 kPa. 3M obtained certification for the one liter SafeSend (Garin 1993b) under Variation 2 provisions for selective testing of combination packagings contained in DOT regulations (49 CFR 178).

The 3M Company also developed the IS-500ML SafeSend Infectious Substance Shipping System, which is a shorter version of the one liter SafeSend container (24.7 cm tall) that uses polyurethane instead of powersorb as the cushioning material. The IS-500ML SafeSend can ship up to 500 ml of materials with a specific gravity less than 2.0. 3M obtained certification for the IS-500ML SafeSend (Garin 1993a) as an infectious substance shipper, which included passing a nine meter (30 ft) drop test (49 CFR 178).

#### **PACKAGING DEVELOPMENT PROGRAM**

Two different requirements for a Type A liquid packaging had been identified within DOE. One need was for packaging to ship samples from the Hanford waste tanks to off-site laboratories for analysis. Those samples have high levels of radioactivity which require significant amounts of shielding to reduce the radiation to levels that meet DOT requirements for shipment. The other need was for packaging to ship slightly radioactive samples generated during remediation activities to laboratories for analysis. These samples typically do not require shielding. This need had been identified by several sites across the DOE, including Hanford. All organizations interested in the Type A liquid packagings stated that their objective was reliable, easy-to-use, and inexpensive packages.

WHC started a program to develop an easy-to-use, cost-effective packaging that could ship shielded Type A liquid samples. Since Type A liquid packagings have to survive the same nine meter drop test (49 CFR 173) that infectious substance packagings have to survive, infectious substance packagings were researched to determine whether any could be used for radioactive liquids. That search identified the IS-500ML SafeSend, but no one liter packagings. Since the IS-500ML SafeSend survived the 9-m drop test and is essentially the same packaging as the SP-1LR SafeSend, WHC decided to use the eight-time reusable one liter SafeSend packaging to start the Type A liquid packaging development program. 3M was approached about certifying the SP-1LR SafeSend as a Type A packaging for radioactive materials, but 3M decided not to assume that liability. WHC assumed all liability for testing and certifying the packaging, which was done through the DOE Type A testing program. Due to the low price of the one-liter SafeSend (less than \$100 each), WHC tested all proposed configurations instead of performing more expensive finite element analysis.

WHC first tested the one liter SafeSend packaging with a one-liter polycoated glass bottle and the items provided with the SP-1LR SafeSend kit. Those items are the SafeSend itself, six urethane foam pads that are placed around the contents bottle, a plastic bag that fits around the foam/bottle configuration, and a fiberboard box that goes around the SafeSend. The poly coated glass bottle cracked during the 9-m drop test. Although the liquid was absorbed by absorbent material in the SafeSend, the radiation level on the exterior of the container would increase by more than 20% and violate International Air Transport Association requirements (IATA 1995). Therefore, that configuration was unsuitable for use with Type A liquids. Additional testing was performed using more resilient foam around the glass bottle inside the one liter SafeSend, but the glass bottle still cracked. WHC concluded that the SafeSend could not be used as a Type A liquid shipper for glass bottles without additional cushioning.

### **HEDGEHOG PACKAGING**

Since the one-liter SafeSend packaging was only designed to ship 2.3-kg payloads, WHC determined that it would not pass a 9-m drop test with shielded inner packagings that weigh up to 11.5 kg empty. Therefore, either a new packaging would need to be developed from scratch or existing packagings would have to be modified for new uses. The packaging that resulted from this development effort utilizes the SafeSend and has been named the Hedgehog.

Since the one liter SafeSend by itself could not be used to ship samples that also require shielding, an impact limiter that could surround the SafeSend was needed. WHC was familiar with Hardigg<sup>2</sup> Cases manufactured by Hardigg Industries, Inc., that are used extensively to ship electronics components. When contacted, Hardigg stated that they could custom-build a Hardigg case for the intended use. WHC designers determined that 10 cm of foam would enable the packaging to survive all Type A liquid packaging tests. The special-order Hardigg case had 10 cm of foam cushioning around a cavity for the SafeSend.

