LA-UR-19-22520
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Title: TA55 Nuclear Material Packaging, TA55-DOP-091 / PA-RD-01022

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Intended for: Training Material, Course #42477

Issued: 2019-03-20

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TA55 Nuclear Material Packaging

TA55-DOP-091 / PA-RD-01022

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Course #42477

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NNSA National Nuclear Security Administration

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Course 42477 Outline

- ***If we need to evacuate this room…***
- **Discussion: Safe handling of nuclear material**
  - Storage Issues
  - Compliant Packaging
- **Nuclear material content restrictions**
- **Packaging Configurations**
  - Inner Containers
  - Outer Containers
  - Nesting and Overpacking
- **Packaging Procedure**
  - Content Checks
  - Container Inspection
  - Performance
  - Contingencies
- **Lessons Learned**
- **Performance Demonstration**

Safe Handling of Nuclear Material

Discussion

- What are the similarities between a glovebox and a container?

- What is the key difference between a glovebox and a container?

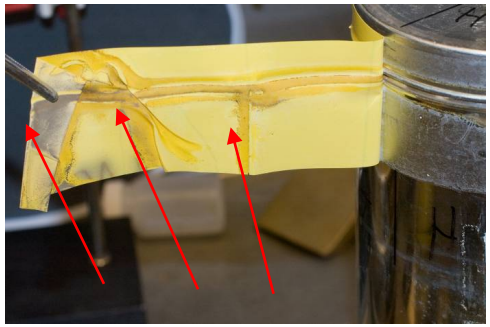
Discussion

- **What happens to nuclear material when it is stored?**
  - Radioactive decay / Radiation fields
    - Generation of heat
    - Radiolysis—Water molecules split; gases generated
    - Degradation of packaging (especially plastic)
  - Chemical reactions
    - Oxidation
    - Gas generation
    - Hydride formation
- **What must a nuclear material container be resistant to?**
  - Corrosion
  - Thermal degradation
  - Radiation
  - Oxidative expansion
  - Pressurization
  - Chemical reactions

Packaging Issues of the Past

AGE

Failure of vinyl tape seal on outer container. Vinyl tape not designed to last two decades.



INCOMPATIBLE MATERIALS

Plutonium oxide powder packaged in direct contact with plastic destroyed inner container.

CORROSION

Thin walled coated carbon steel

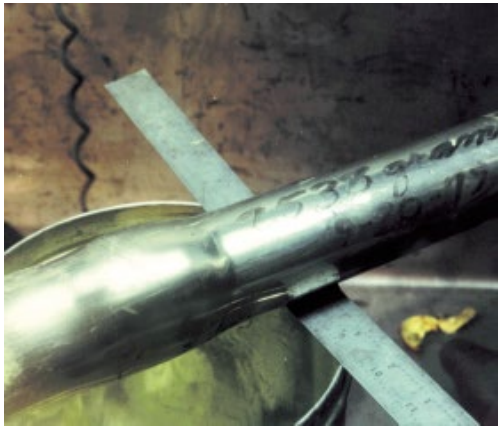
HIGH ACTIVITY MATERIAL

Corrosion due to Pu-238 on rags

Packaging Issues of the Past

Faulty Seal

Improperly sealed containers resulted in oxidized metal, expansion of container until failure.



Gas Generation

Unstabilized material pressurized container until failure.

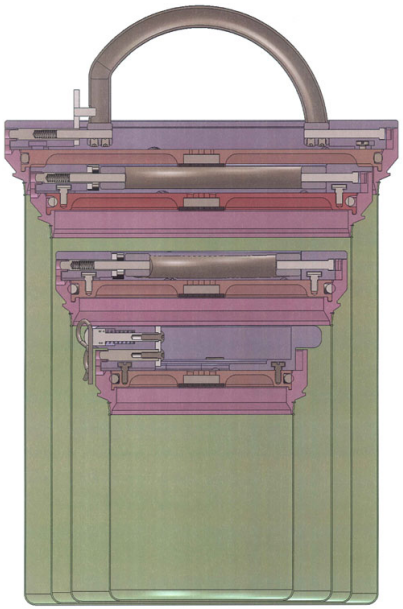
Pyrophoricity

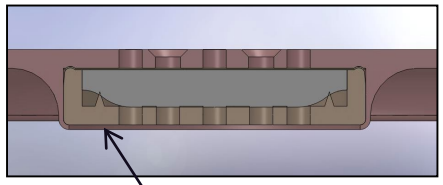
- **The capability of a substance to ignite spontaneously in air**
- **Ignition temperatures**
  - ~480°C for bulk metal
  - ~200°C for powders and fines
- **BUT…Improper storage can result in hydrides or incomplete oxidation on surface**
- **AND Surface reactions with oxygen in the air are <u>EXOTHERMIC</u>, so the material self heats and can reach the ignition temperature within seconds!**

Packaging Compliance

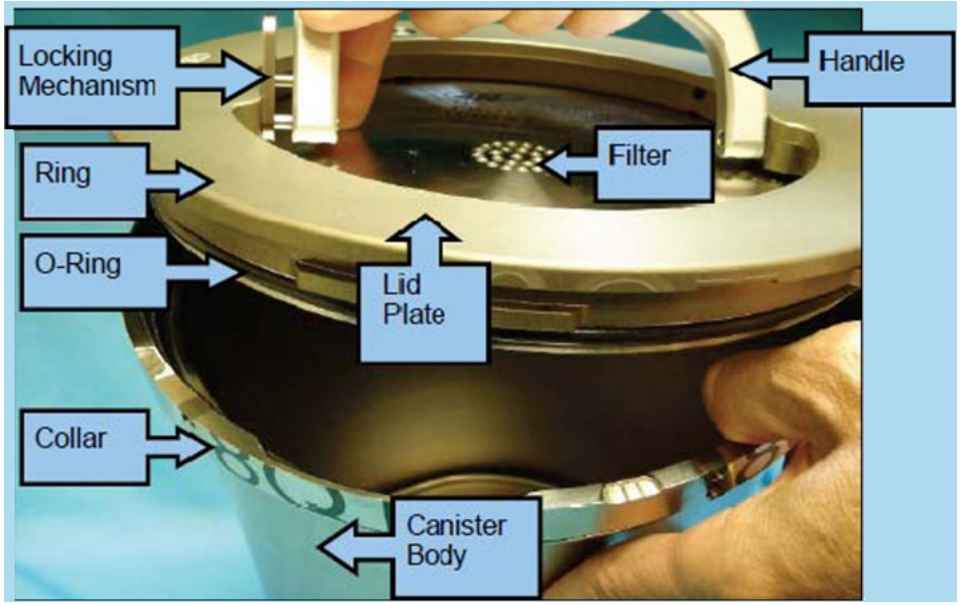
- **M441.1-1, *DOE Nuclear Packaging Manual*—**standardization of packaging requirements across the DOE complex
  - **P118, *Packaging Nuclear Material for On-Site Storage*—**LANL implementation
    - Site Specific Implementation, e.g. TA-55
      - TA55-DOP-091, *TA-55 Nuclear Material Packaging*
      - PA-RD-01022, *TA-55 Nuclear Material Packaging*
- **Your responsibility as a <u>worker</u> is to comply with the following:**
  - **Packaging design criteria:**
    - *Use compliant containers*
    - *Attend training*
    - *Close containers per procedure*
  - **Stored material characteristics criteria**:
    - *Ensure materials are allowed in a container*
  - **Packaging surveillance program:**
    - *Complete pre-use inspections*
    - *Report container issues*
  - **Documentation:**
    - *Data entry into NMCA system*

SAVY 4000





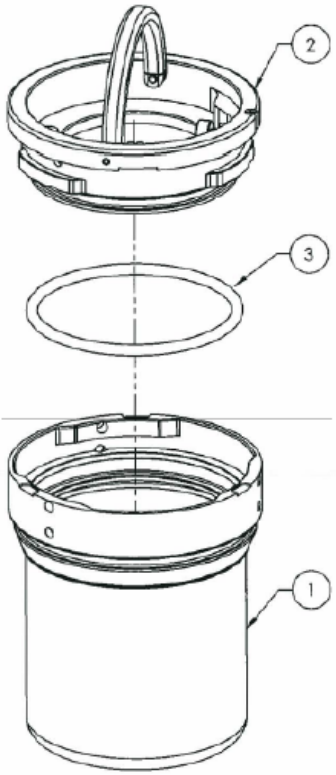
Mechanical Seal



SAVY 4000 – M441.1-1 Compliant Container

- **The body and lid are attached to one-another with a bayonet style closure**
- **The soft durometer Viton O-ring allows for opening/closing without tools and a water/air tight seal**
- **The lid locks into place with a positive mechanical engagement made of aluminum and a stainless steel pin**
- **The internal components that form the containment boundary are made of 316L stainless steel for corrosion resistance**
- **Containers designed to withstand a 12-ft drop**
- **Water-resistant containers***

  (always verify PA-RD-01009)
- **Certified for MAR credit**
  - “Cert” designation in LANMAS
  - Damage ratio: 0.01



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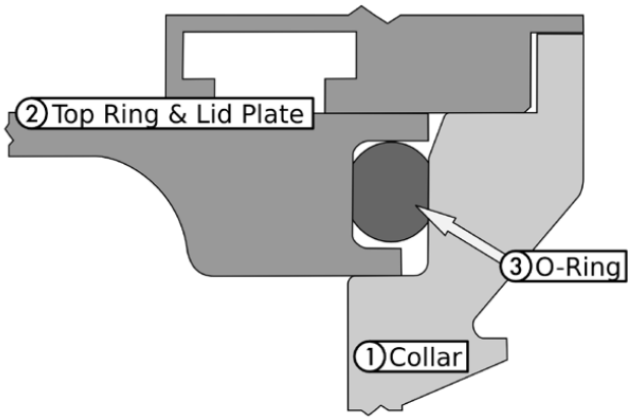

