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Los Alamos National Laboratory SAVY-4000 Field Surveillance Plan Update for 2016

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1.0 INTRODUCTION

The Packaging Surveillance Program section of the Department of Energy (DOE) Manual 441.1-1, *Nuclear Material Packaging Manual* (DOE 2008), requires DOE contractors to "ensure that a surveillance program is established and implemented to ensure the nuclear material storage package continues to meet its design criteria." The Los Alamos National Laboratory (LANL) SAVY-4000 Field Surveillance Plan was first issued in FY 2013 (Kelly et al. 2013). The surveillance plan is reviewed annually and updated as necessary based on SAVY-4000 surveillance and other surveillance findings, as well as results of the lifetime extension studies (Blair et al. 2012, Weis et al. 2015a). The LANL SAVY-4000 Field Surveillance Plan Update was issued in 2014 (Kelly et al. 2014). This 2016 update reflects changes to the surveillance plan resulting from restrictions on handling residue materials greater than 500 g, the addition of specific engineering judgment containers, and 2015 surveillance findings.

The SAVY-4000 container has a design life of five years, which was chosen as a conservative estimate of the functional properties of the materials used in the construction of the SAVY 4000 when exposed to the potential insults including temperature, corrosive materials and gases, and radiation. The SAVY-4000 container design basis is described in a safety analysis report (Anderson et al. 2013). In the National Nuclear Security Administration's (NNSA's) approval of the safety analysis report, it was recommended that the design life clock begin on March 2014 (Nez et al. 2014). However, it is expected that a technical basis can be developed to extend the design life of the SAVY-4000 containers to approximately 40 years (Blair et al. 2012, Weis et al. 2015a).

This surveillance plan update covers five years (2015–2019) and is developed to ensure SAVY-4000 containers meet their design criteria over the current five-year design life and to gather data that can be used in developing the technical basis for a 40-year design life. The technical basis for the longer design life will be developed based on the results of this surveillance plan and the concurrent lifetime extension studies (Blair et al. 2012, Weis et al. 2015a). A long-term surveillance plan will be developed by the completion of this plan and will be based on the results of the first several years of this five-year surveillance plan and the lifetime extension studies.

In addition, the current Hagan container population is so large (approximately 3,500 LANL-wide, approximately 3,000 in PF-4) that it is anticipated Hagan containers will be in use for many years to come. Therefore, this plan includes surveillance activities for the Hagan container system during the time it takes to replace the Hagan containers with manually-compliant containers such as the SAVY 4000. These Hagan examinations not only provide information to determine if additional Hagan surveillance is needed, but also support SAVY lifetime-extension studies because some of the container components are made from similar material (e.g., stainless steel and Viton).

2.0 BACKGROUND

2.1 Previous (2014) Surveillance Plan

The previous surveillance plan (Kelly et al. 2014) encompassed several methodologies for identifying containers for examination including the:

- Field Shelf-Life surveillance sample, which includes both (1) only nondestructive examinations (NDE-only) and (2) NDE and destructive examination (DE) NDE/DE,
- SAVY-4000 Items-of-Opportunity (I-of-O),
- SAVY-4000 Engineering Judgment (EJ) items,
- Hagan I-of-O items, and
- Hagan EJ items.

Table 2-1 shows the plan as described in the 2014 Update (Kelly et al. 2014). However, due to the Technical Area (TA) 55 pause, NDE and DE field surveillance did not begin until 2015.Additional examinations were done during 2015. Table 3-4 of this report updates Table 2-1 of the 2014 Update.

Table 2-1. Summary of Surveillance Sample Frequencies from the 2014 Update[1]

Sample Group	2014	2015	2016	2017	2018
SAVY Field Shelf Life, NDE-only (same four containers over time)	4	4	4	4	4
SAVY Field Shelf Life, NDE/DE	5	3	4	4	4
SAVY I-of-O, NDE-only (DE if a potential problem)	12	12	12	12	12
SAVY EJ, NDE-only or NDE/DE	NS[2]	NS	NS	NS	NS
Hagan I-of-O, NDE/DE	12	12	12	12	12
Hagan EJ, NDE/DE	NS	NS	NS	NS	NS

1 SAVY-4000 Field Surveillance Plan (Kelly et al. 2014).

2 NS = Not Specified.

Note: This table changes in 2016 (Table 3-4). Note that EJ items were not specified in the 2014 plan. For items of opportunity the numbers represent the possible number rather than a requirement.

2.2 Worst-Case Materials

In 2014 the Field Shelf-Life surveillance sample consisted of first identifying a set of "worst-case" materials that were packaged in non-standard containers, Hagan containers, or SAVY-4000 containers. The worst-case materials packaged in non-standard or Hagan containers were repackaged into SAVY-4000 containers. The parameters used to determine worst-case materials were (1) for the O-ring, those materials with the potential for a high gamma dose to the O-ring, (2) for the container body, those materials containing potentially corrosive salts and with

high radiation fields of all types, and (3) for the filter, those materials with the potential to generate corrosive gases and the potential for a high gamma dose to the filter. Figure 2-1 shows plots of dose versus item description codes (IDCs). The 12 IDC groups considered to encompass the worst-case materials are identified with blue stars. These groups were selected because they had a reasonable number of containers with the highest calculated doses and they encompassed the salt-bearing residues. (The doses are for ranking purposes only and do not represent actual dose to the components.)

