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Title: Water Resistant Container Technical Basis Document for the TA-55 Criticality Safety Program

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Report

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1.0 Purpose

Criticality safety at TA-55 relies on nuclear material containers that are water resistant to prevent significant amounts of water from coming into contact with fissile material in the event of a fire that causes a breach of glovevbox confinement and subsequent fire water ingress. The purpose of this document is to provide the technical basis for crediting containers as water resistant at TA-55. This document also serves as a user reference defining the types of water resistant containers that may be used, including example photographs and example drawing numbers where available. These water resistant containers are utilized throughout TA-55, i.e., inside gloveboxes, in storage safes, in floor storage spaces, and in the vault. This technical basis document addresses water ingress only, without respect to other features, such as radiation protection, material at risk, etc.

2.0 Background

The TA-55 Criticality Safety Program (TA55-AP-522) defines “water tight container” as follows:

> A container which when fully submerged will not allow more than 50ml of water ingress except when under sufficient pressure to produce structural discontinuity. The term water tight is equivalent to water resistant. A listing of water tight containers is included in PA-RD-01009.

The TA55 Criticality Safety Requirements (PA-RD-01009) document describes which containers are approved as water resistant when they are referred to in criticality safety evaluations and/or postings.

3.0 Water Resistant Criteria

For the purpose of evaluating the water resistance of nuclear material containers, the facility accident scenario described in the TA-55 DSA is a large seismic event followed by a main floor bounding fire leading to activation of the fire suppression sprinklers for up to two hours. In this scenario, containers located on the main floor of PF-4 would be exposed to water spray from one or more fire suppression sprinklers for up to two hours (TA55-ESS-13-004-R1, Potential Vulnerability to Containers Due to Flooding). For containers stored in floor locations in the PF-4 vault, water can accumulate to a height of 6 inches above the filter (LA-CP-13-00695, Water Penetration Tests on the Filters of Hagan and SAVY Containers). For gloveboxes, it is postulated that there is some likelihood that water spray from sprinkler actuation could enter through open glove ports where the gloves have been burned away (TA55-ESS-14-002-R3, Potential for Criticality in a Glovebox due to a Fire). The path forward defined in the ESS assumes “the need for additional controls for a fully flooded glovebox location environment, independent of water ingress pathway (e.g., FSS sprinklers, firefighter reponse).” Nevertheless, exposure to 6 inches of standing water is judged to be the bounding worst-case scenario for water intrusion for all water resistant containers at TA-55. The basis for containers remaining subcritical with the maximum allowed water ingress of 50 ml is documented in TA55-ESS-13-004-R1 and TECH-08-033, Practical Moderator Concerns with Typical Glovebox Operations.

4.0 Technical Basis for Water Resistance

The containers considered in this document are listed in Table 1 according to the type of container.

4.1 Welded Containers

Welded containers of nuclear material are water resistant because they are designed for radioactive material containment. These containers are tested after welding to ensure containment using tests ranging from a simple smear for contamination (TA55-RD-555, TA-55 Radiation Protection Program) to a helium leakage test (e.g., PMT4-DOP-139, R4, Helium Leak Testing a 3013 Container). This ensures that they will be resistant to water ingress under the prescribed conditions. Welded containers that are free of defects and/or free of external contamination are considered water resistant.

4.2 Hermetically Sealed Containers

Hermetically sealed containers are designed to minimize gas leakage, and they have leakage rates on the order of 1.0E-4 std cc/sec air or less. If 50 cc is the maximum allowed water entry volume, and the time period is limited to 2 hours (7200 sec), then a leakage rate of 6.9E-03 cc/sec would lead to 50 cc of water ingress. This assumes water and air have the same viscosity, however water is ~50 times more viscous than air, and the leakage rate is proportional to the inverse of viscosity which makes this estimate very conservative. Using Poiseuille's law for laminar flow the air leakage rate can be converted to a water leakage rate. An air leakage rate of 1.0E-4 std cc/sec air corresponds to a water leakage rate of 2.7E-7 cc/sec. For a two hour exposure at this leakage rate the amount of water ingress is 2E-3 cc. Stated a different way it would take 5.8 years to get 50 cc of water in the container, so it is a conservative assumption. Therefore, container designs that are demonstrated to be gas tight to this level will be sufficiently water resistant.

