



Bounding Intakes of Exotic Radionuclides at Los Alamos National Laboratory (ORAUT- RPRT-101)

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Presentation Overview

- Background
- Report Overview
- Summary and Conclusions

Background

- As a part of the evaluation of SEC-0109, NIOSH concluded dose reconstruction was not feasible for all employees at LANL from 1976-1995 based on the inability to bound unmonitored exposures to exotic alpha emitters, fission products, and activation products
- NIOSH found that dose reconstruction is likely feasible starting in 1996 with implementation of 10 CFR 835
- November 2018 work group meeting SCA indicated they find no substantiation for NIOSH's belief regarding exotic radionuclides; 100 mrem/year CEDE is bounding for primary radionuclides

Background cont.

- After the work group meeting in November 2018, NIOSH/ORAUT had many discussions on a path forward for addressing MFAP/Exotics
- NIOSH approach
 - Identify radionuclides of concern
 - Determine air concentration required to get 100 mrem CEDE
 - Identify areas where the potential for exposure MFAP/Exotics
 - Capture air sample data from these areas
 - From those areas identify areas of greatest concern
 - Compare actual air concentrations to those required to get 100 mrem CEDE

Report Overview

Report Overview cont.

- The report addresses the issue of bounding dose for exotic radionuclides for LANL workers from 1996 through 2005 using surface contamination survey data, air monitoring data, and personal contamination monitoring to comply with 10 C.F.R. 835
- Exotic radionuclides includes short-lived activation and spallation products from Los Alamos Neutron Science Center (LANSCE; TA-53) and mixed fission products in TA-3 and TA-48
- The report also addresses heavy elements ^{227}Ac , ^{237}Np , ^{241}Am , ^{244}Cm , and Thorium

Workplace Monitoring

- Workplace monitoring was used by LANL Health Physics to ascertain the effectiveness of workplace controls and compliance with 10 C.F.R. 835
- Sitewide procedures addressing various aspects of radiological protection
- Area –specific monitoring instructions which included survey locations and frequencies
- In addition to routine sampling, LANL used continuous air monitors with alarm capabilities

Workplace Monitoring cont.

- A Hazard Index (HI) of less than 1 indicated a low hazard potential from airborne radioactivity and no air monitoring was prescribed
- A HI of 1 to 100 indicated an increased potential for airborne radioactivity and general air monitoring was prescribed
- A HI of 2 corresponds to 2% of an ALI which equates to 100 mrem CEDE
- In addition to routine/general air sampling, LANL used continuous air monitors with alarm capabilities

Worker Self-monitoring

- Workers were required to frisk when exiting High Contamination Areas, Airborne Radioactivity Areas, Contamination Areas, Buffer Areas, and Controlled areas
- LANL maintained and operated a large inventory of portal monitors consisting of Personal Contamination Monitors (PCM) and Hand and Foot monitors (HFM)
 - NIOSH found examples of personnel alarming the portal monitors and the actions taken

Contamination Surveys and Airborne Monitoring Data

- To evaluate the effectiveness of the LANL radiological control program, we analyzed contamination survey and air monitoring data
- Routine smears and air sampling surveys were selected from TA-3, TA-48, and TA-53
 - These TAs were selected because of known work with exotics during the 1996 to 2005 period
- Background information taken from the smear and air survey data included date, TA, bldg. number, survey frequency, number of results

Contamination Surveys and Airborne Monitoring Data

cont.

- Data collected from the smear surveys included results exceeding:
 - 20 dpm/100 cm² alpha (LANL action limit)
 - 1000 dpm/100 cm² Beta (LANL action limit)
 - The LANL action limits are the 10 C.F.R. 835 Contamination Control Limit
- ORAUT derived limits associated with 100 mrem CED
 - 400 dpm/100 cm² alpha (ORAUT derived upper limit)
 - 3,200,000 dpm/100 cm² Beta (ORAUT derived upper limit)

Purpose

- Purpose for compiling the data
 - Demonstrate the number of samples taken in these areas was substantial
 - Determine the likelihood an individual could receive a significant intake
- The purpose of collecting smear data exceeding 400 dpm/100 cm² alpha and 3,200,000 dpm/100 cm² beta was to assess the likelihood of an individual exceeding 100 mrem

Limited Data

- Previous LANL document, evaluation reports, work group meetings and associated papers have indicated the following radionuclides have been associated with limited data:
 - Mixed Fission Products and Mixed Activation Products
 - Americium 241 (^{241}Am) (Separated from Plutonium)
 - Thorium 232 (^{232}Th)
 - Thorium 230 (^{230}Th)
 - Protactinium 231 (^{231}Pa)

Limited Data cont.

