

Joyce L. Connery, Chair
Thomas A. Summers, Vice Chair

**DEFENSE NUCLEAR FACILITIES
SAFETY BOARD**

Washington, DC 20004-2901



April 10, 2024

The Honorable Jennifer M. Granholm
Secretary of Energy
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Granholm:

The Defense Nuclear Facilities Safety Board (Board) has reviewed the glovebox safety program and glovebox glove integrity program at Los Alamos National Laboratory (LANL) for their effectiveness in protecting workers and preventing the spread of radioactive contamination in the Los Alamos Plutonium Facility. The Board also evaluated the progress of corrective actions following several events involving the release of radioactive contamination from gloveboxes at LANL. From the review, the Board has identified safety issues pertaining to the glovebox safety and glovebox glove integrity programs.

The Plutonium Facility's safety basis credits gloveboxes with providing primary confinement of radioactive materials during both normal process operations and abnormal conditions. Given the importance of the glovebox system, the Board encourages LANL to continue to improve aspects of the program to better ensure worker safety. The Board's review did note that LANL's management and operating contractor was instituting changes in organizational responsibility for glovebox safety to improve stewardship of the glovebox safety and glovebox glove integrity programs. The Board identified several safety issues that warrant attention as well as other opportunities to improve glovebox safety and glovebox glove integrity programs and to share lessons learned complex-wide. These safety issues are summarized in the enclosed staff report.

Pursuant to 42 United States Code § 2286b(d), the Board requests that the National Nuclear Security Administration (NNSA) provide the Board with a briefing within 120 days of receipt of this letter to address the following:

- The impact of changes by the LANL management and operating contractor, metrics (e.g., related to glovebox breaches and associated personnel contamination events) that show whether safety improvements are being achieved in the glovebox safety and glovebox glove integrity programs, and any actions implemented to improve operators' real-time awareness of important parameters for safe glovebox operations, such as the magnitude of negative pressure for gloveboxes that rely on negative pressure for confinement.

- NNSA's evaluation of the LANL contractor's glovebox safety and glovebox glove integrity programs, and the NNSA field office's oversight activities focused on programs related to the glovebox system safety.
- NNSA's plan for disseminating lessons learned from the glovebox loss-of-integrity events investigated at LANL during 2020 through 2022, at least.

Sincerely,

A handwritten signature in black ink, reading "Joyce L. Connery". The signature is written in a cursive style with a large, looping initial "J".

Joyce L. Connery
Chair

Enclosure

- c: The Honorable Jill Hruby, Administrator, National Nuclear Security Administration
Mr. Theodore Wyka, NNSA Field Office Manager at Los Alamos
Mr. Joe Olencz, Director, Office of the Departmental Representative to the Board

DEFENSE NUCLEAR FACILITIES SAFETY BOARD

Staff Report

February 16, 2024

Los Alamos National Laboratory Glovebox Integrity Review

Summary. A team from the Defense Nuclear Facilities Safety Board's (Board) staff reviewed the glovebox safety program (GSP) and glovebox glove integrity program (GGIP) at Los Alamos National Laboratory's (LANL) Plutonium Facility (PF-4). The main objective of the review was to evaluate the effectiveness of both programs in maintaining barriers to prevent release of radioactive material and ensure that gloveboxes with plutonium operations can meet their credited safety confinement functions. Another objective was to evaluate the progress of corrective actions taken to correct safety deficiencies and improve the current programs following previous contamination events at LANL.

The Board's staff team conducted several interactions with personnel from the National Nuclear Security Administration's (NNSA) Los Alamos Field Office (NA-LA) and the operating contractor at the site, Triad National Security, LLC (Triad). The staff team discussed numerous topics with these personnel, including qualification of glovebox barriers, degradation and monitoring of glovebox's consumable barriers, use of effective technologies to verify radiological confinement, and communications among the main LANL stakeholders in resolving identified issues impacting the GSP and GGIP.

The staff team notes that Triad has made changes to its programs, such as restructuring the overarching administration team for GSP and GGIP. However, the staff team believes additional measures may be warranted to ensure facility worker safety related to glovebox operations. Overall, the team concluded that improvements are needed to strengthen LANL's GSP and GGIP to mitigate worker hazards for plutonium operations within gloveboxes.

