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Lessons Learned from
Type B Accident Investigation of the August 5, 2003 Plutonium-238 Multiple Uptake Event at the Plutonium Facility, Los Alamos National Laboratory, New Mexico

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Background

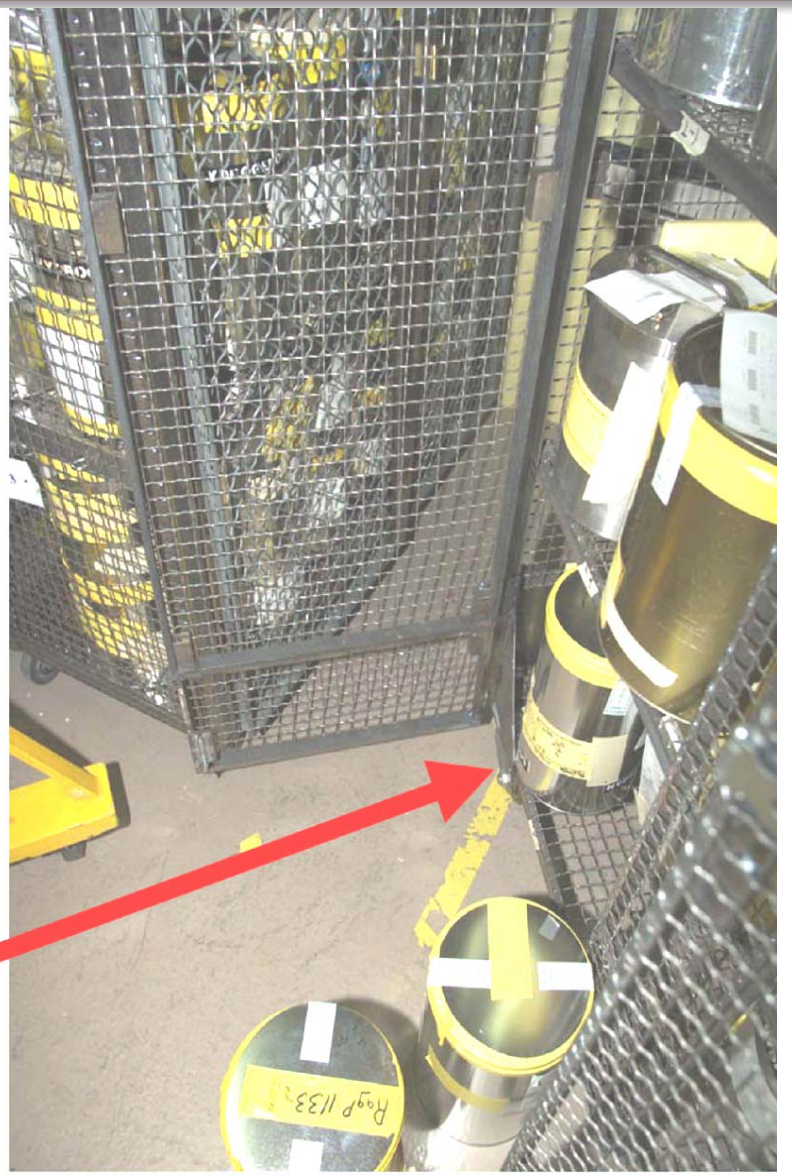
- **Plutonium-238 operations**
- **2 Occurrence Reports in October and November 1994**
- **Contractor-performed Type C Accident Investigation, Glove Box Fire and Decomposition of Rags, November 1994**
- **Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 1994-1 and 2000-1**
- **DOE Type A Accident Investigation, Plutonium-238 Multiple Intake Event, March 2000**
- **Federal oversight**

The Accident - Room 201B

- **Room 201B is a 29’ by 14’ room adjacent to a NMT-9 processing area. The room is used mainly for storing packages containing Pu-238 residues and contaminated materials generated by NMT-9 processing activities.**

The Direct Cause

- **Release of airborne contamination from a degraded package that contained cellulose material and Pu-238 residues. The failed package had been in storage since 1996.**
- **Radiolytic, chemical, and thermal decomposition of the contents and the packaging materials caused the failure of two inner boundaries. Corrosion sealed the "breathable" seams of the outer boundary, allowing decomposition gases to build up inside package.**
- **Simple handling of package dislodged corrosion at seam junction, allowing venting of contaminated gases to room.**



Inner Boundary Failure

- **The inner boundary was a slip-lid can of same design as outer can, but had a particulate filter mounted on the lid. Contents were Pu-238 contaminated cheesecloth. May have had residual nitric acid, cleaning solution, and water.**
  - Thermal and radiolytic decomposition of cheesecloth creates water and gases.
  - Bottom of can corrodes to failure and separation from sidewall.
  - Sidewall corrodes to failure near bottom of can.
  - (Note: photos are views of the bottom of the can)

Bag Failure

- The second boundary was a heavy gauge PVC bag with a particulate filter. This “bag-out” bag is used to contain the contaminated inner can when it is removed from the glovebox.
- Exposure to alpha radiation caused decomposition of the PVC bag, resulting in generation of hydrogen chloride, which combines with water vapor to create hydrochloric acid. This is indicated by browning of the bag.
- Hydrochloric acid contributed to corrosion of the inner and outer cans.
- Weakened bag fails at stress point along seam on bottom of bag.