The one-liter SafeSend provides negligible shielding, so shielded packagings needed to be developed that would fit inside of the SafeSend. Internal shielding for the SafeSend was selected since only small volumes of the samples with the highest levels of radioactivity were needed and because internal shielding would cost less and be much easier to handle than shielding external to the SafeSend. WHC designed three different stainless steel pigs with volumes that can ship 30 ml, 125 ml, and 250 ml samples. Each pig is closed with four bolts and an O-ring seal that has been leak-tested with a reduced internal pressure of 79.3 kPa. The 30-ml and 125-ml sample pigs fit inside of the 250-ml pig, so two pigs will be nested for those configurations. The three configurations provide three different shielding thicknesses: 3.8 cm for 30-ml samples, 2.5 cm for 125-ml samples, and 1.3 cm for 250-ml samples.

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<sup>2</sup>Hardigg is a trademark of Hardigg Industries, Inc.



Prior to formal Type A testing of the Hedgehog packaging, proof tests were performed on the SafeSend. The proof testing revealed that a spacer needed to be placed on top of the SafeSend lid to keep that lid from popping off during the 9-m drop. The SafeSend was not designed by 3M to be able to survive such a severe test (11.5 kg payload from the two stainless steel pigs in the 30-ml configuration), so the wooden spacer in the Hedgehog was added to ensure the SafeSend can survive the 9-m drop and all other Type A liquid tests. Therefore, the Hedgehog shielded Type A liquid packaging consists of the following items: Hardigg case, one-liter SafeSend, foam pads provided with the SP-1LR SafeSend kit that are placed inside of the SafeSend for cushioning the pigs, wooden spacer assembly, and stainless steel pigs. Figure 1 shows a drawing of the 30-ml Hedgehog.

Since the SafeSend by itself was not acceptable for use with liquid-filled glass bottles and the need to ship samples in glass bottles existed, another version of the Hedgehog was developed to ship one-liter glass bottles. This version also uses the Hardigg case and SafeSend, but uses a polycoated glass bottle surrounded by the foam pads provided with the SP-1LR SafeSend kit in place of the stainless steel pigs. The development of the one liter version of the Hedgehog was sponsored by the DOE Office of Transportation, Emergency Management, and Analytical Services (EM-26).

Formal Type A testing of all four versions of the Hedgehog occurred in February 1995. The testing was performed by the DOE Type A testing program. All four versions of the Hedgehog passed all tests for Type A liquid packaging. Since then, the Hedgehog has been used by Westinghouse Hanford, Brookhaven National Laboratory, Nevada Test Site, and Savannah River. Many other DOE facilities anticipate using the Hedgehog within the next year. The testing results for the Hedgehog will be listed in the next revision of the DOE "Blue Book" (Kelly 1994), which lists testing results for all Type A packagings tested by the DOE.

### **ONE LITER LIQUID SHIPPER**

Since all environmental samples do not need to be shipped inside of glass bottles, configurations that use the one-liter SafeSend container and less fragile one-liter poly or Teflon<sup>3</sup> bottles were developed with the name the One Liter Liquid Shipper. This packaging was developed because it is even easier to handle and is less expensive than the Hedgehog and was also sponsored by DOE EM-26. This packaging uses the SP-1LR SafeSend kit and a narrow-mouthed one-liter Teflon or polyethylene bottle. Testing showed that narrow-mouthed, one-liter bottles filled with specific gravity 2.0 liquid successfully passed the 9-m drop tests, but wide-mouthed bottles caused the lid of the SafeSend to fail. The One Liter Liquid Shipper passed all other required Type A tests without the fiberboard box provided with the kit, so use of the fiberboard box as an overpack is optional. The only modification to the SP-1LR SafeSend kit required to use it as the One Liter Liquid Shipper is to drill two small holes into the lip of the lid. A

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<sup>3</sup>Teflon is a trademark of E. I. DuPont de Nemours & Company

tamper indication device such as a lead wire seal then has to be inserted through those holes. See Figure 2 for a drawing of the One Liter Liquid Shipper.

Formal Type A testing of the One Liter Liquid Shipper occurred in August 1995 as part of the DOE Type A testing program. The One Liter Liquid Shipper passed all required Type A liquid packaging testing. This packaging has already been used by Westinghouse Hanford and several other DOE sites have expressed interest in using the One Liter Liquid Shipper. The testing results will be published in a future revision of the "Blue Book" (Kelly 1994).

## CONCLUSION

As a result of this effort, the DOE community now has a family of Type A liquid packagings available to satisfy environmental sampling needs. These packagings can ship up to one liter of Type A liquids and, if necessary, can also provide shielding for smaller liquid volumes. All of these packagings were designed to be reusable and to use off-the-shelf items as much as possible in order to be cost-effective.

