



# Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory

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# INTRODUCTION

This presentation summarizes:

## **Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory**

- Prepared by Oak Ridge Associated Universities Team (ORAUT) for the National Institute for Occupational Safety and Health (NIOSH)
- Published August 15, 2022
- Referred to formally as ORAUT-RPRT-0103 Rev. 00 and as **RPRT-0103** or ORAUT [2022] in this presentation

# PRESENTATION OUTLINE

This presentation covers:

- Why RPRT-0103 was created (Background and Overview)
- What RPRT-0103 examined (Monitoring Practices)
- Which Radiological Work Permits (RWPs) were reviewed for Technical Areas (TAs) 3, 48, and 53
- Conclusions
- References
- Key terms and acronyms

# RPRT-0103 Background and Overview

## RPRT-0103 BACKGROUND (PART 1)

During the evaluation of SEC-00109 [NIOSH 2012, 2017], NIOSH concluded:

- Dose reconstruction is **not feasible** for all employees at Los Alamos National Laboratory (LANL) from **1976-1995** because unmonitored exposures to exotic alpha emitters, mixed fission products (MFP), and mixed activation products (MAP) cannot be bounded
- Dose reconstruction is **likely feasible starting in 1996** when 10 C.F.R. 835 took effect

At the November 2018 Work Group meeting, SC&A disagreed with this position:

- SC&A found no evidence to support NIOSH's conclusion that exotic radionuclide exposures can be bounded starting in 1996 [NIOSH 2018, PDF pp. 37-38]

To address this disagreement, NIOSH/ORAUT produced RPRT-0101, and subsequently RPRT-0103, which analyzes LANL RWP records to evaluate exotic radionuclide exposure monitoring practices

## RPRT-0103 BACKGROUND (PART 2)

**RPRT-0101** Rev 01, *Bounding Intakes of Exotic Radionuclides at Los Alamos National Laboratory* [ORAUT 2023] uses the following approach to evaluating Exotics:

- Identify radionuclides of concern
- Determine air concentration and surface contamination required to get 100 millirem (mrem) committed effective dose (CED)
- Identify work areas where exposure to exotics could potentially occur
- Review air sample and surface contamination data from those areas
- Identify areas of greatest concern based on those data
- Compare actual air concentrations and surface contamination to amounts required to get 100 mrem

# RPRT-0103 OVERVIEW

**RPRT-0103** does the following:

- Supplements RPRT-0101
- Uses RWP documentation to show how work was monitored
- Supports the conclusion in RPRT-0101 that LANL monitored appropriately under 10 C.F.R. 835.402(c)(1)
- Provides qualitative conclusions

# LANL Monitoring Practices

# KEY LANL MONITORING PRACTICES

Key points about LANL's monitoring program for January 1, 1996, through December 31, 2005:

- **Routine bioassay monitoring** was conducted for workers whose jobs could result in more than 100 mrem CED per year
  - monitoring decisions were based on job type, location, and hazards using a Health Physics Checklist
- **Routine internal dosimetry monitoring** focused on the radionuclides handled at LANL (plutonium, americium, uranium, and tritium) with the greatest exposure potential
- **For-cause (special) bioassay** was initiated when field indicators suggested a potential intake during unusual or upset conditions
- For **exotic radionuclides, monitoring** was performed **if needed**
  - LANL provided NIOSH/ORAU with information regarding dosimetry thresholds for the following exotics: actinium-227, curium-244, neptunium-237, protactinium-231, and strontium-90

# RWPS IN LANL MONITORING PRACTICES

The role of RWPs:

**Set monitoring and protective requirements** for nonroutine work that could lead to radioactive material intakes

**Require worker briefings/training** before starting work so workers understand their responsibilities regarding participation in prescribed dosimetry programs

- Covers all RWP requirements
- Holds all attendees accountable for following those requirements
- Requires individuals to verify enrollment in the required dosimetry program
- Requires worker signature on RWP acknowledgement sheet to confirm awareness of requirements

**Note** that a signature indicates briefing attendance only – a worker could sign an acknowledgment sheet and never perform work under that RWP

# LANL MONITORING DOCUMENTATION

LANL planned and prepared for nonroutine “hot jobs” by:

