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Sample Vial Secure Container*

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Abstract

International Atomic Energy Agency (IAEA) inspectors must maintain continuity of knowledge on all safeguard samples and, in particular, on those samples drawn from plutonium product and spent fuel input tanks at a nuclear reprocessing plant's blister sampling station. Integrity of safeguard samples must be guaranteed from the sampling point to the moment of sample analysis at an accepted local laboratory or at the IAEA's Safeguards Analytical Laboratory (SAL) in Seibersdorf, Austria.

The safeguard samples are drawn at a blister sampling station with inspector participation and then transferred via a pneumatic post system to the facility's analytical laboratory. Transfer of the sample by the pneumatic post system, arrival of the sample in the operator's analytical laboratory, and storage of the sample awaiting analysis are very time consuming activities for an inspector, particularly if continuous human surveillance is required for all these activities. These activities could be observed by ordinary surveillance methods, such as a video monitoring system, but this would be cumbersome and time consuming for both the inspector and the operator.

This paper describes a secure container designed to assure sample vial integrity from the point the sample is drawn to treatment of the sample at a facility's analytical laboratory.

Introduction

The Sample Vial Secure Container (SVSC) is a containment system developed at Sandia National Laboratories (SNL) for the U.S. Program for Technical Assistance to IAEA Safeguards (POTAS) to assure continuity of knowledge for safeguard sample vials. The SVSC is a passive tamper-indicating secure container that provides evidence of tampering or substitution, thereby providing evidence that a sample has been modified.

The SVSC is intended to be used in place of the facility's usual pneumatic tube transporter (called a "rabbit") for safeguard sample vials. The SVSC, in conjunction with design verification of the sampling line from the solution tank to the blister sampling station, will provide continuity of knowledge from the point at which the sample is taken to the receipt and treatment of the sample in a facility's analytical laboratory. (The paper, "Maintaining Continuity of Knowledge on Safeguard Samples,"[1] describes the safeguard sampling process in greater detail.)

Alternative Techniques

Several potential techniques to assure the integrity of safeguard sample vials were investigated by SNL. These techniques varied widely in cost and sophistication. Some of the techniques investigated include

- Commercially available paper and plastic seals
- Ultraviolet light interrogation
- Heat shrinkable seals

Although each of these techniques had positive attributes, they were ultimately determined to be unacceptable because they would have been difficult to apply in the blister sampling manipulator box and would have required permanent placement of large electronic equipment in the manipulator box. Considering the difficult requirements, the most promising technique appears to be the SVSC design because it represents a balance of cost, simplicity, and tamper resistance.

System Overview

The SVSC system is a passive tamper-indicating pneumatic tube rabbit that is intended to be used with plutonium product and spent fuel input safeguard samples at the Tokai Reprocessing Plant (TRP) in Tokai, Japan. It consists of three components: a cartridge, a cover, and an identification label (Figure 1). The system has been designed for one-time use. A device that will cut open the SVSC is also required (Figure 2).

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The cartridge and cover are made from polysulfone and designed specifically for use in the pneumatic system at TRP. Geometrically, it is possible to design a secure container incorporating the basic SVSC design concept to accommodate most manually operated pneumatic sample transfer systems. The inside diameter of the cartridge is large enough to accommodate a sample vial. A groove is machined on the inside of the cartridge to engage the cover. The sample vial is inserted into the cover. Next, the cover/sample vial assembly is pressed into the cartridge. The sides of the cover will engage the groove inside the cartridge, causing the two halves to interlock and preventing removal of the cover without leaving visible evidence. Figure 3 shows an assembled SVSC. The system cannot be reused after the two halves have been pressed together.