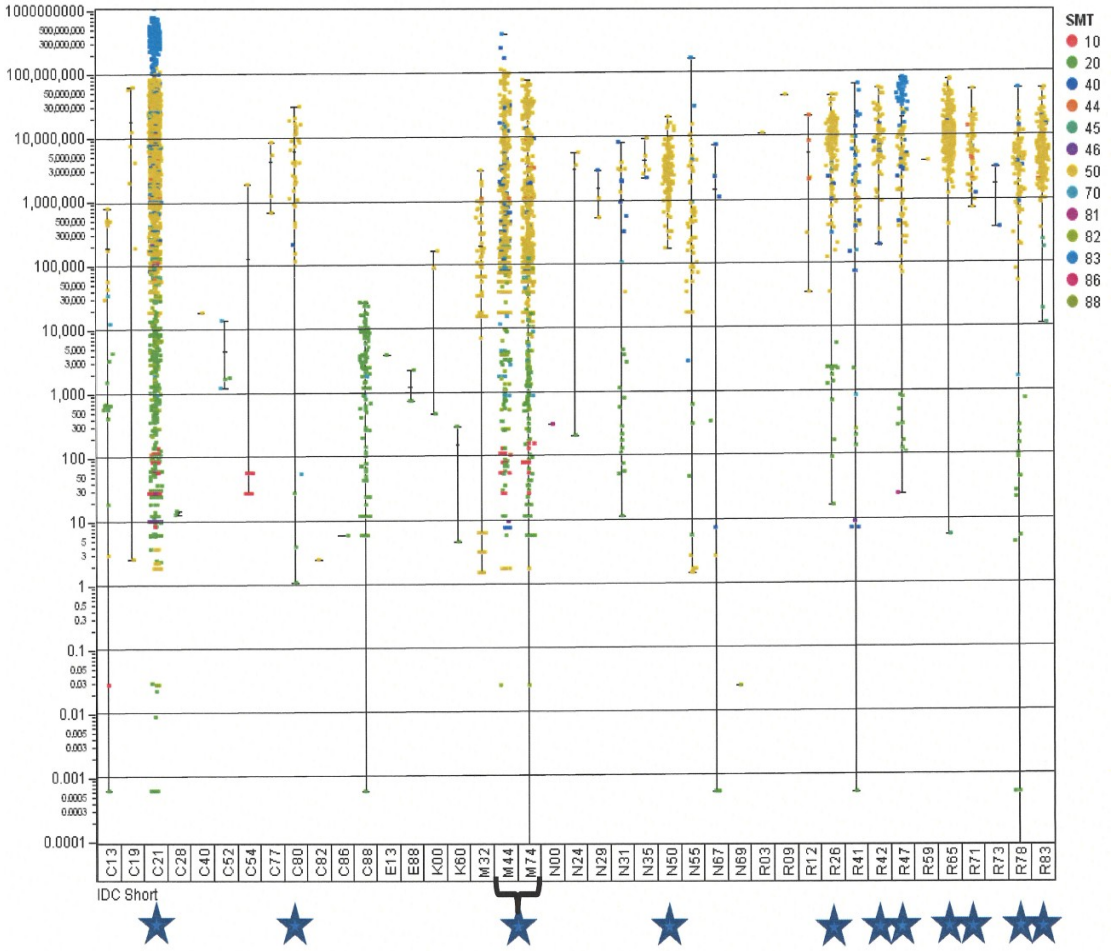

Figure 2-1. Calculated dose for each Item Description Code (see Appendix A for IDC definitions).

The blue stars marking IDC groups indicate those categories of materials that are likely to represent the LANL inventory in terms of the chemical challenge to the container. The color of the dots on the graph indicate the isotopic composition (material type [MT], also known as supplementary material type [SMT]) of the nuclear material, e.g., weapons-grade plutonium, highly enriched uranium, etc. (see Appendix B for MT definitions).

2.2.1 Field Shelf-life Surveillance Containers for 2014

In 2014 the Field Shelf-Life surveillance plan consisted of NDE/DE of an average of four containers per year that were packaged with worst-case materials. In addition, four containers with worst-case materials would undergo NDE only for five years for a total of 24 SAVY-4000 containers packaged with worst-case materials examined over a five-year period (Table 2-2). After three to five years, a decision would be made to either continue NDE only on the four containers or have these containers undergo NDE/DE.

Table 2-2. 2014 Surveillance Items for the Five-Year Plan*

IDC	Item Name	Target Packaging Date (quarter / calendar year)	Target Surveillance Year	Age at Surveillance (years)
N50	XBLC9413	1st / 2013	2014	1
M74	HNN5502CP	1st / 2013	2014	1
C80	PHX3F	1st / 2013	2014	1
C21	RBXS5657-1A	1st / 2013	2014	1
R26	TKS1C1 (SAVY)	1st / 2012	2014	2
N50	ORF633956XBLC	1st / 2013	2015	2
M74	PMP328CF	1st / 2013	2015	2
C80	PHX5R4	1st / 2013	2015	2
R71	PCS68B1	1st / 2013	2016	3
R65	GBS005	1st / 2013	2016	3
R47	INCA-21	1st / 2013	2016	3
R42	SLTF3123A	1st / 2013	2016	3
C21	PBO (SAVY)	1st/ 2012	2016	4
R83	XBLS25	2nd / 2013	2017	4
R78	POX4275C1	2nd / 2013	2017	4
R47	INCA-20	2nd / 2013	2017	4
R78	VTB-16C1	2nd / 2013	2018	5
R71	SWPVTB15	2nd / 2013	2018	5
R65	GBS059	2nd / 2013	2018	5
R42	XBSOX153	2nd / 2013	2018	5
R83	CAXBL128D	1st / 2013	Annual NDE/DE in 2016 or later	≥4
R26	ROTRB9C2 (SAVY)	3rd/ 2011	Annual NDE/DE in 2016 or later	≥4
M44	NAB183-2 (SAVY)	2nd / 2012	Annual NDE/DE in 2016 or later	≥4
C21	CXLOX082911 (SAVY)	1st / 2012	Annual NDE/DE in 2016 or later	≥4

* This table contains the 2014 schedule for the 24 containers with worst-case materials previously chosen for Field Shelf-Life surveillance program. This table is changed in 2016 (Tables 3-1-a and 3-1-b and 3-3-a and 3-3-b).