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Hagan Containers – NOT M441.1-1 Compliant

- **Threaded lid and body**
- **Closure action compresses Viton O-ring set in a groove above the body threads**
- **Internal components that form the containment boundary are made of 304L stainless steel**
- **Water resistant containers***

  (always verify PA-RD-01009)

- **Certified for MAR credit**
  - “Cert” designation in LANMAS
  - Damage ratio: 0.05

- **Phased out: no longer accepted by TA-55 vault for storage**

Hagan Containers – Nonconformance Issues

- **If the serial number on a metal sticker the component as nonconforming**

- **If the lid has a filter gasket that is cracked or crumbling then the lid is nonconforming**

10/02
&
8/02

Ring Drums – NOT M441.1-1 Compliant

- **Closure action of locking ring compresses gasket set in a groove in lid**
- **Internal components that form the containment boundary are made of 304L stainless steel**
- **Torque specification**
  - 5 gal: 5.5 to 6.5 ft-lbs
  - 10, 20 gal: 55 to 60 ft-lbs
- **Water resistant containers***

  (always verify PA-RD-01009)

- **NOT certified for MAR credit**
  - Damage ratio: 1
- **Phased out: replacement with 5, 5.5, and 10 gal SAVY 4000**

5 gal

10 gal
20 gal

Content Restrictions

PA-RD-01022

What needs to be in a container? (M441.1-1, P118)

- **What?**
  - "…nuclear materials …whose composition and quantity create the potential for an airborne contamination hazard that could result in a facility worker receiving an internal radiation dose in excess of 5 rem CEDE"
- **Where?**
  - "Nuclear materials that are stored outside of an engineered contamination barriers" (i.e. outside of a glovebox)
- **How long?**
  - A period longer than short-duration storage ("hours to days but not weeks")
- **How much?**
  - "Nuclear materials of this type … with a total quantity in a storage package exceeding the A_2 thresholds established in 49 CFR § 173.435"

Examples of A_2 threshold values

- Plutonium
  - Weapon Grade (MT 52) 0.35 g
  - Fuel Grade (MT 54) 0.24 g
  - Power Grade (MT 57) 0.066 g
  - Heat Source (MT 83) 0.002 g
- Uranium
  - Depleted U: (MT 11-18) unlimited
  - Enriched U (<20% U-235) (MT 21-33): unlimited
  - Enriched U (>20% U-235): (MT 38): 2,970 g

These are threshold values above which material must be in a M441.1-1 complaint container.

TA55 Packaging Documents

- **PA-RD-01022, *TA55 Nuclear Material Packaging Requirements***
  - Requirements document (RD)
  - Reference document
  - Storage container requirements
    - Content restrictions
    - Approved inner containers
    - Approved outer containers
  - Transfer container requirements
    - Content restrictions and configuration

- **TA55-DOP-091, *TA55 Nuclear Material Packaging***
  - Detailed operating procedure (DOP)
  - Reference document
  - Use Every Time (UET) attachments
  - Field preparation (Reference)
    - Content checks
    - Container inspections
  - Performance (Reference)
    - Load containers
    - Close containers
    - Open containers
    - Data entry

Packaging Scope (TA55-DOP-091)

- **Packaging for storage (onsite)**
  - Packaging of nuclear material for a period of weeks to years
  - May be used for transfer (conveyance)
  - SAVY 4000, Hagan, or ring drum containers
  - More restrictive content (e.g. no corrosives)

- **Packaging for transfer (onsite)**
  - Packaging of nuclear material in a configuration intended for conveyance throughout the facility or short term packaging (up to 1 year)
  - SAVY 4000 containers only
  - Broader content (all solid materials and liquids) with restrictions on quantity/configuration

- **Out of scope**
  - Packaging for in-glovebox use
  - Packaging waste
  - Packaging for shipment
  - Packaging other container types…

Storage Container

- **SAVY 4000 containers, Hagan containers, or ring drums packaged according to the content restrictions for storage**
- **Content restrictions**
  - Decay heat limit: 25 W per container, based on…
    - NDA measurement or
    - Gram amount of nuclear material
  - Content based on material form: Item Description Code (IDC) in LANMAS
    - Allowed: in general, metals, oxides, most residues
    - Not allowed
      - Gases (GXXX)
      - Liquids (LXXX)
      - Pressure generating C02X, N69X, R59X
      - Corrosive C19X
      - Pyrophoric materials (e.g. Pu metal turnings, MXXJ, M76X), C39X, C40X, C61X, R12X
      - Combustible materials (KXXX)
      - Hydrogenous HS-Pu materials (MT 83)

Restricted IDCs for Storage Containers

IDC	DESCRIPTION
C02X	COMPOUND; Acetate
C19X	COMPOUND; Chloride
C39X	COMPOUND; Tritide
C40X	COMPOUND; Hydride
C61X	COMPOUND; Perchlorate
N69X	NON-COMBUSTIBLE; Resin
R12X	PROCESS RESIDUE; Calcium Metal
R59X	PROCESS RESIDUE; Oxalate Precipitate
GXXX	All Gases
KXXX	All Combustibles
LXXX	All Liquids
MXXJ	All Metal Turnings

Content Restrictions (Material Type)

- **Mass limits equivalent to 25 W***

MT	DESCRIPTION	MASS LIMIT (kg) (ElementWt)
44	Americium, Am-241	0.21
51	Plutonium, < 4.00% Pu-240	11.0
52	Plutonium, 4.00 thru 7.00% Pu-240	9.4
53	Plutonium, 7.00 thru 10.00% Pu-240	8.0
54	Plutonium, 10.00 thru 13.00% Pu-240	6.0
55	Plutonium, 13.00 thru 16.00% Pu-240	5.2
56	Plutonium, 16.00 thru 19.00% Pu-240	4.9
57	Plutonium, >19.00% Pu-240	2.7
83 (83%)	Plutonium-238	0.053
83 (89%)	Plutonium-238	0.050
MATERIALS WITH HIGH AMERICIUM (e.g. R83x)		
51 thru 57 with 0-6% Am	Plutonium, all	1.7
51 thru 57 with 0-12% Am	Plutonium, all	1.2
51 thru 57 with 0-24% Am	Plutonium, all	0.7

Element wt. of Am

Element wt. of Pu

**abbreviated list; complete list found in PA-RD-01022*

Content Restrictions (step 2)

- **Material form restrictions***
  - Must be solids; liquids and gases are not allowed
  - Unallowed material characteristics: Pyrophoric, Corrosive, Combustible, or Gas Generating
    - Any material form that includes turnings is prohibited

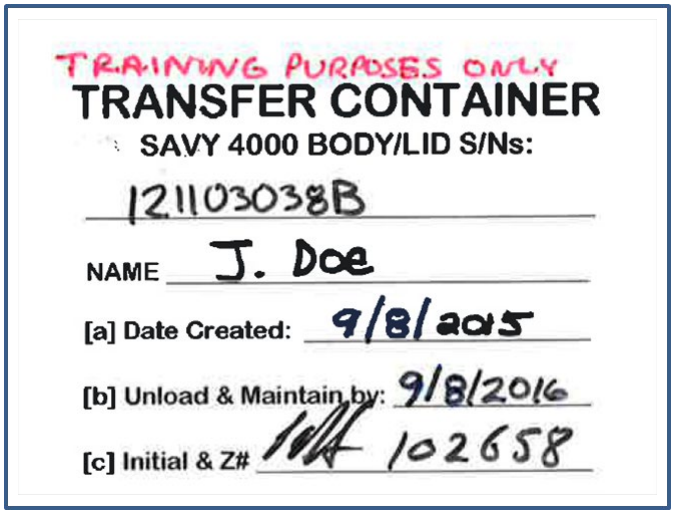
IDC	DESCRIPTION	ALLOWED	NOT ALLOWED	REASON
A99X	ASSEMBLY; Pit	X		
C19X	COMPOUND; Chloride		X	CORROSION
C20X	COMPOUND; Dioxide; High Purity HS-Pu Sintered/Unclad	X		
C02X	COMPOUND; Acetate		X	PRESSURE
C21X	COMPOUND; Dioxide	X		
C40X	COMPOUND; Hydride		X	PYROPHORIC
C52X	COMPOUND; Nitrate	X		
G00X	GAS; Non Specific		X	GAS
L90X	LIQUID/SOLUTION; Water		X	LIQUID
M44X	METAL; Unalloyed Metal	X		
M74X	METAL; Alloyed Metal	X		
M76X	METAL; Alloyed Turnings		X	PYROPHORIC
N00X	NON-COMBUSTIBLE; Non Specific	X		
R83X	PROCESS RESIDUE; MSE Salt	X		

**abbreviated list; complete list found in PA-RD-01022*

Transfer Container

- **SAVY 4000 containers packaged according to the content restrictions for <u>Transfer Containers</u>**
  - Intended to be stored for **<u>up to 1 year</u>**
  - May be stored/staged in safes and floor locations
  - **NOT** allowed to be stored in the TA55 vault
  - SAVY 4000 containers **ONLY**
  - **MUST** have a transfer container label
  - The outermost inner containment layer **MUST** be free of external contamination.

