



## Memorandum

**To:** LANL Work Group

**From:** Brant Ulsh

**Subject:** Weight of Evidence Supports NIOSH's Ability to Bound LANL TA-53 Doses for 1996–2005: Evaluation of Radiological Work Permits

**Date:** February 22, 2024

This memorandum provides results and conclusions from NIOSH's evaluation of additional radiological work permits (RWPs) applicable to the 1996–2005 period for the Los Alamos National Laboratory (LANL) Technical Area-53 (TA-53). The TA-53 includes the Los Alamos Neutron Science Center (LANSCE), which contains accelerators and various other experimental facilities focused on a broad base of neutron research. LANL issued RWPs to inform workers of area radiological conditions within TA-53 and to establish radiological controls for intended work activities [LANL 1998, PDF p. 5]. By evaluating additional captured TA-53 RWP content and application in greater detail, NIOSH is augmenting existing evidence supporting conclusions presented in the *Weight of Evidence Supports NIOSH's Ability to Bound LANL TA-53 Doses for 1996–2005 memo* [NIOSH 2023], as well as those in ORAUT-RPRT-0103, *Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory* [ORAUT 2022].

Concluding that NIOSH can bound workers' radiation doses for TA-53 (or any area of the LANL site) is based on demonstrating that LANL maintained and implemented an appropriate Radiation Protection Program (and procedures) that required sufficiently monitoring its workers. In addition to expanding the current, general knowledge of LANL's Radiation Protection Program, the information contained within captured TA-53 RWPs also supports specific prior conclusions. For example, the RWPs indicate that work performed in beam areas, during and after beam operation, was regularly assessed by LANL Health Physics personnel from hazard and exposure potential standpoints, monitored appropriately, and that LANL Health Physics personnel used administrative and engineering controls as necessary to keep exposures to the workforce below 100 mrem/year and as low as reasonably achievable (ALARA).

The following sections present data obtained directly from RWPs written for TA-53 from 1996 through 2005 [LANL 1942–2023].

### **Overview of RWP Data**

During data capture activities performed in 2019 and 2023, NIOSH obtained copies of all TA-53 RWPs identified by LANL staff for 1996–2005. While the collection of TA-53 RWPs identified by LANL staff is substantial (1,349 RWPs), the completeness of the dataset is uncertain. It is possible that some RWPs were not correctly identified and/or provided for NIOSH’s capture. It is also apparent that some captured RWPs may be missing pages. Additionally noteworthy, is that available LANL procedures indicate RWPs were not mandatory for all work in radiologically-posted areas. As stated in LANL’s 1996 *Standard Operating Procedure for Radiological Controls* document, “RWPs may or may not be required for work in radiologically posted areas as determined by an RCT [radiation control technician] or the health physicist” [ LANL 1995–1999, PDF p. 19]. Recognizing these variables, some assessment limitations necessarily exist. For example, NIOSH cannot link each documented TA-53 work event with a corresponding RWP.

NIOSH has carefully evaluated all 1,349 RWPs for 1996–2005 over various locations within TA-53 for the following: expected (listed) radionuclides, external monitoring, elevated radionuclide air concentrations and intake monitoring, required personnel protective equipment (PPE), health physics coverage, required training, and contamination surveys and air monitoring. In addition to tallying these various RWP associations and requirements, NIOSH has assessed and summarized (to the extent practical given the dataset unknowns and size) the appropriateness of omitting or not documenting certain RWP content (when observed). NIOSH further examined the RWPs for cited documents such as integrated work documents, hazard control plans, test plans, and laboratory implementation requirements.

### **RWP Evaluation Results**

As a broad overview, NIOSH has summarized the 1,349 RWPs by applicable year (Table 1) and their association with primary TA-53 locations (Table 2). The follow-on discussions and tables summarize RWP composition for the aforementioned contents for TA-53 and for the entire 1996–2005 period. Where considered useful, RWP content associated specifically with the LANSCE beam line/flight path area has been parsed out and/or discussed.

