



Investigation of a Plutonium 238 Skin Puncture Event

Steve Costigan
Paul Hoover
Maria Nappi

LANL Radiation Protection

UNCLASSIFIED

LA-UR-19-25813

Background and Initiating Event

- The event occurred in the LANL plutonium facility
- Work area inside a glovebox used for manufacturing Pu-238 power supplies and heat sources
- Campaign to perform preventative maintenance (cable replacement) on numerous glovebox interior door cables and counterweights; this was the last cable replacement
- Overtime work on Saturday August 18
- Workers performing cable replacement did not normally work in this area they were not as knowledgeable/experienced with unique Pu-238 concerns
- A knot in the door counterweight 1/16" cable prevented extraction through a pulley (an unexpected condition)

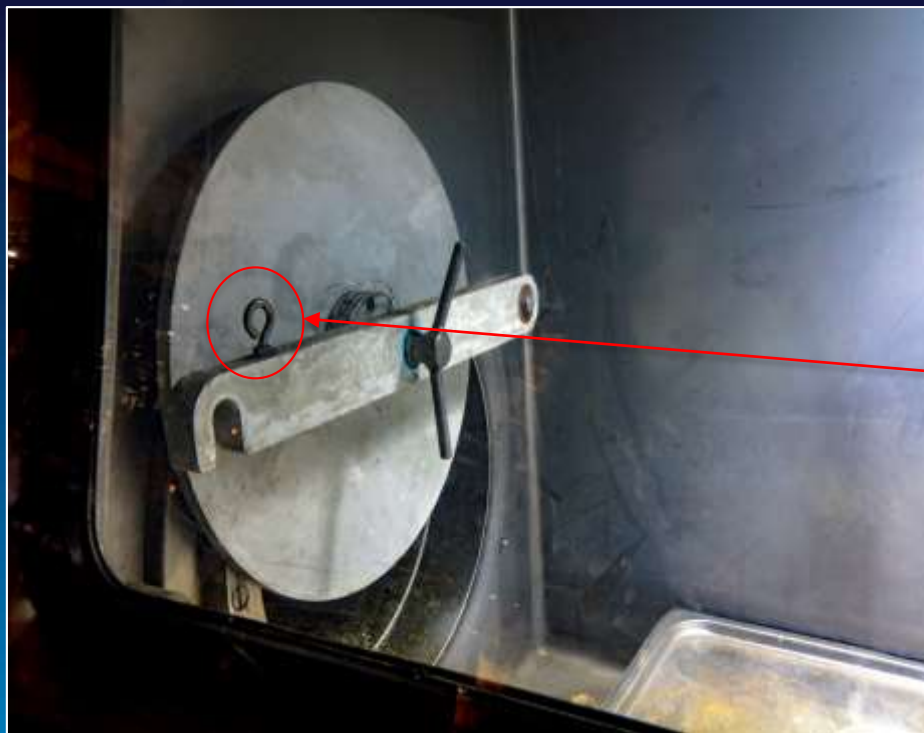
UNCLASSIFIED

Inside a Plutonium Glovebox

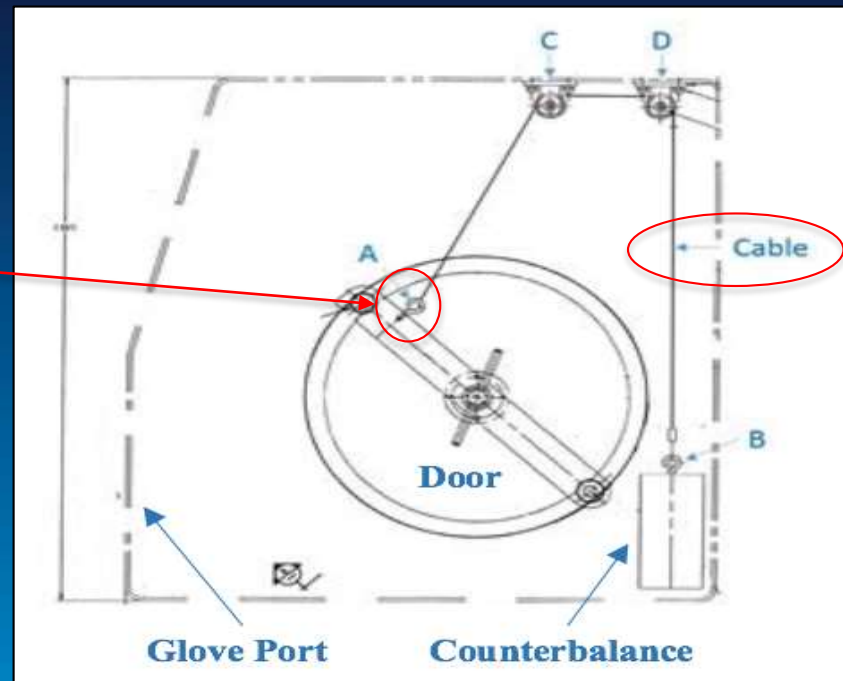


UNCLASSIFIED

Glovebox Inside Door

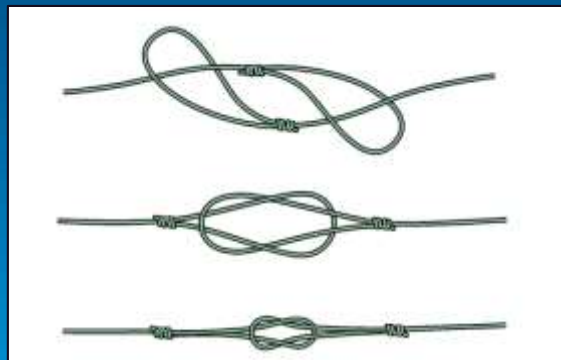
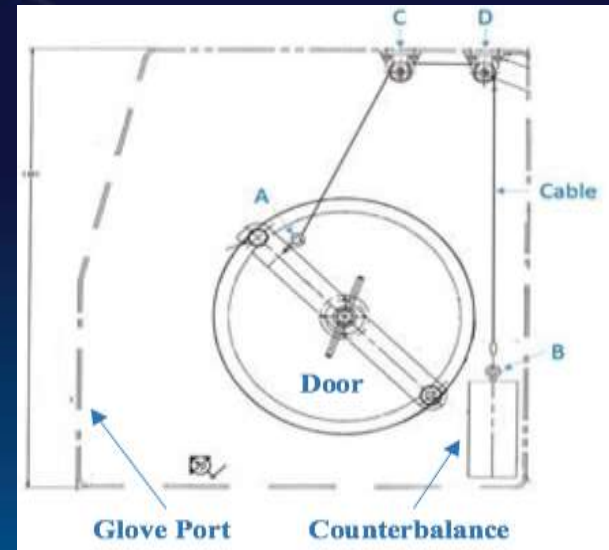


Side View of Counterweight Glovebox Door



UNCLASSIFIED

Glovebox Door Counterweight Cable (1/16" dia.)



UNCLASSIFIED

Initial Radiological Response

- RCTs detected ~33 Bq (2,000 dpm) on left ring finger of anti-C glove
- ~33 Bq (2,000 dpm) on skin in same area after glove removed
- Careful inspection found no evidence of skin break; no redness or signs of skin irritation; no blood visible on skin, anti-C glove, or glovebox glove
