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Title: **Institutional Glovebox Safety Committee (IGSC) Annual Report FY 2008**

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Institutional Glovebox Safety Committee (IGSC) Annual Report FY 2008

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ABSTRACT

Chemical and metallurgical operations involving plutonium, beryllium, and other materials in support of the U. S. Department of Energy's (DOE) nuclear weapons program account for most activities performed in gloveboxes at the Los Alamos National Laboratory. During the month of January 2007, two workers were injured in separate glovebox operations in which a break in a glovebox glove resulted in plutonium penetration into the skin. As a corrective action, the Institutional Glovebox Safety Committee (IGSC) was created under the authority of the Institutional Worker Safety and Security Team (IWSST) with membership made up of those workers and/or managers representing glovebox operations across the Lab. Since then, the IGSC has made numerous inroads in the areas of glovebox operational issues, "Lessons Learned", "best practice", training, and unplanned glove openings. Communication of these topics improves the safety configuration the glovebox system and contributes to the Lab's scientific and technological excellence by increasing its operational safety. In the following report, highlights of the IGSC's first year, and assessment of its effectiveness, and recommendations for improvements are discussed.

Introduction

During the month of January 2007, two workers were injured in separate glovebox operations in which a break in a glovebox glove (hereafter referred to as gloves) resulted in plutonium penetration into the skin.[1] Radiological exposures of this nature can lead to greater risk of cancer. As a corrective action, the Institutional Glovebox Safety Committee (IGSC) was created under the authority of the Institutional Worker Safety and Security Team (IWSST) with membership made up of those workers and/or managers representing glovebox operations across the Laboratory.[2] Workers that have glovebox operational problems, have found a unique solution to a maintenance or setup issue, or have developed what they consider to be a "best practice" can communicate this directly to a member of the IGSC. The committee reviews recent glovebox incidents, identifies barriers to minimizing glove failures and breaches, considers measures that lower the overall risk of glovebox operations, and identifies mechanisms (processes) that systematically reduce glovebox incidents. The committee also responds to audit findings related to glovebox operations and participates in Director's Office (DIR) sponsored effectiveness evaluations.[3] The Chair of the IGSC reports this information to the IWSST. In the following report results of IGSC's first year, an evaluation of committee's effectiveness, an account of glovebox operations and recommendations for IGSC improvements are presented.

Institutional Glovebox Operations

The glovebox is an "absolute barrier", *i.e.*, a sealed enclosure. Chemical and metallurgical operations involving plutonium, beryllium, and other materials in support of the U. S. Department of Energy's (DOE) nuclear weapons program account for most activities performed in gloveboxes at the Lab. Eleven directorates with 23 divisions own 867 gloveboxes.[4] The majority of gloveboxes is owned by ADSMS, followed by ADCLES and ADEPS, as shown in Figure 1.

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[1] LA-UR-07-1305, Investigation of Two Separate Worker Injuries and Resultant Internal Contamination.

[2] Institutional Glovebox Safety Committee Charter, October 17, 2007.

[3] Two DIR Effectiveness Evaluations were conducted in the months of March and August of 2008.

[4] Glovebox inventories were obtained from the following institutional databases: Sunflower Assets and PASSPORT.