- Conducting a prejob survey to characterize the initial (as-is) radiological conditions
- Assessing how the planned work activity could change those radiological conditions
- Establishing boundaries, hold points, and alarm settings
- Setting maximum expected levels of contamination, airborne hazards, and dose rates
- Ensuring RCTs continuously monitored radiological conditions against radiological limits during the in-process stage

After completing the hot job and cleanup activities, LANL performed a postjob survey

If conditions indicated residual contamination, LANL would perform a second postjob survey following additional decontamination

# RWP SELECTION

NIOSH/ORAUT reviewed RWPs that:

- Represented the period from **January 1, 1996, through December 31, 2005**
- Represented the same three Technical Areas assessed in RPRT-0101:
  - TA-3
  - TA-48
  - TA-53
- Involved work with radionuclides other than plutonium, americium, and uranium
- Contained terms such as:
  - prejob surveys
  - in process surveys
  - postjob surveys
  - prejob briefing logs with names of personnel acknowledging the RWP

# Technical Area Summaries

## Technical Area 3 RWP Reviews

- TA-3 conducted a mixture of activities including experimental sciences, work with special nuclear materials, administrative work, public and corporate access, theoretical studies and computations, and physical support operations
- Many of the major facilities for providing physical support such as utilities and maintenance are in TA-3
- Research facilities are scattered throughout the area and include activities involving radioactive materials in the Chemistry and Metallurgy Research facility within Building 29
- LANL staff at TA-3 working on the assessed RWPs were potentially exposed to both alpha emitting radionuclides and exotic radionuclides, primarily fission products

The following slides provide brief descriptions for the 8 RWPs reviewed for TA-3

# TA-3 RWPS (PART 1)

## **RWP 96-3-29-9030-106**

- Effective March 8, 1996, expiration June 28, 1996
- Replace shaft bearings and a motor at FE-40, FE-41, and FE-42 in Room 9030 in Building 29 of TA-3

## **RWP 96-3-29-9030B-423**

- Effective November 7, 1996, expiration February 5, 1997
- Install vibration pickups and thermocouples for filter banks in Room 9030B in Building 29 of TA-3

## **RWP 97-3-29-9030-99**

- Effective February 7, 1997, expiration December 24, 1997
- Check, troubleshoot, and repair if required, the limit switches on the hot cell doors in Room 9030 in Building 29 of TA-3

## **RWP 97-3-29-Wing 9-162**

- Effective March 24, 1997, expiration December 24, 1997
- Inspect, maintain, and repair as needed bridge cranes and hoists in Building 29, Wing 9 of TA-3

## TA-3 RWPS (PART 2)

### **RWP 99-3-29-1117-47**

- Effective December 12, 1998, expiration February 26, 2000
- Decontaminate Rooms 1117, 1117A, and 1119 in Building 29 of TA-3

### **RWP 99-3-29-9030, 9060-144**

- Effective January 16, 1999, expiration December 31, 1999
- Decontaminate under cell doors 10 and 12 in Rooms 9030 and 9060 in Building 29 of TA-3

### **RWP 99-3-29-4064-361**

- Effective July 6, 1999, expiration December 24, 1999
- Decontaminate Room 4064 in Building 29 of TA-3

### **RWP 04-03-29-4064-275**

- Effective January 5, 2004, expiration December 31, 2004
- Perform an initial survey for contamination assessment, decontaminate affected areas, and investigate cause and repair as needed if contamination was found for Room 4064 in Building 29 of TA-3

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## Technical Area 48 RWP Reviews

- TA-48 is known as the Radiochemistry Site
- The facilities at TA-48 supported research and development in nuclear and radiochemistry
- Some measurements of radioactive substances were taken in hot cells equipped for remote handling
- Although radiochemical operations were conducted primarily in Buildings 1, 8, 28, 45, and 107, only Building 1 contained the most significant radiological hazards

The following slides provide brief descriptions for the 8 RWPs reviewed for TA-48

# TA-48 RWPS (PART 1)

## **RWP TA-48-98-46**

- Effective July 22, 1998, expiration July 22, 1999
- General maintenance and decontamination of all acid line plumbing in RC-1 of TA-48