- **Allowed Content**
  1. Storage container content
  2. Liquids (LXXX)
  3. Solid materials (<u>all</u> CXXX, KXXX, NXXX, RXXX)
  4. Pu metal or alloy coupons or pieces
  5. Pu metal or alloy items
  6. Contaminated solids and/or glovebox trash (<u>all</u> KXXX and NXXX)
  7. Pu-238 contaminated cellulose rags
  8. Pu-238 containers and sources (FSIs inside non welded FSOs)
  9. TRU Waste
  10. Pu-238 GPHS-FCs



Packaging Configurations

PA-RD-01022

Approved Packaging Configuration (TA55-DOP-091)

1. Approved inner container(s) inside a contamination-free bag out bag inside a SAVY 4000 container, Hagan container or ring drum
2. Contamination-free welded-sealed container(s) loaded directly inside a SAVY 4000 container, Hagan container, or ring drum without a bag out bag
3. A contamination-free Am-241 oxide middle container with properly closed Am-241 oxide inner container loaded directly inside a SAVY 4000 container without a bag out bag
4. Nested Containers
5. Transfer Containers with allowed contents and configuration

Am-241 containers

Approved Packaging Configuration Exception

- **Unique, one-off, or applying to a <u>small number of containers</u>**
- **Written request from FLM must include:**
  - All packaging layers (e.g. inner container, outer container, bags, etc.)
  - Detailed description of NM contents
  - Evaluation of the package: NM characteristics, packaging design criteria, and performance objectives. (Consult container packaging team for assistance)
- **The NMSDB will approve/deny request. If approved, memorandum forwarded to:**
  - Cognizant system engineer for containers;
  - TA55 vault manager (if container is to be approved for vault storage);
  - FOD; and
  - USQD

- **Memorandum number and the USQD document number in the LANMAS remarks field for each item.**

Approved Inner Containers for Storage

- *"Operators must select an appropriately-sized, approved inner container for the size, weight, and content of the NM to be packaged."*

- **Classified as hermetically-sealed or non-hermetically-sealed containers**
  - Hermetically sealed containers required for Pu metal or alloy

- **Metal containers required for**
  - Pu-bearing materials
  - U-233 materials

- **Exceptions**
  - Plutonium
    - Pu samples allowed in small plastic or glass vials in allowed inner container
    - Hemishells may be packaged in non hermetic inner containers
  - Uranium (NOT U-233)
    - Bulk U metal may use sealed plastic bag as inner container
    - U oxides may use plastic inner container
    - Inner containers not required for DU

Approved Inner Containers

HERMETICALLY SEALED
1. Conflat or Hydride Container
2. SRL Large Part Container
3. SRL Small Cart Container
4. KF Flanged Container
5. J-Cans
6. Aluminum Pressure Cooker
7. Copenhagen Pressure Cooker
8. Welded-Sealed Containers
9. SAVY 4000 Container with Hermetic Cap

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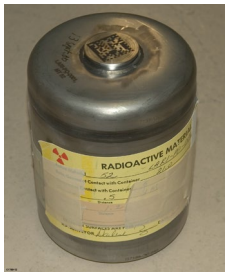

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Approved Inner Containers

NON-HERMETICALLY SEALED
1. Taped Stainless Steel Slip-Lid Containers
2. Crimp-Sealed Containers
3. Hagan Container
4. SAVY 4000 Container without the Hermetic Cap
5. Metal Paint Can Containers
6. Americium-241 Oxide Inner and Middle Containers

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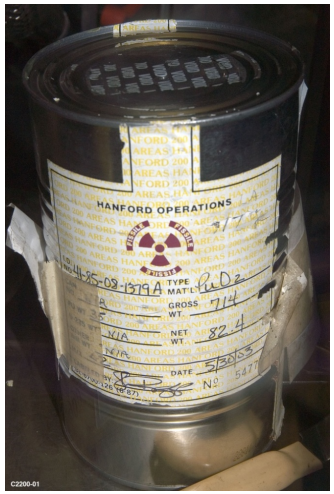

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Approved Outer Containers for TA55-DOP-091

- *"Operators must select an appropriately-sized, approved outer container for the size, weight, and content of the NM to be packaged."*

Don't force contents into container!

- *"Operators must also ensure that the NM package complies with any additional restrictions based on the class of container being used."*

- **SAVY 4000 Containers**
  - Hermetic cap NOT allowed when used as an outer container
  - No more than 1.0 kg of Pu metal allowed in a 1-Qt size SAVY 4000
  - No more than 4.5 kg of Pu metal allowed in a 3-Qt size SAVY 4000

- **Hagan Containers**
  - Introduction into vault is no longer permitted

- **Ring Drums**
  - Filtered lids required

SAVY 4000 and Hagan Dimensions and Inner Volume

SAVY 4000 SIZE	OUTSIDE DIAMETER	OUTSIDE HEIGHT	INSIDE DIAMETER	USABLE INNER HEIGHT	INNER VOLUME
	(inches)	(inches)	(inches)	(inches)	(liters)
1-QT	4.8	5.9	3.7	4.4	1.0
2-QT	4.8	10.0	3.7	8.5	1.8
3-QT	6.5	8.0	5.4	**6.8**	3.1
5-QT	7.7	10.0	6.6	8.7	5.2
8-QT	8.9	11.5	7.8	10.3	8.6
12-QT	10.0	13.9	8.9	12.8	13.5
5-GAL	11.7	15.9	10.2	14.1	19.4
10-GAL	15.5	18.0	14.0	15.9	41.0

HAGAN SIZE	OUTSIDE DIAMETER	OUTSIDE HEIGHT	OUTSIDE HEIGHT	INSIDE DIAMETER	USABLE INNER HEIGHT	INNER VOLUME
	(inches)	(inches)	(inches)	(inches)	(inches)	(liters)
1-QT	4.8	5.7	7.0	4.1	4.8	1.0
3-QT	6.5	8.0	9.2	5.8	**7.1**	3.1
5-QT	7.4	10.0	11.2	6.7	9.1	5.3
8-QT	8.6	11.7	13.0	7.9	10.8	8.8
12-QT	9.7	13.6	15.5	9.0	12.7	13.4

Note that inside dimensions are different!

TA55-DOP-091, Appendix 2

Ring Drum Dimensions and Inner Volume Compared to SAVY 4000

SAVY 4000 SIZE	OUTSIDE DIAMETER	OUTSIDE HEIGHT	INSIDE DIAMETER	USABLE INNER HEIGHT	INNER VOLUME
	(inches)	(inches)	(inches)	(inches)	(liters)
1-QT	4.8	5.9	3.7	4.4	1.0
2-QT	4.8	10.0	3.7	8.5	1.8
3-QT	6.5	8.0	5.4	6.8	3.1
5-QT	7.7	10.0	6.6	8.7	5.2
8-QT	8.9	11.5	7.8	10.3	8.6
12-QT	10.0	13.9	8.9	12.8	13.5
5-GAL	11.7	15.9	10.2	14.1	19.4
10-GAL	15.5	18.0	14.0	15.9	41.0

RING DRUM SIZE	OUTSIDE DIAMETER + BOLT	OUTSIDE HEIGHT (TO TOP OF CAN)	OUTSIDE HEIGHT (TO TOP OF FILTER)	INSIDE DIAMETER	USABLE INNER HEIGHT	INNER VOLUME
	(inches)	(inches)	(inches)	(inches)	(inches)	(liters)
5-GAL	12.6	13.1	13.4	11.2	11.5	18.5
10-GAL	15.3	19.0	19.3	13.9	17.7	43.8
20-GAL	20.4	21.5	21.8	18.1	19.3	81.6

TA55-DOP-091, Appendix 2

Other Approved Outer Containers

APPROVED OUTER CONTAINER CLASS	RESTRICTIONS
1. SAVY 4000 container	Hermetic cap NOT allowed when used as an outer container
2. Hagan container	Introduction into vault is no longer permitted
3. DOT Type-A ring closure drums	Filtered lids required
4. 3013 Container	None
5. Certified sealed radioactive sources	See ANSI N43.6
6. Welded HS-Pu Containers (various)	Must NOT be degraded, distended, or in an abnormal configuration
7. Pits	None
8. Containers meeting the Special Form performance criteria	None
9. Crimp-sealed cans	For use with uranium enriched in U-235 only
10. Type-B containers (DOT Compliant)	Nuclear material packaged for shipment
11. Waste containers	Packaged with materials designated waste DOE O 435.1
12. Fully clad nuclear reactor fuels	Plutonium or uranium enclosed in a metal casing and designed for use in a nuclear reactor to produce power.