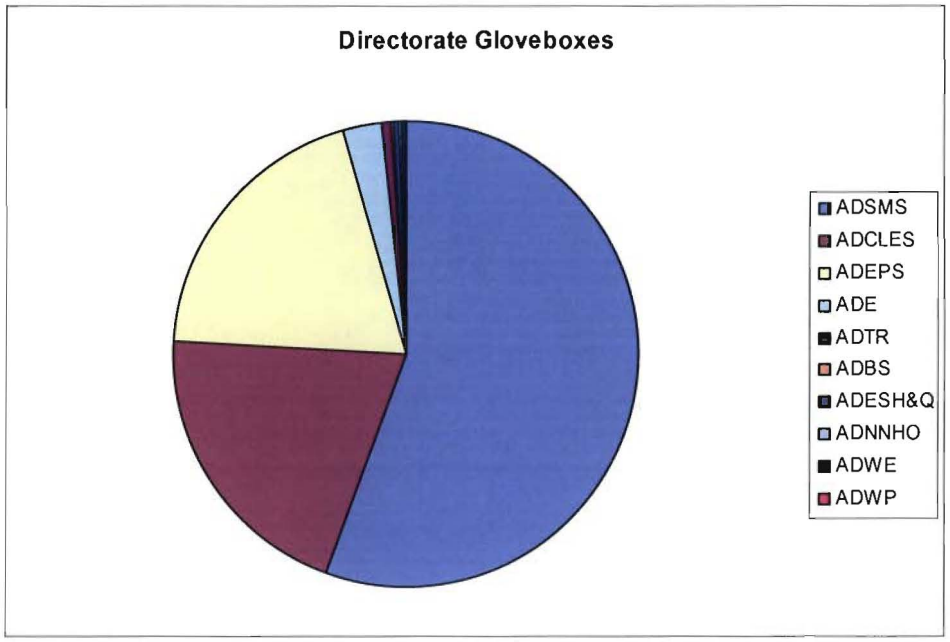

Figure 1. Distribution of Gloveboxes among the Lab's Directorates.

Over 80% of the gloveboxes are located at the Plutonium Facility (TA-55) and the Chemical and Metallurgy Research Facility (CMR).

The weakest link of the glovebox system is the gloves themselves. Physical hazards associated with glovebox operations lead to unplanned glove openings (UGOs) in the form of breaches.[5] A glove breach is an UGO caused by mechanical damage during operations, *e.g.*, penetration with a sharp object; rotating equipment, pinch points, etc. A glove failure is an UGO in a glove caused by degradation of the mechanical properties over time, *e.g.*, exposure to mechanical stresses, chemicals and/or nuclear materials. Thermal sources can cause a breach or a failure. TA-55 tracks all UGOs with the GGIP database.[6] The Waste Characterization, Reduction, and Repackaging Facility (WCRRF) documents UGOs in logbooks. WETF run gloves to failure. At TA-48, only gloves that generate a reportable release, i.e., entered into the RPO system, are tracked. The Target Fabrication Facility and WT-6 do not track UGOs. The Beryllium Technology Facility (BTF) records each glove change in a logbook.

Institutional Glovebox Safety Committee (IGSC)

The IGSC meets, periodically (monthly, if possible), to address glovebox operational issues and to share "Lessons Learned," best practices, training improvements, and UGO data. A standing meeting is now held every third Thursday of the month. Per the

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[5] Michael E. Cournoyer, Ph.D.,* Daniel S. Borrego, Stephen Schreiber, and Young H. Park, "Statistical Analysis of Glovebox Glove Failures in a Nuclear Facility," LA-UR 08-1151, *Proceedings from Probabilistic Safety Assessment and Management 7 (PSAM 9)*, Hong Kong, China, May 18-23, 2008.

[6] M.E. Cournoyer, J.M. Castro, M.B. Lee, C.M. Lawton, Y.H. Park, R.J. Lee and S. Schreiber, "*Elements of a Glovebox Glove Integrity Program,*" Chemical Health & Safety, (2008), doi:10.1016,jachs.2008.03.001, in press.

Institutional Glovebox Safety Committee Charter, members or their alternates are required to attend these meetings.[3] Since October of 2007, 10 meetings have taken place. The directorates that have gloveboxes and their attendances are shown in Table 1.

Table 1. Directorate Attendance at IGSC, Oct. 07 – Sep. 08.

