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Title: Utilization of Glovebox Technology within Institutional Design Requirements and Specifications

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Utilization of Glovebox Technology within Institutional Design Requirements and Specifications

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Topics to be Discussed

- Why is this Important?
- Examples of Current Glovebox Technology
  - *Full View Glovebox Windows*
  - *Oval Gloveports*
  - *Push-Through Glovebox Gloves*
  - *Fire Suppression Systems in Gloveboxes*
- Impacts of Using Current Technology
  - *Performance versus Safety*
- Comparison with Existing LANL Design Requirements and Specifications
- Example Case: Implementation of Push-Through Glovebox Glove Technology
- Summary – Using Current Glovebox Technology

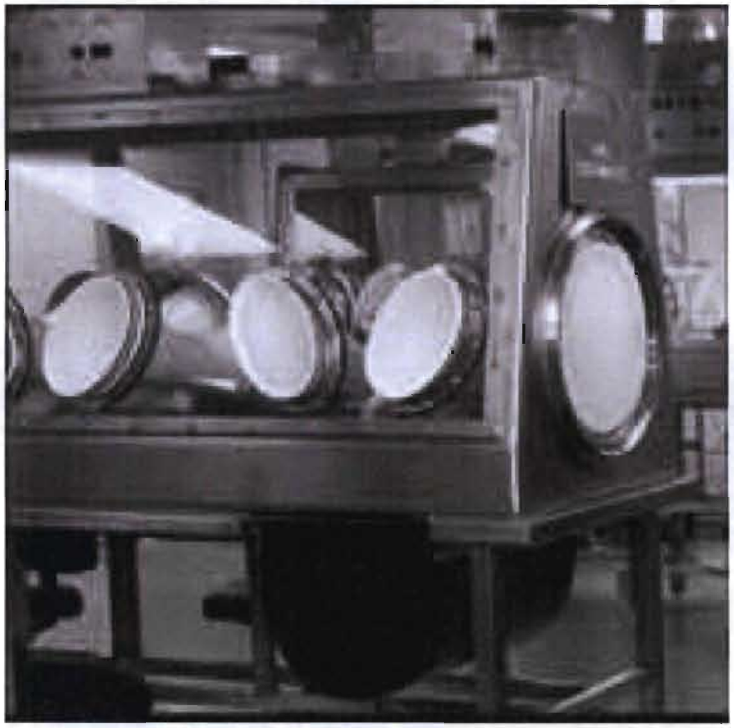
Why is this Important?

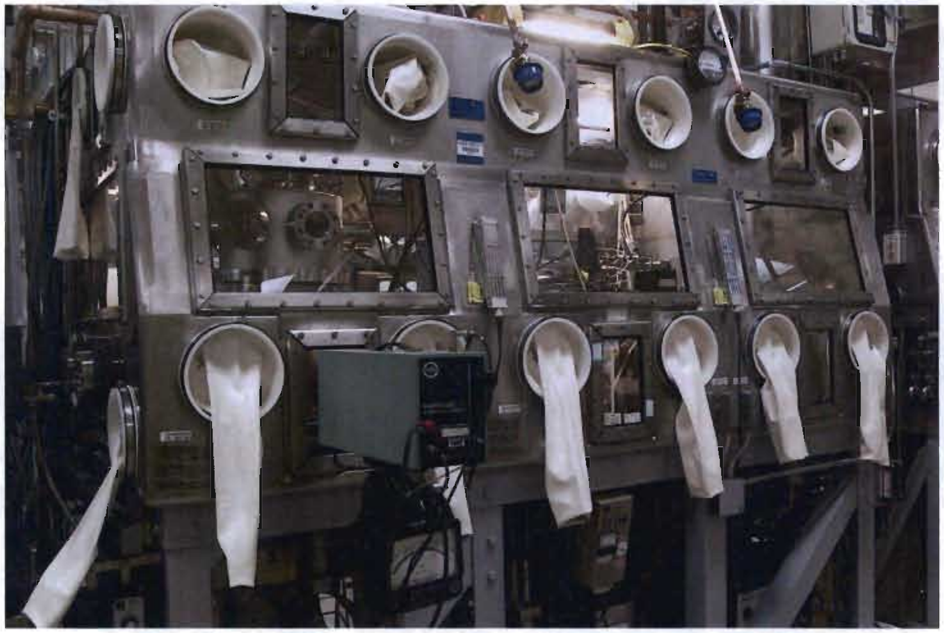
- **Vital to the Plutonium Facility's core mission** at Los Alamos National Laboratory (LANL) is the ability to adapt new technology into glovebox designs to increase ergonomic design, efficiency, and productivity while keeping safety paramount.