**Table 1: TA-53 RWP (1996–2005) Grouped by Year<sup>a</sup>**

Year	First Date	Last Date	Number of RWPs	Percentage <sup>b</sup> of RWPs
1996	1/1/1996	12/31/1996	235	17.4%
1997	1/2/1997	12/31/1997	234	17.3%
1998	1/5/1998	12/31/1998	178	13.2%
1999	1/4/1999	12/31/1999	228	16.9%
2000 <sup>c</sup>	1/10/2000	12/31/2000	88	6.5%
2001	1/2/2001	12/31/2001	124	9.2%
2002	1/2/2002	12/31/2002	79	5.9%
2003	1/2/2003	12/31/2003	59	4.4%
2004	1/5/2004	12/31/2004	58	4.3%
2005	1/1/2005	12/31/2005	66	4.9%

a. Source: [LANL 1942–2023]

b. The percentage is based on the total number of evaluated RWPs (1,349).

c. LANL did not provide RWPs associated with approximately the first six months of 2000.

**Table 2: TA-53 RWP (1996–2005) Grouped by Location<sup>a</sup>**

Location	Number of RWPs	Percentage <sup>b</sup> of RWPs
All Areas	5	<1%
Area A	194	14.4%
Beam line/Flight Path	252	18.7%
Blue Room	75	5.6%
Boneyard	6	<1%
Experimental Area	107	7.9%
General Target Area	251	18.6%
High Resolution Spectrometer (HRS)	30	2.2%
Isotope Production Facility (IPF)	38	2.8%
Low Energy Demonstration Accelerator	5	<1%
Proton Storage Ring (PSR)	241	17.9%
Radioactive Liquid Waste/Waste Handling	35	2.6%
Support	102	7.6%
Time of Flight Isochronous Spectrometer	8	<1%

a. Source: [LANL 1942–2023]

b. The percentage is based on the total number of evaluated RWPs (1,349).

## Expected Radionuclides

Potential exposures to “exotic” radioactive materials associated with TA-53 work activities is documented within the RWPs for 1996–2005. With respect to LANSCE, exotic radionuclides included activation and spallation products produced by the accelerator proton beam in the beam line/flight path area. Actinide sources, which include radionuclides considered exotic, were also used in TA-53 and LANSCE experiments. Actinide sources consisted of sealed sources and targets, bagged unencapsulated sources and targets, neutron generators such as americium-beryllium and plutonium-beryllium, and metallic target material. Other potential sources of actinide exposure included source inventories and decontamination work.

Tables 3 and 4 summarize the number of RWPs containing the various types of radionuclides identified as “expected”<sup>1</sup> radionuclides of interest. Table 3 presents results from TA-53 as a whole (1,349 RWPs), and Table 4 presents a summary of the 252 RWPs associated only with beam line/flight path activities. To aid the summation of the many different observed radionuclides of interest, mixed activation product radionuclides and spallation product radionuclides were combined into a single category denoted as “MASP” (mixed activation and/or spallation products). Similarly, the various actinides noted were not tracked individually but simply denoted as actinides. The presence or absence of cobalt-60 (Co-60) associated with the MASP radionuclides was also tracked. This was done because NIOSH is separately evaluating a proof-of-concept method to bound doses from intakes of all radionuclides for routine TA-53 workers based on Co-60 body burdens measured with LANL’s whole body counter.

**Table 3: TA-53 Expected Radionuclides Listed in RWPs (1996–2005)<sup>a</sup>**

Radionuclides	Number <sup>b</sup> of RWPs	Percentage <sup>c</sup> of RWPs
MASP <sup>d</sup> with Co-60	741	54.9%
MASP <sup>d</sup> without Co-60	88	6.5%
Tritium	20	1.5%
Actinides	97	7.2%
None Identified	407	30.2%

- Source: [LANL 1942–2023]
- Though the total number of captured TA-53 RWPs is 1,349, some RWPs listed both MASP and actinides as radionuclides of interest. As such, the total number of RWPs on the table exceeds 1,349.
- The percentage is based on the total number of evaluated RWPs (1,349).
- Mixed activation and/or spallation product

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<sup>1</sup> The radionuclides of interest noted within the RWPs are typically labeled as “expected,” “measured,” or “anticipated.” Though all radionuclides of interest have been tallied regardless of the label used, only the “expected” label is used when presenting the evaluation results.

