LP-50 Replacement Container System Project

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Gas Transfer Systems

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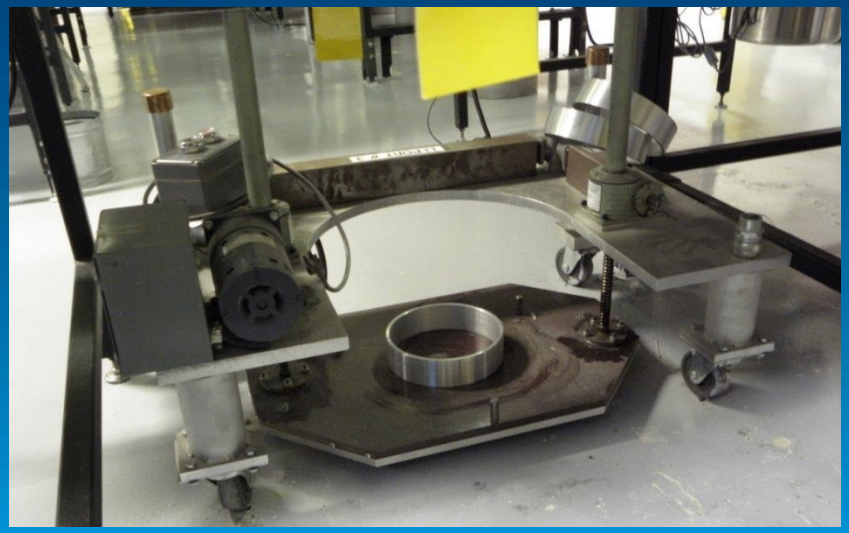
Summary

- What is an LP-50?
- History of LP-50s
- “Clone” Improvements – Why Upgrade
- Design Criteria
- Procurement Process
- Prototype Testing
- Production Testing

What Exactly is an LP-50?
(Low Pressure, ~50 liters)

- A container system (primary & secondary) used to store molecular tritium
- Connects to TGCS (gloveboxes)
- Connects to TGHS (process piping)



History of LP-50s

- 1950s — Atomic Energy Commission/Dept. of Energy(AEC/DOE) approved shipping container.
- Thru 1980's — Savannah River Site(SRS) routinely shipped tritium gas to LANL using LP-50s.
- Early 1990s — SRS discontinued LP-50 shipment and started shipping HTVs & PVs in UC-609s.
- Thru Present — LANL / WETF bulk tritium gas storage

Original LP-50 Shortcomings

- Not designed to be used as a storage container
  - When used for storage: valve failure if repeatedly over-tightened
  - Not ASME certified pressure vessel
  - No record of drop testing

Next generation container needed to buffer HTV loading and shipping operations

New LP-50 “Clone” Design Criteria

- Sized for 10 years of tritium decay
- 250ºF (121.1ºC) temperature rating
- 2 to 4 moles storage limit of tritium molecular gas
- 10’ secondary drop test, 4’ primary drop test
- Able to connect to TGCS & TGHS
- < 1 x 10e-3 std cc/sec leak rate to entire assembly
- < 1 x 10e-9 std cc/sec vacuum leak rate to primary only
- Minimize changes in WETF
- Be ergonomic

