ORAU TEAM
Dose Reconstruction
Project for NIOSH

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☐ New ☒ Total Rewrite ☐ Revision

PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
03/01/2022	00	New report to address an issue from the Advisory Board on Radiation Worker Health regarding the ability to bound dose for exotic radionuclides for Los Alamos National Laboratory energy employees from 1996 through 2005 using surface contamination survey data, air monitoring data, and personnel contamination monitoring to assure that doses for unmonitored workers are less than 100 mrem. Incorporates formal internal and NIOSH review comments. Training required: As determined the Objective Manager. Initiated by Michael S. Kubiak and authored by James M. Mahathy.
08/30/2023	01	Revision initiated to correct self-identified errors discovered while screening documents used to generate Tables 3-1 through 3-5, and A-2 through A-7. The errors consisted of large area swipes, direct reading surveys, external radiation surveys, and radiological work permit related contamination and air monitoring surveys that were mistakenly entered. There were also duplicates of some surveys that were entered as well as some that should have been entered that were missed originally. Added per year to many of the 100 mrem occurrences throughout the report. Incorporates formal internal and NIOSH review comments. Constitutes a total rewrite of the document. Training required: As determined the Objective Manager. Initiated by Pat McCloskey and authored by James M. Mahathy.

TRADEMARK INFORMATION

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ACRONYMS AND ABBREVIATIONS

1LSA	service area in MPF-7, Room 200
1LTC	linear accelerator target crypt, MPF-7
ALI	annual limit on intake
Bq	becquerel
CA	Controlled Area
CAM	continuous air monitor
CED	committed effective dose
C.F.R.	*Code of Federal Regulations*
cm	centimeter
CMR	Chemistry and Metallurgy Research
cpm	counts per minute
DAC	derived air concentration
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DU	depleted uranium
ER-1	Experimental Area Room 1
ER-2	Experimental Area Room 2
F	fast (absorption type)
FP	fission product
FP-2	flight path 2
HFM	hand-and-foot monitor
HI	hazard index
hr	hour
ICRP	International Commission on Radiological Protection
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Science Center
m	meter
MAPs	mixed activation products
MDA	minimum detectable activity
MFAPs	mixed fission and activation products
MFPs	mixed fission products
min	minute
mR	milliroentgen
mrem	millirem
NDA	no detectable activity
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
ORAUT	Oak Ridge Associated Universities Team

PCM	personnel contamination monitor
PSR	Proton Storage Ring
RadCon	radiological control
RBA	Radiological Buffer Area
RCA	Radiological Control Area
RCT	Radiological Control Technician
RLW	radioactive liquid waste
RWP	radiation work permit
S	slow (absorption type)
SEC	Special Exposure Cohort
SNM	special nuclear material
SRDB Ref ID	Site Research Database Reference Identification (number)
Sv	sievert
TA	Technical Area
TGT	target
UCNI	Unclassified Controlled Nuclear Information
WNR	Weapons Neutron Research Facility
yr	year
§	section or sections

1.0 INTRODUCTION

On April 3, 2008, the National Institute for Occupational Safety and Health (NIOSH) received a Special Exposure Cohort (SEC) petition for the Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. The petition, SEC-00109, requested that a class be added to the SEC for service support workers (which includes but is not limited to security guards, firefighters, laborers, custodians, carpenters, plumbers, electricians, pipefitters, sheet metal workers, ironworkers, welders, maintenance workers, truck drivers, delivery persons, radiation technicians, and area work coordinators) who worked in any operational Technical Area (TA) with a history of radioactive material use at LANL from January 1, 1976, through December 31, 2005 [NIOSH 2012].

In Revision 1 of the SEC-00109 petition evaluation report, NIOSH defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The class included [NIOSH 2012, p. 2]:

> *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Los Alamos National Laboratory in Los Alamos, New Mexico from January 1, 1976 through December 31, 1995, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.*

The dose reconstruction limitations identified for the specified class period included the inability to bound unmonitored intakes of exotic alpha emitters, fission products (FPs), and activation products. NIOSH [2012] defined “exotic radionuclides” as being everything other than $^{234/235/238}U$, $^{238/239}Pu$, ^{3}H, ^{241}Am, and ^{137}Cs.

NIOSH selected the December 31, 1995, end date for the class based on its presumption that by January 1, 1996, LANL would have been in full compliance with 10 *Code of Federal Regulations* (C.F.R.) Part 835, Occupational Radiation Protection, § 402 and 702, which stated in 1993 [U.S. Department of Energy (DOE) 1993, pp. 35, 37]:

> *§ 835.402 Individual monitoring.*
>
> *(c) For the purpose of monitoring individual exposures to internal radiation, internal dose evaluation programs (including routine bioassay programs) shall be conducted for: (1) Radiological workers who, under typical conditions, are likely to receive 0.1 rem (0.001 sievert) or more committed effective dose equivalent, and/or 5 rems (0.05 sievert) or more committed dose equivalent to any organ or tissue, from all occupational radionuclide intakes in a year.*
>
> *§ 835.702 Individual monitoring records.*
>
> *(a) Records shall be maintained to document doses received by all individuals for whom monitoring was required pursuant to § 835.402 and doses received during planned special exposures, accidents, and emergency conditions.*

The 10 C.F.R. Part 835 rule became effective on January 13, 1994, and required full compliance by January 1, 1996 [DOE 1993, p. 9].

The 1993 edition of 10 C.F.R. Part 835 [DOE 1993] incorporated the recommendations of International Commission on Radiological Protection (ICRP) Publications 26 and 30 for the calculation of doses [ICRP 1977, 1979]. In 2007, DOE revised the rule to incorporate the newer recommendations of ICRP Publications 60 and 68 [ICRP 1991, 1995]. With this update to the calculated dose came a change in terminology: the dose of interest became committed effective dose (CED). The Energy Employees Occupational Illness Compensation Program Act of 2000 applies this later system of dose assessment, so it is used for all calculations in this document. Unless specified otherwise, the term “dose” in this document refers to the CED.

1.1 PURPOSE

This report addresses an issue from the Advisory Board on Radiation Worker Health about the ability to bound dose for exotic radionuclides for LANL workers from 1996 through 2005 using surface contamination survey data, air monitoring data, and personnel contamination monitoring to comply with 10 C.F.R. Part 835 [DOE 1993].