Examining additional RWP content and requirements within the 407 RWPs in which no radionuclides of interest were noted, NIOSH observed that the exposure concerns with the associated activities may have been limited to beta and gamma external dose potential from mixed activation and spallation products. All but 4 of the 407 RWPs with “None Identified” listed in Table 3 included a requirement for some type of external dosimetry on their “radiation protection requirements” pages, such as: thermoluminescent dosimeter (TLD), electronic personal dosimeter (EPD), neutron, extremity, and/or pocket ion chamber. Four RWPs did not clearly identify external dosimetry requirements:

- One had “special dosimetry” use indicated on its “post-job review” page. This RWP also contained a dose tracking report, further supporting dosimetry use.
- Two did not include the “radiation protection requirement” pages but included dose tracking reports, indicating dosimetry use.
- One did not stipulate external dosimetry requirements or contain the “post-job” portion of the RWP, making dosimetry use uncertain.

**Table 4: Beam Line/Flight Path Expected Radionuclides Listed in RWPs (1996–2005)<sup>a</sup>**

Radionuclides	Number of RWPs	Percentage <sup>b</sup> of RWPs
MASP <sup>c</sup> with Co-60	121	48.0%
Tritium	5	2%
Actinides	27	10.7%
None Identified	99	39.3%

a. Source: [LANL 1942–2023]

b. The percentage is based on the total number of evaluated beam line/flight path RWPs (252).

c. Mixed activation and/or spallation product

## External Monitoring

NIOSH evaluated each TA-53 RWP for external monitoring (dosimetry) requirements. External monitoring via TLD was required in 1,331 RWPs (nearly 99%) with EPDs required in 804 RWPs (almost 60%). The number and percentage of RWPs requiring each type of external dosimeter is shown in Table 5. Note that individual RWPs frequently specified multiple types of dosimeters.

**Table 5: TA-53 External Dosimetry Requirements in RWPs (1996–2005)<sup>a</sup>**

Type	Number <sup>b</sup> of RWPs	Percentage <sup>c</sup> of RWPs
TLD	1,331	98.7%
EPD	804	59.6%
Neutron	87	6.4%
Supplemental/Secondary	335	24.8%
Extremity	13	<1%
None	8	<1%

a. Source: [LANL 1942–2023]

b. Though the total number of captured TA-53 RWPs is 1,349, some RWPs specified requirements for multiple types of dosimeters. As such, the total number of RWPs on the table exceeds 1,349.

c. The percentage is based on the total number of evaluated RWPs (1,349).

As noted in Table 5, specified dosimetry requirements (denoted as “None”) were not present in 8 of the 1,349 TA-53 RWPs:

- Three stated that external dosimetry was not required and noted low dose rates.
- Two included EPD dose tracking reports, indicating EPD dosimetry was used.
- One did not include the radiation protection requirements page, making a determination of dosimetry requirement/use impossible.
- One did not include a dose tracking page report, making a final assessment of dosimeter use impossible.
- One contained a dose tracking page marked as “not applicable,” which could possibly indicate that no external exposure potentials were expected.

As shown in Table 2, 252 of the 1,349 TA-53 RWPs were written for beam line/flight path work. All but one of these RWPs required external dosimetry. The work associated with the single RWP not requiring dosimetry was described as not posing an external dosimetry hazard (in the RWP). It is noteworthy that LANL’s Personnel Access Control System prevented entry into the beam line and flight paths during beam operations; therefore, entry into those areas occurred before an operation started and after cooldown [NIOSH 2023, PDF pp. 5–6].