Background. Two notable glovebox contamination events occurred in PF-4 in June 2020 and January 2022, respectively. Both were significant enough to drive additional Department of Energy (DOE) scrutiny: a formal causal analysis for the June 2020 event [1], and an incident review for the January 2022 event [2].

Workers use gloveboxes in PF-4 to process plutonium and other radioactive materials for a variety of national security and other missions. Direct and inherent hazards associated with these processes include the spread of radiological contamination and introduction of radiological materials into the operator's breathing zone, as well as the potential for workers to suffer internal absorption of contamination through wounds sustained through the glovebox gloves. The PF-4 safety basis credits the glovebox system, in conjunction with the glovebox ventilation system, with maintaining primary confinement of radioactive material for worker safety. As a whole, this confinement system is credited as safety significant. LANL uses the GSP and GGIP [3] to ensure that these gloveboxes maintain their integrity.

LANL Glovebox Safety Program—GSP establishes safety requirements for managing health and safety concerns associated with glovebox work at LANL. It addresses topical areas that include engineering and design, maintenance and inspection, glovebox and glove integrity, glovebox sharps management and housekeeping, radiological monitoring, and training. Safety requirements include protecting workers from chemical, biological, ionizing radiation, mechanical, thermal, and ergonomic hazards. The program also ensures communication of identified glovebox safety issues for continuous improvement.

LANL Glovebox Glove Integrity Program—The purpose of GGIP is to protect workers from hazards associated with glovebox glove work and to maintain glovebox confinement integrity. This program addresses several relevant areas including quality assurance requirements for glove procurement, glovebox glove maintenance, and inspections. GGIP performs periodic testing for glovebox glove service life extension, sets inspection intervals for both regularly and infrequently used gloves, and outlines criteria for glove inspections.

Notable Glovebox Release Events—The June 2020 event was a glove breach that resulted in significant personnel uptake of plutonium-238 contamination. Two chelation treatments were administered to the operator who was working with the glove in question, and subsequent bioassay results indicated six of the fifteen personnel who were in the room also had internal uptake. The January 2022 event was a failure of the seals on an unused glovebox sample port that resulted in a release of weapons-grade plutonium with ensuing skin contamination of four workers. There were initial indications of potential personnel uptake, and one worker received chelation treatment for dose mitigation.

Following the 2020 and 2022 events, Triad developed corrective actions to improve GSP and GGIP. However, in 2022–2023, LANL experienced an increased number of glove breaches, failures, and contamination events (most events listed in Table A-1 in the appendix), fortunately with limited to no radiological contamination spread. Considering these developments, the staff team conducted a review of LANL’s GSP and GGIP focused on: a) the effectiveness of glovebox barriers (e.g., gloves, seals) to prevent release of radioactive contamination, b) the qualification of glovebox barriers, c) the degradation and monitoring of glovebox consumable barriers, and d) the use of effective technologies to proactively establish radiological material confinement.

In-Progress Changes to Glovebox Safety Management—During the staff team’s review, Triad instituted significant changes to correct negative trends in glovebox and glove-related incidents. The Associate Laboratory Directorate for Weapons Production (ALDWP)—the organization within Triad responsible for most of the production work in PF-4—placed responsibility for glovebox safety under the chief operations officer (COO) and is instituting several changes to the glovebox safety management structure, including:

- a. **Improving training** for new and existing glovebox operators to include more hands-on applications and use of non-contaminated glovebox mockups. Additionally, LANL plans to incorporate best practices from the American Glovebox Society and other DOE sites to develop training and operator aids.