## **RWP TA-48-98-62**

- Effective November 10, 1998, expiration November 10, 1999
- Offload targets in the warm corridor of RC-1 Hot Cell of TA-48

## **RWP TA-48-98-47**

- Effective July 24, 1998, expiration December 30, 1998
- Remove gloveboxes in Room 430 in RC-1 of TA-48

## **RWP TA-48-98-50**

- Effective August 6, 1998, expiration August 6, 1999
- Transport accelerator production of tritium foil stacks from the Chemistry and Metallurgy Research facility in steel containers to Building 311 of TA-48

## TA-48 RWPS (PART 2)

### **RWP TA-48-03-01**

- Effective January 10, 2003, expiration December 31, 2003
- Inspect the radiological inventory in hot cell pits in RC-1, Room 322 of TA-48

### **RWP TA-48-03-08**

- Effective January 13, 2003, expiration December 31, 2003
- Perform warm corridor and hot cell entries for health physics, waste, maintenance, and shipping operations in Building 1, Room 332 at TA-48

### **RWP TA-48-03-09**

- Effective February 10, 2003, expiration March 7, 2003
- Decontaminate Room 413 in RC-1 of TA-48

### **RWP TA-48-03-23**

- Effective September 10, 2003, expiration December 31, 2003
- Clean up hoods in RC-1 of TA-48

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## Technical Area 53 RWP Reviews

- TA-53 housed the Los Alamos Neutron Science Center
- TA-53 had approximately 400 buildings and other structures during the period of this evaluation
- Radiological work at TA-53 was primarily associated with accelerator operations, which produced short-lived activation and spallation products
- Workers on the assessed RWPs were potentially exposed to alpha-emitting radionuclides and exotic radionuclides, primarily activation and spallation products
- Worker protections included shielding, fencing, access controls, sweep procedures, beam shutoff mechanisms, monitoring devices, dosimetry, training, administrative controls, and emergency response

The following slides describe the 8 RWPs reviewed for TA-53

# TA-53 RWPS (PART 1)

## **RWP 1999-122-01**

- Effective June 7, 1999, expiration September 30, 1999
- Set up an area in and around A-East for removal of inserts in the A-6 pit and culvert area of Sector M of Building 3 of TA-53

## **RWP 2001-035-01**

- Effective February 14, 2001, expiration May 31, 2001
- Replace target system Culligan bottles in the Service Area, Target 1L in Building 7 of TA-53

## **RWP 2002-006-01**

- Effective January 7, 2002, expiration March 31, 2002
- Install traps in three radioactive liquid waste lines in Experimental Area Room 1 on the lower floor in Building 7 of TA-53

## **RWP 2002-007-01**

- Effective January 7, 2002, expiration July 31, 2002
- Open the 1L hydrogen system cold box following a move from a service area in MPF-7, Room 200 (1LSA) to repair and rebuild for reinstallation in Building 3 of TA-53

## TA-53 RWPS (PART 2)

### **RWP 2003-001-01**

- Effective January 2, 2003, expiration December 24, 2003
- Operate the 1L Target systems in the Building 7 Service Area of TA-53

### **RWP 2003-022-01**

- Effective January 28, 2003, expiration July 20, 2003
- Perform maintenance and upgrades to 1L water, hydrogen and instrumentation control systems located in the Target Cell and Pump Alcove in support of a 2003 outage at 1L Target systems in the Building 7 Service Area of TA-53

### **RWP 2004-054-01**

- Effective April 27, 2004, expiration May 20, 2004
- Target shipment from the New Isotope Production Facility Building 984 in TA-53

### **RWP 2004-128-01**

- Effective December 9, 2004, expiration December 31, 2004
- Perform contamination surveys to characterize, post, establish controls, and establish the decontamination efforts required for the Building 7 Service Area and Crypt, Target 1L and 1LSA

# RPRT-0103 Conclusions

# CONCLUSION (PART 1)

RPRT-0103 Attachment 1 summarizes key details (including radionuclides) from all 24 RWPs that NIOSH/ORAU reviewed:

Table A-1. Summary of RWP information.