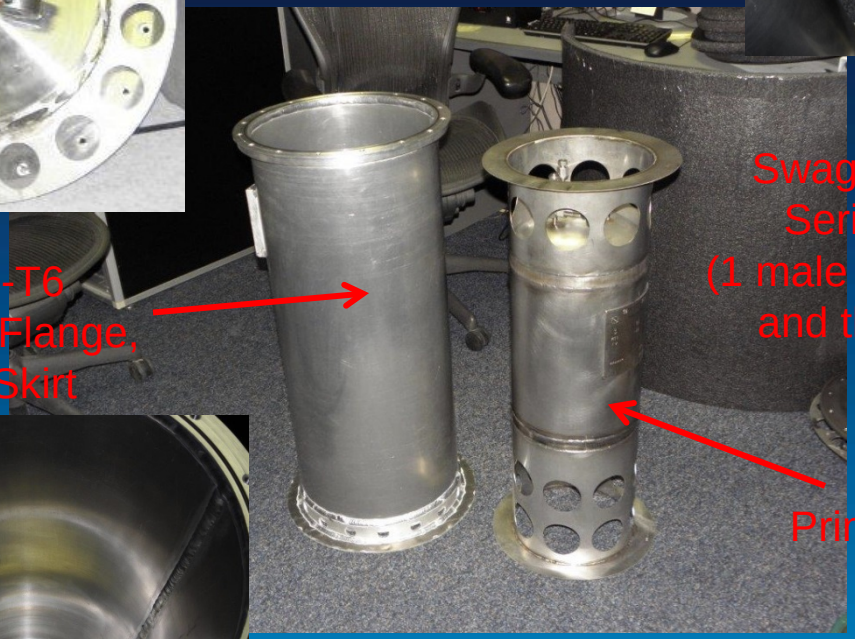
New LP-50 “Clone” Features

- All-metal VCR fitting Swagelok bellows valve
- ASME stamped (P = 80 psig, S = 30 psig)
- Drop Tested (Primary & Secondary)
- 2.4 moles of T_2 gas storage (initial fill 2000 torr, RT)
- Only design changes to facility were pin length & location on existing lifting cart & load-in port
- Also, thermal well added to Primary

The LP-50 Replacement Clone

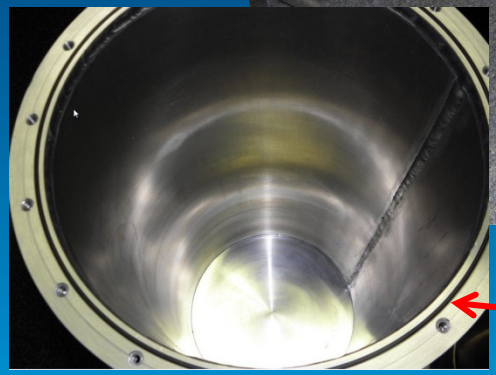
SS 316L
Secondary Lid
Valve & Pressure Gauge

Swagelok Bellow
Series Valves
(1 male and 1 female)
and thermal well



Al 6061-T6
Secondary Flange,
Shell & Skirt

SS 316L
Primary Shell &
Skirt



0-Ring Seal
EPDM

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Procurement Process
(Divide and Conquer)

- Phase 1: Prototype Design and Review

  Completed Sept 2015

- Phase 2: Prototype Fabrication and Evaluation Testing – One Complete System Built

  Completed Feb 2017

- Phase 3: Fabrication and Certify Final Container System

  Completed March 2018

LP-50 “Clone” Prototype Tests (Phase 2)

- ASME certified pressure test

  1.1 MAWP (pneumatic to both vessels)
- Pre/Post drop inside-out leak test requirement: 10e-3 std cc /sec He
- Mass spectrometer level II helium leak tests

LP-50 "Clone" Prototype Tests (Phase 2 Cont'd)

- Ergonomic evaluations (simulate actual operations as much as practical)
- Functional evaluations
  - Mechanically "fitted" to Load-In Glovebox
  - Placed within existing seismically qualified rack
  - Noted required pin length and location design changes
  - Connecting to Process Piping not practical

LP-50 “Clone” Prototype Tests (Phase 2 Cont’d)

Drop Tests (Phase 2 Cont'd)

- Primary vessel, drop test:
  - Pressurized to 80 psig with helium
  - Lifted 4 feet bottom-up at 45° angle and dropped on concrete floor
  - Impact point contacted floor closest to valve/valve stem
  - Visual inspection reveal crumpled top skirt, no discernable valve/valve stem damage

Drop Tests (Phase 2 Cont'd)

- Secondary vessel, drop test:
  - Primary vessel inserted into secondary vessel
  - Secondary vessel pressurized to 30 psig with helium
  - Lifted 4 feet bottom-up at 45° angle and dropped on concrete floor
  - Visual inspection revealed bent crash skirt, flange and valve stem
    - Valve stem deformation caused by inertial force, not direct contact with skirt or floor

Final Production (Phase 3)

- Finalize design and ASME calculations
- Build 4 full assemblies (drop 1 / deliver 3):
  - Included vacuum leak testing on each Primary to 1.0e-9 std cc/sec using respective Secondary as bell jar
- Quality includes ASME data reports, C of C, welding certs & procedures, test reports
- Nothing new – follow through!