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Unapproved Packaging Configuration

- **Any container used as an outer container for a NM package stored outside of the glovebox line that is not approved for use in PA-RD-01022**
- **"Nonstandards" or "Legacy Containers"**
- **Prioritized for repackaging based on risk**
- **<u>Special handling may be required</u>**
  - Develop recovery plan (RadCon, CSE, FLM, process owner)
  - Overpack container for movement
  - Introduce or repackage

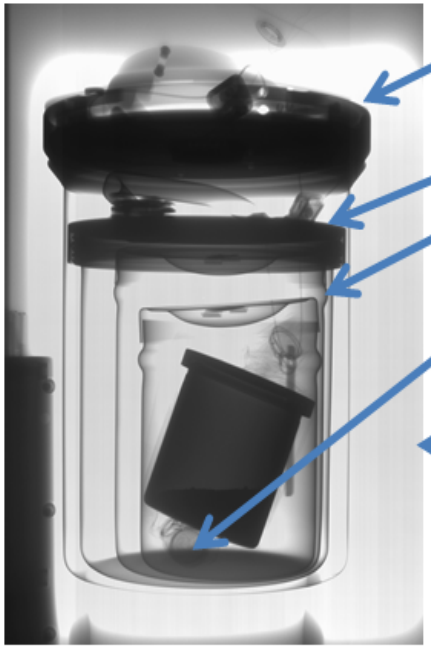
Examples:

- Stainless-steel slip-lid
- Tin-coated slip-lid
- Paint-type
- Pail
- Non-filtered or taped drum
- Crimp-sealed cans when used as outer containers for plutonium
- SAVY 4000 Containers with Hermetic Cap

Nesting

- **Placing multiple outer containers are placed inside one another to create a single package.**
- **Nested packages must meet the following criteria:**
  - The first (outermost) layer is a SAVY-4000 container;
  - The second layer is a SAVY-4000 or Hagan container free of external contamination at the time of packaging;
  - The package includes an approved inner container

Example of an approved nested container



- Outermost container is a SAVY
- Second container is Hagan
- Package includes approved inner container (SS slip lid)
- Package includes a bagout bag (not required)
- Radiograph was used to verify that the sum of all metal wall thicknesses is less than 0.75 inches thick

Overpacked Containers

- **Overpacking is the process of placing an unapproved package (typically due to a packaging issue) inside a SAVY 4000 container and closing the outer container.**
- **Intended to place an unapproved container in a safe and stable configuration until repackaging can occur.**
- **Overpacked containers are authorized for staging, handling and/or transfer of unapproved containers for up to ten (10) working days after the overpacking occurs.**
- **Extensions may be obtained through the NMSDB.**

- ***Containers used for overpacking are not considered Transfer Containers and shall not have Transfer Container labels.***

Storage vs. Transfer Containers (Part I)

QUESTION	STORAGE CONTAINER	TRANSFER CONTAINER
Can I store a ____ in the PF-4 Vault?		
Where do I find the Packaging Configuration/Contents for a ____?		
Where do I find the mass limits for nuclear material in a ____?		
Can I package a SAVY 4000 container as a ___?		
Can I package a Hagan container as a ___?		
Can I package a ring drum as a ___?		
Can I store a loaded ____ for more than 1 year in the floor safe or floor location?		
Is annual container maintenance required for ____?		

Storage vs. Transfer Containers (Part II)

QUESTION	STORAGE CONTAINER	TRANSFER CONTAINER
Can I use a properly loaded ____ to handle and transfer nuclear material outside of a glovebox?		
Can I use a ____ to package small amounts of liquids?		
Can I put Pu metal or Pu alloy in a non-hermetically sealed inner container inside a ____?		
Is a bagout bag required to package an item in a ____?		
Can I package Pu metal turnings or Pu alloy turnings in a ____?		
Can I package uranium that is NOT enriched in U-233 inside a plastic inner container inside a ____?		
Is containerization and inner packaging information required if loading/unloading a ____ on same work day?		
Can I package Pu in small glass vials inside a taped slip lid inside a SAVY-4000 ___?		

Packaging Procedure

Field Preparation

TA55-DOP-091

Acceptance Criteria

TA55-DOP-091, Section 4.0

- All containers packaged according to this procedure for staging, handling, and transferring of NM outside of an approved, engineered contamination barrier MUST meet the definition of Approved Packaging Configuration or Approved Packaging Configuration Exception.

- All materials packaged according to this procedure MUST meet approved content requirements or have an exception granted through the NMSDB.

Field preparation steps ensure that containers have <u>allowed content</u> in an approved configuration.

Field Preparation for Packaging

TA55-DOP-091, Section 3.4

- **Attachment A, Pre-Packaging Container Content Checklist (UET)**

  Work planning…

  Complete EITHER

  - **A-1. Storage Container Content Checks**

  OR

  - **A-2. Transfer Container Content Checks**

  THEN Complete

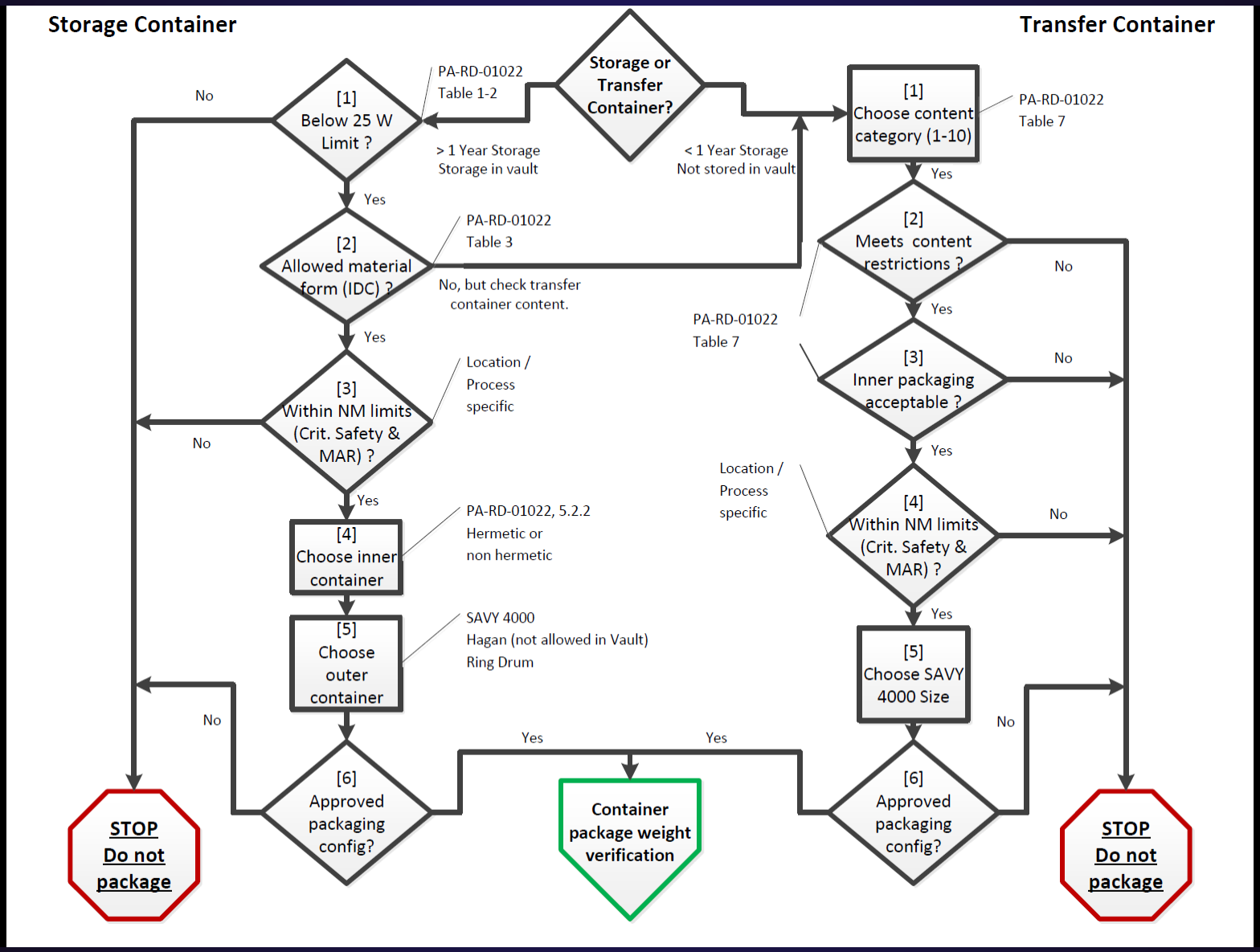
  - **A-3. Container Package Weight Verification**

No data retention requirements for attachments

- **Attachment B, Pre-Use Container Inspection Checklist (UET)**

  Completed as close to the time as packaging as practicable

Content Checks Road Map



Content Checks Exercise

Is the following item allowed in a storage container?

What storage configuration would you used to store this item in the PF4 vault?

- **Material Properties**
  - LOT ID: XBLS8A
  - IDC: R837
  - MT 56+44
  - NetWt: 275 g
  - ElementWt: 114 g
  - Wattage: 3.3 W (2006)

- **Current Package Information**
  - Inner Container: Stainless steel slip-top, taped (Vollrath 80010)
  - Currently in unspecified glovebox

					(OpEntry)	(ug/gPu)
	Pu238	Pu239	Pu240	Pu241	Pu242	Am241
mass%	0.13034	85.69850	13.16354	0.65262	0.35500	254774.3
sigma	0.00619	1.23797	1.25432	0.00951	0.00000	3693.3
%RSD	4.75%	1.44%	9.53%	1.46%	< .01%	1.45%
%TotPwr:	2.2803	5.0950	2.8736	0.0686	0.0013	89.6812

Specific Power (W/gPu): (32.4429 +/- 0.4331)e-003 (1.34%)

Effective Pu240 fraction: (14.0884 +/- 1.2544)e-002 (8.90%)

Time since chemical separation: 28595.29 +/- 13.00 days (0.05%)

****
****
total Pu: 100.543 g
sample power: 3.2619 W
specific power: 32.4429 mW/gPu
date: 13-Sep-2006
****

Package Weight Verification

1. **Select appropriate shielding** *(TA55-DOP-091, Tables 3.3-1, 3.3-2, 3.3-3)*

SAVY Outer Shielding

SAVY Inner Shielding

Hagan Outer Shielding

2. **Estimate or measure the weight of each package component** *(e.g. NM, inner container, bag out bag, inner shielding, outer container body, outer container lid, external shielding, etc.)* **to obtain the estimated package weight.**
3. **Verify the estimated package weight will not exceed the maximum package weight** *(TA55-DOP-091, Appendix 2)*
4. **Verify the total side wall thickness for all metal layers is ≤ 0.75 inches unless otherwise permitted by a specific criticality safety evaluation.**