RAD	DIV.	Oct	Dec	Feb	Mar	Apr	Jun	Jul	Jul	Aug	Sep
ADCLES	B										
	C		X	X						X	X
	EES										
ADE	ES										
	AET	X	X	X	X	X	**	**	**	**	**
ADBS	CT	X	X	X						X	
ADWP	DE										
ADSMS	PMT	X		X	X	X	X	X	X		
	WCM		X								
	MQ		X				X	X		X	X
ADNNHO	EWMO	X	X	X	X	X	X	X	X		
	TA55	X	X	X	X	X	X	X	X	X	X
ADESH&Q	IHS		X								
	RP										
ADTR	ISR										
	IAT										
	N										
	NN										
ADEP	WES	X	X	X	X	X	X	X	X	X	X
ADEPS	MPA		X		X						
	MST	X	X	X	X	X		X	X		
ADWE	WT	X	X	X	X	X	X	X	X	X	X
	W	X	X	X	X	X		X			X
IWSST		X	X	X	X	X		X		X	X

*Represented by TA55

**Gloveboxes managed by WT-11

Results of the committee include the following:

Operational Issues

1. TA-48 Operations: commercially obtained inert gloveboxes have electrical decay issues.
2. TA-55 Operations: when marking sharps in a glovebox extra care must be taken to assure that the labeling activity does not become a hazard.
3. TA-55 Operations: efforts aimed at reducing glovebox operation injuries sometimes clash with new safety procedures, *e.g.*, replacing Anti'C gloves made of latex with those made of Nitrile may give the glovebox worker more protection against a puncture, but also increases the risk of ergonomic injury.
4. TA-55 Operations: there are some situations in which lead-loaded gloves are needed. For example, lead-loaded gloves should be used for operations that involve routine hands-on work with Pu-238 or containers with significant quantities of Pu-238. Other

gloves in Pu-238 work areas that are not routinely used for handling of Pu-238 do not need to be lead-loaded (for example, upper level gloves).

5. TA-55, PMT-2 Operations: Pu-238 worker received 10 mrem while implementing the TA-55 Sharps Policy.
6. TA-55 Operations: expander tools cause about one-fourth of the breaches in the last year.
7. TA-55 Operations: Glass Column Breaking Activity, glass shards penetrated bag-out bag, as shown in Figure 2.

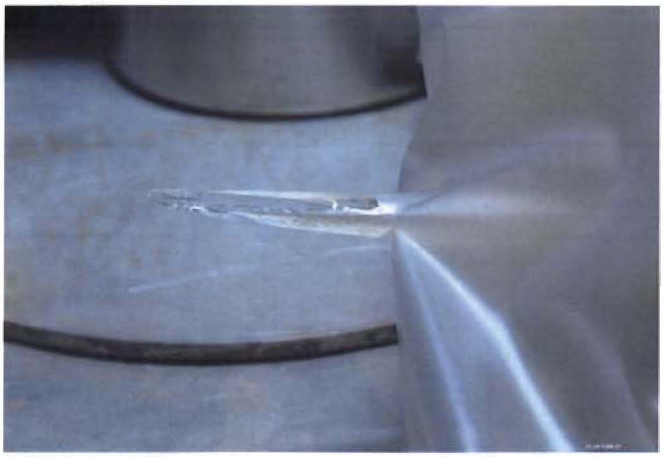

Figure 2. Glass shards penetrated bag-out bag.

8. TA-55 Operations: PMT-2 Glass Column Breaking Activity, leather over-gloves breached, as shown in Figure 3.

Figure 3. Leather over-gloves breached.

9. TA-55 Operations: better methods for sealing can other than with tape need to be studied.
10. WCRRF Operations: a newly installed glove had a pinhole in it.

11. DIR; As a result of the Glovebox Safety Effectiveness Evaluation,[7] it was clear that the ISD 101-28, *Glovebox Safety Program*, needs more requirements.

Lessons Learned

Seven Glovebox Operation "Lessons Learned" have been reviewed by the committee, as listed in Table 2. They have also been entered into a database.

Table 2. Glovebox Operation "Lessons Learned".