## POSTSCRIPT

The only difficulty with using off-the-shelf items as part of any packaging design is the lack of control over any changes vendors make to their item, which could adversely affect the overall packaging design. For example, 3M Corporation made the decision to suspend manufacturing of the SafeSend, effective September 30, 1995. This decision was made, in spite of protests by WHC, because 3M decided the SafeSend line of packagings was not a highly profitable business area. However, 3M has been conducting negotiations with Nalge Company for Nalge to buy the SafeSend line and begin manufacturing themselves. The expectation is that Nalge will begin fabricating SafeSends (under a new name) in early 1996. If Nalge makes any changes to the SafeSend design, at a minimum, engineering evaluations will be needed to show that the Nalge version of the SafeSend performs at an equal level to the 3M SafeSend and those evaluations will have to be provided to each organization that uses either the Hedgehog or the One Liter Liquid Shipper.

## REFERENCES

- 49 CFR 173, "Shippers-General Requirements for Packagings," Title 49, *Code of Federal Regulations*, Part 173, as amended, U. S. Department of Transportation, Washington, D.C.
- 49 CFR 178, "Specifications for Packagings," Title 49, *Code of Federal Regulations*, Part 178, as amended, U. S. Department of Transportation, Washington, D.C.
- Alvarez, L., and Insley, T., "Anatomy of a 'Super Pack' Combination Packaging", *Chemical Packaging Review*, May/June 1992, pp. 12-15.

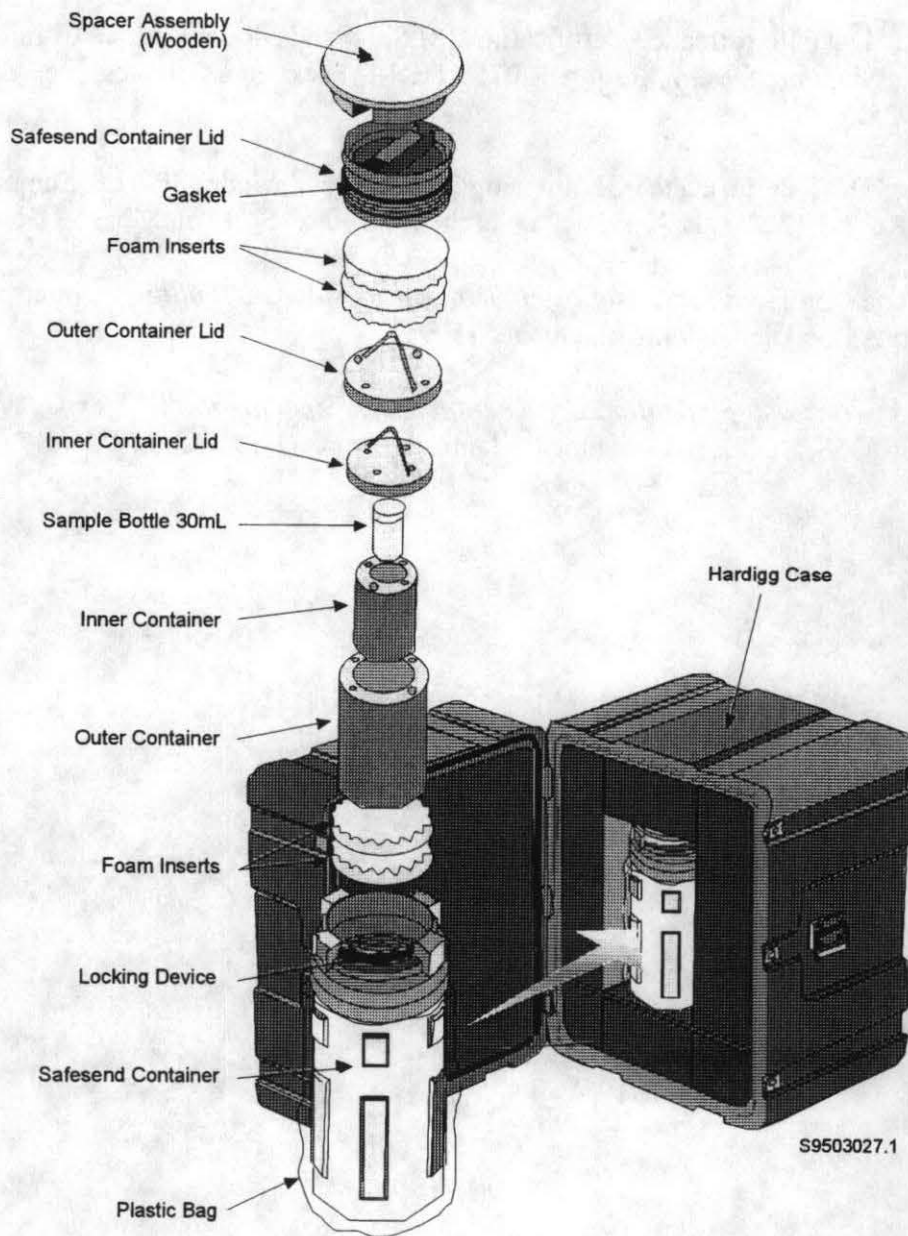
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International Air Transport Association, *Dangerous Goods Regulations*, International Air Transport Association, Montreal, Quebec (1995).