SAVY 4000 Package Weights

SAVY 4000 SIZE	SAVY 4000 TARE WT.	SAVY 4000 WITH INNER SHIELDING ONLY	SAVY 4000 WITH OUTER SHIELDING ONLY	SAVY 4000 WITH INNER & OUTER SHIELDING	MAXIMUM PACKAGE (GROSS) WEIGHT (CONTAINER AND CONTENTS)
	(kg)	(kg)	(kg)	(kg)	(kg)
1-QT	1.5	2.1	2.0	2.6	10.0
2-QT	2.0	N/A	N/A	N/A	12.2
3-QT	2.6	4.1	3.7	5.2	15.0
5-QT	3.4	5.5	5.0	7.1	18.1
8-QT	4.2	6.7	6.4	8.9	20.0
12-QT	5.4	8.8	8.5	11.9	22.2
5-GAL	8.6	13.0	N/A	N/A	24.9
10-GAL	11.9	19.0	N/A	N/A	39.9

TA55-DOP-091, Appendix 2

The SAVY-4000 containers have been drop-tested at the maximum gross weight and leak rate measured. The certification is based on not exceeding the maximum gross weight.

Hagan and Ring Drum Package Weights

HAGAN SIZE	HAGAN TARE WT.	HAGAN WITH INNER SHIELDING ONLY	HAGAN WITH OUTER SHIELDING ONLY	HAGAN WITH INNER & OUTER SHIELDING	MAXIMUM PACKAGE (GROSS) WEIGHT (CONTAINER AND CONTENTS)
	(kg)	(kg)	(kg)	(kg)	(kg)
1-QT	1.1	1.7	1.6	2.2	4.4
3-QT	1.8	3.3	2.9	4.4	7.6
5-QT	2.3	4.4	4.0	6.1	12.4
8-QT	3.0	5.5	5.3	7.8	13.1
12-QT	4.3	7.7	7.4	10.8	11

Maximum storage height of 8 feet for Hagans

RING DRUM SIZE	RING DRUM TARE WT.	RING DRUM WITH INNER SHIELDING ONLY	RING DRUM WITH OUTER SHIELDING ONLY	RING DRUM WITH INNER & OUTER SHIELDING	MAXIMUM PACKAGE (GROSS) WEIGHT (CONTAINER AND CONTENTS)
	(kg)	(kg)	(kg)	(kg)	(kg)
5-GAL	3.4	7.9	N/A	N/A	12.4
10-GAL	6.8	15.2	N/A	N/A	34.0
20-GAL	14.1	26.3	N/A	N/A	N/A*

TA55-DOP-091, Appendix 2

Container Inspections

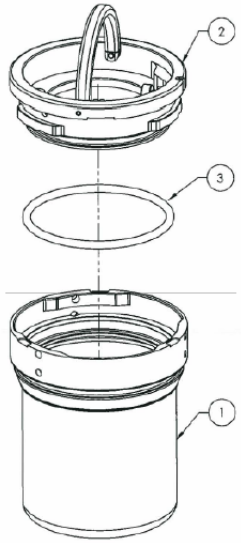
Examples of Severely Dented Containers

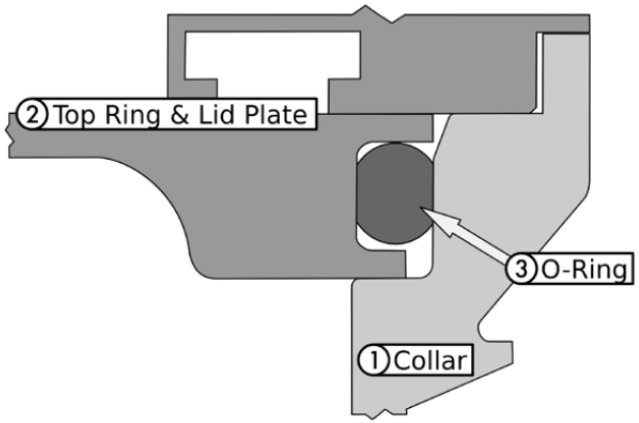
Body Separated from Lid

Pay particular attention to the bottom of the container

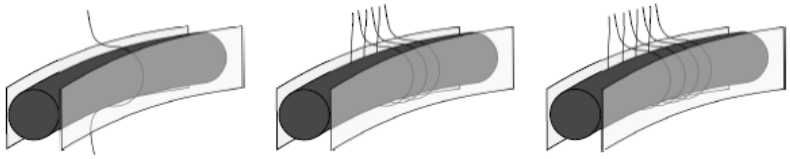
Container Inspection for SAVY 4000 Containers

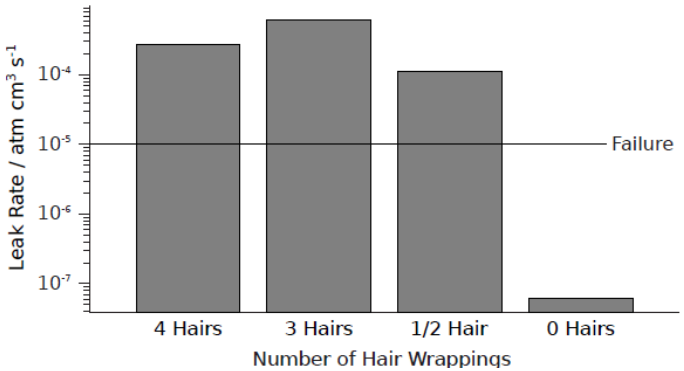
- ✓Verify container lid and are body free of visible defects
- ✓Verify transfer containers have transfer container labels and have not expired.
- ✓Remove O-ring
- ✓Clean all sealing surfaces of the container and the O-ring using a lint-free isopropyl alcohol wipe
- ✓Inspect all sealing surfaces of the container and O-ring for cleanliness and damage
- ✓Coat the O-ring with a light coating of grease
- ✓Verify container cavity is clean and dry
- ✓Perform functional check of lid closure
- Nonconforming components
  - Segregate component
  - Obtain replacement
  - Contact packaging engineering team

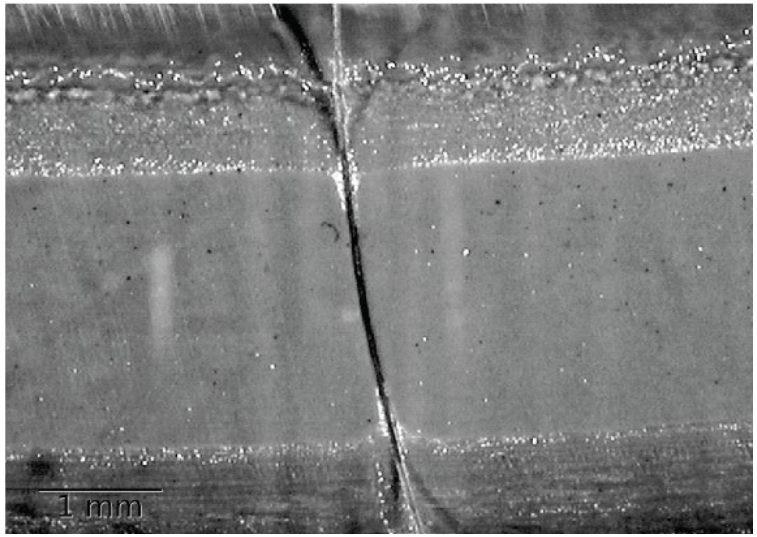


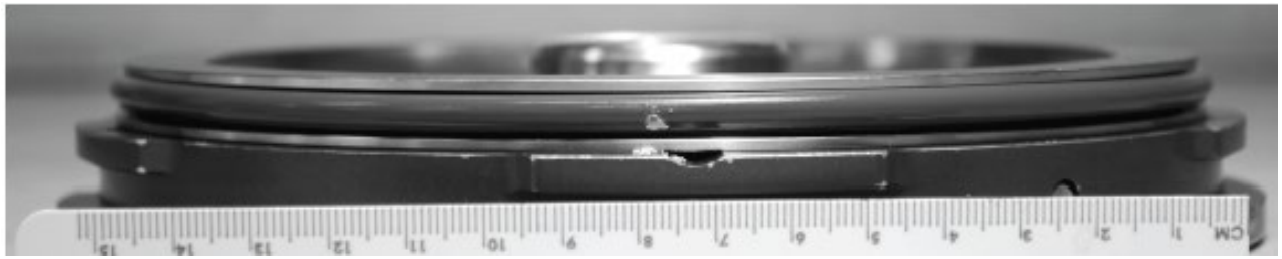


Why is the visual inspection important?