During deliberations after designation of the SEC class for 1976 through 1995, the LANL Work Group questioned the ability of NIOSH to bound doses from exotic radionuclides; these include short-lived activation and spallation products from the Los Alamos Neutron Science Center (LANSCE; TA-53) and mixed fission products (MFPs) in TAs 3 and 48 after 1995. NIOSH maintains that, by complying with 10 C.F.R. Part 835 [DOE 1993], LANL monitored all workers with a potential to receive in excess of 100 mrem/yr. NIOSH has indicated in previous papers and presentations to the LANL Work Group that it does not rely solely on 10 C.F.R. Part 835 compliance for the conclusion that unmonitored workers were unlikely to have received intakes resulting in greater than 100 mrem/yr [NIOSH 2019, pp. 19–21].

The LANL radiological control program was designed to comply with 10 C.F.R. Part 835 [DOE 1993] but with an intended outcome that unmonitored individuals would be unlikely to receive doses greater than 100 mrem/yr. The Oak Ridge Associated Universities (ORAU) Team (ORAUT) discusses the tenets and requirements of that program in this report with the focus on limiting exposure to nonplutonium radionuclides. These radionuclides include exotic radionuclides and heavy elements such as ^{227}Ac, ^{237}Np, ^{241}Am, ^{244}Cm, and thorium. Emphasis is placed on workers doing routine work, such as guards and custodians, and actions taken during contamination incidents. That latter emphasis is supplemented with an analysis of data from surface contamination surveys, air monitoring, and incidents to demonstrate program effectiveness.

In addition, NIOSH has a substantial amount of internal dosimetry data for LANL workers. These data show that intakes for monitored workers from 1996 to 2005 were generally less than 100 mrem/yr, and doses for unmonitored workers would likely have been even lower [ORAUT 2009]. NIOSH found no evidence that unmonitored workers received doses above the 10 C.F.R. Part 835 monitoring limit [DOE 1993].

During LANL Work Group deliberations, routine work monitoring has been described as monitoring for plutonium, uranium, and tritium. Such routine work is defined as work not done under a radiation work permit (RWP) and that involved workers such as guards and custodians. After the November 29, 2018, LANL Work Group meeting, NIOSH and the ORAU Team determined that additional surface contamination survey data and air monitoring data were needed to support the position that the areas where exotic radionuclides were handled were well monitored for contamination [NIOSH 2018]. Three TAs where exotic radionuclides are known to have been handled were selected for review: the South Mesa Site (TA-3) containing Chemistry and Metallurgy Research (CMR); the Meson Physics Facility (TA-53) containing the LANSCE; and the Radiochemistry Site (TA-48) [LANL 1995, pp. 25, 68, 125]. In 2019, the ORAU Team captured some surface contamination survey data and air monitoring data from these three TAs for the period from January 1, 1996, to December 31, 2005. These data were primarily gross alpha and gross beta air concentrations and swipe surface contamination results. The ORAU Team produced a QA outline and data entry instructions to facilitate the use of these data [ORAUT 2023a]. The ORAU Team compared the data from the first and second data entries and resolved differences [ORAUT 2023b]. Section 3.0 discusses the data from the three TAs, the assessment methods, and the results. NIOSH makes no claim that these data are complete. The goal of this report was to produce a qualitative analysis of these data.

1.2 SCOPE

This report:

- Discusses the LANL radiological control program,
- Uses examples of routine airborne and surface contamination monitoring data from monitoring programs in areas where exotic radionuclides and radionuclides other than plutonium were handled at LANL from 1996 through 2005 to demonstrate that LANL maintained exposures to less than 100 mrem/yr, and
- Discusses the use of worker self-monitoring with portal monitors by LANL Health Physics to screen workers for contamination when leaving contaminated work locations.

2.0 RADIOLOGICAL CONTROL

LANL Health Physics operated a comprehensive radiological control program through the entirety of the evaluated period, 1996 to 2005. The program included workplace controls, workplace monitoring, radiation worker training, worker self-monitoring, and worker external and internal monitoring and RWPs.

Classification of potential contamination areas is as follows:

- Contamination Area. Any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in appendix D of 10 C.F.R. Part 835 [DOE 1993], but do not exceed 100 times those values.
- Airborne Radioactivity Area. Any area, accessible to individuals, where:
  - The concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the derived air concentration (DAC) values listed in appendix A or appendix C of this part; or
  - An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.
- Radiological Buffer Area (RBA). Intended to provide boundaries to minimize the spread of contamination and to limit doses to general employees who have not been trained as radiological workers.
- Controlled Area (CA). Any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material.

2.1 WORKPLACE CONTROLS

LANL incorporated engineering controls to protect workers from both external and internal radiation exposure [Hoover 2021a]. These controls were designed to limit potential doses of radiation to workers to 100 mrem/yr. Examples of these controls included:

- Facility design,
- Laboratory hoods,
- Laboratory gloveboxes,
- Hot cells,
- Shielding,
- Ventilation systems, and
- Closed entry to beam lines.

2.2 WORKPLACE MONITORING

Workplace monitoring was a linchpin used by LANL Health Physics to ascertain the effectiveness of workplace controls and compliance with 10 C.F.R. Part 835 [DOE 1993]. By January 1, 1996, the health physics field monitoring and contamination control programs at LANL were well established and formalized with more than 60 procedures addressing various aspects of radiological protection as well as an established process for tracking and notifying staff of revisions [Rodriguez 1996a,b]. These procedures covered program administration, exposure and contamination control, monitoring, instrumentation, protective equipment, emergency response, and the as low as is reasonably achievable program.

In addition to sitewide procedures, area-specific routine monitoring instructions were an important part of the radiological control program at facilities where radioactive materials were handled and stored. The survey locations and frequencies helped to define the "safety envelope" for a facility. For example, the stated purpose of the *ESH-1 / TA-3 CMR Building Wing 2 Routine Monitoring Instructions* was to provide survey frequencies for ESH-1 Radiological Control Technicians (RCTs) and Health Protection Technicians to use in operating the radiological control program at TA-3 [Costigan et al. 2000]. This document defines the routine monitoring tasks of the RCTs assigned to TA-3 and delineates responsibilities. Routine surveys are described with survey frequencies ranging from daily to annually. These instructions also specify types of routine external radiation surveys and air monitoring, which include annual continuous air monitor (CAM) system calibration, monthly performance tests, and daily operability checks. LANL published similar routine monitoring instructions for each technical area. Additional examples of these instructions for the three technical areas evaluated in Section 3.0 are for TA-3 [Montoya 2004; Lesses and Montoya 2005], TA-48 [Costigan 1997; LANL 2000a] and TA-53 [Salazar 2005]. LANL Health Physics maintained the same level of monitoring across the site where radiological operations were conducted. An example of routine monitoring instructions for other areas included in this report is TA-55 radiation monitoring instructions (memorandum to UNCI-ESH-1 at TA-55 [Stokes 2000]) used at TA-55.