Lessons Learned
Overall program went well, but…

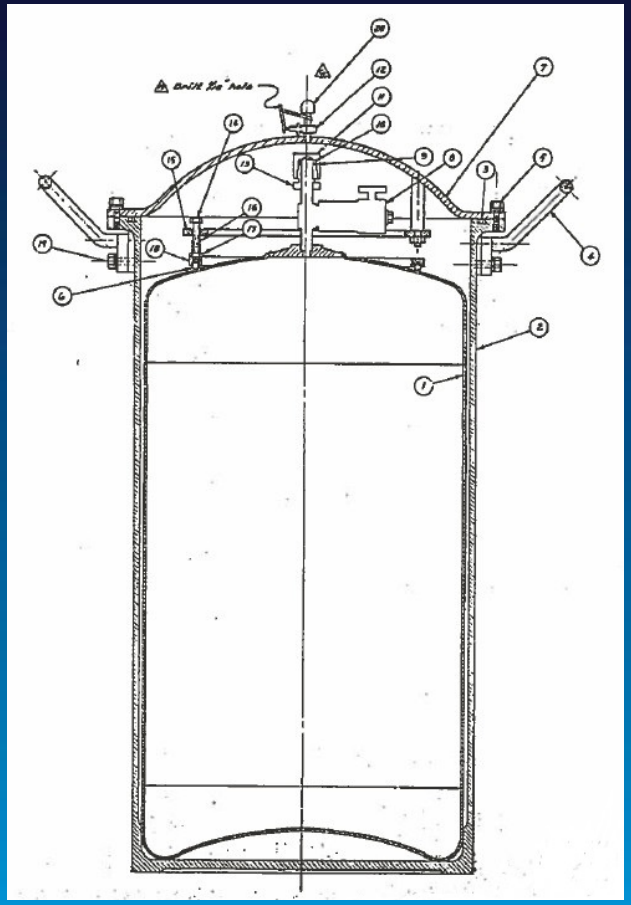
- Procurement
  - Phase 1 & 2 type activities (i.e. prototype) should be time & effort, not fixed firm price
  - Phase 3 (final production) can be fixed firm price
- When leak checking, specify what stable background level is desired upfront
- Perform all fabrication testing during prototype testing

Questions?
Thank You to Our Entire Team!

Reference Info

What Exactly is an LP-50?
(Low Pressure, ~50 liters) (Cont'd)

Original Drawing View (circa 1954)



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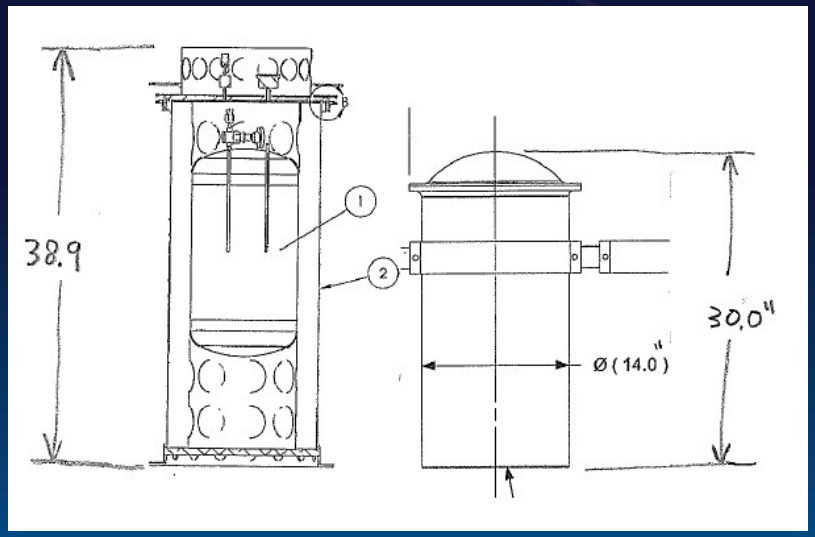
The LP-50 Replacement Clone
Compare size between new and old



	"Clone"	Existing
Height	38.9"	30"
Weight	95 lbs	50 lbs
Volume	22.1 liters	50 liters
Pressure Rating	80 psig @ 250 F	25.2 psig @ 300 F

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The LP-50 Replacement Clone (Continued)

Table 1: General Design Characteristics of New Container to Replace Existing LP-50 Container

Component	Pressure Rating*	Approximate Volume, liters	Approximate Weight**, lbf	
Secondary Vessel Main Body (AL 6061-T6)	30 psig at 250 °F	79.0	38	68 Subtotal
Secondary Vessel Lid (SS 316L)	30 psig at 250 °F	-----	30	
Primary Vessel (SS 316L)	80 psig at 250 °F	22.1	27	

*All ratings are per ASME BPVC Section VIII, DIV 1-2015.
**Total weight of full assembly is 95 lbf. Total weight of Secondary Main Body plus Primary is 65 lbf.