- b. **Instituting and using an improved glovebox database** that tracks information including glove change-out and modifications to gloveboxes, notably ventilation types (e.g., negative pressure or inert atmosphere). This database also evaluates how often the gloves are being used and records glove breaches and failures, enabling users to analyze data for trends to proactively initiate adequate controls.
- c. **Increasing staffing** for the ALDWP-COO group responsible for glovebox safety and glove integrity (known as operational performance assurance, or OPA).
- d. **Reconstituting the Institutional Glovebox Safety Committee** to improve communication and sharing of lessons learned among major stakeholders within LANL. Meetings will be held monthly as the committee continues to implement new changes, but the frequency could be reduced to quarterly if corrective actions succeed in reducing glove breaches and failures.
- e. **Continuing previous glove-related corrective actions**, such as more frequent change-out for gloves in high-use or highly damaging environments (e.g., plutonium-238 operations).
- f. **Merging the documents [4, 5] governing GSP and GGIP into a single document [3]**. LANL performed this change during the revision of both documents to facilitate easy access and management.
- g. **Improving communication between LANL and commercial glove suppliers**. LANL increased its communication with glovebox glove vendors, relaying feedback about glove performance to improve manufacturing conditions for robust gloves that are tailored for the harsh glovebox processing applications at LANL defense nuclear facilities.
- h. **Closing unused or infrequently used glovebox ports**. The DOE incident review for the January 2022 contamination event identified a legacy sample port as the location from which contamination spread. During discussions onsite, glovebox system engineers stated that they had previously identified these locations as potential risks for contamination spread. While this observation was noted in annual system health reports, it was not acted on in a timely manner due to competing priorities and lack of communication between the multiple organizational chains of command within PF-4.

The staff team transmitted a review agenda to LANL on December 13, 2022, conducted virtual discussions during the weeks of April 13 and May 22, 2023, and conducted discussions at LANL on June 26–29, 2023. The staff team discussed its findings from the review with NA-LA and Triad personnel on September 7, 2023.

Discussion. The staff team reviewed LANL’s GSP and GGIP and identified safety issues in the following areas: (1) deficiencies in instrumentation and requirements to maintain workers’ awareness of negative pressure throughout operations in gloveboxes; (2) lack of practical tools to improve inspection regimes for ensuring integrity of gloveboxes and glovebox gloves,

(3) impacts of uncharacterized material stabilization in gloveboxes, and (4) failure to share lessons learned from glovebox operational events and experiences with the DOE complex per the requirements of DOE Order 210.2A, *DOE Corporate Operating Experience Program* [6].

Deficiencies in Instrumentation and Requirements to Maintain Workers' Awareness of Negative Pressure Range throughout Operations in Gloveboxes—Gloveboxes used for radiological operations in PF-4 are connected to the facility glovebox ventilation system and have visual pressure gauges indicating pressure differentials between gloveboxes and the ambient room environment. The glovebox system, in conjunction with the ventilation system, is credited with maintaining primary confinement for worker safety. As a whole, this confinement system is credited as safety significant. The glovebox in-service inspection (ISI) procedure [7], which LANL system engineers use to determine whether the glovebox system meets the criteria necessary to perform its credited safety function, states that glovebox pressure must be negative relative to the room. The procedure describes how this is done:

The glovebox pressure must be negative relative to room. This...may be indicated by the pressure gauge or some other indicator (such as gloves or bags being sucked into the glovebox). If a glovebox has a faulty pressure gauge, this is noted in the comments column and the appropriate maintenance activity will be scheduled. Faulty pressure gauges do not render the glovebox inoperable or UNSAT.

Regarding this last sentence, during discussions with the staff team, the LANL system engineers stated that pressure gauges are not necessary to ensure confinement, because there are other ways to ensure negativity, and thus the gauges are not part of the credited safety-significant confinement system.

While these same criteria are used by glovebox workers—meaning that they can use means other than a pressure gauge to determine that a glovebox is operable—LANL personnel also stated that workers are trained to not typically conduct work in gloveboxes with a faulty pressure gauge, and to report the faulty gauge to the system engineers or other key personnel. However, operators may continue to work in gloveboxes with faulty pressure gauges upon receiving permission to do so.

The staff team noted that the glovebox pressure gauges are one of the primary and most reliable methods that operators can use to verify glovebox negative pressure. Working in a glovebox without a functioning pressure gauge would leave workers without the best safety method for determining the glovebox is operable and performing its confinement function.