Routine surveys were a primary way in which LANL demonstrated to DOE that radiological operations were being conducted in a manner that did not compromise the health and safety of workers or threaten the environment [Hoover 2021a]. By procedure, "A surface shall be considered contaminated if either the removable or total radioactivity is detected above the levels in Table 2-2" [Hoover 2021a,

p. 13]. Table 2-2 of the *LANL Radiological Control Manual* (RadCon Manual) is reproduced below in Table 2-1. Further, by procedure, “If an area cannot be decontaminated promptly, then it shall be posted by ESH-1 as specified in 10 CFR 835. For area surveys where more than 10% of the total number of samples (swipes, smears, or instrument measurements) exceed Table 2-2 values, the affected area shall be decontaminated and/or posted accordingly” [Hoover 2021a, p. 13]. Health Physics either decontaminated areas of surface contamination or covered them. By procedure, routine area contamination monitoring was performed weekly, monthly, quarterly, semiannually, and annually [Hoover 2021a].

Table 2-1. Table 2-2, LANL RadCon Manual summary of contamination values with action levels [Hoover 2021b, p. 4].

Summary of contamination values

Nuclide[a]	***Removable***[b,c] ***(dpm/100 cm²)***[d]	***Total (fixed***[e] ***+ removable***[c]***) (dpm/100 cm²)***[d]
Natural U, ^{235}U, ^{238}U, and associated decay products	*1,000 alpha*	*5,000 alpha*
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa, ^{227}Ac, ^{125}I	*20*	*500*
Natural Th, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{129}I, ^{131}I, ^{133}I	*200*	*1,000*
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above[f]	*1,000 beta-gamma*	*5,000 beta-gamma*
Tritium organic compounds, surfaces contaminated by HT [elemental tritium (tritiated gas)], *HTO* [tritiated water], *and metal tritide aerosols*	*10,000*	*10,000*

a. *The values in this table apply to radioactive contamination deposited on, but not incorporated into, the interior of the contaminated item. For purposes of this table only, it is assumed that tritium contamination deposits onto the surface but is not incorporated into the interior of the contaminated item. This table does not apply to personnel contamination. → Where contamination by both alpha- and beta-gamma-emitting nuclides is present, the limits established for the alpha- and beta-gamma-emitting nuclides apply independently.* ***10 CFR 835, Appendix D***

b. *The amount of removable radioactive material per 100 cm² of surface area should be determined by first swiping the area with dry filter paper or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. (Note: the use of dry material may not be appropriate for tritium.)* ***10 CFR 835, Appendix D*** *→ For objects with a surface area less than 100 cm², the entire surface should be swiped, and the activity per unit area should be based on the actual surface area.* ***10 CFR 835, Appendix D*** *→ Except for transuranics, ^{228}Ra, ^{227}Ac, ^{228}Th, ^{230}Th, ^{231}Pa, and alpha emitters, it is not necessary to use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.* ***10 CFR 335, Appendix D***

c. *The “removable” and “total” levels may be averaged over 1 m² provided the maximum activity in any area of 100 cm² is less than three times the values in Table 2-2. For purposes of averaging, any square meter of surface shall be considered to be above the activity guide* G *if (1) from measurements of a representative number* n *of sections it is determined that* $1/n \sum_n S_i \geq G$, *where* S_i *is the dpm/100 cm² determined from measurement of section i; or (2) it is determined that the sum of the activity of all isolated spots or particles in any 100-cm² area exceeds 3 G.* ***10 CFR 335, Appendix D***

d. *As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute (cpm) observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation. At LANL, the instrument is calibrated so that the meter reading will directly correspond to the alpha or beta surface emission rate. A nominal conversion to activity in dpm is possible by multiplying the instrument contact reading in cpm by a factor of 2.*

e. *When measuring fixed contamination during a survey, the active area of the probe used must be taken into account. For example, if the active area is 100 cm² and the nuclide is natural uranium, then the 5000-dpm α/100-cm² limit will apply. For a 40-cm² probe, 2000 dpm α would be the limit because of the reduced active area of the probe.*

f. *This category of radionuclides includes mixed fission products* [MFPs], *including the Sr-90 that is present in them. It does not apply to Sr-90 that has been separated from the other fission products or mixtures in which the Sr-90 has been enriched.* ***10 CFR S35, Appendix D***

According to 10 C.F.R. § 835.403(a), DOE required monitoring of airborne radioactivity to be performed: (1) where an individual is likely to receive an exposure of 40 or more DAC-hr in a year (2% of an annual limit on intake [ALI]), or (2) as necessary to characterize the airborne radioactivity [DOE 1993; Fanning and Keith 2001]. LANL used a hazard index (HI) approach to define need for air monitoring. In general, an HI less than 1 indicated a low hazard potential from airborne radioactivity and no air monitoring was prescribed. An HI between 1 and 100 indicated a low to moderate airborne potential and general air monitoring was prescribed. Note that an HI of 2 corresponds to a potential intake of 2% of an ALI. Air monitoring was performed on daily and weekly frequencies and included real-time sampling. The LANL radiological control program also used continuous air monitoring to identify airborne contamination. The ORAU Team has access to many incident records of CAM alarms. CAM alarms allowed LANL to respond quickly to airborne radiation areas, which in turn helped to reduce surface contamination and prevented prolonged exposure to contaminated areas.

An analysis of some LANL routine surface contamination and air monitoring results is presented in Section 3.0 to help evaluate the effectiveness of workplace controls.