- Additional radionuclides associated with limited data:
 - Neptunium 237 (^{237}Np)
 - Curium 244 (^{244}Cm)
 - Actinium 227 (^{227}Ac)

Worst Case Radionuclides

- Of these radionuclides, ORAUT evaluated which alpha and beta emitter would require the smallest amount of surface contamination to be resuspended and a worker exposed for a year (2000 hours) to receive 100 mrem CED for both alpha and beta
 - ^{227}Ac type F worst-case alpha emitter
 - ^{90}Sr type S worst case beta emitter (Fission Product)

Worst Case Radionuclides cont.

- Data collected from the air sample surveys included results exceeding
 - 0.04 dpm/m³ alpha (ORAUT derived limit)
 - 320 dpm/m³ beta (ORAUT derived limit)
- The purpose of collecting air data exceeding 0.04 dpm/m³ alpha and 320 dpm/m³ beta was to assess the likelihood of an individual exceeding 100 mrem CED
 - ²²⁷Ac type F worst-case alpha emitter
 - ⁹⁰Sr type S worst case beta emitter

Contamination Surveys and Airborne Monitoring Results

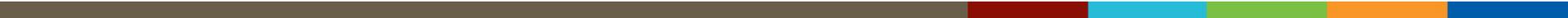
- Table 3-1 summarizes the monitoring results for all three TAs as a whole and individually
 - Table 3-2 shows the results by year
 - Tables 3-3 through 3-5 are summarized below
 - A review of the data shows that over 98% of all smears and 99% of air monitoring data were below the lower limits for alpha
 - The evaluated data does not represent a random sample or all the data, but the data does suggest the workplaces were well controlled
 - The results exceeding the limits still need to be evaluated further
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Table 3-3, Breakdown of Smear Survey Results above Lower LANL Limits

Technical Area	Total Number of Smears	Percentage of Results exceeding lower limit
All	40,717	1.2
3	8,771	3.9
48	7,888	0.70
53	24,058	0.34

Table 3-4, Breakdown of Results Above Derived Upper Surface Contamination Limit (100 mrem Limit)

Technical Area	Total Number of Smears	Percentage of Results exceeding Upper limit
All	40,717	0.04
3	8,771	0.16
48	7,888	0.03
53	24,058	0.01

Table 3-5, Air Concentrations Above Alpha and Beta Derived Limits (100mrem limit)

Technical Area	Total Number of Area Air Sample Results	Percentage of Results exceeding 100 mrem limit
All	67,067	0.38
3	61,704	0.15
48	3214	0.45
53	2149	7.0

Technical Area 3 -Overview

- This area included small labs with bench scale operations to larger radiological operations of Chemistry Metallurgy Research (CMR) (Bldg. 29) and Sigma Complex (Bldg. 66)
- All smears with alpha plus beta results were from Radiological Buffer Areas (RBA) or Contamination Areas (CA)
- Surface contamination was not found in the same location for over two consecutive surveys

Technical Area 3 - Contamination Surveys

- There were 28 smeared spots that exceeded the derived upper limit for alpha 400 dpm/100cm²
- No spot exceeded the derived upper beta limit 3,200,000 dpm/100cm²
- 17 of the 28 smeared spots were found in the Sigma Complex area where uranium was the radionuclide of interest
- The other 11 smears exceeding the upper derived limit were found in CMR where actinides were primary source of concern

Technical Area 3 – Contamination Surveys cont.

- Surface contamination smears were below the upper derived limit 99.87% of the time
- Surveyed spots with readings above the lower LANL surface contamination limit were posted and/or cleaned and resurveyed
- For this TA, considering the minimal number of surface contamination samples above any limit and the minimal amount of time potentially exposed, routine workers would not be exposed to surface contamination levels for a year to exceed 100 mrem CED

Technical Area 3 – Airborne Results

- Airborne contamination results exceeding an alpha or beta limit were found on 119 sets of results for TA-3
 - Sets are a grouping of airborne results from a specific location
 - Ex. On 1/26/00 In TA-3 Wing 5 there were 67 results and only 1 exceeded the limit
- All were for alpha results exceeding 0.04 dpm/m^3
- In all, 179 individual air monitoring results exceeded 0.04 dpm/m^3
- The set of individual air monitoring results that exceeded limits is 0.15% of the total air monitoring