The NDE/DE containers were staggered to maximize the span of the container ages. However, field surveillance did not begin until 2015 and a restriction on handling residue materials greater than 500 g meant that almost all of the items with IDC "R__" materials had to be moved to the future. Therefore, the 2014 plan had to be extensively modified. The changes are shown in Table 2-3.

Table 2-3. Changes to the 2014 Plan Including Items Completed in 2015[1]

IDC	Item Name	Planned Surveillance Type	Status in 2015	Reason for Change	Age at Surveillance (years)
N50	**XBLC9413**	**NDE/DE**	**Completed**	**NA**	**2**
M74	HNN5502CP	NDE/DE	Moved	Logistical Issues	NA[2]
C80	**PHX3F**	**NDE/DE**	**Completed**	**NA**	**2.4**
C21	**RBXS5657-1A**	**NDE/DE**	**Completed**	**NA**	**2.6**
R26	TKS1C1 (SAVY)	NDE/DE	Moved	Residue with >500 g	NA
N50	ORF633956XBLC	NDE/DE	Moved	Moved to 2017	NA
M74	PMP328CF	NDE/DE	Moved	Removed because of logistical issues	NA
C80	**PHX5R4**	**NDE/DE**	**Completed**	**NA**	**1.8**
R71	PCS68B1	NDE/DE	Moved	Residue with >500 g	NA
R65	GBS005	NDE/DE	Moved	Residue with >500 g	NA
R47	INCA-21	NDE/DE	Moved	Residue with >500 g	NA
R42	SLTF3123A	NDE/DE	Moved	Residue with >500 g	NA
C21	**PBO (SAVY)**	**NDE/DE**	**Completed**	**NA**	**3.6**
R83	**XBLS25**	**NDE/DE**	**Completed**	**NA**	**2.6**
R78	POX4275C1	NDE/DE	Moved	Residue with >500 g	NA
R47	INCA-20	NDE/DE	Moved	Residue with >500 g	NA
R78	VTB-16C1	NDE/DE	Moved	Residue with >500 g	NA
R71	SWPVTB15	NDE/DE	Moved	Residue with >500 g	NA
R65	GBS059	NDE/DE	Moved	Residue with >500 g	NA
R42	XBSOX153	NDE/DE	Moved	Residue with >500 g	NA
R83	**CAXBL128D**	**NDE-only**	**Replaced and Completed**	**Residue with >500 g Replaced with XBLSCL1217**	**1.9**
R26	**ROTRB9C2**	**NDE-only**	**Replaced and Completed**	**Residue with >500 g Replaced with ROTRBJ-1C1**	**3.5**

IDC	Item Name	Planned Surveillance Type	Status in 2015	Reason for Change	Age at Surveillance (years)
M44	**NAB183-2**	**NDE-only**	**Replaced and Completed**	**Logistical Issues Replaced with XAP6 Replaced with ROTRBJ-1C1**	**3**
C21	**CXLOX082911**	**NDE-only**	**Completed**	**NA**	**3**

[1] This table shows the 2014 items that moved to the future and the items that were replaced. The table also shows the reason that they were moved or replaced. The 10 items that were completed in 2015 are shown in bold.
[2] NA = Not Applicable.

2.2.2 2014 SAVY-4000 Item of Opportunity Sample

In addition to the Field Shelf-Life surveillance sample, the plan was for up to 12 I-of-O containers per year. The assumption was that one SAVY-4000 container would be selected each operational month from those moving in and out of the vault or from those used as transfer containers based on programmatic use. A container would be selected for this sample based on logistical considerations. The containers in this sample would have NDE only, unless the NDE indicated a potential problem, in which case the container would undergo further evaluations including DE. In 2015 there were 10 I-of-O containers with NDEs. All of these containers were transfer containers (Table 2-4).

Table 2-4. SAVY-4000 Item of Opportunity Sample (Transfer Containers) with NDEs in 2015[1]

Transfer Container Sample No.	SAVY-4000 Serial Number	Date of Transfer Container Creation	Date of Maintenance	Age at Maintenance (years)
1	041208024(L/B)	Unavailable	12/10/2014	-[2]
2	081305013(L/B)	11/24/2014	9/10/2015	0.81
3	041208053(L/B)	Unavailable	12/23/2014	-
4	121101064(L/B)	Unavailable	12/23/2014	-
5	121101043(L/B)	Unavailable	12/23/2014	-
6	081301145(L/B)	8/5/2014	12/23/2014	0.39
7	081301130(L/B)	8/5/2014	12/23/2014	0.39
8	041208033(L/B)	Unavailable	12/10/2014	-
9	081301147(L/B)	8/5/2014	1/13/2015	0.45
10	081305013(L/B)	11/24/2014	9/10/2015	0.81

[1] Weis et al. 2015b.
[2] - Age was not specified for these containers

2.2.3 2014 Plan for Item of Opportunity Hagan Examinations

The plan was that up to 12 Hagans per year would be examined; one container would be selected each operational month from those moving in and out of the vault based on programmatic needs. These I-of-O containers would be selected based on logistical considerations. The containers in this sample would have NDE/DE. These examinations would provide additional information relevant to the SAVY lifetime-extension program and also provide information to determine if additional Hagan surveillance is needed.