Facility Tracking ID	Group	Date	Event Trigger
TA-55 2008-6	PMT-2	02/26/08	Tearing glove on corner of the glovebox window as it is being replaced.
TA-55 2008-8	RP-1	03/04/08	Tearing glove on equipment.
TA-55 2008-14	PMT-5	03/10/08	Nicking glove on clipboard.
TA-55 2008-12	PMT-5	03/26/08	Aging, radiological degradation.
TA-55 2008-18	PMT-2	05/07/08	Tearing the glove on can opener, while opening a bagout bag.
TA-55 2008-24	PMT-2	06/18/08	A trolley cable failed.
TA-55 2008-29	PMT-2	07/01/08	Tearing the glove on screwdriver, while removing tape from a can.

A significant observation that is being obtained from "*Lessons Learned*" critiques is that there was **not** one breach or failure that could not have been prevented. WT-11 had its glovebox workers have a briefing on all seven "Lessons Learned" reported at the IGSC. Workers not able to attend the briefing had required reading on them.

Best Practices

1. TA-48 Operations: O-rings in radiological gloveboxes should be inspected every few weeks not every 6 - 8 months. Something is degrading the o-ring; possibly Ultra Violate Light (UV). If degradation is caused by UV, covering the O-ring with
2. TA-55, PMT-2 Operations: Store all sharp tools in a designated glovebox. When a task requires a sharp tool, the worker must first don the more puncture resistant nitrile Anti'C glove before retrieving the sharp tool from the designated glovebox.
3. TA-55, PMT-4 Operations: before attending a Lessons Learned Critique, the group responsible for the incident should determine plausible event triggers and precursors.
4. TA-55 Operations: four students at the Mechanical Engineering Department of New Mexico State University are working on a new glove design.

[7] SRO Review Team Exit Meeting, March 27, 2008.

5. TA-55 Operations: as part of an effort to replace leaded gloves with unleaded gloves, glove workers are performing the following acceptable dexterity test: the Purdue Pegboard and the Minnesota Dexterity Test.
6. TA-55 Operations: glove information has been tracked on the GGIP database since 1995.
7. TA-55 Operations: the Glovebox Glove Working Team (GGWT) meets periodically (monthly, if possible) to address glove issues. The team recommends to line-management through the TA-55 Radiological Control Board (RCB) measures that minimize glove breaches and failures.
8. TA-55 Operations: a material-testing laboratory is employed to obtain a better understanding of the environmental effects that glovebox operations have on gloves and to qualify a new glove material.
9. TA-55 Operations: as part of TA-55 Continuous Improvement Program, Control Charts are used to effective characterize data collected from glove breaches and failures.
10. TA-55 Operations: trending analysis, through the Data Analysis Support Team (DAST), is conducted to identify emergent issues or recurrence of previously closed UGO issues.
11. TA-55 Operations: using the DOE Occurrence Reporting Casual Analysis Guide,[8] a Casual Analysis Tree (CAT) was made for the screwdriver breach incident. Also, a Cause and Effect Diagram (Fishbone) was made.
12. TA-55 Operations: daily inspections must be performed each day before gloves are used. These include a visual inspection and self-monitoring for radiological contamination by operators.
13. TA-55 Operations: when gloves are installed, they must be labeled with their install and expiration dates.
14. TA-55 Operations: the maximum ceiling life for a glove is 10 years from the date of manufacture (The date of manufacture is stamped on the inside surface of each glove). If a shortage of gloves exists, this requirement can be suspended for up to a year, provided that the glove passes the radiological, visual, and dexterity inspection.
15. TA-55 Operations: an extension of glove service life is allowed after a team comprised of a Radiological Control Technician (RCT) and a glovebox Subject Matter Expert (SME) performs an inspection (A best practice adopted from Savannah River Site). A maximum of four extensions is allowed.
16. TA-55 Operations: plugging ports that are never or infrequently used is allowed and encouraged.
17. TA-55 Operations: a glove that is past its expiration date, and that has not had its service life extended is considered *out of service* and not used without additional compensatory measures. Compensatory measures required for use of an expired glove include a pre-use inspection, a Radiological Work Permit (RWP), and respiratory protection.
18. TA-55 Operations: the changing of a glove is documented and the information is entered into the GGIP database.