Further, American Society for Testing and Materials (ASTM) C852/C852M-2022, *Standard Guide for Design Criteria for Plutonium Gloveboxes* [8], includes quantitative criteria for glovebox confinement requirements, stating “the glovebox shall be designed to operate at 50 to 500 Pa [0.2 to 2.0 in. H₂O gauge] pressure negative to the room in which it is located.” Given that the guide gives a quantitative pressure range for gloveboxes, it would be prudent for LANL to consider the gauges themselves as the primary (and most reliable) method for ensuring negativity, with more explicit requirements to not use gloveboxes with faulty gauges. Given

their importance, the gauges would also benefit from additional surveillances and maintenance to ensure their functionality.

The staff team observed that the pressure gauges on LANL gloveboxes are simple devices that do not proactively alert workers to changes in glovebox pressure. In other words, there are no engineered measures (e.g., auditory alarms, obvious color coding, other visual indicators) designed to warn operators that glovebox pressure has changed during operation. Operator awareness of glovebox pressure depends on how often workers check the gauge. LANL personnel informed the staff team that operators consistently perform this check prior to beginning work but only perform it sporadically thereafter. LANL should consider augmenting its current pressure gauges with auditory or visual alarms that would proactively alert operators to changing pressure conditions.

Furthermore, the pressure gauges used at PF-4 are of an older design, are not conveniently located in the line of sight for the operator to view, and do not have color-coded indicators to help glovebox operators quickly ascertain whether there is adequate negative pressure. Nuclear industry guidance from the United Kingdom [9] recommends having a “safe” working zone with the pressure gauge located in the line of sight of operators. Pressure gauges at LANL would benefit from clear, colored markings delineating the safe working zone. This would also help operators or system engineers ensure that the quantitative requirements for glovebox confinement such as those established in ASTM C852/C852M-2022 are clearly met.

Improvements to Inspection (ISI) Regimes—LANL’s system engineers perform ISIs, which are credited to meet safety basis surveillance requirements, and separate inspections for system health reports, which are required for the LANL conduct of engineering program to ensure the integrity of the glovebox system.

Both types of inspection are mainly visual, which limits the extent of degradation to that which can be observed. Visual inspections alone are not likely to detect small existing glovebox leaks, and reliance on operators’ experience and visual observation would make it difficult to identify minor damage to feedthroughs and other glovebox appurtenances (such as the sample port that leaked in the 2022 contamination event). Without more rigorous techniques, inspections may fail to proactively detect defects that can cause contamination spreads due to normal operational pressure changes, such as the movement of gloves. The use of tools in the inspection process (e.g., durometers for gloves and resilient seal materials, *in situ* leak testing for glove and sleeve systems) or use of engineered preventive systems to determine ambient air leakage (e.g., glovebox oxygen analyzers that already exist for inert glovebox confinement systems) would improve the inspection process and help inspectors to detect defects and degradation before they manifest as contamination events. In addition to their application for product quality, oxygen analyzers for inert gloveboxes could be used to better detect infiltration of ambient air to assist in routine glovebox inspection programs for worker safety.

In addition to the scheduled inspections for the ISI and system health programs, radiological control technicians periodically take area contamination swipe samples and smears of gloveboxes. They also collect air filter samples from fixed monitoring positions to check for radioactive contaminants in the air. Glovebox workers check glovebox gloves for contamination

using swipes before and after use. The glovebox ISIs conducted by system engineers do not typically involve swipes or samples for radioactive contamination. It may be beneficial to consider these additional leak detection methods during ISIs, to help detect small leaks and ensure the integrity of the glovebox system.

For gloveboxes credited with a safety significant confinement function, LANL mandates an ISI frequency of three years. This is a long surveillance interval, especially given the potential for degradation of seals and the fact that ISIs at LANL do not use tools to identify early indications of degradation. LANL personnel explained to the staff team that annual glovebox system health reports are designed to check many of the same elements as ISIs; however, the staff team notes that these are not formally credited in the safety basis.

LANL performs inspections upon receiving glovebox gloves from the manufacturers, to check compliance with dimensional requirements and identify abnormalities such as pinholes, cuts, and tears. However, these are primarily visual inspections, limiting the inspectors' ability to detect some types of defects (e.g., loss of elasticity, small pinholes).