### **Elevated Radionuclide Air Concentrations and Associated Worker Monitoring**

NIOSH evaluated radionuclide air concentrations and associated worker monitoring identified in TA-53 RWPs to expand current knowledge of the site’s RWP use to assess, control, and monitor airborne radionuclide exposure potentials. NIOSH assessed RWPs meeting any of the following three conditions:

- Reported radionuclide air concentrations equal to, greater, or possibly greater than 10% Derived Air Concentration (DAC) for either pre-job or post-job work

- Required nasal swipes
- Reported any air monitoring results while performing the job detailed in the RWP

### Elevated Radionuclide Air Concentrations

Pre-job radionuclide air concentrations were identified as equal to, greater, or possibly greater than 10% DAC in 28 (2.1%) of the 1,349 TA-53 RWPs. In each of these 28 RWPs, the pre-job air concentrations were described as “anticipated” (none were measured values). Two of these 28 RWPs also noted estimated post-job values greater than 10% DAC. In total, 18 of the 1,349 RWPs noted post-job values exceeding 10% DAC; 5 had values measured, and 13 had values estimated.

NIOSH investigated RWP details associated with the five RWPs noting measured, post-job air concentrations exceeding 10% DAC. One of the five RWPs recorded a post-job air concentration of exactly 10 DAC. This RWP required continuous Radiation Control Technician (RCT) coverage. However, no nasal swipes or respiratory requirements were noted. A review of this RWP’s “Acknowledgement Log” and dose summary sheets revealed that 11 of the 19 workers listed on the RWP had in vivo measurements performed during the RWP work period or within a year after. The remaining four RWPs contained measured DAC values ranging from less than 1 DAC to approximately 1.5 DAC. Three of these also stipulated continuous RCT coverage, while one required intermittent RCT coverage. Only one of these four RWPs required respiratory protection; five nasal smears obtained for this RWP were all below detection limits.

It is worth noting that none of the 97 RWPs listing actinides as expected radionuclides (see Table 3) recorded airborne activity >10% DAC or positive nasal swipe results.

### Worker Monitoring

LANL Health Physics personnel stipulated nasal swipe collection in 192 of the 1,349 TA-53 RWPs (14.2% of all RWPs). Table 6 summarizes the expected radionuclides for those 192 RWPs requiring nasal swipes.

**Table 6: Expected Radionuclides for TA-53 RWPs Requiring Nasal Swipes<sup>a</sup>**

<b>Radionuclides</b>	<b>Number of RWPs</b>	<b>Percentage<sup>b</sup> of RWPs</b>
Co-60 and other MASP	158	82.3%
Actinides	6	3.1%
None Identified	28	14.6%

a. Source: [LANL 1942–2023]

b. The percentage is based on the total number of RWPs stipulating nasal swipes (192).

For the six RWPs listing actinides as being expected, NIOSH found that none noted area or personnel contamination, reported air concentrations were all less than 10%

DAC, and all required respiratory protection. Notably, six RWP's associated with work in the beam line/flight path area required nasal swipes; all results were reported as having no detectable activity.

Aside from the nasal swipe requirements, no additional bioassay was initially indicated as required on any TA-53 RWP's. As determined appropriate, however, follow-up bioassay (e.g., in vivo, in vitro, or chest count) was performed.

At least one nasal swipe result was recorded in 91 of the 192 RWP's requiring nasal swipes; in total, 802 nasal swipe results were recorded within these 91 RWP's. Within the 802 nasal swipe results, two positive alpha results measured at 12 and 133 disintegrations per minute (dpm), and 30 positive beta results ranged from 48 dpm to 662 dpm.

LANL required initiation of Radiation Protection Observation Reports (formerly known as Radiation Incident Reports) if the sum of readings in both nostrils for nasal swipes was greater than or equal to 50 dpm for alpha, and/or greater than or equal to 500 dpm for beta. A total of three individuals had nasal swipe results that exceeded these thresholds. Nasal swipes for one of the individuals indicated beta results above 500 dpm. Follow-up in vivo monitoring was performed for this person, and the results showed no detectable activity. The Radiation Protection Observation Report initiated for this individual also noted that LANL Health Physics staff suspected the elevated nasal smears were a result of cross-contamination. A second Radiation Protection Observation Report was initiated for an employee whose nasal swipes exceeded both the alpha and beta action limits. No information regarding follow-up bioassay was observed in this report. However, NIOSH determined this individual was on routine in vivo bioassay, and none of this person's results were greater than the minimum detectable activity. The third Radiation Protection Observation Report was initiated for an employee (unidentified) whose nasal swipes exceeded the beta limit.