- No detectable α activity on skin after two washes with mild detergent
- Same-day discussion and consensus among employee, responding RCTs, HP management that no skin puncture had occurred
- All other indicators (e.g., nasal swipes, air sampling, CAMs, area contamination) were negative
- Exceeds special bioassay action level; α skin contamination >1,000 dpm
- Special bioassay initiated August 20 (one sample, simulated 24-hour urine)
- Internal (Sub-ORPS) notifications made same day

UNCLASSIFIED

Glovebox Glove Puncture



UNCLASSIFIED

Intake Discovery and Response

Until now, our experience was that without a skin breach, an intake from external skin contamination at this level was extremely unlikely:

- 8/22: Fact finding; included discussion and confirmed absence of skin breach
- 8/30: Results of special bioassay indicate significant Pu-238 intake
- 8/30: LANL wound-counting performed (1" NaI); Pu-238 activity in skin identified
- 8/30: Additional special bioassay initiated by LANL internal dosimetry
- 8/30: Consultation among LANL internal dosimetry, Occupational Medicine and REAC/TS (ORISE) regarding treatment
- 8/30: Chelation (DTPA) initiated same day; continuing chelation prescribed
- 8/31: Successful excision by hand surgeon at LANL OM clinic
 - LANL NaI wound counter used throughout excision process
 - Requiring offsite medical assistance resulted in additional reporting