Container Inspection of Hagan Containers

- ✓Verify container lid and body are free of visible defects
- ✓Verify Hagan container body label is not on a metal sticker
- ✓Verify Hagan filter gasket is not cracked or crumbling
- ✓Remove O-ring
- ✓Clean all sealing surfaces of the container and the O-ring using a lint-free isopropyl alcohol wipe
- ✓Inspect all sealing surfaces of the container and O-ring itself for cleanliness and damage
- ✓Coat the O-ring with a light coating of grease
- ✓Check that the container cavity is clean and dry
- ✓Perform functional check of lid closure
- **Nonconforming components**
  - Segregate component
  - Obtain replacement
  - Contact packaging engineering team

Container Inspection for Ring Drums

- ✓**Verify container lid, body, gasket, and bolt/nut are free of visible defects**
- ✓**Inspect all sealing surfaces of the container and O-ring itself for cleanliness and damage**
- ✓**Verify container cavity is clean and dry**
- ✓**Perform functional check of lid closure**

- **Nonconforming components**
  - Segregate component
  - Obtain replacement
  - Contact packaging engineering team

Packaging Procedure

Closing and Opening Containers

TA55-DOP-091

Packaging Process

TA55-DOP-091, Section 5.0

Reference procedure

Performance

- 5.1 Loading Material and Closing Container
  - 5.1.1 Loading Material
  - 5.1.2 Closing a SAVY 4000 Container
  - 5.1.3 Closing a Hagan Container
  - 5.1.4 Closing a Ring Drum
  - 5.1.5 Entering Packaging Data into the NMCA System
- 5.2 Unloading Container Contents
- 5.3 Contingencies
  - 5.3.1 Dropped Loaded Container
  - 5.3.2 Suspected or Identified Packaging Issues
  - 5.3.3 Expired, Loaded Transfer Container

Loading Material

- **Ensure the following:**
  - The lid is removed
  - The O-ring is installed (SAVY 4000 and Hagan containers)
  - The components and contents are acceptable for use per Section 3.4
  - Ensure Pu-238 contaminated cheesecloth rags are segregated from other nuclear material
- **Ensure appropriate shielding is in place if needed**
  - IF radiation is ≥75 mrem/hr beta/gamma and/or ≥75 mrem/hr neutron at contact
- **Ensure external surfaces of inner package are free of contamination**
- **Place appropriate filler material necessary**
  - Aluminum foil or steel wool can be used as filler to prevent damage to inner containers and/or content during handling.
  - Metal fixtures (e.g. for criticality spacing, heat dissipation, component protection, etc.) are allowed and must be included in the verification of the metal layer thickness requirement
- **Ensure the visible o-ring sealing surfaces are free of debris**
- **Ensure the bag out bag does not overlap the sealing surfaces**

Closing a SAVY 4000

Beware of Pinch Points!

- **Ensure the SAVY 4000 lid is seated by placing the lid onto the container and pressing down slowly (i.e., compress the O-ring) until:**
  - a hard stop is felt,
  - the lid is flat relative to the container body,
  - the O-ring is no longer visible, and
  - the locking mechanism turns
- **Turn locking mechanism to the closed position. If the locking mechanism does not turn, then ensure lid is properly seated**
- **Verify markings on lid and body line up**
- ***Never lift a SAVY-4000 unless the lid is in the locked position***
- **Install a Tamper Indicating Device (TID), if required**
- **Install outer container shielding**
  - IF radiation is ≥75 mrem/hr beta/gamma and/or ≥75 mrem/hr neutron at contact
- **Label the container**
- **Perform MC&A transactions, as required**

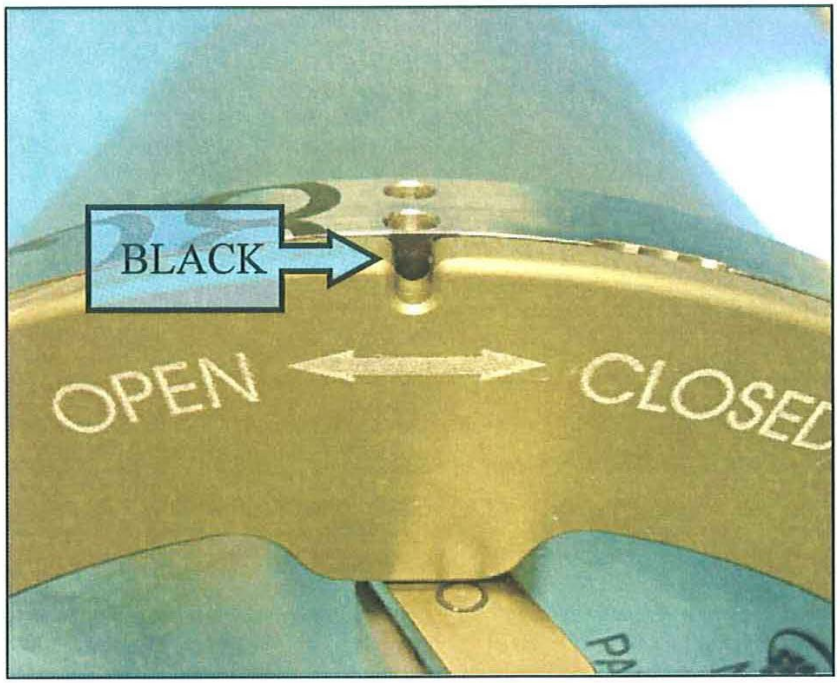
Closing a SAVY 4000

Beware of Pinch Points!

Lid Not Completely Closed

Closing a SAVY 4000

Verifying Locking Mechanism Closed



Closing a Hagan

- **Place lid on container and screw the lid down until the o-ring engages the lid, then hand tighten until very snug.**
  - Issues to consider: cross-threading, lid stops before engaging o-ring due to friction from galling or debris.
- **Ensure lid has properly engaged o-ring.**
  - **When this occurs the threads are no longer visible.**
  - The markings *typically* indicate closed.
- **Install outer container shielding, if required.**
  - IF radiation is ≥75 mrem/hr beta/gamma and/or ≥75 mrem/hr neutron at contact
- **Install a TID, if required.**
- **Label the container.**
- **Perform MC&A transactions, as required.**

Threads no longer visible

Closing a Ring Drum

Beware of Pinch Points!

- **Ensure cover gasket is properly fitted into cover groove.**
- **Place lid on drum and ensure that gasket is properly seated around the curl.**
- **Install and seat ring as follows:**
  - Position the ring around the lid with lugs pointed downward.
  - Apply downward pressure on the lid and seat the lid and entire drum curl into the inner channel of the ring using a non-sparking dead-blow mallet.
  - Ensure bolt, lugs, and filter are centered on the seam.
- **Insert the bolt through the unthreaded lug of the ring.**
- **Install the locking hex nut and tighten the nut until hand tight.**
- **Ensure drum is closed tight with the appropriate tools:**
  - Apply downward pressure on the lid.
  - Hammer the outside of the ring with a non-sparking dead-blow mallet (if necessary).
  - Tighten the bolt with a wrench.
- **Install a TID, if required.**
- **Label the container.**
- **Perform MC&A transactions, as required.**

Torque specification:

5 gal:	5.5-6.5 ft-lbs
10, 20 gal:	55-60 ft-lbs

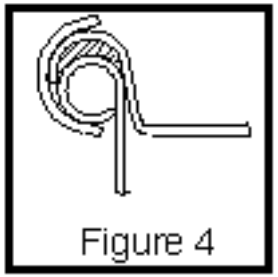


Figure 4

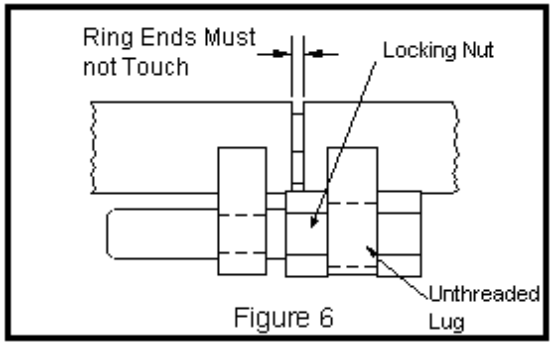
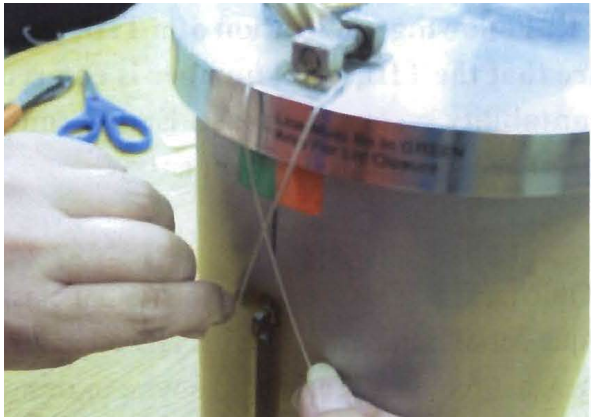


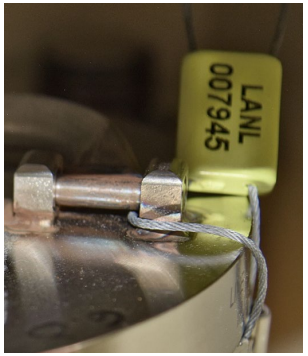
Figure 6

TID Installation

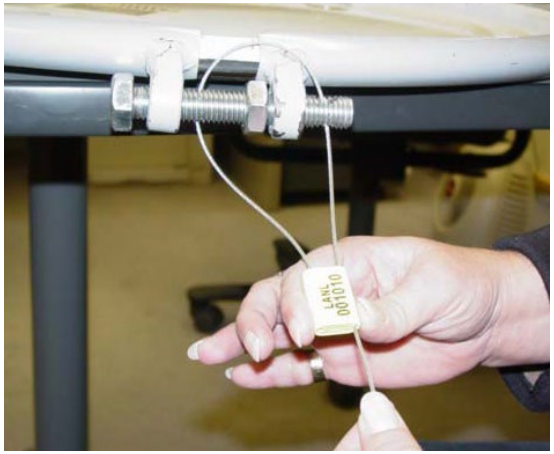
SAVY 4000

Hagan





Ring Drum



Data Entry

REQUIRED CONTAINER INFORMATION			
Category	Information	Field Description	Example
SAVY 4000	SAVY 4000 body serial number	Container/Material Name	071105021B
	SAVY 4000 lid serial number	Container/Material Name	071105021L
	SAVY 4000 body type	Container Type (Body)	CERT01-S03Q
	SAVY 4000 lid type	Container Type (Lid)	SAVY Lid
Hagan	Hagan body serial number	Container/Material Name	04/02-08028
	Hagan filter serial number	Container/Material Name	10/02 LANL-2187
	Hagan body type	Container Type (Body)	CERT05-H5Q
	Hagan lid type	Container Type (Lid)	Hagan Lid
Ring Drum	Container serial number	Container/Material Name	10/02-5015
	Container type	Container Type	10G

