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Receipt Examination and Testing of the SAVY-4000 Nuclear Material Storage Containers

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Abstract

The Nuclear Process Infrastructure (NPI-1) group at Los Alamos National Laboratory (LANL) coordinates with Nuclear Filter Technology, Inc. (NFT) to perform document reviews, visual inspections and component testing of the SAVY-4000 nuclear material storage containers. These source examinations ensure that the containers and associated shielding meet the production specification requirements, and ultimately ensure that the workers who handle the containers are protected from exposure due to loss of containment of stored nuclear materials. This poster will describe the array of document reviews, visual inspections and component tests performed during the receipt examinations.

Introduction

Los Alamos National Laboratory (LANL, NPI-1) and Nuclear Filter Technology (NFT) work together through document reviews, visual inspections and component testing to ensure that the SAVY-4000 nuclear material storage containers meet the required specifications. These tests and documents provide confidence that the containers are reliable containment systems to allow workers to handle significant quantities of plutonium without the need for respirator protection. A procedure was developed to identify the verification requirements for a SAVY-4000 production lot and the process for performing source examinations and document-package verification for the SAVY-4000 container. The supplier compiles the document packages for each production lot of SAVY- 4000s and submits copies to LANL personnel. These document reviews and source verifications ensure that containers and shielding meet the production specification requirements for a particular order of containers. Components that do not meet the specified requirements are rejected, re-worked or used as-s (depending on the condition), or scrapped and replaced. Components that are reworked or replaced must meet the specifications in the manufacturing drawings and production specification.

A photograph illustrating the 1-quart SAVY-4000 container is shown in Figure 1. The SAVY 4000 container is composed of two primary sub-assemblies, the body and the lid. The body and lid are attached to one-another with a bayonet style closure such that the lid fits tightly within a collar attached to the body. The user achieves a leak tight seal by pushing the lid downward into the collar resulting in radial compression of the O ring in a "piston groove" configuration between the body collar and the lid. The lid locks into place with a positive mechanical engagement made of aluminum and a stainless steel pin, and no tools are required to open or close the container. The lid has a built-in filter made up of ceramic fibers that prevents hydrogen build-up inside the container and prevents particulate release. The filter is

protected on the outside by a membrane that allows gases to pass but blocks out liquid water, thereby facilitating shedding of water. The containers and lids are interchangeable within a given container size, and the assembly does not need to be checked for leaks at each closure.

Figure 1. Photograph of the 1-Qt SAVY-4000 Nuclear Material Storage Container

Document Reviews

The manufacturer (NucFil) carries out initial inspection and acceptance tests during the fabrication of the SAVY-4000 and all of its components. These tests include dimensional inspection, visual and dye penetrant weld inspection, weld qualification sampling, helium leak testing, filter testing, water entry testing, hydrogen diffusion testing and bar code readability testing. As the authorized procurement organization, LANL is responsible for the inspection of the SAVY-4000 containers, documentation and accompanying certification upon receipt to ensure completeness and quality of the manufacturing record. The list of documents required by the specification is shown in the form in Figure 2.

Purchase Order Number:		Date:
Lot Number:	Serial Numbers:	Through:
Verifier (Print Name):		
Required Documents		
☐	Drawings	
☐	Fabrication Schedule	
☐	Quality Assurance Manual (Fabrication)	
☐	Welder Performance Qualification Record	
☐	NDE Personnel Certifications	
☐	Calculations	
☐	Filter Material Certificate of Analysis	
☐	Dimensional Inspection Report	
☐	Liquid Penetrant Test	
☐	Weld Visual Inspection	
☐	Helium Leak Test	
☐	Filter Performance	
☐	Surface Finish Report	
☐	Material Certification	
☐	Shop Traveler, Completed	
☐	Certificate of Compliance	
☐	Supplier Deviation Disposition Request	

Figure 2. SAVY-4000 Data Package Acceptance Form

Visual Inspections

All of the SAVY-4000 containers must pass a series of visual inspections in order to be considered fully compliant with specifications. The visual inspections of the SAVY-4000 are designed to ensure that specific traits of the container were correctly made. These traits include the Tamper Indicating Device (TID), the closure mechanism, the cleanliness of the container, absence of burrs and dents, lid interchangeability, serial number markings on the lid and body, bar code readability on the lid and body, absence of cracks/dirt on O-ring, and the overall height dimension.

Statistical Sampling

A statistical sampling plan was developed for the source examination testing (see Table 1). A Lot is defined as a single order of a given size of containers. Initial sample sizes ranged from 25 to 50 containers. A random sample of containers was selected from each lot for the statistical sample. A different verification-sampling plan based on power specification or

tolerance-limit requirements can be instituted based on measurement variability of quantitative measurements, i.e., percent penetration, DOP, and Helium leak tests.