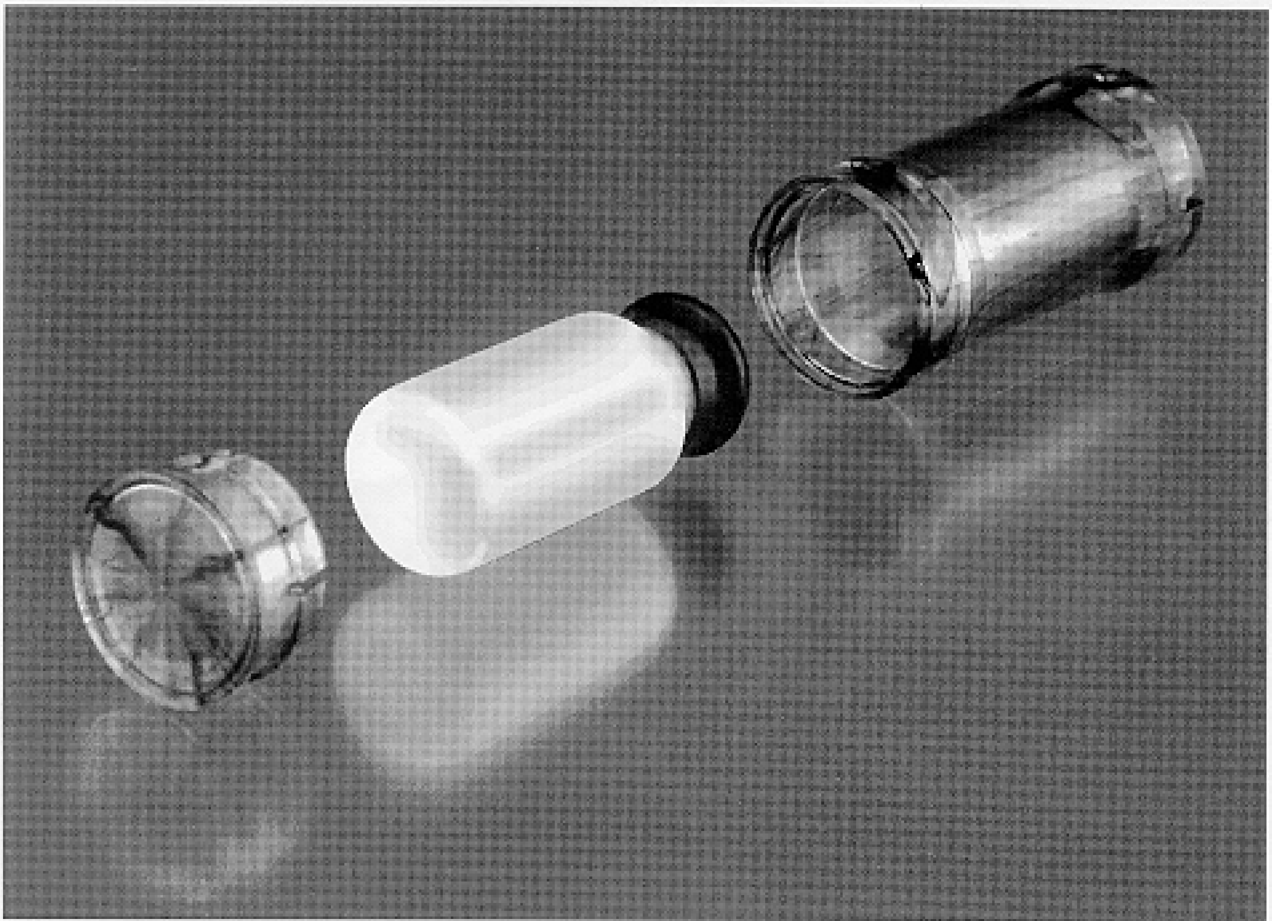


Figure 1. Sample Vial Secure Container

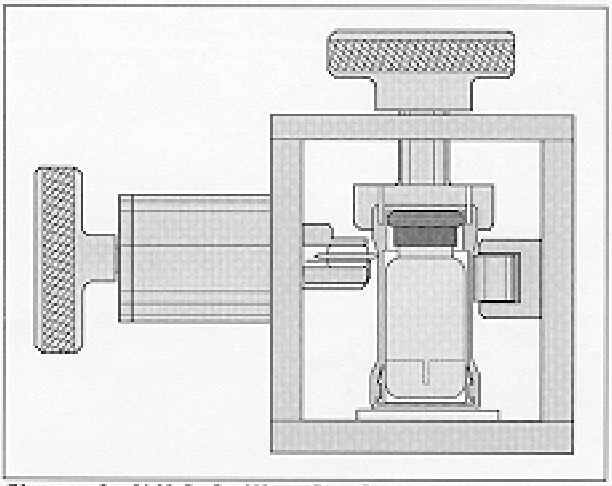


Figure 2. SVSC Cutting Device

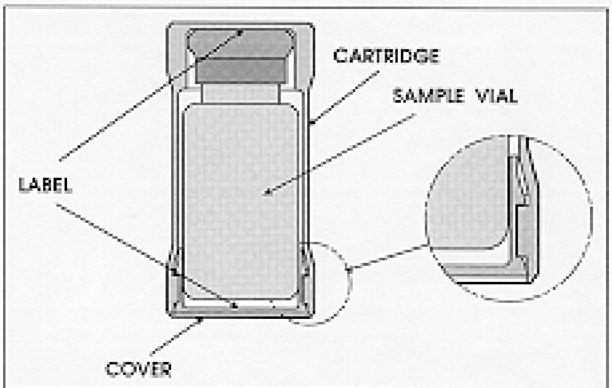
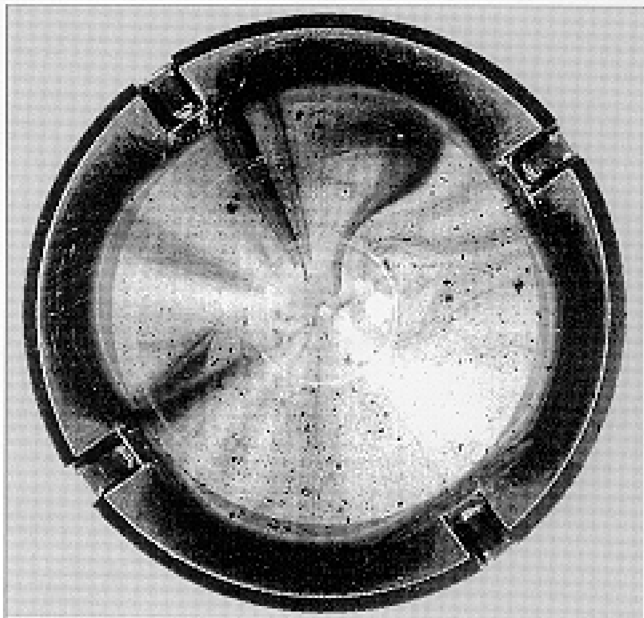


Figure 3. Assembled SVSC

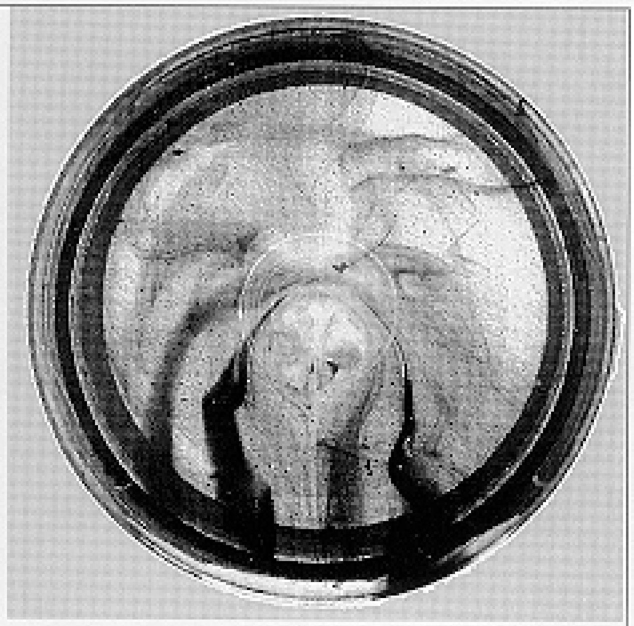
An identification label, with a randomly generated code, is placed on the inside of both the cartridge and cover. After the cartridge and cover are pressed together, the only way to reveal the codes is to cut open the SVSC.

The identification label is intended to be a first order of identification. The second order of identification is a unique random swirled pattern introduced during the injection molding process of the SVSC. This pattern provides a "fingerprint" for each individual cover and cartridge. This pattern is the second order of identification and will be inspected on a random basis or if tampering and/or substitution is suspected.