Technical Area 48 - Overview

- TA-48 is known as the Radiochemistry site supporting research and development in nuclear and radiochemistry
- Radiochemistry 1 (RC-1) was the only bldg. of radiological concern
- RC-1 activities included small scale radiochemistry, chemical research of high alpha activity in the alpha facility, sample counting room, small-scale production of medical radioisotopes
- The radionuclides used in these locations primarily included actinides and mixed fission and activation products (MFAP)

Technical Area 48 – Contamination Surveys

- Surface contamination smears exceeding either the lower alpha or beta contamination limit were found in 56 surveys, all in RC-1
 - All smears exceeding the lower LANL Surface Contamination limit were found in an RBA or CA
- From the 56 surveys (7888 smears) , alpha contamination exceeding the lower LANL limit was found on 57 smears and beta contamination on 54 smears
- Individual smears exceeding the lower LANL limit were .7% of the total number of smears

Technical Area 48 - Contamination Surveys cont.

- As for the derived upper contamination limits
 - No smears exceeded the upper beta limit
 - There were four smears that exceeded the upper alpha limit
- Of the total number of smears 99.9 % were at or below the derived upper limit

Technical Area 48 – Airborne Results

- Airborne contamination results exceeding a derived limit were found on 10 sets of airborne results for TA-48
- All were from RC-1
- Twenty-nine individual air monitoring results exceeded the derived alpha limit
- NO beta results exceeded the derived limit
- Of the total monitoring results available 0.45% exceeded a limit

Technical Area 53 - Overview

- TA-53 housed the LANSCE
- During the period of evaluation, TA-53 had approximately 400 bldgs. and other structures and had about 800 personnel
- There were many controls established to protect workers including shielding, fencing, access controls, sweep procedures, beam shutoff mechanisms, monitoring devices, dosimetry, posted safety information, training, other administrative controls and emergency response mechanisms.

Technical Area 53 – Contamination Surveys

- The radionuclides of interest in this area were primarily actinides and MAPs
- Surface contamination exceeding either lower LANL limit was found on 46 surveys
- All smeared locations were in areas that LANL monitored for external exposures and intakes
- From the 46 surveys (24,058 smears), alpha contamination above the lower LANL limit was found on 107 smeared spots and beta contamination on 59 smeared spots

Technical Area 53 cont.

- The set of individual smears exceeding the lower LANL surface contamination limit is 0.34% of the total smears available
- Considering the derived upper limit, ORAUT found three smeared spots exceeding the alpha limit and no smeared spots exceeding the beta limit
 - One spot in experimental area in MPF-3M and the other two in the beam target area
- This equates to 99.9% of all the smeared spots were at or below the derived upper limit

Technical Area 53 – Air monitoring Results

- For air monitoring samples analyzed for gross alpha and beta contamination, 286 individual air monitoring results exceeded the derived alpha limit and 14 exceeded the derived beta limit
- The set of air monitoring results that exceeded the alpha and beta limits is about 7% of the total air monitoring results
- Air monitoring results represent sampling at the target area, along the beam line, and at the beam service area and ancillary support facilities
- A majority of the results exceeding the limit were found in Experimental Area A

Technical Area Summary

- While the analysis included limited contamination survey and air monitoring data for three TAs, results of the smear and air monitoring data demonstrate that LANL effectively controlled radioactive contamination
- Radionuclides of interest for the period of evaluation were primarily actinides (uranium, plutonium, and americium) in TA-3 and TA-48 but included activation and fission products. Spallation activation products as well as alpha-emitters including plutonium were of primary interest in TA-53

Summary and Conclusions

List of Summary and Conclusions

- In the report, the LANL radiological control program is discussed and demonstrates that contamination was well controlled in TA-3, TA-48, and TA-53
- Data shows LANL controlled routine contamination that could lead to doses greater than 100 mrem
- The LANL Radiological program included the use of portal monitors to identify and remediate workplace contamination
- They required frisking upon exiting CAs, HCAs, ARAs, and RBAs
 - Examples of PCM alarms and responses

List of Summary and Conclusions cont.

- The weight of the evidence clearly indicates that workers doses to unmonitored exotic radionuclides would not likely exceed 100 mrem
- Doses for workers monitored by bioassay can be bounded using bioassay results.
- Doses to the unmonitored worker are bounded at 100 mrem

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