Donning his new canine decoder, Professor Schwartzman becomes the first human being on Earth to hear what barking dogs are actually saying.

Examples of Current Glovebox Technology

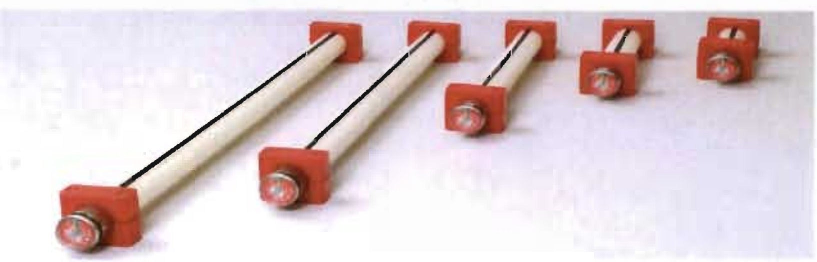
- Full View Glovebox Windows
- Oval Gloveports

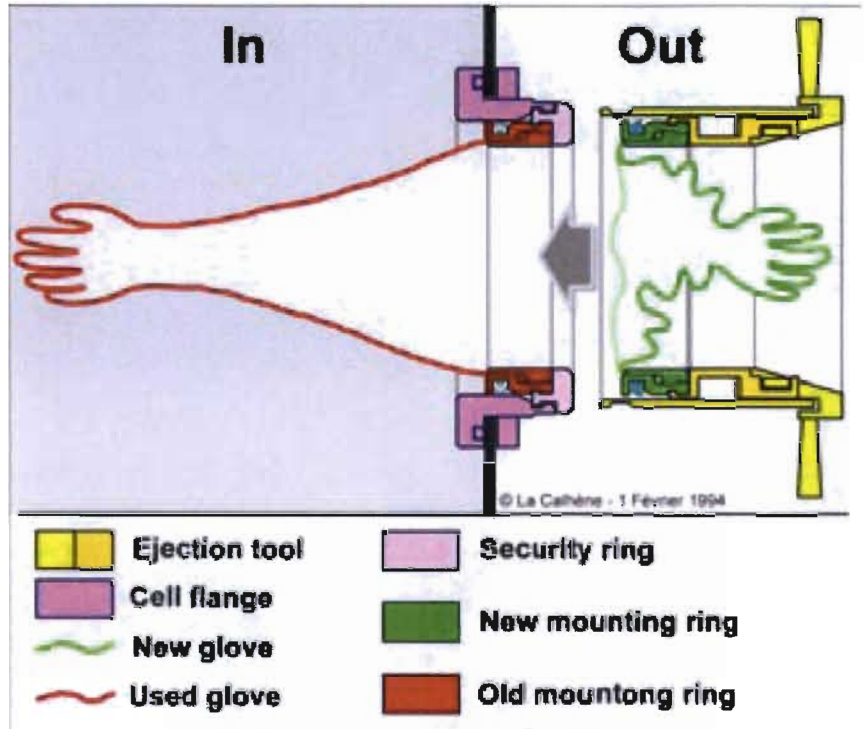




Examples of Current Glovebox Technology

- Push-Through Glovebox Gloves
- Fire Suppression Systems in Gloveboxes

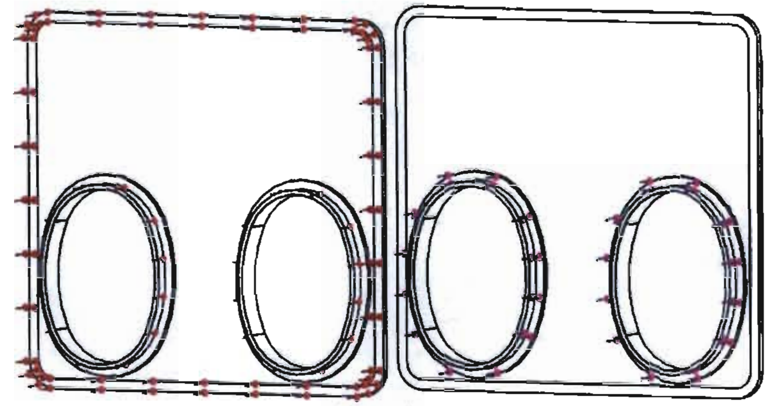




Impacts of Using Current Technology

Full View Glovebox Windows

- *Design Advantages:*
  - Increased Visibility
- *Design Disadvantages*:
  - Less Ductile Material (i.e. Glass) – Failure Strength
  - Load Combinations – Seismic loading not addressed
  - Combustibility Issues (i.e., Lexan)