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**Figure 1 - 30 ml Hedgehog Packaging**

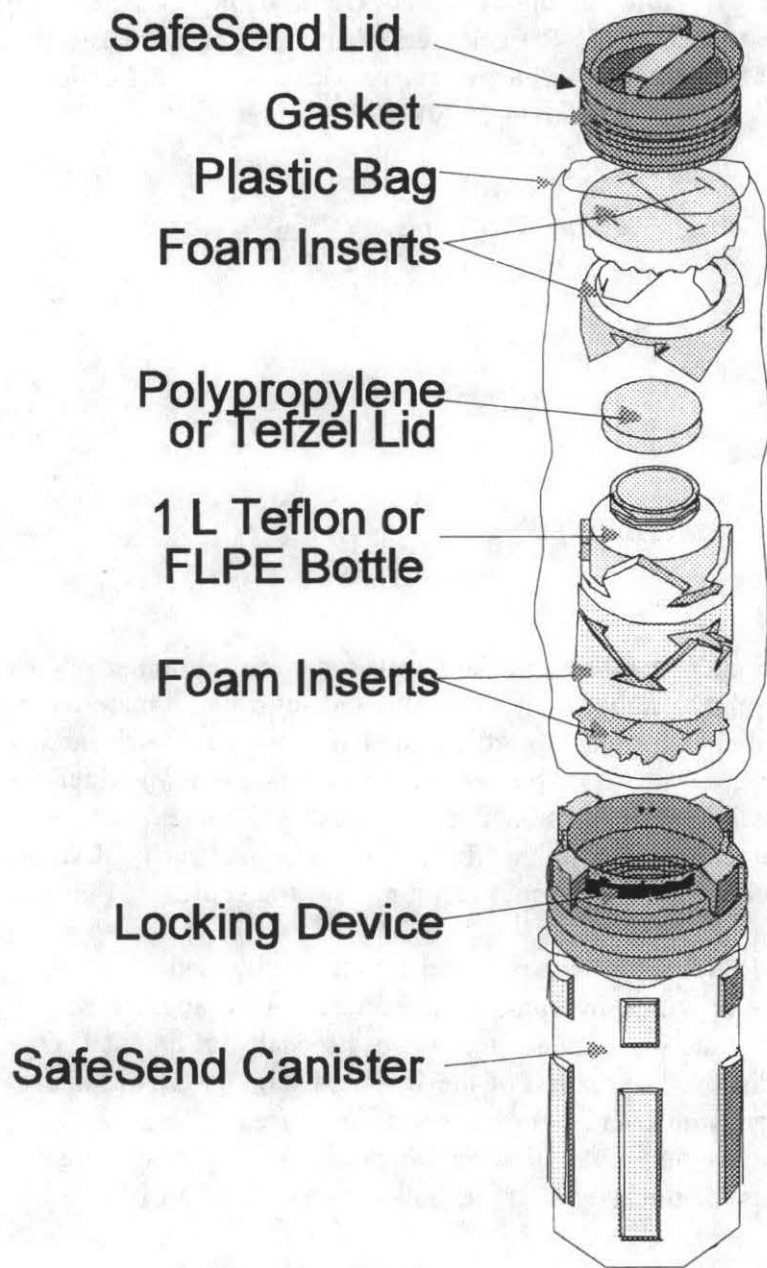


Figure 2 - One Liter Liquid Shipper