Outer Boundary Failure

The outer boundary was a slip-lid "foodpack" can with the lid circumferentially taped with vinyl tape. No particulate filter was installed on this boundary, seams and lid were assumed to "breathe" as per manufacturer.

- Acid and water vapor, and decomposition gases passed through filters on inner boundaries and attacked outer can.
- Corrosion products collected under the lid, and held in place by the tape, inhibited breathing around the lid.
- Corrosion products collecting around the bottom edge of the can sealed the seam.

(**Note**: No significant defects are visible on the exterior of the can.)

Board Conclusions

- **This accident was preventable.**
- **The Board concluded that observed failure mechanisms were similar to those previously observed within LANL and DOE. Reference documents include:**
  - *Summary of Plutonium Working Group Report on ESH Vulnerabilities associated with the Department's Plutonium Storage*, DOE/EH-0415, 1994;
  - **Plutonium Storage Safety at Major Department of Energy Facilities, DNSFB Tech Report #1, 1994;**
  - *Criteria for Safe Storage of Plutonium Metals and Oxides*, DOE-STD-3013, first published in 1994;
  - **Plutonium Dioxide Storage: Conditions for Preparation and Handling, LA-12999-MS, 1995; and**
  - *Criteria for the Interim Safe Storage of Plutonium-Bearing Solid Materials*, DOE, 1995.

Board Conclusions (cont)

- **The Board concluded that:**
  - **The technical basis for the Pu-238 residue packaging and storage activities was inadequate, ineffective, and in some cases nonexistent;**
  - **Lessons learned from previous events, including events occurring within the same activity, had not been effectively incorporated into practices;**
  - **The release could have been significantly higher, but for fortuitous geometry and timing, and there were no barriers in place;**
  - **There was no Hazard Control Plan in place for the activities in room 201B, and the established work controls were inadequate and ineffective;**

Board Conclusions (cont)

- **The Board concluded that:**
  - **Some procedures existed that may have reduced the probability of this accident, but adherence to procedures was not enforced;**
  - **The packages were placed in storage with no schedule for disposition;**
  - **NMT implementation of ISM inadequate and ineffective; and**
  - **NMT, LANL, and DOE Oversight inadequate and ineffective.**

Complacent Safety Culture

- **The Board is very concerned about a weak safety culture that was complacent towards procedures and accepted risks without understanding consequences.**
  - **Operational practices were often inconsistent with applicable procedures, instructions, and site-specific training (e.g., CAM alarm response, glovebox cleaning, Ops. Center logs);**
  - **Confusion often existed regarding the applicability of various requirements to actual operations (e.g., SNM packaging, radiation protection, ALARA);**
  - **Confusion existed over intention of RWPs and what the requirements actually were (e.g., "continuous coverage," "taped openings," number of gloves, sign-in and pre-job briefs);**

Weak Safety Culture

- Involvement of subject matter experts in operational decisions was marginal (NMT-2, NMT-4, NMT-7, NMT-11, NMT-14, and NMT-16 all have SMEs that could have assisted);
- Worker safety expectations were often informal and not clearly understood by staff (e.g., “two-man-rule for safety,” 50 mrem/day ALARA goal);
- NMT policies/expectations were inconsistently applied to Pu-238 and Pu-239 operations (e.g., cheesecloth & nitric acid, Vault controls vs. room 201B controls);
- SAR assumptions about worker safety were not carried forward to practices.

Root Causes

- **RC1 - The NMT failed to balance management attention and resources between accomplishing the programmatic mission and providing an appropriate level of protection for the workers handling Pu-238.**

- **RC2 - The DOE, NNSA, and LANL failed to adequately evaluate and understand the magnitude of the worker safety risks that they have accepted for the activities conducted by the NMT-9.**

- **RC3 - The DOE, NNSA, and LANL managed the DNFSB Recommendations 1994-1 and 2000-1 as projects for addressing legacy materials storage rather than as an effort to mitigate potential hazards to workers.**

Lessons Learned

- **There are two important lessons to learn from this investigation:**
  - **This accident could have been avoided through the proactive evaluation and incorporation of lessons learned from both internal and Department-wide experiences. There was enough information available before this activity began, and more became available during the storage of these materials, to provide an understanding of the issues involved.**
  - **This accident could also have been avoided if the safety culture was one which always questioned the adequacy of current practices; one that pondered the possibility of failure rather than assuming success; one that understood that risks should only be accepted after evaluation and thoughtful consideration; and one that always pursued improvement.**

FR Value Added

- **There are important lessons to learn from this investigation as an FR:**
  - **Review previous Accident Investigations, ORPS, DNFSB reviews prior to FR assignment to facility.**
  - **Verify flowdown of safety basis requirements, especially the less obvious requirements that do not have specific TSRs.**
  - **Do not accept status quo.**
  - **Adequate FR coverage is necessary to ensure appropriate depth of oversight.**
  - **Ensure knowledge and communication of facility operations status provided to program sponsors.**
  - **Very good opportunity for FR to enhance their technical competency and proficiency as AI board member.**