Additionally, glovebox operators are required to perform similar visual inspections upon installation of new gloves, and before and after every glovebox operation. These inspections, apart from swipes for radioactive contamination, do not make use of tools to detect pinhole leaks or check the physical properties of gloves. LANL personnel informed the staff team that they plan to explore the use of *in situ* leak check devices for inspections in PF-4, as well as explore other avenues to incorporate tools (e.g., durometers to determine material hardness) into glove receipt inspections.

Impacts of Uncharacterized Material Stabilization in Gloveboxes—The staff team also reviewed an event in which LANL personnel heated legacy material in a glovebox process furnace to stabilize the material for disposition in June 2023. The operators noticed an abnormal amount of smoke emanating from the furnace, fogging of the glovebox windows, and elevated furnace temperatures. The following day, operations personnel noticed evidence of a surface reaction on the internal stainless-steel walls of the glovebox as well as a glossy coating on the glovebox gloves.

The uncharacterized material stabilization event is similar to a glovebox pressurization event that occurred at Rocky Flats Environmental Technology Site in February 2001. For that event, workers were conducting thermal stabilization of uncharacterized lathe holdup material containing plutonium chips, machine oils, and mineral oil. Such operations often have the potential for pressurization or an explosion in a furnace. During the thermal stabilization, the workers observed unusual glovebox pressure fluctuations due to the generation of gaseous products at high temperature. The event prompted the Board to issue a letter to DOE on March 23, 2001 [10], requesting to be informed on corrective actions to address the glovebox pressurization during the stabilization of uncharacterized material.

Given the glovebox fogging event LANL recently experienced, LANL management needs to pay keen attention to material characterization before thermal stabilization activities, particularly when they involve incompletely characterized legacy materials. In addition, LANL

should consider improving its hazard analysis for material stabilization processes to mitigate glovebox impacts. Personnel should sample and test uncharacterized material to design a stabilization method suitable for the confined glovebox environment that will have no or limited impact on glovebox integrity. The Board's staff and resident inspectors will continue to engage with the site on the importance of evaluating the hazards associated with legacy materials prior to thermal stabilization in the gloveboxes.

Communication of Issues Across Organizations—The incident review report for the January 2022 radioactive material release concluded that, among other things, “an insufficient understanding of the current configuration of the gloveboxes among operations, maintenance, and facilities personnel” led to the event.

The gloveboxes in question had an unusual setup, because they had been reconfigured from an inert to an air atmosphere. Further, the operators did not recognize that certain actions (such as closure of the glovebox spool doors) could have a detrimental effect on the glovebox ventilation and contribute to the risk of a contamination release. Additionally, glovebox system engineers informed the staff team that they had previously identified legacy sample ports as potential risks for contamination spread and noted this in the annual system health reports. However, LANL did not act on this observation in a timely manner due to competing priorities and failures to communicate between the multiple organizational chains of command within PF-4.

While LANL has recently instituted many important changes to GSP and GGIP, mechanisms are needed to ensure that key information is shared among the many organizations with glovebox safety responsibilities within LANL. As noted above, there have been past instances where the group identifying a safety issue was not the same as the group responsible for addressing it. Further, responsibilities for cognizance, maintenance, and operations of glovebox enclosures and gloves are often divided among different organizations. For example, the glovebox safety database and the information used to compile annual system health reports are owned by different groups (OPA, and Plutonium Facility Engineering, respectively).

Some recent organizational changes at LANL should help address these past issues. Creation of the OPA group in 2022, consolidation of several groups (i.e., OPA, Process Maintenance and Decontamination Services, and a matrixed connection to Plutonium Facility Engineering) under the ALDWP COO, and empowerment of those groups to take actions related to safety issues should all facilitate communication among key stakeholders and assist in prioritizing corrective actions. Additionally, the ALDWP glovebox safety subcommittee, which has a defined charter and is run by members of the OPA group, shows clear evidence (through meeting minutes and observations by members of the staff team) of disseminating information to other workers within ALDWP and facilities such as PF-4.