RWP number	TA	Radionuclide(s)	Number of signatures signed logs	Nasal smears (Y-#/N)	RCT coverage	Number of surveys provided
96-3-29-9030B-423	3	Cs-137	22	Y-22	Continuous and intermittent	8
96-3-29-9030-106	3	Cs-137	12	Y-8	Continuous and intermittent	8
99-3-29-1117-47	3	Tc-99, U	44	Y-65	Continuous	213
97-3-29-9030-99	3	Cs-137	4	Y-2	Continuous	4
97-3-29-Wing 9-162	3	Cs-137	22	N	Intermittent	6
99-3-29-4064-361	3	Tc-99, U	69	N	Continuous and intermittent	8
01-03-29-4064-275	3	Tc-99, U	2	N	Continuous	11
99-3-29-9030, 9060-144	3	Cs-137	10	Y-1	Continuous and intermittent	7
TA-48-98-46	48	All used at TA-48	11	Y-5	Intermittent	14
TA-48-98-62	48	MAP	10	N	Continuous	11
TA-48-98-47	48	All associated with shot debris	3	N	Intermittent	3
TA-48-98-50	48	MAP	15	N	Intermittent	20
TA-48-03-08	48	MAP	8	N	Intermittent	24
TA-48-03-23	48	Nb-91, Nb-92, Nb-93m, Nb-94, DU, Th-232, Pu-239, Pu-242, Am-243, Cm-248, Np-237, Zr/Y-88, Rh-83, Se-75, Ga/Ge-68, Na-22	8	N	Intermittent	15
TA-48-03-01	48	MAP	13	N	Continuous	4
TA-48-03-09	48	Sr/Y-90	7	N	Continuous	9
1999-122-01	53	Co-60, Co-57, Co-58, Mn-54, Be-7, Na-22	22	Y-30	Continuous	20
2001-035-01	53	Co-57, Co-60, Hf-175, Lu-171, Mn-54, Na-22	12	Y-2	Continuous	24
2002-006-01	53	Co-57, Co-60, Hf-172, Lu-172, Mn-54, Na-22	7	Y-6	Continuous	12
2002-07-01	53	Co-57, Co-60, Hf-172, Lu-172, Mn-54, Na-22	14	N	Continuous	23
2003-001-01	53	Co-60, Fe-59, Lu-172, Mn-54	17	N	Continuous	42
2003-022-01	53	Co-60, Fe-59, Lu-172, Mn-54	24	N	Continuous	74
2004-054-01	53	Sr-82	8	N	Continuous	11
2004-128-01	53	Gd-148, Co-60, Co-57, Na-22, Mn-54, Lu-172	4	N	Continuous	8

## CONCLUSION (PART 2)

Review of RWPs and associated documentation concludes that:

- LANL monitored jobs covered by RWPs
- LANL RCTs reacted to changing radiological conditions to protect worker safety
- LANL maintained the capacity to perform bioassay for exotic radionuclides if it was warranted based on the exposure potential

### **Overall Conclusion:**

LANL monitored the reviewed nonroutine radiological jobs in a manner that supports the conclusion from RPRT-0101 that those workers with the potential to receive exotic radionuclide intakes greater than 100 mrem CED/year were monitored for those exposures.

## KEY REFERENCE DOCUMENTS

NIOSH [2012]. Special Exposure Cohort Petition Evaluation Report Petition SEC-00109 Rev. 1 Los Alamos National Laboratory (LANL) May 29, 2008. August 13. [SRDB Ref ID: 165232]

NIOSH [2017]. Special Exposure Cohort Petition Evaluation Report Petition SEC-00109 Addendum Los Alamos National Laboratory (LANL). April 24. [SRDB Ref ID: 173741]

NIOSH [2018]. Advisory Board on Radiation and Worker Health Los Alamos National Laboratory Work Group Thursday, November 29, 2018. Transcript. [SRDB Ref ID: 184934]

ORAUT [2022]. Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory. ORAUT-RPRT-0103 Rev. 00, August 15. [SRDB Ref ID: 193468]