Table 1. Source Verification Statistical Sampling Plan

Statistical Sampling	Lot Size	Sample Size	Probability of Detecting a Single Problem	If it Occurs in ___ or more Items
A	75	25	95%	7 (~10%)
B	75	50	96%	3 (~5%)
C	250	25	94%	25 (~10%)
D	250	50	94%	12 (~5%)

If a single failure is detected in case A, then 14 additional containers are evaluated. If no more failures are detected, then there is a 95% confidence that the number of failures in the lot is less than 10%. If a single failure is detected in case B, then 15 additional containers are evaluated. If no more failures are detected, then there is a 95% confidence that the number of failures in the lot is less than 5%. If a single failure is detected in case C, then 19 additional containers are evaluated. If no more failures are detected, then there is a 95% confidence that the number of failures in the population is less than 10%. If a single failure is detected in case D, then 36 additional containers are evaluated. If no more failures are detected, then there is a 95% confidence that the number of failures in the population is less than 5%. If two or more failures are detected either initially or when a second sampling has one failure, then in case A a total of 50 items need evaluation, in Case B a total inspection of 75 containers is required, in case C a total of 59 containers need evaluation, and in case D a total of 112 containers require evaluation. If no failures are detected, then there is 95% confidence that failures in the batch are less than 10% for cases A and C and less than 5% for cases B and D. If three or more failures are detected, LANL reserves the option to reject the lot or to continue sampling in the case of A, C, and D.

Observed Component Testing and Inspections

Dimensional Inspection. The SAVY-4000 components are inspected for critical dimensions. The critical dimensions include but are not limited to O-ring sealing and filter assembly dimensions. The dimensions must be within tolerances defined on design drawings. All other dimensions are inspected on a statistical sampling basis.

Visual and Dye Penetrant Weld Inspection. Every primary weld on the SAVY-4000 is visually inspected to ensure proper joining. The primary weld is also dye penetrant tested to ensure the weld contains no cracks, gaps or surface pores.

Helium Leak Testing. Each SAVY-4000 must undergo a helium leak test, utilizing a modified envelope method, which allows helium to be backfilled into the SAVY-4000 while the surrounding atmosphere is exposed to vacuum. This test ensures that the containment boundary is fully functional. The maximum helium leak rate is 1.0E-05 std cc/sec @ 10 kPa.

Filter Testing. The filter of each SAVY-4000 is tested to make sure that it is functional. The filter must capture greater than 99.97% of 0.45 micron mean diameter DOP (dioctyl phthalate) aerosol at a minimum of 200 ml/min of air at no more than 1.0 inches of water column pressure differential and a DOP concentration of 65 ±15 micrograms per liter.

Water Entry Testing. Every SAVY-4000 is tested to ensure that the filter resists water entry and thus prevents a criticality in the event of a facility accident where the sprinkler systems are activated. The filter system must prevent water entry up to 12 in. water column.

Hydrogen Diffusion Testing. The SAVY-4000 is tested to ensure that the filter diffuses hydrogen gas to prevent build up of pressure and/or flammable mixtures of gasses. The filter must provide for a minimum hydrogen gas diffusivity rate of 2.4e-5 mol H_2/s/H_2 mol fraction.

Testing Documentation. The Observed Test Data-Collection Form (see Figure 3) is used to document the observed testing process. This document allows the observers to list each container that was tested, the size of the container, how many containers were tested, when the test took place and the amount of containers that passed the test. There must be a tester (provided by the manufacturer) and a verifier (provided by LANL) present at the test to ensure the test was run correctly and properly documented. Also, both parties sign to confirm that the tests were conducted and that the components passed the tests. Each step of the test must be documented, and if any part of the test is done incorrectly or if calibrations have expired, the test must be stopped and a nonconformance report, which includes a corrective action and a disposition, must be filled out. A noncompliance report must also be filled out if the container fails any of the tests mentioned earlier.

Type Test Performed:	☐ Helium Leak Rate	☐ Water Penetration through Filter	☐ Hydrogen Diffusion
	☐ DOP	☐ Finish on O-ring Sealing Surface	☐ O-ring Testing
			☐ Other

Purchase Order Number:	**Quantity Ordered:**	**Container Size:**	**Date:**

Statistical Sampling Plan: ☐ A ☐ B ☐ C ☐ D ☐ Other

Test Lot:	☐ **Small Test Lot**	☐ **Large Test Lot A**	☐ **Large Test Lot B**

Supplier's Tester: (Print Name)_____	**Certification:** ____	**Level & Dates Valid** _____ _____

Title & Revision of Test Procedure:

Action #	Requirement	YES	NO	Initial
1	All required calibrations current with sufficient ranges (if not, explain in the Comment section below)	☐	☐	
2	Test system setup correctly (if not, explain below)	☐	☐	
3	Serial Numbers verified (if not, explain below)	☐	☐	
4	All SAVY-4000s passed test (if not, explain below & add NucFil NCR & CAR numbers)	☐	☐	

Quantity Tested: _____ **Quantity Passed:** _____

LANL Verifier: _____ _____
Print **Signature:** **Date:**

Supplier's Tester: _____ _____
Print **Signature:** **Date:**

Figure 3. SAVY-4000 Observed Test Data Collection Form

Test Results

A summary of the combined inspections and observed tests are listed in Table **2 for 79 5-**Qt SAVY-4000 containers inspected at NucFil in March, 2011. The results of the inspections, including a transaction identification number (TransId), the title of the testing event (TestEventName), the component name (PartName), the test performed (TestPerformed), the test result (TestResult), the test result value (ResultValue), the person performing the verification (Verifier), and the date of the test (TestDate) were captured in a database.