5-2: Pressure Load

Oval Gloveports

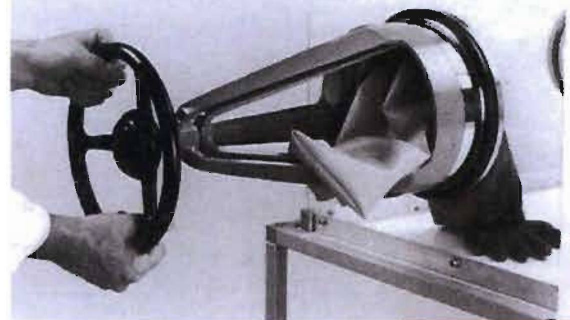
- *Design Advantages:*
  - Increased Range of Motion in Major Axis
  - Reduced Repetitive Motion Injuries (Ergonomic)
    - Orient Major axis in direction of motion
- *Design Disadvantages:*
  - Cross Sectional Area is slightly larger than 8-inch round gloveport
    - Increased Shine Path for Certain Nuclear Isotopes
    - Reduced Negativity if Failure of Glovebox Glove

6-1: Operating Conditions Stress Plot 5 inH_2O

Impacts of Using Current Technology

Push-Through Glovebox Gloves

- *Design Advantages:*
  - Decreased Time to Perform a Glove Change
  - Decreased Risk to Contamination or Exposure of Workers
- *Design Disadvantages:*
  - Leak Integrity – additional seal
  - Combustibility Issues (i.e. Molded Plastic)



Fire Suppression Systems in Gloveboxes

- *Design Advantages:*
  - Decreased Response Time to a Glovebox Fire
  - Increased Mitigation Effect to the Extent of Fire Damage
- *Design Disadvantages:*
  - Reduced Negativity in Glovebox When System Activates
  - Increased Risk of Contamination or Exposure to Workers
  - Interaction of Fire Suppression Chemical with Processing Material, Programmatic Equipment, and Vital Safety Systems

Comparison with Existing LANL Design Requirements and Specifications*

LANL Design Requirements:

Full View Windows

- Type: Safety glass, Polycarbonate resin (Lexan), or Chemically Strengthened Glass
- Density – 2.5 g/cc
- Refraction Index of 1.52
- Combustibility – If Lexan material is used, should be fire retardant with silicate coating and will be considered against the combustible loading calculations associated with a glovebox

Push-Through and Oval Gloveports

- Use Central Research Laboratories type
- Use weld-in/clamp-in (GB shell) or clamp-in (GB window) variety
- Use o-ring materials for bolt-in, push-through gloveports of type [neoprene, buna-N, Viton, silicone]

Fire Suppression Systems in Gloveboxes

- No requirements at present in LANL Master Specifications
- There are Fire Protection Requirements like heat detectors in Gloveboxes, fire screens on Glovebox filters, and fire shields on Glovebox window gaskets.

**Note: Requirements and specifications define minimum performance and functionality of the design to meet safety requirements at the site or institution.*

Example Case - Implementation of Push-Through Glovebox Glove Technology

Background: New Glovebox Line for LANL being Mass Spectrometry Leak Detection (MSLD) tested at a fabricator:

- All gloveports in the line utilized one type of push-through gloveport technology.
- Specification given to vendor for Glovebox Leak tightness: Repair or replace any leak greater than $1x10^{-6}$ std cc/sec. (LANL Master Specification – Glovebox Fabrication/Installation)
- Initial helium leak tests performed on seals for push-through gloveports did not pass.
- Vendor indicated in their opinion, leak is due to a flawed seal design in the proprietary gloveport ring.
- Project engineer requested system engineers review the data and provide recommendations for leak test criteria for push-through gloveport technology.

Review of Institutional Requirements and Specifications

- In order to ensure a thorough review was completed, system engineers reviewed all applicable
- DOE orders/guide documents
- National codes and standards
- LANL master specifications
- Glovebox-gloveport specifications from other DOE sites:
    - Savannah River Site, Y-12 (Oak Ridge)

Example Case - Implementation of Push-Through Glovebox Glove Technology

Analysis:

Site or Standard	LANL	DOE	Amer. Glovebox Soc.	Savannah River Site
Referenced Documents	LANL Master Glovebox Specifications •11 5311.08, *Glovebox Design* •11 5311.10, *Glovebox Fabrication* •11 5311.14, *Glovebox Gloves*	DOE O 420.1, *Facility Safety* •Cites DOE G 420.1-1, *Design Guide for Nonreactor Nuclear Safety Design Criteria* •DOE G 420.1-1 cites ANS 11.16 and ANSI/ASTM C852 for Glovebox design	AGS Standards •G001-2007, *Guideline for Gloveboxes* •G006-2005, *Standards of Practice for the Design and Fabrication of Nuclear Application Gloveboxes* •G005-2003, *Standards of Practice for Specification of Gloves for Gloveboxes*	Specification •M-TRT-A-001, Rev. 0, *SRTC Glovebox Leak Testing Requirements (U)* •0902-SRS-Spec for Gloves & G005-2003

Example Case - Implementation of Push-Through Glovebox Glove Technology

Site or Standard	LANL	DOE	Amer. Glovebox Soc.	Savannah River Site
Glovebox Leak Criteria	MSLD (helium) test to range of 10^{-6}–10^{-7} std cc/sec	Pressure Decay Test • 0.3 vol% air/hr at 1 kPa for 12 hrs. ANS 11.16 Not a published standard	G001-2007 Non – Nuclear Glovebox Leak Criteria •MSLD (helium) test to 10^{-3} std cc/sec •Pressure Decay Test to 0.5 vol% air/hr at 1 kPa for 12 hrs. G006-2005 Nuclear Glovebox Leak Criteria •MSLD (helium) test to 10^{-4} std cc/sec •Pressure Decay Test to 0.3 vol% air/hr at 1 kPa for 12 hrs.	• M-TRT-A-001, Rev. 0 Same as G006-2005 - Includes negative pressure rise test • Spec. provides for optional tests with Tracer Gas and Oxygen Analyzer • Also perform structural proof test where box is pressurized to 1.25 times the relief device rating

Example Case - Implementation of Push-Through Glovebox Glove Technology

Site or Standard	LANL	DOE	Amer. Glovebox Soc.	Savannah River Site
Gloveport Leak Criteria	• Gloveports only, no specific leak criteria specified • Use Central Research Laboratories type • Use weld-in/clamp-in (GB shell) or clamp-in (GB window) variety • Use o-ring materials for bolt-in, push-through gloveports of type [neoprene, buna-N, Viton, silicone]	No leak criteria for Gloveports identified	Gloveports: •No reference to specific leak acceptance criteria. They should provide a portion of the containment boundary •Circular or oval type	CRL and La Calhene gloveports (predominantly CRL) •Glove rings w/ gloves not MSLD leak test •Plugs have been MSLD tested to 10^{-4} std cc/sec

Example Case - Implementation of Push-Through Glovebox Glove Technology

Site or Standard	LANL	DOE	Amer. Glovebox Soc.	Savannah River Site
Glove Leak Criteria	11 5311.10 & 11 5311.14 Glove Leak Criteria •Electrical Cont. Test •Pressure Decay Test • 50% vol air/hr at 30 mbar (3 kPa) for 1 hr.	No leak criteria for glovebox gloves	G005-2003 - Glove Leak Criteria •Air leak test per EN 374 •Air leak test per horizontal inflation (no pressure specified) •Electrical Cont Test	0902-SRS-Spec for Gloves - Glove Leak Criteria •Electrical Cont. Test •Pressure Decay Test • < 15 mbar air/hr at 15-30 mbar (1.5-3 kPa) for 1 hr.

Example Case - Implementation of Push-Through Glovebox Glove Technology

Conclusions

Review of Institutional Requirements and Specifications indicated three inconsistencies:

1. The boundary conditions for a glovebox need further clarification as to where the performance capabilities with push-through gloveport technology should reside, i.e. as part of the glovebox shell or as an extension of the glovebox glove.
2. The LANL master glovebox specification did not provide any direction for the leak testing acceptance criteria of the push-through gloveport technology.
3. The LANL glovebox leak rate criterion for glovebox shells, windows, panels, etc is a couple of orders of magnitude higher than the AGS standard or any other DOE site requirement. Because of the types of nuclear material isotopes that LANL must control, an argument can be made that a more conservative glovebox leak rate is required for worker safety, but the reason for this disparity is not well documented, which calls into question whether that strict of a leak rate criterion is really needed.