ORAUT [2023]. Bounding Intakes of Exotic Radionuclides at Los Alamos National Laboratory. ORAUT-RPRT-0101 Rev. 01, August 30. [SRDB Ref ID: 197263]

# Thank you.

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## KEY TERMS AND ACRONYMS (PART 1)

Term	Definition
10 C.F.R. 835.402(c)(1)	Section of the Code of Federal Regulations (C.F.R.) that requires internal dosimetry monitoring for radiological workers who, under typical conditions, are likely to receive a committed effective dose of 0.1 rem (100 mrem) or more from all occupational radionuclide intakes in a year
<b>CED</b> committed effective dose	<p>Sum of the effective doses to various tissues or organs in the body each multiplied by the appropriate tissue weighting factor and committed for a 50-year period following an acute intake or the onset of chronic intake. It does not include contributions from external dose</p> <p>The internal dose measurement LANL used to decide if a worker needed routine bioassay monitoring</p>
dosimetry thresholds	Describes the point at which radiological personnel monitoring will be performed
<b>dpm</b> disintegrations per minute	A unit of radioactivity

## KEY TERMS AND ACRONYMS (PART 2)

Term/Acronym	Definition
exotic radionuclides referred to as “ <b>exotics</b> ”	<p>All radionuclides other than <math>^{234/235/238}\text{Uranium}</math>, <math>^{238/239}\text{Plutonium}</math>, tritium, <math>^{241}\text{Americium}</math>, and <math>^{137}\text{Cesium}</math></p> <p>This presentation and RPRT-0103 includes mixed fission and activation products when using the term “exotics”</p>
hot job	LANL term for non-routine, higher-hazard radiological work activities
in process (survey)	<p>Refers to work that is actively being performed</p> <p>An in-process survey would be a radiological survey conducted during work activities</p>
<b>LANL</b> Los Alamos National Laboratory	U.S. Department of Energy laboratory in New Mexico
<b>MAP</b> mixed activation products	Radioactive isotopes formed by neutron irradiation [activation] of materials (structure, coolant, impurities) during nuclear operations

## KEY TERMS AND ACRONYMS (PART 3)

Term/Acronym	Definition
<b>MFP</b> mixed fission products	Radioactive isotopes formed after heavy atomic nuclei (like $^{235}\text{U}$ or $^{239}\text{Pu}$ ) or undergo nuclear fission
<b>mrem</b> millirem	A unit measuring radiation dose
<b>NIOSH</b> National Institute for Occupational Safety and Health	A Federal agency responsible for conducting research and making recommendations for the prevention of work-related injuries and illnesses
<b>ORAUT</b> Oak Ridge Associated Universities Team	Contractor team assisting NIOSH with fulfilling its responsibilities under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA)  ORAUT includes teaming partners (ORAU, MJW, NV5-Dade Moeller)
postjob surveys	Radiological survey conducted after the conclusion of work activities to assess the conditions of the work area

## KEY TERMS AND ACRONYMS (PART 4)

Term/Acronym	Definition
prejob surveys	Radiological survey conducted before the start of work activities to assess the conditions of the work area
<b>RCT</b> radiological control technician	An individual that ensures safety by monitoring radiation levels, conducting contamination surveys, and enforcing radiation protection procedures
<b>RPRT</b>	An abbreviation for report  It is used as part of the ORAU team's official report number (e.g., ORAUT-RPRT-0103)
<b>RWP</b> radiological work permit	The document that establishes worker protection and monitoring requirements and contains specific approvals for radiological work activities  The RWP serves as an administrative process for planning and controlling radiological work and informing the worker of the radiological conditions
SC&A	Acts as the independent technical support contractor for the Advisory Board on Radiation and Worker Health, which advises NIOSH

## KEY TERMS AND ACRONYMS (PART 5)

Term/Acronym	Definition
<b>SEC</b> Special Exposure Cohort	Designation that applies to certain classes of employees that allows eligible claimants to be compensated without the completion of a NIOSH dose reconstruction
<b>SRDB</b> Site Research Database	A comprehensive record repository used by the NIOSH Dose Reconstruction Program  Cited references include the associated SRDB number
<b>TA(s)</b> technical area(s)	Subdivisions of work locations at the LANL site that generally reflect operational activities