However, the institutional glovebox safety committee, which is one of LANL’s proposed avenues to ensure effective communication across the entire laboratory, does not appear to be as well established at this time. While the effort by LANL to reconstitute this organization is laudable, the utility of this committee (e.g., responsiveness to information provided by the OPA group or the ALDWP glovebox safety subcommittee) is not yet clear. LANL could improve its

response to glovebox safety issues and more consistently implement safety improvements by making effective use of this tool to ensure all organizations within the laboratory are aware of key developments and issues related to glovebox safety.

Sharing Lessons Learned from Glovebox Operational Events—Following the January 2022 contamination event, DOE convened a formal accident investigation board to investigate the incident. Although the accident investigation was later downgraded to an incident review based on bioassay results, this effort still culminated in a report documenting several judgments of need. While the report is comprehensive and NNSA held discussion forums of the investigation in mid-2022, there has been no formal dissemination of lessons learned to the DOE complex per the requirements of DOE Order 210.2A.

DOE Order 210.2A institutes DOE’s program for the complex-wide dissemination of operating experience. It would be appropriate for either LANL to issue a lessons learned document or for DOE headquarters to issue a higher-level operating experience program document per DOE Order 210.2A addressing the significant radiological events of June 2020 and January 2022, and potentially other events of similar magnitude.

Opportunity to Apply Consensus Standards—Recommended best practices from the American Glovebox Society (AGS) are listed in standards such as AGS-G001-2007, *Guideline for Gloveboxes* [11], and AGS-G005-2014, *Standard of Practice for the Specification of Gloves for Gloveboxes* [12]. These standards highlight best practices that would greatly ameliorate LANL’s GSP and GGIP issues. Reviewing these standards for items applicable to LANL’s glovebox safety programs may identify further opportunities for safety improvement. For example, best practices for verifying the quality of procured gloves include independent laboratory testing of glove batches to determine compliance with the requirements specified; qualification testing of glove characteristics using appropriate methods of sampling and testing for each lot of gloves; and air leak testing of gloves immersed in water with interior pressurized. Best practices for glovebox integrity inspections include negative pressure testing of the glovebox and ultrasonic testing to detect locations of leaks.

Missed Opportunities to Improve NA-LA’s Oversight for Glovebox Safety System Programs—The staff team discussed oversight responsibilities with NA-LA during the onsite interaction. NA-LA personnel stated that their oversight of glovebox management at LANL is somewhat inconsistent due to NA-LA’s limited staff. NA-LA facility representatives and safety system oversight personnel perform occasional walkdowns, but such walkdowns typically do not include dedicated assessments of GSP and GGIP. The January 2022 incident report included a judgment of need stating that NA-LA “needs to include configuration management of glovebox configurations to include auxiliary equipment and disposition of legacy unused appurtenances on gloveboxes in their oversight focus.” Given the importance of GSP and GGIP to worker safety at LANL, more consistent safety oversight by NA-LA would be appropriate to ensure LANL implements these programs rigorously.

Conclusion. Based on the recent history of glovebox and glovebox glove breaches and contamination events at the Los Alamos Plutonium Facility, the staff team reviewed LANL’s GSP and GGIP for implementation gaps. The staff team identified several safety issues and

opportunities for improvement in LANL's programs and in NA-LA's safety oversight. The staff team found:

- Deficiencies in the workers' real-time awareness of whether adequate negative pressure is maintained throughout glovebox operations.
- Lack of implementation of practical tools to improve the inspection regimes for ensuring integrity of gloveboxes and glovebox gloves.
- Failure to share lessons learned from LANL's operational events and experiences involving releases of radioactive contamination from gloveboxes with the rest of the DOE complex per DOE Order 210.2A.
- Opportunities to improve communication of safety issues across organizations, improve evaluation of potential impacts on glove and glovebox integrity from stabilization of uncharacterized materials in gloveboxes, apply best practices from AGS standards, and strengthen NA-LA's oversight of glovebox safety programs.

Appendix A: Recent Glovebox and Glovebox Glove Events at Los Alamos National Laboratory (LANL)

During 2022 to 2023, LANL experienced several glovebox incidents, fortunately with limited or no contamination spread, which are listed in Table A-1 below.