2.3 WORKER SELF-MONITORING

The requirement for workers exiting areas suspected of contamination to self-monitor was another key tenet of the LANL radiological control program in the period of evaluation. Hoover [2021a, p. 13] states:

> 1. *Personnel exiting Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, and Radiological Buffer Areas or Controlled Areas established for contamination control shall frisk for contamination as required by Article 338. This does not apply to personnel exiting areas containing only radionuclides, such as tritium, that cannot be detected using hand-held or automatic frisking equipment.*
>
> 2. *Monitoring for contamination should be performed using frisking equipment that under laboratory conditions can detect total contamination of at least the values specified in Table 2-2. Use of automatic monitoring units that meet the above requirements is encouraged.*
>
> 3. *Personnel found with detectable contamination on their skin, personal clothing, or company-issued clothing other than noble gases or natural background radioactivity should be promptly decontaminated as described in Article 541.*

The radiological protection program provided fixed instruments for personal contamination monitoring in each TA. Attachment A of the LANL RadCon Manual stated [Hoover 2021a, p. 14]:

> 1. *Personnel shall perform a whole-body frisk* [survey themselves] *under the following conditions:*
>
>   a. *Immediately upon entry into an uncontaminated area after leaving existing Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas;*
>
>   b. *As directed by the radiological work permit, the ESH-1 RCT, or the area exit posting.*
>
> 2. *In addition to the above, personnel exiting a Controlled Area or Radiological Buffer Area containing Contamination, High Contamination or Airborne Radioactivity Areas should, at a minimum, perform a hand and foot frisk. The frisk is optional if the*

Controlled Area or Radiological Buffer Area exit is immediately adjacent to the location where the existing worker has already performed a whole-body frisk.

3. *Where frisking cannot be performed at the exit from Contamination Areas, High Contamination Areas, and Airborne Radioactivity Areas due to high background radiation levels, personnel shall perform the following:*

    a. *Remove all protective equipment and clothing at the exit.*

    b. *Proceed directly to the nearest designated monitoring station.*

    c. *Conduct whole-body-frisk.*

4. *Personnel frisking shall be performed after removal of protective equipment and before washing or showering.*

Attachment A of the LANL RadCon Manual stated that personnel should take actions including the following in response to a contamination alarm [Hoover 2021a, p. 16]:

5. *Response to a personnel contamination monitor alarm should include the following actions:*

    a. *Remain in the immediate area.*

    b. *Notify ESH-1 personnel and line supervision.*

    c. *Take actions that may be available to minimize cross-contamination, such as putting a glove on a contaminated hand.*

2.3.1 Portal Monitors

LANL maintained a large and comprehensive inventory of instrumentation for monitoring individuals and areas in accordance with 10 C.F.R. Part 835 [DOE 1993]. These included fixed and portable instruments appropriate for the wide variety of radiological activities at LANL. Portal monitors consisted of personnel contamination monitors (PCMs) and hand-and-foot monitors (HFMs). Radiation protection instruments were calibrated in house at LANL. Table 2-2 lists PCMs used in TAs; Table 2-3 lists HFMs [Hoover 2021a]. These tables provide additional support showing that LANL Health Physics operated a comprehensive radiological control program through workplace monitoring and worker self-monitoring. Section 2.3.2 provides examples of LANL Health Physics' responses to alarms on these monitors.

Table 2-2. PCM use, 1996 to 2005.[a,b]

Model	HS#	TA	Building	Location
PCM-1B	8505	3	29	Wing 9
PCM-2	6421	3	29	Wing 2
PCM-2	7145	3	29	Wing 2
PCM-2	9995	3	29	Wing 2
PCM-2	6422	3	29	Wing 2
PCM-2	7147	3	29	Wing 3
PCM-2	7143	3	29	Wing 4
PCM-2	7144	3	29	Wing 4
PCM-2	6411	3	29	Wing 5
PCM-2	7150	3	29	Wing 5
PCM-2	6420	3	29	Wing 5
PCM-2	6419	3	29	Wing 7
PCM-2	7148	3	29	Wing 7
PCM-2	7149	3	29	Wing 7
PCM-2	9999	3	29	Wing 7
PCM-2	6412	3	29	Wing 9
PCM-2	7146	3	29	Wing 9
PCM-1B	8502	3	102	Not available
PCM-1B	8503	3	66	S102
PCM-1B	8501	21	312	Not available
PCM-1B	8501	54	G	Not available
PCM-1B	8507	54	1009	Not available
PM-6A	6503	48	RC-1	Not available
PM-6A	6504	48	RC-1	S Hallway
PCM-1B	4868	48	RC-1	Main/North Hallway
PCM-1B	5004	48	RC-1	Hot Cell Area
PCM-1B	5005	48	RC-1	Hot Cell Area
PCM-1B	8508	48	RC-1	Machine Shop
PCM-2	11501	48	RC-1	ARF Entrance
PCM-2	11502	48	RC-1	Alpha Wing
PCM-1B	4867	50	RC-1	Decontamination
PCM-1B	8501	50	37	Not available
PCM-1B	5007	50	37	Not available
PCM-2	6423	50	69	Not available
PCM-2	9995	50	69	Not available
PCM-2	9997	50	1	Main
PCM-2	11503	50	1	Main
PCM-2	11504	50	1	Main
PCM-2	11505	50	1	Main
PCM-1B	4870	53	Proton Storage Ring Shack	Not available
PCM-1B	5006	53	Area A	West
PCM-1B	5009	53	Area A	East
PCM-1B	8503	53	ER-2	Not available
PCM-1B	5010	53	1L	Service Shack
PCM-1B	8509	53	M111B / ER-2	Not available
PCM-2	9999	53	PRAD Area	Not available
Ludlum 53	PN 1232409	53	ER-2	Not available
PCM-2	6413	55	Not available	Station 118
PCM-2	6414	55	Not available	Station 118
PCM-2	6415	55	Not available	Station 116
PCM-2	6416	55	Not available	Station 116
PCM-2	6417	55	Not available	Station 116
PCM-2	6418	55	Not available	Station 116

Model	HS#	TA	Building	Location
PCM-2	11506	55	Not available	Station 116
PCM-2	11507	55	Not available	Station 116
PCM-2	11508	55	Not available	Station 116

a. Source: Hoover [2021a].
b. ARF = Actinide Research Facility; HS# = instrument number prefix; PRAD = Proton Radiography Facility.