Recommendations

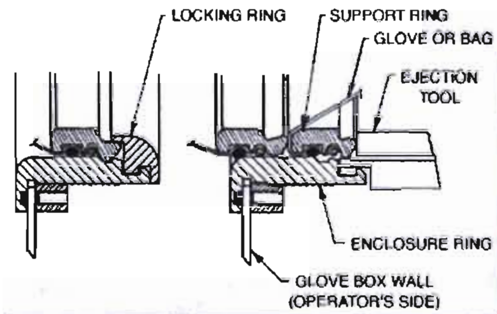
Following System Engineer recommendations came from the review:

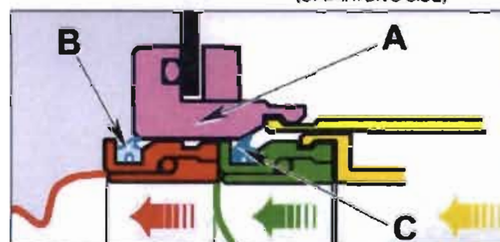
1. Revise the LANL Master Specifications to
   a) State minimum leak test acceptance criteria for gloveport assemblies (i.e., with gloves and/or plugs).
   b) Remove any reference to a specific vendor of push-through gloveport technology because the leak test criteria should be sufficient to identify vendors with quality products that meet the acceptance criteria.
2. For existing push-through gloveport technology already in use at LANL, the variance process may need to be implemented to address these occurrences.

Summary - Using Current Glovebox Technology

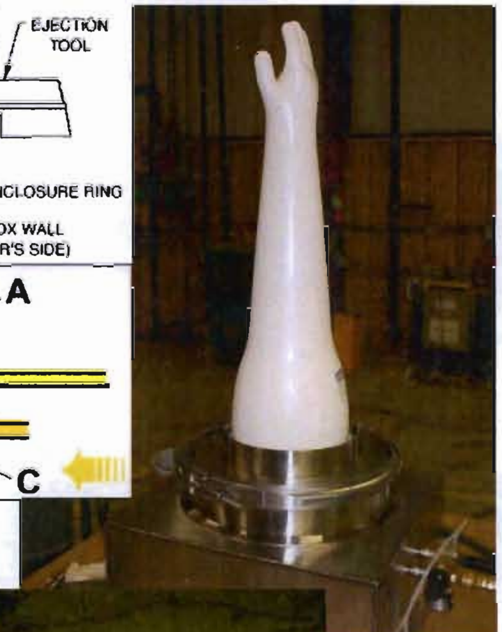
- No formal process at LANL to evaluate Current Glovebox Technology and to update requirements and specifications in the Master Specification Documents
- Bulk of testing for Current Glovebox Technology left to end user to verify performance of the product
- **Resulting Impacts:**
  - Cost to programmatic projects
    - Missed milestones – schedule slips due to un-passable equipment – unable to meet existing LANL Safety & Q/A requirements.
    - Allocation of resources to perform an evaluation to assess what design requirements are needed to utilize the technology in Glovebox designs at LANL and potentially perform verification testing.

O-Ring Design





Lip-Seal Design

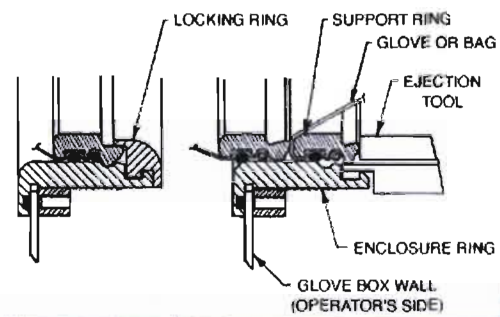


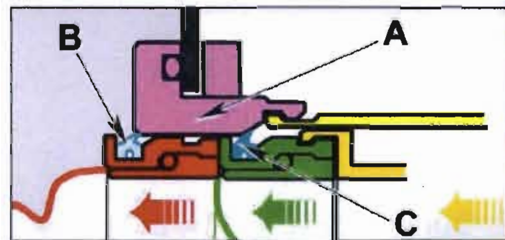
Back-up Slide – LANL Pressure Decay Testing

- Expected Leak Testing Performance of System
  - The leak-tightness performance of the ejectable assembly system fitted with bags or gloves shall be 3.0E-03 cm^3/sec at a test pressure of 5mB (2" WC)
  - This performance allows the installation of at least 20 gloves or 20 bags on a Class 3 glovebox with a volume of 1 m^3 (based on the AGS-G001-1998 %volume leak standard and with a safety coefficient of 2.) (See Appendix A.)
- Test Parameters
  - Inflating Pressure: 11mB < inflating pressure < 19mB
  - Test Pressure: > 10mB
  - Stabilization Time: 1 minute < Stab. Time < 5 minutes
  - Test duration: 1 minute
- Results

Type of Seal	Pressure Leak Rate (Pa/min)	% Vol/hr Leak Rate
Lip Seal Design Glove Assembly	1.34	0.077
Lip Seal Design Plug Assembly	1.9	0.114
O-Ring Design Glove Assembly	5.26	0.23

O-Ring Design





Lip-Seal Design