UNCLASSIFIED

Wound Count Details

- Initial wound count results: 152 – 244 Bq (4.1 – 6.6 nCi) Pu-238, Am-241 detected < L_c (~0.7 Bq [0.02 nCi])
- Wound counter detects low-energy x-rays; estimate depends on assumptions of depth in skin
- Excision conducted by orthopedic hand surgeon
 - With no visible wound, excision site had to be identified using NaI
 - No visible foreign body observed
 - Total Pu-238 activity removed from skin ~303 Bq (8.2 nCi), ~95%
 - Medical decision terminating excision with ~15 Bq (0.4 nCi) residual in skin

UNCLASSIFIED

Dose Estimates

August 31, internal dosimetry communicated unmitigated CED likely to be greater than 0.1 Sv (10 rem)

- Based on single initial bioassay result
- Estimate unmitigated by medical treatment (i.e., no chelation or excision)

Preliminary report issued September 12 - based on single bioassay result, unmitigated

| Sv (rem) | | | |
|--------------|--------------|--------------|--------------|
| | Mean | LCL | UCL |
| CED | 0.092 (9.2) | 0.018 (1.8) | 0.412 (41.2) |
| Bone Surface | 3.03 (303) | 0.619 (61.9) | 13.61 (1361) |
| Liver | 0.642 (64.2) | 0.131 (13.1) | 2.88 (288) |

Official dose assessment issued in June:
36 mSv (3.6 rem) CED and 1.19 Sv (119 rem) to bone surface.

Investigation Results

■ Contributing Causes

- Job reviews did not identify need to introduce sharp hazard controls for frayed cable ends
- Work was not paused or stopped when unexpected knot in cable was found
- Work document steps were generic and did not match activity steps
- Validation of work document and oversight of work execution not performed

■ Root Causes

- Work document renewal did not follow work planning processes
- Hazard analysis/identification processes did not include maintenance activities
- Skill of craft requirements were not fully understood
- Skill of craft and training/qualification were not properly implemented
- Frayed cable ends were not addressed when identified
- Work planning did not consider greater hazard posed by Pu-238

“....mitigation of the frayed cable hazard was based solely on employee awareness without the benefit of additional controls”

Health Physics Lessons Learned

- Lost opportunity to reduce dose during 12 day interval between intake and identification of intake
- Potential for intake without visible wound not recognized; later identified a possible similar 2005 event at another site
- Issued standing order, later incorporated into procedures
 - Confirmatory scan (with NaI wound counter) required when skin contamination detected or is thought to have occurred, and involved α -emitting or hard-to-detect nuclides (Ω only or $E_{\beta} < 200 \text{ keV } E_{\text{max}}$)
- Reemphasized need for emotional/psychological care for employee and employee's family

UNCLASSIFIED

Support for the Worker

- Psychological support for employee and family was established and maintained:
 - Established a relationship of trust between employee and HP, and ensuring ongoing contact
 - HP was at each chelation treatment
 - Meetings held with immediate family in addition to employee meetings
- Provide a handout on intakes and risks for employee to take home
- Provide a driver for employee's trip home the day of the event
- Opportunity to educate worker population regarding intakes and associated response

UNCLASSIFIED



QUESTIONS

UNCLASSIFIED

Notifications and Investigation

- DOE/NNSA field office personnel informed of significant intake on August 30
- Further discussion with DOE/NNSA subject matter experts starting August 31
 - CED likely to exceed 0.1 Sv (10 rem) communicated early
- LANL management charts investigation August 31
- Second fact finding meeting held on September 4
 - Cable maintenance campaign was paused
- Compensatory actions issued September 12
 - Extent-of-condition assessment for sharps in all contaminated enclosures prior to any additional work
 - Conduct hazard identification and PPE review with respect to sharps
 - Mandatory workforce meetings to raise sharps awareness
- DOE/NNSA endorses LANL-led investigation on September 12 with federal SME Observers
- Investigation report issued October 19

UNCLASSIFIED