Table 2-3. HFM use, 1996 to 2005.[a,b]

Model	HS#	TA	Building	Location
HFM-6	7027	3	29	Wing 7
HFM-6	7028	3	29	Wing 4
HFM-6	7029	3	29	Wing 2
HFM-6	7034	3	29	Wing 4
HFM-6	7035	3	29	Wing 4
HFM-6	7038	3	29	Wing 2
HFM-6	7039	3	29	Wing 9
HFM-7	5240	3	29	Wing 3 / Wing 2
HFM-7	5241	3	29	Wing 7
HFM-7	5242	3	29	Wing 4
HFM-7	5243	3	29	Wing 5 / Wing 9
HFM-7	5244	3	29	Wing 3
HFM-7	5245	3	29	Wing 5
HFM-7	5246	3	29	Wing 9 / Wing 2
HFM-7	8711	3	29	Wing 5
HFM-7	8713	3	29	Wing 4
HFM-7	8714	3	29	Wing 3 / Wing 9
HFM-7	8715	3	29	Wing 7
HFM-7	8716	3	29	Wing 9
HFM-7	9323	3	29	Wing 9
HFM-7	5250	3	66	D106
HFM-7	8705	3	66	B2A
HFM-7	8706	3	66	K105
HFM-7	8707	21	150	Not available
HFM-7	5249	48	RC-1	Basement
HFM-7	8703	48	RC-1	Machine shop
HFM-7	8704	48	RC-1	Alpha Wing
HFM-7	8708	48	RC-1	ARF
HFM-7	8709	50	69	Not available
HFM-7	8718	50	69	Not available
HFM-6	7034	54	33	Not available
HFM-7	5247	54	Various	Not available
HFM-7	8506	54	Various	Not available
HFM-7	8507	54	Various	Not available
HFM-7	8702	54	412	Not available
HFM-7	8707	54	231	Not available
HFM-7	8710	54	Various	Not available
HFM-7	8717	54	Various	Not available
HFM-7	9324	54	Various	Not available
HFM-8	180 units in TA-55-4	55	Lab exits	Not available

a. Source: Hoover [2021a].
b. ARF = Actinide Research Facility.

2.3.2 Evidence of Portal Monitoring Use

Multiple examples of workers alarming PCMs and HFMs are present in LANL documents; some of these documents are listed in Table 2-4. The following examples help demonstrate that LANL not only complied with 10 C.F.R. Part 835 [DOE 1993], but also had a coordinated system to protect workers.

Table 2-4. Some documents with results of portal monitors.[a]

Title	SRDB Ref ID
Radiation Incident Report Notification Checklists – August 1996	178426
Notification Checklists 1999	55552
Radiological Incident Reports January–May 1999	55553
Radiological Incident Report TA-53 Building 7 - 1999	178757
Contamination of Room 408 With Tc-99 in TA-48	55578
Radiological Incident of Employee Foot and Shoe Contamination in TA-48	55580
Radiological Incident of Employee Wing 300 in TA-48	55583
Radiological Incident of Employee Contamination in 400 Wing of TA-48	55585
Radiological Incident of Employee Contamination in Alpha Wing of TA-48	55587
Radiological Incident Reports TA-48 2003	59508
Radiological Incident Reports TA-54 Area G 2002	61765
Radiation Protection Work Control Breakdown Results in Unplanned Uptake	164550
Radiological Incident Reports TA-48 1999	176857
UCNI - RWPs TA-55 2001 (Set 6 Box 2-0691 - Ten Notable RWPs)	178195
UCNI - Radiological Incident Reports TA-55 32-63	178413
Index of Radiological Incidents for TA-55 1999	178420
Radiological Incident Reports LANL 1997	178425
UCNI - Radiological Incident Reports TA-55 64-95	178435
UCNI - Radiological Incident Reports TA-55 96-127	178446
UCNI - Radiological Incident Reports TA-55 128-155	178447
UCNI - Radiological Incident Reports TA-55 1-31	178453
Radiological Incident Reports TA-3 CMR 2000	178739
Worksheets Logbook Notes and Shift Attendance List TA-53 2001	178799
Radiological Incident Reports TA-3 Building 29 December 2003–December 2004	181206
Radiological Incident Reports TA-48 January, March, May–December 1998	181219
Radiological Incident Reports TA-3 Building 29 February–April, October 2000	181222
UCNI - Radiological Incident Reports TA-55 (1-201) 1997	183593
UCNI - RWPs TA-55 CY1998 (One Notable RWP)	183625

a. SRDB Ref ID = Site Research Database Reference Identification (number); UCNI = uncontrolled classified nuclear information.

On [redacted], a worker alarmed the PCM-2 in [redacted]. Contamination levels of 50,000 dpm alpha and 15,000 dpm beta were detected on the worker's [redacted]. Contamination of 3,000 dpm alpha was removed with Masslinn. Collected nasal smears were reported as no detectable activity (NDA) [LANL 1999a, p. 2].

On [redacted], after bagging contaminated filters in [redacted], a worker set off the alarm on a PCM-2. Contamination of approximately 6,400 to 6,900 dpm beta was detected on the [redacted] of the worker's [redacted]. The worker was decontaminated using soap and water. Collected nasal smears were reported as NDA [LANL 2000b, pp. 31–57]. No bioassay was performed on the worker for this event; however, the worker participated in routine bioassay. The worker was monitored for both ^{239}Pu and ^{241}Am on September 6, 2002; results were reported as less than minimum detectable activity (MDA) [LANL 1963–2004].

On [redacted], a worker frisking in [redacted] set off the alarm on a fixed monitor for the wing. Health Physics personnel arrived after the monitor alarmed. They monitored the worker's [redacted], which were contaminated to about 500 dpm alpha with 60 dpm removable alpha contamination. On examination, Health Physics found alpha contamination in Room 5120. The [redacted] of [redacted] workers were collected. Those workers performed whole-body frisks using an HFM-7. Nasal smears were collected from each worker from those rooms; all were negative [LANL 2000c, pp. 11–28].

On [redacted], a worker alarmed an HFM-7 in [redacted]. One [redacted] was decontaminated. No area contamination was found. The cause of contamination was considered to be a hot particle. Nasal smears were collected from each worker from those rooms; all were negative [LANL 2000c, pp. 2–11].

On [redacted], a worker set off a PCM at the exit to [redacted]. Health Physics confirmed [redacted] contamination of 52,000 dpm/100 cm^2 beta and [redacted] contamination of 26,000 dpm/100 cm^2 beta. The worker's [redacted] was immediately decontaminated, and the [redacted] were removed for analysis and decontaminated. A collected nasal smear was negative. Later analysis of the contamination on the [redacted] revealed the radionuclides were $^{82/85}Sr$ [LANL 1999b, pp. 86–104].

On [redacted], a worker leaving [redacted] set off an HFM. Health Physics confirmed alpha contamination of the right [redacted] and personal [redacted] with the highest reading being 700 counts alpha. The [redacted] was decontaminated. The worker was able to clear HFM-6 and exit the contaminated area. The floors of [redacted] were decontaminated [LANL 2002a]. While not required for this particular contamination, the worker was on routine bioassay for plutonium and uranium. Results of routine bioassay performed after the contamination event were less than the MDAs reported for plutonium and uranium.