REQUIRED PACKAGING INFORMATION			
Category	Information	Field Description	Example
ALL	Overall package weight	Gross Weight	3.25
	Overall package weight units	Gross Weight Units	kg
	Approved inner container type	Packing Material	SS_Slip_Lid
	Shielding	Packing Material	Outer_Shld

For containers packaged with segregated Pu-238 (MT83) contaminated cheesecloth (cellulose), ensure the IDC is coded as “K15”

No longer requires operator to specify lid size.

Does not require NMCA balance. (May be calculated using container weights in Appendix 2. If calculated, place note in remarks.)

Unloading a Container

Unloading normally takes place in a hood, but it is not required

- **Inspect the container for obvious signs of failure. If there are obvious signs of failure, then introduce container into glovebox line for unpacking**
- **RCT monitors external surfaces. If contamination detected, then follow the RCTs instructions**
- **Remove TID according to the TID procedure, if required**
- **Remove container lid**
  - SAVY 4000: (1) retract locking pin, (2) release locking mechanism by turning counterclockwise until it stops, (3) remove the lid using a tool (e.g. lid removal lever)
  - Hagan: unscrew using a strap wrench, ratchet wrench, or wrench adaptor as needed
  - Ring drum: (1) loosen bolt, (2) remove ring, (3) remove lid by pulling slowly upward
- **Remove the container contents**
- **RCT surveys the interior for contamination. If contamination is detected, then proceed according to RCT's instructions**
- **Perform MC&A transactions, as required**

Packaging Procedure

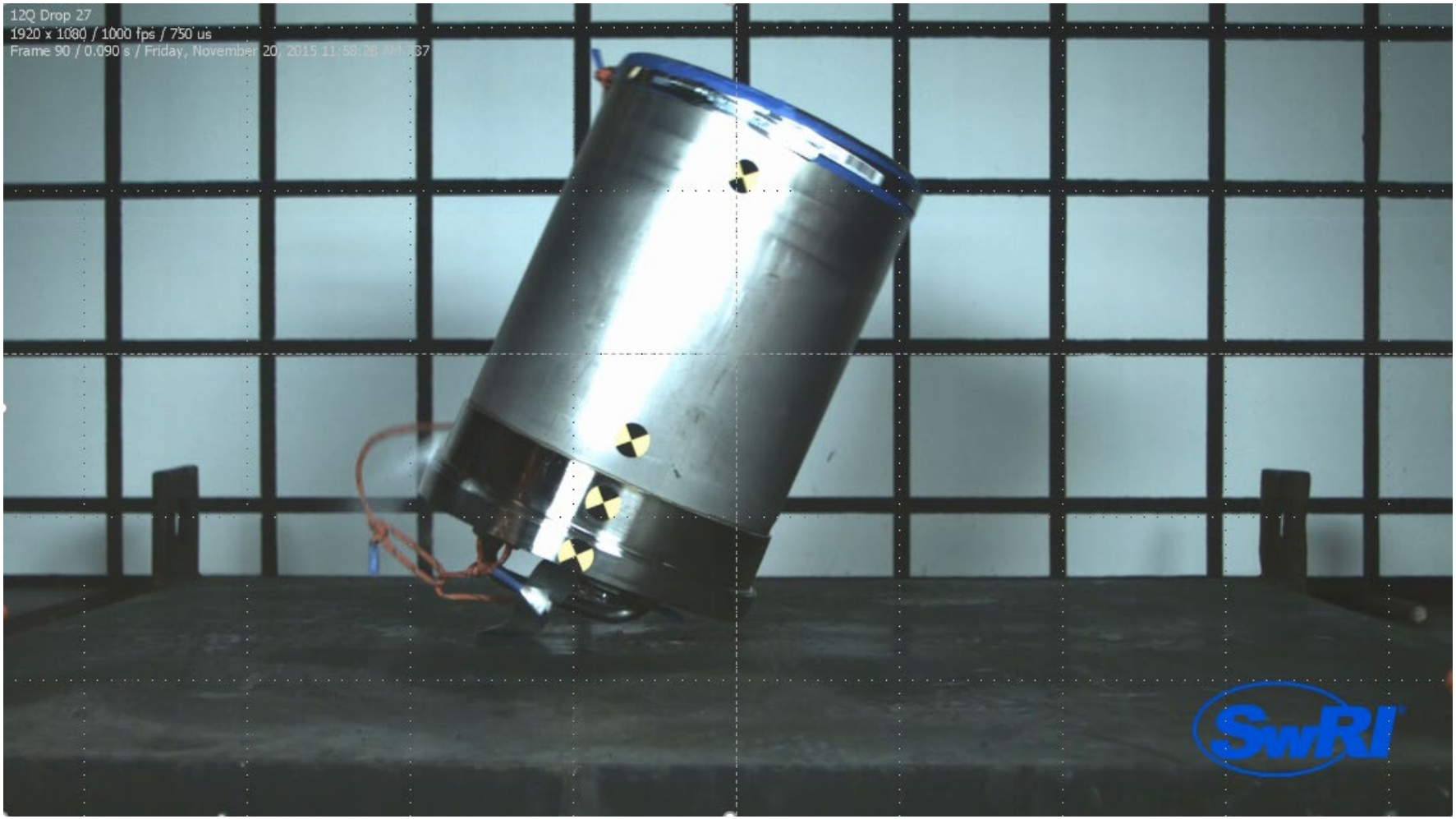
Contingencies

TA55-DOP-091

Dropped Loaded Container

- **Alert others, evacuate the area, and control access.**
- **Notify the operations center.**
- **Alert RCT and follow RCT instructions.**
- **Recovery options (directed by PIC / FLM)**
  - Continue using the dropped container (requires approval of the cognizant system engineer for containers).
  - Introduce the container and/or container contents into the glovebox line.
  - Repackage the container.
  - Overpack the container (temporary: allowed for 10 working days).

What Can Happen When A Container Is Dropped?

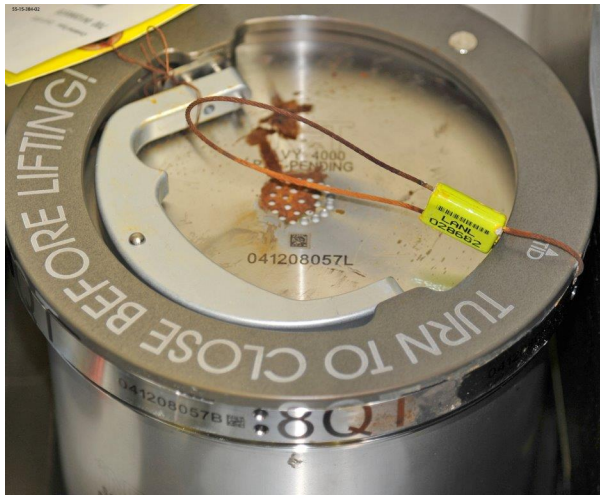


Suspected or Identified Packaging Issues

- **Examples:**
  - Contaminated container;
  - Container is bulging, dented, breached, corroded, or otherwise visibly defective;
  - Container is suspected of containment failure;
  - HS-Pu containers outside the glovebox line that are degraded, distended or in an abnormal configuration;
  - Unapproved outer container (not previously identified); or
  - Transfer Container unlabeled or improperly labeled;

- **Alert others in the area and control access.**
- **Notify the OC, process owner, and the cognizant system engineer for containers of the abnormal condition.**
- **Develop a recovery plan (FLM, radiation protection, process owner, the container engineering team, cognizant systems engineer for containers and NMSDB).**

Suspected or Identified Packaging Issues



- Special requirements for handling and opening
- Reporting issues helps to focus surveillance program

Expired Loaded Transfer Container

- **RCT surveys container for contamination.**
- **<u>IF</u> contamination is detected**
  <u>THEN</u> follow RCT instructions.
- **Inspect the outside of the container for signs of degradation, bulging, etc.**
- **<u>IF</u> signs of degradation or contamination are observed,**
  <u>THEN</u>
  - Alert others in the area and control access.
  - Notify the OC, process owner, and the cognizant system engineer for containers of the abnormal condition.
  - Develop a recovery plan (FLM, radiation protection, process owner, the container engineering team, cognizant systems engineer for containers and NMSDB).
- **Unload container.**

Expired Loaded Transfer Container

Pu in HCl solution in plastic volumetric flasks stored for 1.5 years

More challenging content is allowed in transfer containers.
Therefore, it is important that these containers are maintained.