Table A-1. LANL Glovebox Events in 2022 - 2023

Date Reported in Board Resident Inspector Weekly Activity Report	Event Description	Event Synopsis
November 3, 2023	Glovebox worker detected contamination on their personal protective equipment	Radiological control technicians responded and found a tear on the right thumb of the glovebox glove. No skin contamination.
October 6, 2023	Breach in glovebox gloves	Responding radiological control personnel determined a glovebox breach. The impacted individual had contamination on a personal protective equipment glove, but no skin contamination.
August 25, 2023	Contamination spread in a laboratory room	The contamination spread was traced to a breached glovebox glove. No skin contamination and no evidence of airborne radioactivity.
August 18, 2023	Four continuous air monitors alarmed in a laboratory room	The cause of the airborne activity was a release from spool pieces connecting to the dropbox where the workers were installing doors to adjacent gloveboxes.
June 23, 2023	(a) Glovebox glove breach (b) Glovebox glove failure	(a) Breach occurred in a heat source plutonium glovebox. Worker felt airflow along their arm due to a substantial tear in the glove. (b) An old, degraded glove developed a small crack upon use. Neither event resulted in skin contamination or any detectable airborne release.
June 9, 2023	Crack on a glovebox window	Workers noticed the inner glovebox window of the double pane was cracked. No evidence of any airborne release or contamination spread.
April 21, 2023	Two glovebox glove breaches	Both breaches were identified through visual inspections of glovebox gloves prompted by discovery of radioactive contamination on workers' personal protective equipment, in one case by a radiological survey performed immediately upon exiting the glovebox gloves, and in the other case by radiological monitoring at the laboratory room exit. Neither resulted in skin contamination or indication of any uptake.
January 13, 2023	Waste material sparking	Workers repackaging a legacy item for disposal observed sparking while pouring material from a can into a tray. Reaction occurred in a glovebox with no flame present.
April 21, 2023	Auto-ignition of grit paper disk	Small flame traveled along the path where the grinding surface had been in contact with plutonium.
December 23, 2022	Breach in glovebox gloves	Radiological control technician found contamination on the worker's personal protective equipment.

References

- [1] Los Alamos National Laboratory, *Causal Analysis for TA-55 Glove Breach and Pu-238 Dose Event of June 2020*, ORI-CR-2020-008, July 28, 2020.
- [2] U.S. Department of Energy National Nuclear Security Administration, *Incident Review of the January 7, 2022, Contamination Event at the Los Alamos National Laboratory for Lessons Learned*, May 20, 2022.
- [3] Los Alamos National Laboratory, *TA-55 FOD Glovebox and Enclosure Safety Program*, PA-RD-01015, R7, June 5, 2023.
- [4] Los Alamos National Laboratory, *Glovebox Safety Program*, P101-28, R4, November 01, 2018.
- [5] Los Alamos National Laboratory, *TA-55 PF-4, RLUOB, and CMR Glovebox Glove Integrity Program (GGIP)*, TA55-AP-039, R12, 2020.
- [6] U.S. Department of Energy, *DOE Corporate Operating Experience Program*, DOE Order 210.2A, April 2011.
- [7] Los Alamos National Laboratory, *Glovebox In-Service Inspection*, TA55-ISI-628, R6.2, November 24, 2020.
- [8] American National Standards Institute, *Standard Guide for Design Criteria for Plutonium Gloveboxes*, ASTM C852/C852M, 2022.
- [9] Nuclear Industry Guidance, *An Aid To The Design Of Ventilation For Glove Boxes*, Issue 1, January 2012.
- [10] Defense Nuclear Facilities Safety Board Letter to Department of Energy, *Safety Management during Thermal Stabilization Activities at Rocky Flats Environmental Technology Site*, March 23, 2001.
- [11] American Glovebox Society, *Guideline for Gloveboxes*, AGS-G001-2007, February 2007.
- [12] American Glovebox Society, *Standard of Practice for the Specification of Gloves for Gloveboxes*, AGS-G005-2014, June 2014.