Although no Hagan I-of-O items were examined, there were four Hagan EJ items that underwent NDE/DE (Table 2-5). This investigation was triggered by the discovery that a Hagan container packaged with high wattage BLO material had a degraded bag-out bag (Item ID BLO39). This item was repackaged into a SAVY container (Serial Number 031403040B). Four more EJ items were selected for NDE/DE because they had similar dose readings and/or wattages as compared to the BLO39 item. The materials were repackaged into SAVY containers (Table 2-5). The BLO-39-11-16 item is a sister item to the BLO39 item and will be added the group of NDE-only containers to be monitored over time. The remaining three containers will have NDE/DEs in the future as part of the Field Shelf-Life surveillance.

Table 2-5. Four Hagan Engineering Judgement containers with NDE/DE in 2015

Item	MT	IDC	Container	Outermost Container age (year)	Wattage (W)	Dose B/G means beta/gamma
RBXS5657-2A	MT56	C21	5 Qt Hagan (with suspect filter gasket)	10.8	10.5	B/G 43.0 mR/hr (presumably at surface of Hagan)
MOX51T	MT52	C21	3 Qt Hagan	14.3	6.2	B/G 40 mR/hr (presumably at surface of Hagan)
BLO-39-11-16	MT57	C21	Slip lid inside a 3 Qt Hagan inside an 8 Qt Hagan	4.9	5	B/G 13 mR/hr @ 30 cm
XBS9455	MT52	R65 (<500 g)	3 Qt Hagan	12.2	1.1	B/G w/o Pb 1.0R/hr, w Pb 15.0 mR/hr

2.2.4 2014 SAVY-4000 Engineering Judgment Sample

The plan in 2014 was that the Field Shelf-Life surveillance and I-of-O samples could be augmented with containers selected using EJ. The EJ sample would consist of containers believed to have the greatest potential for degradation (e.g., containers with materials that create high thermal conditions) that are not captured in the Field Shelf-Life and I-of-O samples. EJ items were not specified in 2014. Although no SAVY EJ items were examined in 2015, two items are specified for 2016. These items are discussed in Section 3.1.1.

2.3 Results from 2014 and 2015 Field Surveillance

Due to the TA-55 pause, DE and NDE surveillance did not begin until 2015. Table 2-6 summarizes these examinations. The detailed surveillance results are documented in the "FY 2015 Annual SAVY-4000 Surveillance Report" (Weis et al. 2015b).

Table 2-6. 2015 Surveillance Sample Frequency Summary*

Sample Group	Number examined in 2015
SAVY Field Shelf Life, NDE-only	4
SAVY Field Shelf Life, NDE/DE	6
SAVY I-of-O (Transfer Containers), NDE-only	10
Hagan EJ, NDE/DE	4

* (see Tables 2-3, 2-4 and 2-5 for details)

2.3.1 SAVY Field Shelf-Life Results

The 10 SAVY Field Shelf-Life surveillance containers had one bag-out bag failure and two containers with discoloration and coatings. The coatings could be wiped off. In all cases the O-rings passed the leak rate and durometer tests. The filters also passed the filter pressure drop and filter penetration tests. The six DEs were limited to Fourier transform infrared (FTIR) spectroscopy. There was no evidence of O-ring degradation in the FTIR spectra.

2.3.2 SAVY Item of Opportunity Results

All but one of the 10 SAVY I-of-O transfer containers passed visual inspections. One container had a manufacturing defect. Nevertheless, in all cases the O-rings passed the leak rate and durometer tests. The filters also passed the filter pressure drop and filter penetration tests.

2.3.3 Hagan Engineering Judgment Results

The four Hagan EJ containers passed the O-ring leak rate and durometer tests. The FTIR spectra measurements are currently in process. Results will be documented in a Hagan report to be released by the end of May 2016.

3.0 CURRENT (2016–2019) SURVEILLANCE PLAN

3.1 Changes to the 2014 Surveillance Plan

A significant impact on the 2014 surveillance plan is the restriction on handling residue materials greater than 500 g. This requirement means that 13 of the residue containers identified in the 2014 five-year surveillance plan will be examined in the future when the 500-g restriction is removed. If this restriction is not removed, these containers will be replaced with appropriate substitutes. Two of these containers were in the NDE-only group, CAXBL128D and

ROTRB9C2. Item CAXBL128D was replaced with item XBLSCL1217. This substitution is considered appropriate because the two items have the same IDC code (R83), Molten Salt Extraction material. Item ROTRB9C2 was replaced with ROTRBJ-1C1. This substitution is considered appropriate because the two items have the same IDC code (R26), Filter Residue.

Another three items must be moved in the future because of logistical issues. One of these, NAB183-2, was in the NDE-only group and was replaced with XAP6. This was justified because the two items have the same IDC code (M44), Plutonium Metal.

3.2 2016 SAVY and Hagan Engineering Judgment Items

A high wattage container that will have an EJ NDE/DE in 2016 is a SAVY transfer container. This transfer container (Serial Number 071201061B) was packaged with a welded general purpose heat source (GPHS, approximately 60 watts). It was stored for approximately three years. This was inappropriate storage time, since transfer containers are required to be maintained yearly. The DE of this container will provide an opportunity to find out if a high heat load has caused any degradation to the O-ring or filter over this time period.