Table 2. Baseline Surveillance Data Example

TransId	TestEventName	PartName	TestPerformed	TestResult	ResultValue	Verifier	TestDate
17926	PO110187_Baseline	031105060B	TIDHoleAlignOK	pass		Prochnow	15-Mar-11
17951	PO110187_Baseline	031105060L	ClosureMechanismOK	pass		Prochnow	15-Mar-11
17976	PO110187_Baseline	031105060B	CleanSurface	pass		Prochnow	15-Mar-11
18001	PO110187_Baseline	031105060B	NoBurrsOrRust	pass		Prochnow	15-Mar-11
18026	PO110187_Baseline	031105060B	NoDents	pass		Prochnow	15-Mar-11
18051	PO110187_Baseline	031105060L	LidInterchangeOK	pass		Prochnow	15-Mar-11
18076	PO110187_Baseline	031105060B	BarcodeOKBody	pass		Prochnow	15-Mar-11
18101	PO110187_Baseline	031105060L	BarcodeOKLid	pass		Prochnow	15-Mar-11
18126	PO110187_Baseline	031105060B	PermInfoOKBody	pass		Prochnow	15-Mar-11
18151	PO110187_Baseline	031105060L	PermInfoOKLid	pass		Prochnow	15-Mar-11
18176	PO110187_Baseline	031105060B	OuterHeightOK	pass		Prochnow	15-Mar-11
18803	PO110187_Baseline	031105060B	ORingSealingSurfaceOK	pass		Sanchez	16-Mar-11
18828	PO110187_Baseline	031105060L	ORingSealingSurfaceOK	pass		Sanchez	16-Mar-11
18906	PO110187_Baseline	031105060B	ORingInspectedAndInstalled	pass		Prochnow	16-Mar-11
18965	PO110187_Baseline	031C105060L	HydrogenDiff	Pass	0.0000877	Smith	16-Mar-11
19094	PO110187_Baseline	031105060B	DimensionCKBody	pass		Sanchez	16-Mar-11
19144	PO110187_Baseline	031105060B	HeliumLeakBody	pass	0.00000014	Smith	17-Mar-11
19169	PO110187_Baseline	031105060L	HeliumLeakLid	pass	0.00000014	Smith	17-Mar-11
19202	PO110187_Baseline	031105060B	Dye_Pen	pass		Sanchez	17-Mar-11
19379	PO110187_Baseline	031105060L	WaterPenFilter	pass		Sanchez	18-Mar-11
19406	PO110187_Baseline	031105060L	DOP	pass		Sanchez	18-Mar-11

Table 3 lists the total number of tests and inspections that were performed on the 79 5-Qt SAVY-4000 containers in March, 2011. A total of 1,257 tests and inspections were performed on this lot of containers.

Conclusions

Los Alamos National Laboratory (LANL, NPI-1) and Nuclear Filter Technology (NFT) work together through document reviews, visual inspections and component testing to ensure that the SAVY-4000 nuclear material storage containers meet the required specifications. These tests and documents provide confidence that the containers can be credited as true engineered containment systems. This allows workers to handle significant quantities of plutonium without the need for respirator protection.

Table 3. SAVY-4000 Tests performed on 79 5-Qt Containers in March, 2011

Test Performed	Number of Tests
BarcodeOKBody	79
BarcodeOKLid	79
CleanSurface	79
ClosureMechanismOK	79
DimensionCKBody	83
DOP	29
Dye_Pen	25
HeliumLeakBody	29
HeliumLeakLid	29
HydrogenDiff	5
LidInterchangeOK	79
NoBurrsOrRust	79
NoDents	79
ORingInspectedAndInstalled	79
ORingSealingSurfaceOK	79
OuterHeightOK	79
PermInfoOKBody	79
PermInfoOKLid	79
TIDHoleAlignOK	79
WaterPenFilter	30
TOTAL	**1,257**

References

NPI1-DOP-004, R0. SAVY-4000 Container Source Verification Procedure

LANL Nuclear Material Container Surveillance and Maintenance Database, David Prochnow, Judi Hammer, Paul Smith, Jenifer Hoffman. Presentation to M441.1-1 Working Group, May 5, 2011