On [redacted], a worker alarmed the PCM-1B in [redacted]. The worker's [redacted] were contaminated with 4,800 dpm beta. Subsequent surveys also detected 47,000 dpm on the worker's [redacted] dosimeter. Collected nasal swipes were reported as NDA [LANL 2003a, pp. 9–20].

On [redacted], a [redacted] to [redacted] alarmed the PCM-1B. Contamination was found on the [redacted] of a [redacted] and the isotope was identified as ^{188}W. The activity was 46,000 dpm and not removable with tape. The [redacted] and other personnel performed no work with radioactive materials. Masslinn swipes and direct surveys of the floor, hoods, and office sign in the area detected no contamination. It was determined that the contamination was brought to LANL on the [redacted] from a facility in Texas. The [redacted] was washed to NDA. No bioassay was performed for this visitor [LANL 2003a, pp. 482–490].

Portal monitors were extremely beneficial in the LANSCE (TA-53). LANL [2001a] documents many examples of PCM use. The following is an account recorded on August 12, 2001 (p. 19), in which 1LSA is a service area in MPF-7, Room 200; 1LTC is the linear accelerator target crypt, MPF-7; ER-1 is Experimental Area Room 1; ER-2 is Experimental Area Room 2; FP-2 is flight path 2; and REB is a room in the Proton Storage Ring (PSR), MPF-28:

> *While waiting for beam to stabilize between 1900 and 2000 hrs we prepared the FP-2 grid; documentation; and staged instruments. At 2000 hrs the beam was stabilized @ 56uA and we started the survey. At 2030 hrs the 2080 failed and we had to get another instrument, and then the beam dropped off until approx 2100 hrs. From 2100 hrs to 2300 hrs we finished the FP-2, shutter open survey in both ER-1 and ER-2 with 60 survey points. In ER-1 the highest reading was survey point #1 next to the shield bulk head which read 10 mR/hr gamma and 29 mrem neutron. The remaining readings in ER-1 were <5mR gamma + neutron. On top of FP#2 there is a lot of background radiation from the hole in the roof from the 1LSA and from the RLW* [radioactive liquid waste] *drain line: These reading were 180 mR/hr @contact, 100 mR/hr @ 30cm, 30 mR/hr @ 1m from the roof, 8 mR/hr from the RLW line, and the general background is approx 10 mR/hr: As the radiation levels from 1LSA* [may] *increase, I believe the south section of FP#2 should*

> *be roped off to prevent entry without an RCT to verify dose rates in that area, FP#2 has a safety fence on the west side between FP#3, but needs a safety fence on the East side between FP#1. No readings were taken in the gap between FP#1 and FP#2. A proper ladder also needs to be installed to allow access to the top of FP#2. In ER-2 all reading* [sic] *were <0.2 mR/hr gamma and 0 mrem neutron: No reading* [sic] *were taken on top of FP#2 in ER-2 because there was no safety tape or fall barriers. All personnel surveyed NDA through the ER-2 PCM.*

On [redacted], work was being performed in [redacted] on the target water system in the [redacted]. After the work was completed, the worker removed his anti-contamination clothing and proceeded to the PCM which alarmed. RCTs were notified and the worker was surveyed and found to have contamination levels on [redacted] of 800 to 3,000 cpm. Contamination was also found on the worker's [redacted] with levels up to 1,200 cpm. The RCTs also checked all areas where contamination might have been tracked and no contamination was detected. The worker was decontaminated and nasal smears were taken with a combined result of 208 dpm beta; the action level for beta combined was 500 dpm. Health Physics analyzed the smears with a photon detector; lutetium and hafnium isotopes were noted [LANL 1999c, pp. 13–26]. While not required by the results of the nasal smears Health Physics monitored the worker by whole body counting on February 4, 1999, with radionuclides ^{22}Na, ^{7}Be, ^{54}Mn, ^{11}C, ^{13}N, and ^{152}Eu all reported as less than MDA [LANL 1963–2004]; neither lutetium nor hafnium were identified in the whole body count.

On [redacted], the ESH-1 Field Office received a call informing RCTs that a worker alarmed the PCM-1B in [redacted] while doing a self survey before exiting [redacted]. An RCT responded to the scene and found beta/gamma contamination on the [redacted] (380,000 dpm), [redacted] (1.6×10^6 dpm), and [redacted] (4,000 dpm) of the worker. The worker donned a [redacted] and [redacted] and was escorted to the MPF-502 Decontamination Facility. The worker's [redacted] were removed, bagged, and retained by ESH-1. The [redacted] and [redacted] were successfully decontaminated. While not required by the results of the nasal smears, Health Physics monitored the worker by whole body counting on February 10, 1999, with radionuclides ^{22}Na, ^{7}Be, ^{54}Mn, ^{11}C, ^{13}N, and ^{152}Eu all reported as less than MDA. The area was secured and posted until Health Physics was able to do a complete survey of the area [LANL 1999c, pp. 27–34; 1963–2004].

On [redacted], a worker alarmed a PCM-1B in [redacted] after using the monitor. The worker's [redacted] was contaminated to approximately 86,000 dpm beta/gamma. The worker was escorted to a decontamination trailer and the [redacted] was successfully decontaminated with soap and water [LANL 1999c, pp. 48–53]. The worker participated in the routine bioassay program.

On [redacted], a worker alarmed the PCM-1B while exiting [redacted]. [Redacted] contamination of 48,000 dpm beta activity was detected around the [redacted] and [redacted]. The worker was successfully decontaminated using soap and water. A result of collected [redacted] smears showed 42 dpm beta was detected in the [redacted] [LANL 1999c, pp. 66–82]. Health Physics monitored the worker by whole body counting on May 14, 1999, with ^{173}Hf reported as less than MDA [LANL 1963–2004].

On [redacted], a worker alarmed the PCM-1B while exiting [redacted]. Skin contamination of 47,000 dpm beta/gamma was detected on the [redacted]. The cause of contamination was considered to be a hot particle. The [redacted] was successfully decontaminated using a mild cleanser and Kimwipes [LANL 1999c, pp. 87–92]. The ORAU Team has no evidence of bioassay results for this worker.

On [redacted], a worker exiting [redacted] alarmed a PCM. Health Physics determined contamination of the worker's [redacted] with a hot spot (contamination area greater than neighboring regions of the area) on the [redacted] reading 1,200 dpm beta and 200 dpm alpha. On investigation, Health Physics determined the cause of the alarm was radon contamination (NIOSH assumes this meant from radon progeny) and released the worker [LANL 2001a, p. 92].