Seven individuals identified as having positive nasal smears below limits either received special request chest counts and/or were on a routine in vivo program. One of the seven results had no associated name. One of the other individuals did not appear to be on a routine bioassay program but did have a baseline whole body count and in vitro results approximately six months before the nasal swipes were taken.

Though NIOSH cannot confirm, the absence of nasal swipe results in 101 of the RWP's may result from on-the-job adjustments to monitoring requirements. As often noted in RWP's, attendant RCT's had the authority to adjust monitoring (and PPE) as they felt necessary, and 80 of the 101 RWP's included such stipulations. Of the remaining RWP's, 16 contained no indication that nasal swipes were needed in the "post-job review" section. However, of those 16 RWP's, 3 RWP's stated "no information available," so those appear incomplete. An additional 4 RWP's had associated "post-job review" sections indicating that nasal swipes were taken, but records of the results are not

evident. One RWP contained a “sample analysis” form indicating nasal swipes were obtained from five individuals, but results were not indicated within the RWP.

## Personal Protective Equipment

NIOSH assessed LANL-identified PPE requirements for all 1,349 TA-53 RWPs. Table 7 summarizes the types of PPE LANL required and the number/percentage of RWPs specifying each type.

**Table 7: TA-53 PPE Requirements in RWPs (1996–2005)<sup>a</sup>**

Type	Number <sup>b</sup> of RWPs	Percentage <sup>c</sup> of RWPs
Level 1 <sup>d</sup>	386	28.6%
Level 2 <sup>e</sup>	323	23.9%
Gloves <sup>f</sup>	264	19.6%
Booties <sup>f</sup>	32	2.4%
Gloves with booties <sup>f</sup>	27	2.0%
Anti-splash/Waterproof Anti-contamination clothing	26	1.9%
Skull cap/Hood	348	25.8%
Taped openings	399	29.6%
Full-face respirator	221	16.4%
None	266	19.7%
Other <sup>g</sup>	85	6.3%
Unknown (PPE page not included)	5	<1%

a. Source: [LANL 1942–2023]

b. The total number of RWPs is 1,349. More than one type of PPE may be specified in an RWP.

c. The percentage is based on the total number of evaluated RWPs (1,349).

d. Level 1 PPE includes coveralls, two pairs of surgeon’s gloves, and booties.

e. Level 2 PPE includes two coveralls, two pairs of surgeon’s gloves, and two pairs of booties.

f. Gloves and booties in this table were only counted when Level 1 or 2 were not required.

g. Other PPE was typically determined by the RCT based on current, pre-job, or initial entry into an area. Note that RCTs typically had the discretion to relax or increase PPE requirements based on current contamination or radiological conditions.

One or more types of PPE were required in 983 (73%) of the TA-53 RWPs. Level 1 or Level 2 PPE was required in 709 of the 1,349 TA-53 RWPs (52.6%). No PPE was prescribed in 266 (19.7%) of the RWPs.

NIOSH reviewed all 266 RWPs that did not prescribe PPE use. They reviewed the following fields: RWP number, effective date, expiration date, expected radionuclides, description of work, surface contamination and/or air monitoring, airborne activity >10% DAC, and nasal swipes (yes or no). External radiation exposure was the primary concern in these 266 RWPs. No elevated DACs or nasal swipes requirements/results were noted in any of them. Most of the associated work was for inspections, equipment

installation and repair, operational checks, and general maintenance. The majority (250 of 266, or 94%) also required intermittent or continuous RCT coverage. As noted previously, RCTs typically had the authority to adjust PPE and monitoring requirements if any unusual or unexpected contamination or radiation exposure levels were detected.