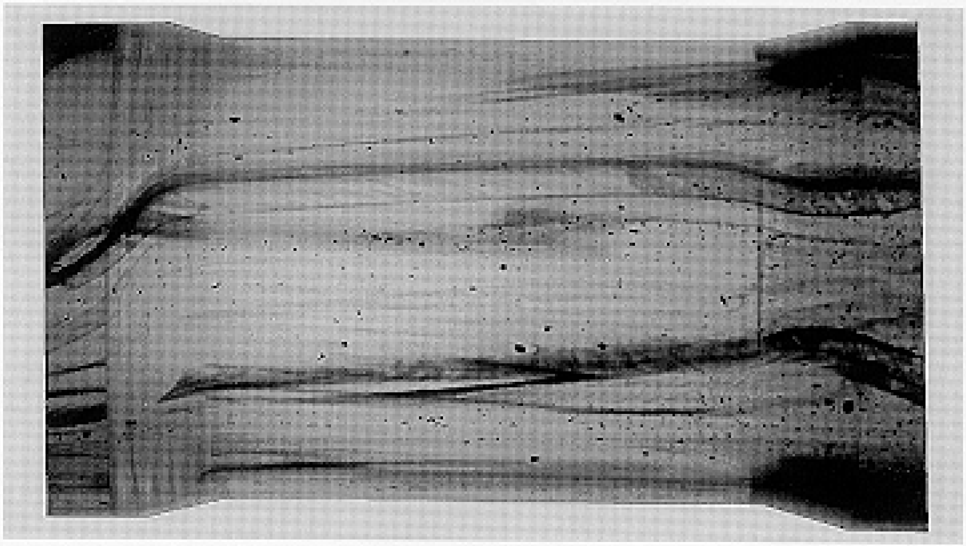
The random pattern of each SVSC is photographed during the manufacturing process. (Figure 4 shows a typical set of photographs for an SVSC.) For each SVSC, a photograph is taken of the pattern on the bottom (4a) and side (4c) of the cartridge and on the top of the cover (4b). These three photographs are cataloged in a photo notebook. To verify the authenticity of an SVSC after it has been used, the patterns in the photographs are compared to the patterns on the SVSC.



a. Bottom Pattern



b. Cover Top Pattern



c. Side Pattern

Figure 4. Typical Set of SVSC Photographs

Safety features have been designed into the cartridge and cutting device to ensure that the sample vial is oriented in the cartridge and cutting device properly. This will prevent the accidental cutting of the sample vial when the SVSC is cut open.

Status

The tooling required to injection mold the SVSC was manufactured, and limited production has been performed in order to characterize the manufacturability process of the SVSC. The temperatures, cycle times, and material concentrations have been determined. This was required in order to determine the repeatability of the random pattern and the dimensional tolerances of the parts.

Eighty SVSCs have been provided to the IAEA to support a vulnerability test being conducted by Harwell in the United Kingdom. A photo notebook and an application and verification procedures document were provided as well. The photo notebook has a set of three photos for each SVSC sent for the vulnerability test. The procedures document describes how to assemble the SVSC in a hot cell, as well as how to inspect the SVSC for evidence of tampering and authenticity after it has been used. The vulnerability test is expected to be complete by August 1993. Design changes resulting from the vulnerability test and recommendations from facility operators and inspectors will be incorporated into the final SVSC design and its associated hardware. Full production and IAEA implementation are expected after any weaknesses have been rectified and final facility and environmental tests have been performed.

Summary

The SVSC is designed to solve the very challenging problem of safeguarding plutonium nitrate samples drawn at a reprocessing plant. Its primary function is to provide continuity of knowledge for safeguard samples drawn at a nuclear reprocessing plant from the time the sample is drawn at the blister sampling station to receipt and subsequent treatment at the facility's analytical laboratory.

Reference

1. F. Franssen, A. B. M. N. Islam, C. Sonnier, J. L. Schoeneman, M. Baumann, "Maintaining Continuity of Knowledge on Safeguard Samples," in *Proceedings of the 33rd Annual Meeting of the Institute of Nuclear Materials Management*, Orlando, Florida, 1992.