4.3 Filtered Containers

4.3.1. Hagan Containers

Hagan containers are made of stainless steel and they have a threaded lid, a Viton o-ring seal, and a carbon filter sealed permanently into the lid with a neoprene gasket. The filter gasket and o-ring seals are designed and helium leakage tested upon manufacture to be gas tight to less than or equal to 1.0E-04 atm cc/sec. The carbon filters have been tested and demonstrated to be water resistant (LA-CP-13-00695, Water Penetration Tests on the Filters of Hagan and SAVY Containers). The carbon filters have also been demonstrated to pass the DOT Type A water spray test (NucFil-019® DS-1-2002-Rev 1, WIPP SAR and DOT 7A Certification of Direct Sample NucFil-019® DS Drum Vent Filter).

4.3.2. SAVY 4000 Containers

SAVY containers are made of stainless steel, they have a bayonet closure system with a Viton o-ring seal, and they have a filter with a water resistant membrane (PTFE) which is permanently installed just above the filter itself. The o-ring seal is designed and helium leakage tested upon manufacture to be gas tight to less than or equal to 1.0E-04 atm cc/sec (LA-CP-13-01502, Safety Analysis Report for the SAVY 4000 Container Series, Rev. 3). The SAVY filters have been tested and demonstrated to be water resistant (LA-CP-13-00695, Water

Penetration Tests on the Filters of Hagan and SAVY Containers). The SAVY containers have also been demonstrated to pass the DOT Type A water spray test (LA-UR-15-21142, Testing and Certification of the SAVY 4000 Nuclear Material Container for DOT Type A Liquid Transport – 15636).

4.3.3 DOT Type A and UN Drums

DOT Type A and UN Drums used at TA-55 are made of steel and they have a ring closure mechanism with a rubber gasket seal. They also have a carbon filter sealed permanently into the lid with a neoprene gasket. They are procured to DOT Type A and/or UN standards, and the ring closure seal meets the Leakproofness Test – Liquid (49 CFR 178.604) and the Hydrostatic Pressure Test-Liquid (49 CFR 178.605) required by 49 CFR 178 (UN 1A2_X425_S 55 Gal Steel Drum Specification). The carbon filters have been tested and demonstrated to be water resistant (LA-CP-13-00695, Water Penetration Tests on the Filters of Hagan and SAVY Containers). The carbon filters have also been demonstrated to pass the DOT Type A water spray test (NucFil-019® DS-1-2002-Rev 1, WIPP SAR and DOT 7A Certification of Direct Sample NucFil-019® DS Drum Vent Filter).

4.4 Special Form containers

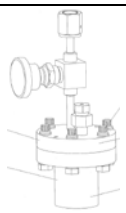
Special Form containers are required to meet either a leakage rate criteria or a leach criteria (ISO 9978, Radiation protection - Sealed radioactive sources - Leakage test methods). The leakage rate criteria is 1.3E-04 atm cc/sec. The leach criteria for leachable solids, liquids and gasses is 9.9E-07 atm cc/s. Both of these criteria are sufficient to demonstrate water resistance.

4.5 Crimp Seal Containers

The types of crimp seal containers that are used in PF-4 passed a water submersion test. Containers were submerged horizontally in a water bath with 6 inches of water column above the top of the containers for 2 hours (LA-UR-15-23121, Water Ingress into Crimped Convenience Containers under Flooding Conditions). These containers, if free of obvious defects, can be considered water resistant.