In addition to the transfer container, a SAVY container (AAP020X) packed with high-wattage (21 watts) HATCH material (weapons grade plutonium oxide with 7% plutonium (Pu) 238 added) showed stains on the outside and a coating on the tamper-indicating device. This container is also a 2016 EJ NDE/DE. It is approximately two and a half years old. The HATCH material in this container will be repackaged into three SAVY containers and one of these will be added to the NDE-only surveillance program. (We currently denote this future container as SAVY (HATCH/3).

All four containers in Table 2-5 will have future surveillances. This group includes BLO-39-11-16, a sister item to BLO39, which is the container with the degraded bag-out bag (Section 2.1.4). This container will become part of the ongoing NDE-only group. The other three containers will have future NDE/DEs (2019 or later) as part of the Field Shelf-Life surveillance program.

3.3 2016 Surveillance Containers

Table 3-1-a shows the items currently identified for NDE-only and NDE/DE in 2016. The NDE/DE items include six residue items and a M74 item to replace those that were moved. The list also includes a N55 item and a M44 item. The M44 item is a worst-case metal item. The N55 item is a high-dose item and considered an appropriate substitute for a N50 item (a worst-case group).

There are a total of 11 SAVY NDE/DEs planned for 2016. The NDE/DE items include nine Field Shelf-Life SAVY containers and two SAVY EJ containers. All of these containers are new and therefore not listed in Table 2-3. There are four Field Shelf-Life NDE-only containers for a total of 15 SAVY surveillance containers. Three of the four NDE-only items were replaced as indicated in Table 2-3.

Table 3-1-a. SAVY NDE-only and NDE/DE Shelf-Life Surveillance Items for 2016

Sample	Item Name	MT	IDC	Chemical Form	Material Mass (g)	NDE-only or NDE/DE	SAVY 1st Packing Date	Age (year)	Processing Date Status (quarter)
1	CXLOX082911	52	C217	Compound Dioxide	786.9	NDE-only	1/18/2012	3	2nd
2	XBLSCL1217	52/44	R832	Process Residue, MSE Salt	Pu-178.5, Am-10.6	NDE-only	3/21/2013	1.9	2nd
3	XAP6	53	M447	Metal, Unalloyed Metal	69.5	NDE-only	1/26/2012	3	2nd
4	ROTRBJ-1C1	52	R26	Process Residue, Filter Residue	452	NDE-only	7/10/2013	2.6	2nd
5	AAP02OX	52 (7%238)	C217	Compound, Dioxide	509	NDE/DE	3/21/2013	2.9	2nd
6	XBLSCL1302	52	R83	Process Residue, MSE Salt	199	NDE/DE	3/21/2013	3.0	3rd
7	XBLSCL1301	52/44	R83	Process Residue, MSE Salt	192.7/8.6	NDE/DE	3/21/2013	2.6	3rd
8	XBLSCL1213	52/44	R83	Process Residue, MSE Salt	377/6.5	NDE/DE	4/9/2013	3.8	3rd
9	XBLSCL1120A	52	R83	Process Residue, MSE Salt	155	NDE/DE	3/28/2013	2.9	3rd
10	GPHS	83	C21	Compound, Dioxide	120	NDE/DE	3/9/2013	3	3rd
11	ROTRB9C3	52	R26	Process Residue, Filter Residue	500	NDE/DE	7/10/2013	2.6	4th
12	PMP91308	52	M44	Unalloyed Metal	3221	NDE/DE	8/18/15	1	4th
13	SLT1303	52	R42	Process Residue, DOR Salt	392	NDE/DE	5/15/2013	2.8	4th
14	SCRES65B	53	N55	Non-Combustible, Non-Actinide Metal	718	NDE/DE	7/10/2013	2.6	4th
15	ARIAAQ137	52	M44	Metal, Unalloyed Metal	2500	NDE/DE	4/17/2013	2.6	4th

Three Hagans are identified for possible NDE/DE in 2016 (Table 3-1-b). These Hagans have been selected for DE because they are residues with high dose and high wattage. These are potential NDE/DEs because there are resource issues that will need to be resolved before they can be examined. When they are examined they will need to be repackaged and they will provide worst-case material for SAVYs. The resulting three new worst-case SAVYs will be included in the future surveillance program.

It is anticipated that there will be another 10 SAVY I-of-O containers that will have NDE, but these have not been identified.

Table 3-1-b. Hagan Possible Engineering Judgment NDE/DE Surveillance Items for 2016

Sample	Item Name	MT	IDC	Chemical Form	Material Mass (g)	1st Use Date	Age (year)	Processing Date Status
1	XORER65SLT2	52	R65	Process residue; ER Salt	457	8/1/05	10.7	TBD*
2	TDC205	54	R47	Process residue; Incinerator Ash	475	7/10/07	8.7	TBD
3	INC22101	54	R47	Process residue; Incinerator Ash	413	5/23/03	10.8	TBD

* TBD = To Be Determined - depends on resource availability.

Table 3-2 summarizes the surveillance activities as of the end of 2016.

Table 3-2. Surveillance Activities in 2015 and 2016

Sample Group	2015	2016	Total
SAVY Field Shelf Life, NDE-only	4	4	4 containers with two NDEs each (8 NDEs)
SAVY Field Shelf Life, NDE/DE	6	9	15
SAVY EJ NDE/DE	0	2	2
SAVY I-of-O (Transfer Containers), NDE-only	10	10	20
Hagan EJ, NDE/DE	4	3*	7
TOTAL	**24**	**25/28***	**48/51***

* If resources are available.