As shown in Table 2, 252 of the 1,349 TA-53 RWPs were written for beam line/flight path work. Some level of PPE was required in 157 (62%) of these RWPs, with Level 1 or Level 2 PPE required in 63 of the 157 (40%) [LANL 1996; LANL 1942–2023]. As noted previously, LANL’s Personnel Access Control System prevented entry into the beam line and flight paths during beam operations. Therefore, entry into those areas occurred before the start of an operation and after a time of cooldown [NIOSH 2023, PDF pp. 5–6].

### Health Physics Coverage

All TA-53 RWPs required some type of Health Physics coverage. Types of coverage included intermittent, continuous, and equipment (or “other”) surveys. Table 8 provides the total number of RWPs specifying each type of coverage for the 1,349 TA-53 RWPs. Table 9 provides the same information for the 252 RWPs associated with the beam line/flight path area.

**Table 8: TA-53 Health Physics Coverage Requirements in RWPs (1996–2005)<sup>a</sup>**

Type of Health Physics Coverage	Number of RWPs	Percentage <sup>b</sup> of RWPs
Intermittent	398	29.5%
Continuous	908	67.3%
Equipment/Other	43 <sup>c</sup>	3.2%

a. Source: [LANL 1942–2023]

b. The percentage is based on the total number of evaluated RWPs (1,349).

c. This total includes 5 RWPs for which actual coverage is unknown. This is due to missing monitoring requirements pages.

**Table 9: TA-53 Beam Line/Flight Path Health Physics Coverage Requirements in RWPs (1996–2005)<sup>a</sup>**

Type of Health Physics Coverage	Number of RWPs	Percentage <sup>b</sup> of RWPs
Intermittent	128	50.8%
Continuous	110	43.6%
Equipment/Other	14	5.6%

a. Source: [LANL 1942–2023]

b. This percentage is based on the total number of RWPs associated with the TA-53 beam line/flight path health physics coverage requirements (252).

RWP Health Physics coverage noted as “Equipment/Other” included work such as general inspections, checking entries, cables, vacuum recovery after power outages, maintenance and repair work, operational checks, and swiping various materials and equipment prior to release. These data corroborate the description of RCT coverage provided in Section 1.2 of ORAUT-RPRT-0103, *Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory* [ORAUT 2022, PDF p. 10].

## Required Training

NIOSH evaluated each RWP for required job training and identified the following requirements: Department of Energy (DOE) Radiological Worker 1, DOE Radiological Worker 2, and facility-specific (TA-53/LANSCE) training (Table 10). DOE Radiological Worker 1 training was required in 1,240 (almost 92%) of the RWPs. Many RWPs included both radiological worker training and facility-specific training.

**Table 10: TA-53 Training Requirements in RWPs (1996–2005)<sup>a</sup>**

Required Training	Number <sup>b</sup> of RWPs	Percentage <sup>c</sup> of RWPs
Radiological Worker 1	176	13.0%
Radiological Worker 1 + Radiological Worker 2	1,064	78.9%
Facility Specific	848	62.9%

a. Source: [LANL 1942–2023]

b. Though the total number of captured TA-53 RWPs is 1,349, some RWPs specified multiple training requirements in a single RWP. As such, the total number of RWPs on the table exceeds 1,349.

c. The percentage is based on the total number of evaluated RWPs (1,349).

Of the 252 RWPs written for work in the beam line/flight path area, 250 (99.2%) required either Radiological Worker 1, Radiological Worker 2, facility-specific training, or a combination of training. Note that the other two beam line RWP training requirements are unknown because the pages designating the training requirements were not included.

## Contamination Surveys and Air Monitoring

NIOSH evaluated the TA-53 RWPs to determine the extent of air monitoring and contamination surveys conducted before, during, and after work completion. NIOSH found the following:

- Pre-job surveys were performed for 1,244 RWPs (92.2%).
- Post-job surveys were performed for 1,052 RWPs (78.0%).