LANL Health Physics documented instances where workers failed to comply with the requirements for using portal monitors or left a controlled area with a PCM alarm, as indicated in two instances for which Radiological Incident Reports were initiated [LANL 1999d, pp. 19–20]. Although the use of personnel self-monitoring was a component of the radiological control program, it was not the only component. The program relied on each component to keep doses to 100 mrem/yr or less, including but not limited to contamination surveys, air monitoring, and worker training. Rare instances of noncompliance with PCM use requirements by workers does not prevent NIOSH from performing dose reconstructions.

Additionally, many Occurrence Reporting and Processing System reports were reviewed for the period 1996 through 2005. There were 386 reports sitewide for the period. Of these, 127 (approximately 33%) were from TA-3, 39 (approximately 10%) were from TA-48, and 14 (approximately 4%) were from TA-53.

3.0 CONTAMINATION SURVEY AND AIR MONITORING DATA IN TECHNICAL AREAS 3, 48, AND 53

To evaluate the effectiveness of the LANL radiological control program, the ORAU Team analyzed example survey and air monitoring data. The ORAU Team selected results of routine smear surveys in three areas, TA-3, TA-48, and TA-53, and routine air sampling results for the same TAs. The three TAs were selected because exotic radionuclides were known to have been handled there from January 1, 1996, to December 31, 2005. This exercise was not intended to be all inclusive of all areas at LANL that handled exotic radionuclides. Although data from 1996 through 2005 are represented, the ORAU Team does not have data for each TA for every year and the data are not distributed equally among the TAs. Documents with routine smear and air monitoring data used for this report are listed in Attachment A, Table A-1.

Routine surface contamination documents typically contained laboratory results for many smears taken within a building on a weekly or quarterly frequency. Information extracted from each surface contamination monitoring document includes sample collection date, TA and building number, survey frequency, number of results, number of gross alpha results exceeding 20 dpm/100 cm^2, number of gross alpha results exceeding 400 dpm/100 cm^2, number of gross beta results exceeding 1,000 dpm/100 cm^2, and number of gross beta results exceeding 3,200,000 dpm/100 cm^2. The limits of 400 dpm/100 cm^2 and 3,200,000 dpm/100 cm^2 were derived in ORAUT [2021] and are explained in the equations provided later in this section. These two limits are referred to as “ORAU Team criteria.” The 20 dpm/100 cm^2 and 1,000 dpm/100 cm^2 were standard action levels as indicated in the LANL RadCon Manual [Hoover 2021b, Table 2-2] (Table 2-1 in this report).

The purpose of compiling these data was twofold:

1. To determine whether the routine surface contamination survey programs conducted during the period of interest (1996 through 2005) in the areas where exotic radionuclides could have been handled were robust. The numbers of surveys and smears per survey were tallied. Note that the data in this report include results from routine surveys only.

2. To assess the routine surface contamination status in these areas and to determine the likelihood that unmonitored workers in these areas could have received significant intakes due to resuspended surface contamination. Contamination areas are defined in 10 C.F.R. Part 835 as having removable alpha contamination exceeding 20 dpm/100 cm^2 or removable beta contamination exceeding 1,000 dpm/100 cm^2 [DOE 1993]. The number of smears per survey

that exceeded this threshold was tallied. LANL worked to maintain removable alpha and beta contamination to those values under the LANL RadCon Manual [Hoover 2021b, Table 2-2] (Table 2-1 in this report).

Areas with readings above the limits listed in Table 2-2 of the LANL RadCon Manual for surface contamination areas were posted and/or resurveyed, as demonstrated in a 1997 memorandum [LANL 1997a, p. 2]:

> *SUBJECT: THIRD QUARTER SMEAR SURVEY FOR TA-53*
>
> *Attached is the 1997 Third Quarter Smear Survey for TA-53. The survey information is provided on a smear data/map format. All smears were taken during the months of August and September 1997.*
>
> *A 100cm^2 smear was taken at each survey location using NuCon smears. The smears are then taken to the TA-53 ESH-1 Satellite Count Lab located in MPF-1, Laboratory Operations Building (L. O. B.) and are counted on the Canberra 2400 alpha/beta proportional counter and an NaI gamma counter. All data is corrected for background and counter efficiencies and reported in disintegrations per minute (dpm). Areas with readings above release limits listed in Table 2-2 of the LANL RadCon Manual for Surface Contamination Areas are posted appropriately and/or resurveyed.* [emphasis added]

The purpose of tallying the number of smears per survey exceeding 400 dpm/100 cm^2 alpha and 3,200,000 dpm/100 cm^2 beta was to assess the likelihood that unmonitored individuals could have received intakes resulting in doses exceeding 100 mrem/yr. For this assessment, ^{227}Ac type F was assumed to represent the worst-case alpha emitter and ^{90}Sr type S was assumed to represent the worst-case beta emitter. The rationale behind these numbers is given later in this section.

Routine air monitoring documents typically contained laboratory results for air filters exchanged on a weekly or other periodic frequency for multiple locations within a building. Information extracted from each air monitoring document included sample collection date, TA and building number, survey frequency, number of results, number of gross alpha results exceeding 0.04 dpm/m^3 and if the measurement had sufficient sensitivity to detect 0.04 dpm/m^3, and the number of gross beta results exceeding 320 dpm/m^3. Like with the surface contamination data, the purpose of compiling these air monitoring data was twofold:

1. To determine whether the routine air monitoring programs during the period of interest (1996 through 2005) in the areas where exotic radionuclides could have been handled were robust. This is why the numbers of surveys and samples were tallied. As with the surface contamination data, the air monitoring results in this report only include results from routine air monitoring contained in the analyzed set of data.

2. To assess the routine air contamination status in these areas and to determine the likelihood that unmonitored workers in these areas could have received significant intakes due to airborne contamination. The purpose of tallying gross alpha results exceeding 0.04 dpm/m^3 and gross beta results exceeding 320 dpm/m^3 was to assess the likelihood that unmonitored individuals could have received intakes resulting in doses exceeding 100 mrem/yr. As with the surface contamination assessment, ^{227}Ac type F was assumed to represent the worst-case alpha emitter and ^{90}Sr type S was assumed to represent the worst-case beta emitter. The rationale behind these numbers is given later in this section.