3.4 Future Field Shelf-Life Surveillance Containers

Table 3-3-a provides a list of the SAVY containers currently planned for Field Shelf-Life NDE-only or NDE/DE in the future. The items in red are residue items that moved from the FY 2015 plan to the future because of a restriction on handling residue materials greater than 500 g. If this restriction is not removed these containers will be replaced with appropriate substitutes. Figure 3-1 places these containers on the dosage versus IDC plot. These items cover the 12 worst-case IDC groups.

Additional containers will be added to this list over time. Selection of future containers will take into consideration the age of the containers. The goal is to get older containers to provide a wide a distribution of ages as soon as possible.

Table 3-3-a. SAVY Containers Planned for Field Shelf-Life NDE/DE or NDE-only in 2017 and Beyond

SAVY Serial Number	Item Name	IDC	Surveillance Category	Surveillance Type	Surveillance Year
121103083B	XBLSCL1217	R83	SAVY Shelf-Life/NDE	NDE-only	Continuing from 2015
111103026B	CAXBL128D	R83	SAVY Shelf-Life/NDE	NDE-only	Continuing from 2015
121103013B	NAB183-2	M44	SAVY Shelf-Life/NDE	NDE-only	Continuing from 2015
031105010B	ROTRB9C2	R26	SAVY Shelf-Life/NDE	NDE-only	Continuing from 2015
041208057B	SAVY (HATCH/3 from AAP020X)	C21 (HATCH)	EJ	NDE-only	Continuing from 2016
111308080B	BLO-39-11-16	C21	EJ	NDE-only	Continuing from 2017
121103054B	MOX51T	C21	EJ	NDE/DE	Future
081305008B	RBXS5657-2A	C21	EJ	NDE/DE	Future
081305197B	XBS9455	R65	EJ	NDE/DE	Future
041208038B	ORF633956XBLC	N50	SAVY Shelf-Life	NDE/DE	Future
041208025B	GBS005	R65	SAVY Shelf-Life	NDE/DE	Future
041208004B	GBS059	R65	SAVY Shelf-Life	NDE/DE	Future
111103028B	HNN5502CP	M74	SAVY Shelf-Life	NDE/DE	Future
041208043B	INCA-20	R47	SAVY Shelf-Life	NDE/DE	Future
041208009B	INCA-21	R47	SAVY Shelf-Life	NDE/DE	Future
041208028B	PCS68B1	R71	SAVY Shelf-Life	NDE/DE	Future
091205182B	POX4275C1	R78	SAVY Shelf-Life	NDE/DE	Future
121103062B	SLTF3123A	R42	SAVY Shelf-Life	NDE/DE	Future
111103001B	SWPVTB15	R71	SAVY Shelf-Life	NDE/DE	Future
031105059B	TKS1C1	R26	SAVY Shelf-Life	NDE/DE	Future
021205029B	VTB-16C1	R78	SAVY Shelf-Life	NDE/DE	Future
091205175B	XBSOX153	R42	SAVY Shelf-Life	NDE/DE	Future
NA*	XORER65SLT2	R65	SAVY Shelf-Life	NDE/DE	>2019
NA	TDC205	R47	SAVY Shelf-Life	NDE/DE	>2019
NA	INC22101	R47	SAVY Shelf-Life	NDE/DE	>2019

* NA = Not Applicable.

The items in red are residue items that moved from the FY 2015 plan to the future because of a restriction on handling residue materials greater than 500 g.

Figure 3-1. The containers in Table 3-1-a, 3-1-b, 3-3-a and 3-3-b are shown on the dosage versus IDC plot.

3.5 Future SAVY-4000 Item of Opportunity Sample

In addition to the Field Shelf-Life surveillance sample, the plan is for up to 10 I-of-O containers per year. The assumption is that SAVY containers will be selected from those moving in and out of the vault or from those used as transfer containers. A container will be selected for this sample based on logistical considerations. The containers in this sample will have NDE only, unless the NDE indicates a potential problem, in which case the container would undergo further evaluations including DE.

3.6 Future SAVY-4000 Engineering Judgment Sample

The Field Shelf-Life surveillance and I-of-O sample containers could be augmented with containers selected using engineering judgment. This EJ sample has not been specified at this time. However, it will consist of containers believed to have the greatest potential for degradation (e.g., containers with materials that create high thermal conditions) that are not captured in the Field Shelf-Life and I-of-O samples.

3.7 Future Hagan Item of Opportunity Sample

The plan is that up to six Hagans per year will be examined. Containers will be selected from those moving in and out of the vault based on programmatic needs. These I-of-O containers will be selected based on logistical considerations. The containers in this sample will have NDE/DE.

These examinations will provide additional information relevant to the SAVY lifetime-extension program and also provide information to determine if additional Hagan surveillance is needed.

3.8 Future Hagan Engineering Judgment NDE/DE Containers

There are another five Hagans identified for future NDE/DE (Table 3-3-b). These Hagans will have DEs because they are residues with high dose and high wattage. They need to be repackaged and they will provide worst-case material for SAVYs. These Hagans are identified as Future Hagan EJ items.