- 1,470 in-process surveys (not including pre-job, post-job, item release, offsite shipment, or on-site shipment) were collected during the execution of 379 RWPs (28.1%).
- Pre-job airborne radioactivity DAC values are “NA” for 299 RWPs and left blank for 353 (48.3 % when combined).
- 207 RWPs contained air monitoring results obtained during jobs with the potential for airborne radioactivity release.
- Post-job airborne radioactivity DAC values were marked as “NA” in 439 RWPs and not noted in 495 (69.2 % when combined).

Determining whether or not any of the TA-53 RWPs failed to stipulate contamination and/or airborne radioactivity measurements when such monitoring should have been required is not currently possible, given the RWP investigative approach used for this large-scale effort. Additional RWP analysis would likely provide more insight into this question. An ever-present assessment factor that must also be considered is that LANL did not require documentation of in-process surveys during work performed under RWPs [Archuleta 2022, PDF p. 7].

ORAUT-RPRT-0103, *Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory*, provides a detailed examination of eight TA-53 RWPs [ORAUT 2022, PDF pp. 27–34]. This RWP review concluded that LANL Health Physics personnel appropriately monitored work and the work environments performed under RWPs. The review also concluded that when contamination incidents occurred, LANL Health Physics personnel followed up with appropriate monitoring and reporting when required.

Acknowledging the limitations of the current, large-scale TA-53 RWP assessment, it is worth noting that no evidence directly negating conclusions from the in-depth RWP assessment described above has been observed. Additionally, the current RWP evaluation has noted that Radiation Protection Observation Reports were generated (see the section on Worker Monitoring) when unexpected or unusual conditions arose. Radiation Protection Observation Reports were associated with 25 (1.9%) of the 1,349 TA-53 RWPs.

### **Documents Cited Within RWPs**

LANL provided supplemental information to many of the RWPs that were analyzed. Many LANL RWPs referenced existing LANL procedures and safety-related documents. Examples include standard operating procedures, hazard control plans, special work permits, test plans, integrated work documents, and security plans. Some of the 1,349 RWPs also contained full-text copies of such documents. NIOSH’s evaluation determined that 225 of the 1,349 TA-53 RWPs (16%) cited these document types.

## **Conclusion**

NIOSH captured and evaluated 1,349 RWPs written for 1996–2005 LANL TA-53 activities to augment existing evidence supporting conclusions presented in *Weight of Evidence Supports NIOSH's Ability to Bound LANL TA-53 Doses for 1996–2005* [NIOSH 2023] and ORAUT-RPRT-0103, *Review of Potential Exposure to Exotic Radionuclides Using Radiological Work Permit Data at Los Alamos National Laboratory* [ORAUT 2022]. The evaluations reported in these documents conclude that LANL's Radiation Protection Program was maintained and implemented in an appropriate manner that sufficiently monitored its workers during this period and, as an integral part of the protection program, LANL regularly utilized RWPs to assess work hazard and exposure potentials, stipulate monitoring and PPE requirements, and mandated administrative and engineering controls to maintain worker radiation doses under 100 mrem/year.

Observations from this larger scale RWP evaluation support the conclusions above. The results indicate LANL Health Physics staff adequately monitored work areas and workers in a manner commensurate with knowledge of work exposure potentials and program procedures. Notably, NIOSH found that all TA-53 RWPs required some type of Health Physics coverage and RWPs were used to control personnel radiation exposure across all LANSCE areas (Table 2).

Additional summary information obtained from evaluating the 1,349 TA-53 RWPs include:

- External monitoring use was stipulated in over 99% of the RWPs.
- Though elevated airborne radioactivity occurrences were not common, the evaluated RWPs provide evidence of appropriate precautions, monitoring, and follow-up bioassay when warranted.
- Radiation Protection Observation Reports were issued in the event of unplanned/unexpected work events.
- Evidence of RCT authority to make on-the-job adjustments to monitoring and PPE needs.
- Training requirements were consistently noted.
- A majority of RWPs stipulated pre- and post-job contamination surveys.

The results of this evaluation confirm the wide spread use of RWPs for 1996–2005 TA-53 activities. It is evident that the RWPs incorporated knowledge of ongoing activities and experience with TA-53 contamination conditions and hazards to identify and stipulate appropriate requirements for work performed.

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