Important: *Report packaging issues to packaging team!*

Lessons Learned

Degraded Bag Out Bag

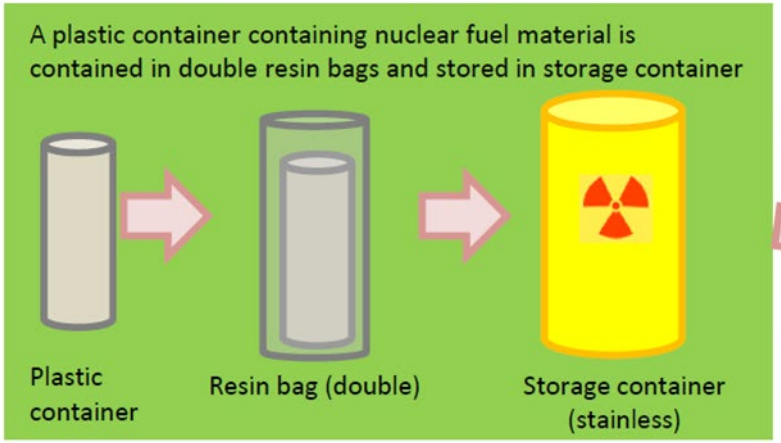
- **Degradation anticipated under normal conditions due to heat and dose**
  - Opening containers requires respiratory protection or engineered control (e.g. glovebox or hood).
- **Inner height of SAVY 4000 <u>smaller</u> than similar sized Hagan containers**
  - Hazard from forcing air through the bagout bag filter

Degraded Bag Out Bag

- **Lessons learned**
  - Handling legacy packages / high dose material
    - Expect degradation of PVC bag out bag
    - Potential for contamination on inside surfaces of outer container
  - Respiratory protection
    - Respirator required to handle NM outside of an approved container or engineered contamination barrier (unless under RWP)
  - Attention to detail—dimensions of SAVY 4000 and Hagan containers are different
    - Select appropriate size outer container
    - See sizes Appendix 2 in TA55-DOP-091

Oarai Research and Development Center Contamination Incident (Japan)

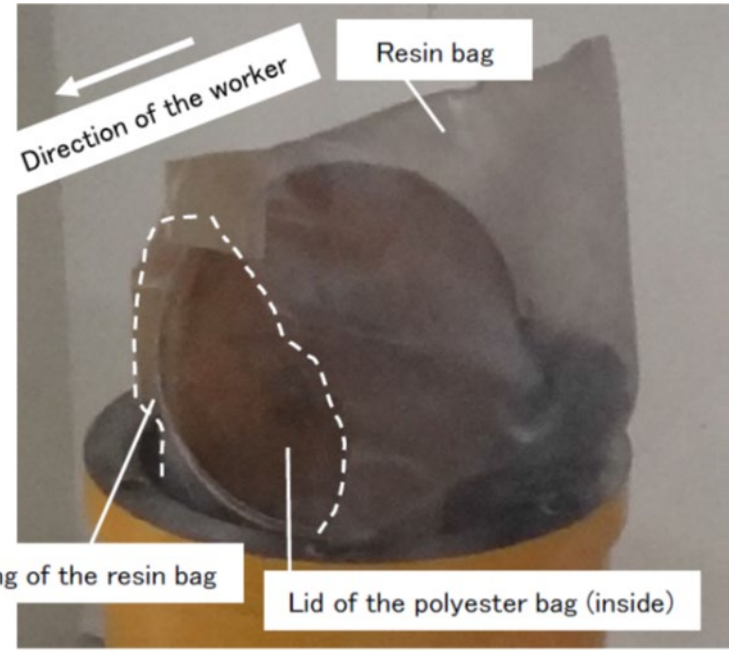
- Around 11:25, June 6, 2017 (Tue), in Room No. 108 of Plutonium Fuel Research Facility (PFRF) (controlled area), resin bags ruptured and contamination occurred when five workers were inspecting a storage container containing plutonium and uranium in a hood
- In February 2017, workers started inspecting 80 storage containers to "improve the management condition of nuclear fuel materials"
- Accident occurred while checking the 31st container
- Contents: epoxy mounted samples of U and Pu



The storage container was uncovered to check the storage situation in a hood.

Oarai Research and Development Center Contamination Incident (Japan)

- Five workers in room
- Lid was rising up as six bolts were loosened one by one
- Hiss of inside gas escaping on final two bolts
- Smear sample between container and lid confirmed no contamination
- Proceeded to remove final two bolts, heard one burst/bang
- Workers locked room, and confirmed presence of their external contamination

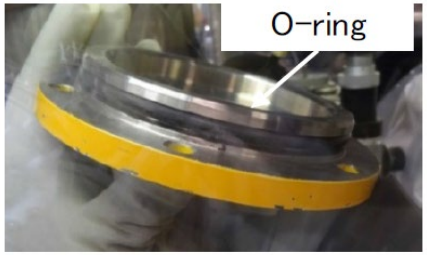


Enlarged photo taken by the worker at the time of the burst of the resin bag

(The side of the bag was partially damaged in a way to split in the vertical direction)

Ⓒ Outside of the polyester container

ⒹContaining situation inside the polyester container



Ⓐ Interior surface of the storage container

Oarai Research and Development Center Contamination Incident (Japan)

Oarai Research and Development Center Contamination Incident (Japan)

- **Skin exposure from surface contamination**
  - From accident to completing initial decontamination for all workers (7.67 hours)
    - Maximum 83 μSv
  - From exit of controlled area to hospital decontamination (22 hours)
    - Maximum 0.11 μSv
- **Internal exposure**
  - Lung monitoring showed 22,000 Bq from Pu-239 and 220 Bq from Am-241 (Whole body internal given as 360,000 Bq in news report)
  - Ca-DTPA chelate administered

Committed effective dose*	Number of people
100 mSv and higher and lower than 200 mSv	1
10 mSv and higher and lower than 50 mSv	2
Lower than 10 mSv	2

10 μSv = 1 mrem

*Committed effective dose of 50 years

Oarai Research and Development Center Contamination Incident (Japan)

- **Lessons Learned**
  - Handling of legacy packages
    - Expect degradation of PVC bag out bag
    - Potential for contamination on inside surfaces of outer container
  - Reporting packaging issues
    - When the lid of the storage container was opened in July 1996, inflation of the bag and damage to the bottom of the polyester container were confirmed, and therefore the packaging was redone. Since then, no document on inspection of the inside of the storage container was found until June 2017
  - Incompatible materials
    - Potential for gas generation for Pu packaged in contact with plastic (plastic container, Pu samples in epoxy)
  - Importance of respiratory protection
    - Respirator required to handle NM outside of an approved container or engineered contamination barrier (unless under RWP)
    - Full face respirator has much higher assigned protection factor (1000 vs 10)

Performance Demonstration

Performance Demonstration

Beware of Pinch Points!

- **Container Loading**
  - Demonstrate final validation checks before loading
- **Container Closing**
  - Demonstrate loading material
  - Demonstrate how to close a SAVY 4000, Hagan container, and ring drum
  - Demonstrate proper placement of a TID
- **Container Unloading**
  - Demonstrate unloading SAVY 4000, Hagan container, and ring drum contents
  - Demonstrate appropriate contamination checks during unloading

Questions?

- **SMEs for TA55-DOP-091 & PA-RD-01009:**
  - Paul Smith (SSE-2)
  - Joshua Narlesky (AMPP-4)
  - Tim Stone (NPI-9)

- **Transfer container labels**
  - Jude Oka (NPI-9)
  - Tristan Karns (NPI-9)
  - Kirk Reeves (NPI-9)
  - Tim Stone (NPI-9)
  - Paul Smith (SSE-2)

- **Container Cognizant System Engineer**
  - Larry Peppers (ES-55)
  - Tristan McDonald

Additional Slides

Storage vs. Transfer Containers (Part I ANSWERS)

QUESTION	STORAGE CONTAINER	TRANSFER CONTAINER
Can I store a ____ in the PF-4 Vault?	Yes	No
Where do I find the Packaging Configuration/Contents for a ____?	PA-RD-01022, Section 5.2	PA-RD-01022, Section 5.3
Where do I find the mass limits for nuclear material in a ____?	PA-RD-01022, Section 5.2	PA-RD-01022, Section 5.3
Can I package a SAVY 4000 container as a ___?	Yes	Yes
Can I package a Hagan container as a ___?	Yes	No
Can I package a ring drum as a ___?	Yes	No
Can I store a loaded ____ for more than 1 year in the floor safe or floor location?	Yes	No
Is annual container maintenance required for ____?	No	Yes

Storage vs. Transfer Containers (Part II ANSWERS)

QUESTION	STORAGE CONTAINER	TRANSFER CONTAINER
Can I use a properly loaded ____ to handle and transfer nuclear material outside of a glovebox?	Yes	Yes
Can I use a ____ to package small amounts of liquids?	No	Yes, see restrictions in Section 5.3
Can I put Pu metal or Pu alloy in a non-hermetically sealed inner container inside a ____?	Yes, hemishells only	Yes, see restrictions in Section 5.3
Is a bagout bag required to package an item in a ____?	Yes, unless using configurations 2, 3 or 4	No, see restrictions in Section 5.3
Can I package Pu metal turnings or Pu alloy turnings in a ____?	No	No
Can I package uranium that is NOT enriched in U-233 inside a plastic inner container inside a ____?	Yes, uranium oxide only	Yes, see restrictions in Section 5.3
Is containerization and inner packaging information required if loading/unloading a ____ on same work day?	Yes	No
Can I package Pu in small glass vials inside a taped slip lid inside a SAVY-4000 ___?	Yes	Yes