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[8] DOE G 231.1-2, Occurrence Reporting Casual Analysis Guide, dated 08-20-03.

19. TA-55 Operations: the discovery of any detectable contamination on a glove, or visual identification of a breached glove, requires additional information gathering. The attributes of the glove breach or failure are also documented and a "*Lessons Learned*" critique is conducted.
20. TA-55 Operations: each of the elements the Glovebox Glove Integrity Program (GGIP) is assessed at least annually and the results are documented.
21. TA-55 Operations: Piercan USA has some Kevlar over-gloves that fit comfortably over North Safety Hypalon gloves.
22. TA-55 Operations: use of optical microscope (OM) in the investigation of glovebox breaches, as shown in Figure 4. Courtesy of PMT-1, Kirk Veirs.

Figure 4. Use of Optical Microscope to Study Breach.

23. W-7: An effort is under way at getting material out of gloveboxes.
24. WETF Operations: gloves are inspected quarterly.

Training Improvements

1. TA-55 Operations: to familiarize glovebox workers with glove issues and performance in a glovebox environment, a thorough glove inspection-training program has been implemented. This training includes hands-on participation, in which workers must identify early warning signs that the glove is degrading and its performance is being compromised.
2. TA-55 Operations: to help mitigate glovebox operation injuries, the science of ergonomics has been integrated into the training program.
3. TA-55 Operations: an updated glove change procedure has been issued. Training is available on the difference between the old and new version.
4. TA-55 Operations: work is being done to convert the cold lab in PF-39 at TA-55 into a Human Performance Improvement Simulation Center.
5. BTF Operations: training plans for glovebox operations are being developed.
6. WCRRF Operations: training plans for glovebox operations are being developed.

Glove Breach and Failure Data

Twenty-seven unplanned glove openings (UGOs) have been reviewed by the committee, as shown in Table 3.

Table 3. Unplanned Glove Openings (UGOs).

Facility	Month	UGOs
TA-55	Oct-07	3
TA-55	Nov-07	1
TA-55	Dec-08	1
TA-55	Jan-08	1
TA-55	Feb-08	3
TA-55	Mar-08	3
TA-55	Apr-08	0
TA-55	May-08	3
TA-55	Jun-08	4
WCRRF	Jun-08	1
TA-55	Jul-08	3
WEFT	Aug-08	1
TA-55	Aug-08	1
TA-55	Sep-08	2
	Total	**27**

IGSC Effectiveness

A main objective of the committee is to address glovebox operational issues and to share "Lessons Learned," best practices, training improvements, and UGO data. Operational issues are being discussed, but not addressed. Best practices and training improvements are being shared at the IGSC meetings. Another of the IGSC objectives is to capture, analyze, track and trend site wide glove box breach/failure data. Per RPOs and logbooks the number of UGOs reported versus those that occurred is listed in Table 4.

Table 4. Unplanned Glove Openings (UGOs).

Facility	UGO Occurred	UGO Reported
TA-55	25	25
WEFT	3	1
WCRRF	6	1
CMR	3	0

UGOs from TA-55 have been effectively reviewed and evaluated by the committee. The review of UGOs from other facilities has not been effective. At this time, the committee is not set up to analyze data from the tracking of glovebox breaches and report results to

the IWSST. There is a second database (Radiation Protection Observations) that captures unplanned glovebox glove breaches/failures, but the IGSC does not currently review, track or trend relevant RPO data. The reporting of UGOs from WEFT, WCRRF, and CMR could be improved. The one breach from WEFT that was presented to the IGSC is currently having a "Lessons Learned" written up on it.

The sharing of "Lessons Learned" across the institution is another objective. Of the nine "Lessons Learned" that have been distributed in FY08, seven have been shared at the IGSC, shown in Table 5.

Table 5. Glovebox Operations "Lesson Learned".