Table 3-3-b. Engineering Judgment Hagan Containers Planned for NDE/DE in the Future

1st Use Date	Age (yr)	Wattage (W)	Item Name	IDC	MT	Element Weight (g)
4/19/01	14.9	12.6	TDC59	R47	83	26.7
4/19/01	14.9	12.3	TDC119	R47	83	26
4/19/01	14.9	9.9	TDC118	R47	83	20.9
4/19/01	14.9	7.8	TDC25	R47	83	16.4
4/19/01	14.9	11.2	TDC40	R47	83	23.7

3.9 Expanded Current Surveillance Plan

The current surveillance program adds another 13 containers to the NDE/DE Field Shelf-Life surveillance items and another two containers to the NDE-only items in addition to the containers identified in 2014. This increases the total number of Field Shelf-Life containers from 24 to 39. Table 3-4 provides the revised sampling frequencies for the updated five-year surveillance plan (2015–2019).

Table 3-4. Summary Surveillance Sample Frequencies for 2015–2019[1]

Sample Group	2015	2016	2017	2018	2019	Total
SAVY Field Shelf-Life, NDE-only	4 from 2014 plan	4 from 2015	6 total: 4 from 2015, + 1 BLO, + 1 HATCH/3	6	6	**26**
SAVY Field Shelf-Life, NDE/DE	6 (from 2014 plan)	9	6	6	6	**33**
SAVY I-of-O, NDE-only or NDE/DE if needed	10 (transfer containers)	10	10	10	10	**50**
SAVY EJ, NDE/DE	0	2 total: HATCH container and Transfer container	TBD[2]	TBD	TBD	**2+TBD**
Hagan EJ NDE/ DE	4 (EJ NDE/DE - Heat Load items)	3[3] (Table 3-1-b)	5 Pu-238 Residue Items (Table 3-3-b) (possibly examined after 2019)			**4+TBD**

Hagan I-of-O NDE/DE (up to 6 each year)	0	0	6	6	6	**18**
Total	**24**	**25/28**	**27 + EJs**	**28 + EJs**	**28 + EJs**	**133/136[3] + EJ TBDs**

[1] I-of-O items in 2016 and beyond represent the possible number rather than a requirement.

[2] TBD = To Be Determined.

[3] If resources are available.

4.0 SURVEILLANCE MEASUREMENTS

The main focus of surveillance examinations is to evaluate O-rings, filters and the container's condition, particularly for any sign of performance degradation, corrosion or leakage. For example, since the container has a filter, pressurization could be an indication of a plugged filter and could increase the potential for and severity of loss of containment. Measurements and examinations to assess potential problems will be conducted on all surveillance containers. Some of these evaluations provide "yes/no" data and others provide quantitative data. If there is a "yes" response and/or there are any observations that indicate a potential problem with the container, the Nuclear Material Storage and Disposition Board (the Board) will be notified promptly.

4.1 Non-Destructive Examinations (NDE) for SAVY-4000 and Other Surveillance Containers

Examinations during the unpacking of the outer container:

- Any visual indications of pressurization (slight bulging) or corrosion? (yes/no)
- Does visual inspection show signs of any dents or gouges that may have occurred in normal handling or possibly due to dropping the container? (yes/no)
- Weight measurement: do trends indicate moisture absorption or metal oxidation? (yes/no)
- Do contamination surveys show any indication of O-ring seal failure, weld failure or filter failure? (yes/no)

Visual examination to determine inner package condition and if the container was packaged according to procedures:

- O-ring installed improperly? (yes/no)
- Inner container not consistent with material form (e.g., not a stainless steel slip lid for oxide, not a hermetically sealed lid for metal, etc.)? (yes/no)
- Bag-out bag not present? (yes/no)
- Bag-out bag not intact (e.g., contamination found outside bag-out bag)? (yes/no)
- Any liquid observed inside the bag-out bag? (yes/no)
- Metal inner container not intact (e.g., holes corroding through, plutonium in contact with bag-out bag, etc.)? (yes/no)

Examination of the empty SAVY-4000 or Hagan container:

- Leakage testing shall be in accordance with ANSI N14.5. For a SAVY-4000 container, the test pass rate shall be equal to the design release rate established as 5.6 × 10-6 cm3s-1 of fluid. For both SAVY-4000 containers and Hagan containers, the testing helium leak rate criterion for this Surveillance Plan will be 1.0 × 10-5 atm cm3 s-1 at a differential pressure of 10 kPa.
- Do the interior and/or exterior surfaces of the container show any signs of corrosion or discoloration? (yes/no). If the response is "yes,"
  - a photograph of the affected area is taken.
  - if there is a coating and it is wipeable, the photograph is sufficient and the container passes inspection.
  - if it is not wipeable, then the container does not pass inspection and further analysis of the potential corrosion is required (e.g., evaluation of pitting).
- Does the functional check of the closure system show any impingement of moving parts impeding closure? (yes/no)
- Does the O-ring groove on the body collar show any signs of damage (e.g., scratches, burr, etc.)? (yes/no)

Examination of O-Ring:

- Does the SAVY-4000 O-ring need replacement based on the visual inspection: scratches, cuts or other damage on the O-ring itself that might prevent an effective seal? (yes/no)
- Shore M hardness measurements that will be evaluated using Parker O-ring manufacturer recommended tolerances. The hardness measurements will be directly compared to those measurements obtained from our accelerated aging studies and shelf-life studies.
- O-ring thickness will be measured with a laser micrometer. The measured thickness can be compared to the nominal thickness of Parker V0986-50 O-rings, and the compression set of the O-ring estimated from these values.

Examination of Filter Function:

- Based on visual inspection of the outside of the lid, does the area around the filter show indications of particulate escape? (Particulates could indicate that the filter is compromised.) (yes/no)
- Based on visual inspection of the inside and the outside of the lid, does the filter material itself show indications of discoloration or occlusion? (yes/no)
- Aerosol filter test at a flow rate of ~200 ml/min
- % penetration (<0.03%)
- Pressure drop across the filter (<1 inch water column)

4.2 Destructive Examination (DE)

In addition to the NDE measurements and qualitative evaluations that will be performed on all surveillance containers as noted above, detailed DE of O-rings will be performed on the field surveillance sample and possibly on I-of-O requiring replacement of the O-ring. These data will be used to supplement ongoing accelerated aging studies (Blair et al., 2012).