Table 1. Water Resistant Containers Approved for Use at TA-55

Container	Style	Photograph/Model (Example)	Drawing # (Example)	Technical Basis
3013 Welded containers	Welded	 	LANL 134Y542424	Welded Containers (Section 4.1)
Hagan	Threaded top, Viton o-ring seal, carbon filter		NFT 20000003	Filtered Containers (Section 4.3.1)
SAVY-4000	Bayonet closure, Viton o-ring seal, ceramic filter with PTFE membrane		NFT 20180000, LANL Spec 55Y-002926	Filtered Containers (Section 4.3.2)
Conflat	Bolted, copper gasket (Conflat)	  	LANL 55Y-003228, 55Y-003227, 14-MET1-C116	Hermetically Sealed Containers (Section 4.2)
J-can (aka Jay-can)	Bolted, copper gasket (Conflat)		LANL 142Y802277	Hermetically Sealed Containers (Section 4.2)

Container	Style	Photograph/Model (Example)	Drawing # (Example)	Technical Basis
SRL Large and Small parts storage containers (with gaskets installed)	Bolted, rubber o-ring seal		LANL 55Y-003065, LANL VES-004	Hermetically Sealed Containers (Section 4.2)
Hydride container	Bolted, copper gasket (Conflat)		LANL 55Y-003226	Hermetically Sealed Containers (Section 4.2)
KF Flanged Containers	KF Flange clamp, polymer seal or metal seal		unavailable	Hermetically Sealed Containers (Section 4.2)
Aluminum Pressure Cookers	Screw clamp, neoprene o-ring seal		LANL 157Y700694, 157Y700695, 157Y700696	Hermetically Sealed Containers (Section 4.2)
Copenhagen Pressure Cookers	Aluminum, Bolted gasket seal		unavailable	Hermetically Sealed Containers (Section 4.2)
Department of Transportation (DOT) 7A/Type-A and UN containers	Steel, rubber gasket seal, ring closure, carbon filter		NFT NMC-5GAL	Filtered Containers (Section 4.3.3)
Department of Transportation (DOT) Type B containers	Generally steel with double o-ring seal		unavailable	Hermetically Sealed Containers (Section 4.2)

Container	Style	Photograph/Model (Example)	Drawing # (Example)	Technical Basis
Certified Sealed Radioactive Sources (ANSI N43.6)	Welded		unavailable	Welded (Section 4.1)
EP-61 containers	Welded		unavailable	Welded (Section 4.1)
FSO containers	Welded		unavailable	Welded (Section 4.1)
Containers meeting the Special Form performance criteria	Special Form		unavailable	Special Form (Section 4.4)
Crimp Seal Food Pack Cans	Crimp Seal	 	unavailable	Crimp Seal (Section 4.5)
ARIES Welded Container	Welded		unavailable	Welded (Section 4.1)

5.0 References

LA-CP-13-00695,Water Penetration Tests on the Filters of Hagan and SAVY Containers

TA55-ESS-13-004-R1, Potential Vulnerability to Containers Due to Flooding

TA55-RD-555, TA-55 Radiation Protection Program

TA55-ESS-14-002-R3, Potential for Criticality in a Glovebox due to a Fire

TECH-08-033, Practical Moderator Concerns with Typical Glovebox

PMT4-DOP-139, R4, Helium Leak Testing a 3013 Container (U)

UN 1A2_X425_S 55 Gal Steel Drum Specification

LA-UR-15-21142, Testing and Certification of the SAVY 4000 Nuclear Material Container for DOT Type A Liquid Transport – 15636

LA-CP-13-01502, Safety Analysis Report for the SAVY 4000 Container Series, Rev. 3

LA-UR-15-23121, Water Ingress into Crimped Convenience Containers under Flooding Conditions

NucFil-019® DS-1-2002-Rev 1, WIPP SAR and DOT 7A Certification of Direct Sample NucFil-019® DS Drum Vent Filter