Facility Tracking ID	Title	Date of Incident	Facility Distr.	IGSC Distr.	LANL Distr.
TA-55 2008-6	Tearing glove on corner of the glovebox window as it is being replaced.	02/26/08	03/04/08	07/29/08	08/21/08
TA-55 2008-8	Tearing glove on equipment.	03/04/08	03/18/08	07/29/08	08/21/08
TA-55 2008-14	Nicking glove on clipboard.	03/10/08	04/25/08	07/29/08	
TA-55 2008-12	Aging, radiological degradation	03/26/08	04/02/08	07/29/08	
TA-55 2008-24	A trolley cable failed.	04/09/08	06/18/08	07/29/08	08/14/08
TA-55 2008-18	Tearing the glove on can opener, while opening a bagout bag.	05/07/08	05/14/08	07/29/08	08/14/08
TA-55 2008-29	Tearing the glove on screwdriver, while removing tape from a can.	07/01/08	07/02/08	07/29/08	
TA-55 2008-32	PMT-2 "Sharps Watch" Good Catch!		07/25/08	10/20/08	
TA-55 2008-40	Tearing over-glove on cutting tool.	09/17/08	9/22/08	10/20/08	

All of them have been reviewed before they were entered on the on the Lab's "Lessons Learned" website. The "Lessons Learned" data is exclusively from a single facility. There is no indication of a change from tracking facility specific data toward tracking institution-wide data.

The IGSC meeting attendance can be use as an input metric for sharing available operational issues, "Lessons Learned", best practices, and training improvements across the institution. There are 23 organizations who own 1 or more gloveboxes and who should be sending representatives to IGSC meetings. Since October of 2007, the IGSC has met 10 times. Attendance could be improved. On a positive note, ADSMS, ADNHHO, ADEP, and ADWE have had perfect attendance.

Recommendations:

1. Operational issues discussed at the IGSC should be entered into LIMTS and tracked.
2. Best practices presented in this paper that have not been previously reported in a "Lessons Learned" should be consolidated into an institutional "Lessons Learned" and distributed.
3. To improve the dissemination of Glovebox Safety "Lessons Learned", the Assurance Amber Alert from AWE could be adapted.
4. The ISD should be revised to include the following basic requirements:
    a. Daily inspections shall be performed each day before gloves are used.
    b. When gloves are installed, they shall be labeled with their install and expiration dates.
    c. The maximum ceiling life for a glove shall be 10 years from the date of manufacture (The date of manufacture is stamped on the inside surface of each glove).
    d. An extension of glove service life shall be allowed after a team comprised of a Radiological Control Technician (RCT) or industrial hygienist and a glovebox Subject Matter Expert (SME) performs an inspection.
    e. The inspection of a glove shall be documented and the information entered into the PASSPORT database.
    f. A glove that is past its expiration date, and that has not had its service life extended shall be considered *out of service* and not used without additional compensatory measures.
    g. The changing of a glove shall be documented and the information entered into the PASSPORT database.
    h. The discovery of an UGO shall require additional information gathering. The attributes of the UGO are also documented and a "*Lessons Learned*" critique is conducted. The key attributes of the event are entered into the PASSPORT database.
    i. Each of the elements of the Glovebox Safety Program shall be assessed at least annually and the results documented.
5. Once PASSPORT has been shown to be a useful database for UGO information, a DOE-wide database should be developed. The American Glovebox Society may be a useful resource to implement this database.
6. The following input and output metrics could be developed to monitor the effectiveness of the Glovebox Safety Program:
    a. Unplanned Glove Openings tracked as an output metric.
    b. Glovebox ergo injuries tracked as an output metric.
    c. Glovebox work observations tracked as an input metric.
    d. Glovebox glove failures per gloves inspected tracked as an input metric.

Summary

The sharing of several operational issues, "Lessons Learned", best practices, training improvements, and UGO data has resulted from the formation of the IGSC. Best practices have been recommended as future requirements of ISD 101-28, *Glovebox Safety Program.* Improvements in the sharing of "Lessons Learned" and UGO data, as well as attendance, are needed to make the IGSC more effective. Communication of these topics improves the safety configuration the glovebox system and contributes to the Lab's scientific and technological excellence by increasing its operational safety.