DE tests for the SAVY-4000 O-rings:

- Compression set will be estimated from the measured thickness of the O-ring and the nominal thickness of Parker V0986-50 O-rings, 0.2100 inches ± 0.0005 The estimated compression set values will be directly compared to those measurements obtained from our accelerated aging studies.
- FTIR spectroscopic measurements to track changes in the O-rings at the molecular level.
- Polymer swelling measurements will be taken on a section of the O-ring in accordance with ASTM D2765–95. Swelling measurements will be compared with those obtained from our accelerated aging studies.

NDE and DE tests will also be performed on Viton-based O-rings and Neoprene-based gaskets from Hagan containers included in the surveillance program. However, since we are not conducting accelerated aging studies on the polymeric materials used in Hagan containers, we do not have a base of knowledge for comparison to compression set measurements.

NDE and DE tests for the Hagan O-rings and gaskets:

- Shore M hardness measurements that will be evaluated using Parker O-ring manufacturer recommended tolerances. The hardness measurements will be directly compared to those measurements obtained from our accelerated aging studies and shelf-life studies.
- FTIR spectroscopic measurements to track changes in the O-rings at the molecular level.

5.0 REPORTING REQUIREMENTS

As stated previously, if there are any "yes" responses and/or there are any observations that indicate a potential problem with the container during the NDE and NDE/DE, Nuclear Material Storage personnel and the Board will be notified promptly.

An annual report summarizing the surveillance and lifetime-extension studies for all containers examined to date will be delivered to the Board in December. The SAVY-4000 Project Leader shall submit the report with assistance from staff members for each tested component.

6.0 SURVEILLANCE DATABASE

A key component of the surveillance program is the surveillance database. LANL initiated the development of a database with relevant information about stored materials and containers, including material, packaging, and surveillance information for each storage container. The

database will document important information for trending studies such as the age of the container, how long it has been in service, its in-service history (e.g., what materials have been loaded for what periods of time), and the dates of replacements of key components such as O-rings. The database will also provide information about the materials in these containers so that a material causing potential problems to the inner container can be identified. The database will also be used to document the inspection/testing results from this plan and from the lifetime extension studies.

To make sure that items that are scheduled for future surveillance are tracked properly, these items will be assigned to the LANMAS field SubMBA of MMGT. The MMGT identifier prevents the containers from being retrieved from the vault for purposes other than surveillance.

7.0 REFERENCES

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APPENDIX A. ITEM DESCRIPTION CODE (IDC) DEFINITIONS

IDC*	DESCRIPTION
C13	COMPOUND; Carbide
C19	COMPOUND; Chloride
C21	COMPOUND; Dioxide
C28	COMPOUND; Fluoride
C40	COMPOUND; Hydride
C52	COMPOUND; Nitrate
C54	COMPOUND; Nitride
C77	COMPOUND; Sulfate
C80	COMPOUND; Tetrafluoride
C82	COMPOUND; Trichloride
C86	COMPOUND; Trioxide
C88	COMPOUND; U3O8
E13	REACTOR ELEMENT; Carbide
E88	REACTOR ELEMENT; U3O8
K00	COMBUSTIBLE; Non Specific
K60	COMBUSTIBLE; Paper/Wood
M32	METAL; Beryllide
M44	METAL; Unalloyed Metal
M74	METAL; Alloyed Metal
N00	NON-COMBUSTIBLE; Non Specific
N24	NON-COMBUSTIBLE; Filter Media
N29	NON-COMBUSTIBLE; Glass
N31	NON-COMBUSTIBLE; Graphite
N35	NON-COMBUSTIBLE; HEPA Filter(s)
N50	NON-COMBUSTIBLE; MgO
N55	NON-COMBUSTIBLE; Non-Actinide Metal
N67	NON-COMBUSTIBLE; Plastics/Kim Wipes
N69	NON-COMBUSTIBLE; Resin
R03	PROCESS RESIDUE; Hydrogenous Salt
R09	PROCESS RESIDUE; Calcium Salt
R12	PROCESS RESIDUE; Calcium Metal
R26	PROCESS RESIDUE; Filter Residue
R41	PROCESS RESIDUE; Hydroxide Precipitate
R42	PROCESS RESIDUE; DOR Salt
R47	PROCESS RESIDUE; Incinerator Ash
R59	PROCESS RESIDUE; Oxalate Precipitate
R65	PROCESS RESIDUE; ER Salt
R71	PROCESS RESIDUE; Salt
R73	PROCESS RESIDUE; Silica
R78	PROCESS RESIDUE; Sweepings/Screenings
R83	PROCESS RESIDUE; MSE Salt

*The IDC codes used in this plan are abbreviated to the first three characters. Those used in LAMCAS are four characters.

APPENDIX B. DETAILED MATERIAL TYPES IN THE SURVEILLANCE POPULATION*

MT	DESCRIPTION
42	>60% Pu-242
52	Pu-239 with 4.00%–7.00% Pu-240
54	Pu-239 with 10.00%–13.00% Pu-240
56	Pu-239 with 16.00%–19.00% Pu-240
83	Pu-238

* DOE Manual 470.4-6, "Nuclear Material Control and Accountability" (8-26-07).