Leak Testing Before Drop Tests General (Phase 2 Cont'd)

- Preliminary probe of all fittings/connections
- Vessel enclosed in plastic bag and left to "soak" for a minimum of 30 minutes to allow accumulation of helium (before & after drops)
- Probe then inserted to top of bag
- Background reading of 1.4e-6 atm cc/sec He was observed (52°F) for both vessels
- NDL after each drop

History of LP-50s

- 1950s - Atomic Energy Commission/Dept. of Energy(AEC/DOE) approved shipping container.
- Thru 1980s — Savannah River Site(SRS) routinely shipped tritium gas to LANL using LP-50s.
- Early 1990s — SRS discontinued LP-50 shipment and started shipping HTVs & PVs in UC-609s (DOT approved Type B shipping container).

  SRS also starts using New Replacement Tritium Facility (mercury free!).

1990s — LANL / WETF bulk tritium gas storage

Thru Present

Original LP-50 Shortcomings
Why we need to go through this process

- Not designed to be used as a storage container
  - When used for storage: valve failure if repeatedly over-tightened
  - Valve replaced by cutting disk containing valve from top of container and re-welding new valve in place
    - Tritium-permeated, mercury contaminated metal
    - Common failure: welded disk to body joint
  - Not ASME certified pressure vessel
  - No record of drop testing

Procurement Process
(Divide and Conquer)

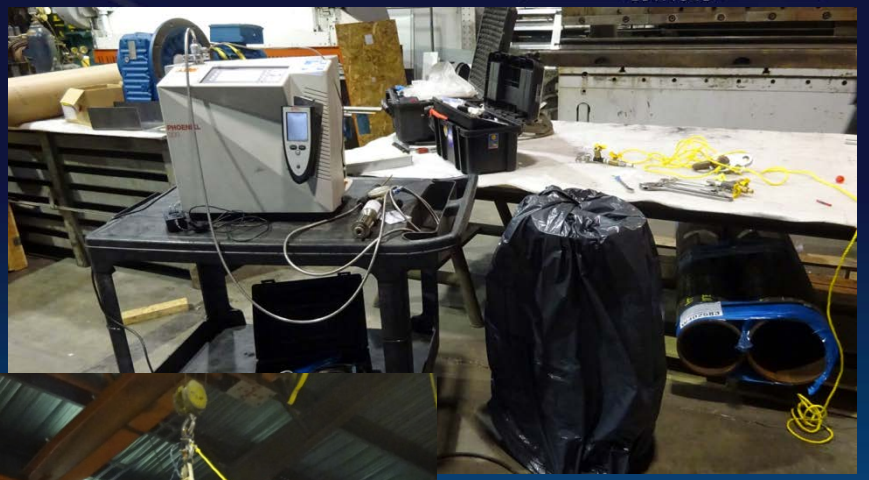
- Phase 1: Prototype Design and Review
  - Included both bolted and clamp design feature
- Phase 2: Prototype Fabrication and Evaluation Testing – One Complete System Built
  - Design changes include elimination of clamp design option plus fabrication observations
- Phase 3: Fabrication and Certify Final Container System
  - Build 4 complete systems, Drop test one complete system
  - Accept 3 complete systems

COMPLETE Sept 2015

COMPLETE Feb 2017

COMPLETE March 2018

Drop Tests & Helium Leak Tests (Phase 2 Cont'd)



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Drop Tests & Helium Leak Tests (Phase 2 Cont'd)

- Secondary vessel, drop test:
  - De-pressurized primary vessel to 30 psig with helium
  - Primary vessel inserted into secondary vessel, top plate installed then torqued to 5 ft/lbs
  - Secondary vessel pressurized to 30 psig with helium