Under 10 C.F.R. Part 835, DOE did not require bioassay programs for workers who were unlikely, under typical conditions, to receive 100 mrem in a year [DOE 1993]. However, to ascertain if LANL controlled internal doses from exotic radionuclides, the ORAU Team used limiting assumptions with the analysis of monitoring data. These assumptions include:

- Worker breathing rate = 0.02 m^3/min;
- Worker occupancy = 2,000 hr/yr (100% occupancy); and
- Surface contamination resuspension factor = 1.0×10^{-6} m^{-1} (90th-percentile maximum likelihood) [Abu-Eid et al. 2002].

In previous LANL documents and discussions, including evaluation reports, Work Group meetings and associated papers, the following radioactive materials have been identified as having data deficiencies potentially affecting the feasibility of dose reconstruction: MFPs and mixed activation products (MAPs), ^{241}Am (separated from plutonium), ^{232}Th, ^{230}Th, ^{227}Ac, ^{231}Pa, ^{237}Np, and ^{244}Cm. Of these, considering the dose conversion factors presented in ICRP Publication 68 [ICRP 1995], NIOSH has determined that ^{227}Ac type F (assigned to the alpha category because of its progeny) and ^{90}Sr type S are the alpha and beta emitters handled at LANL that would result in the highest dose consequences per unit activity of material. In this evaluation therefore, when evaluating gross alpha and gross beta survey results when the specific radionuclides are unknown, NIOSH assumed ^{227}Ac type F (alpha) or ^{90}Sr type S (beta). This ensured that the worst case scenario was being evaluated.

The ORAU Team derived projected doses from direct air monitoring or resuspended surface contamination using effective dose coefficients for inhalation from ICRP Publication 68 [ICRP 1995] for alpha- (^{227}Ac type F) and beta-emitting (^{90}Sr type S) radionuclides. Air concentration values (dpm/m^3) that would result in 100 mrem CED per year using the above assumptions are presented in ORAUT [2021]. The selected radionuclides resulted in the lowest calculated air concentration value for their respective categories. Type S ^{90}Sr was chosen as the more limiting beta emitter because it has a lower air concentration than type F even though type F was the likely material type to be found on site at LANL. Note that these assumptions result in a conservative estimate of the workplace values, indicating a potential for intakes resulting in 100 mrem/yr. The selected radionuclides and associated material types are not likely to be the predominant component of an encountered mixture, and a worker does not typically spend 2,000 hours in a single location for a year. Doses based on more realistic assumptions at these airborne activity and surface contamination levels will be smaller.

The following equations from ORAUT [2021] were used to determine the 100-mrem values:

$$AC_{100} = \frac{D \times C_1}{H \times C_2 \times R \times F} \tag{3-1}$$

where:

AC_{100}	=	air concentration (Bq/m^3) of ^{227}Ac type F or ^{90}Sr type S that would result in 100 mrem/yr
D	=	dose of 100 mrem/yr
C_1	=	0.00001 Sv/mrem conversion factor
H	=	2,000 hr/yr worked
C_2	=	60 min/hr conversion factor
R	=	breathing rate of 0.02 m^3/min
F	=	ICRP effective dose coefficient of 6.3×10^{-4} Sv/Bq for ^{227}Ac or 7.7×10^{-8} Sv/Bq for ^{90}Sr

Note: To convert to dpm/m^3, the 6.6 × 10^{-4} Bq/m^3 result for ^{227}Ac is multiplied by 60 dpm/Bq yielding 0.04 dpm/m^3 and the 5.4 Bq/m^3 for ^{90}Sr is multiplied by 60 dpm/Bq yielding 320 dpm/m^3.

$$SC_{100} = \frac{D \times C_1 \times C_2}{F \times R \times H \times C_3 \times RF \times C_4} \tag{3-2}$$

where:

SC_{100}	=	resuspended surface contamination (Bq/100cm^2) of ^{227}Ac type F or ^{90}Sr type S that would result in 100 mrem/yr from inhalation
D	=	dose of 100 mrem/yr
C_1	=	0.00001 Sv/mrem conversion factor
C_2	=	constant value of 100 to adjust result to 100 cm^2 to account for surface smear area
F	=	ICRP effective dose coefficient of 6.3 × 10^{-4} Sv/Bq for ^{227}Ac or 7.7 × 10^{-8} Sv/Bq for ^{90}Sr
R	=	breathing rate of 0.02 m^3/min
H	=	2,000 hr/yr worked
C_3	=	60 min/hr conversion factor
RF	=	resuspension factor of 1 × 10^{-6} m^{-1}
C_4	=	10,000 cm^2/m^2 conversion factor

Note: To convert to dpm/100 cm^2, the 6.6 Bq/100 cm^2 for ^{227}Ac is multiplied by (60 dpm/Bq) yielding 400 dpm/100 cm^2 and the 5.4 × 10^4 Bq/100 cm^2 for ^{90}Sr is multiplied by (60 dpm/Bq) yielding 3,200,000 dpm/100 cm^2.

Note: The overall difference between equations 3-1 and 3-2 is a factor of 10,000. This is the product of the 1 × 10^{-6} m^{-1} resuspension factor and the conversion from cm^2 to 100 cm^2 for surface contamination.

Table 3-1 summarizes monitoring results for all three TAs as a whole (TA-3, TA-48, and TA-53) and individually. Table 3-2 summarizes them by year. A review of the data in Tables 3-1 and 3-2 shows that more than 98% of all smears and 99% of air monitoring results used in the report were below the lower limits for alpha of 20 dpm/100 cm^2 and 0.04 dpm/m^3, respectively. While evaluated data do not represent a random sample or all survey data, these results suggest workplaces were well controlled in terms of radioactive contamination. However, the results over those limits must be considered to determine if any could have contributed to internal doses greater than 100 mrem/yr. These data are provided in Table 3-3.

To determine if resuspended surface contamination could have led to worker doses greater than 100 mrem/yr, the ORAU Team looked at the number of alpha and beta results exceeding the upper limits (400 dpm/100 cm^2 alpha and 3,200,000 beta dpm/100 cm^2). A total of 26 alpha surveys exceeded 400 dpm/100 cm^2 in TA-3, or 0.3% of all spots surveyed in TA-3. Sixteen of the 26 spots were found in the Sigma complex with uranium being the radionuclide of interest in 1999. A total of four alpha surveys exceeded 400 dpm/100 cm^2 in TA-48, or 0.05%: one smear each in Rooms 309, 312, 338 Hot Cell, and 409, all where alpha-emitting radionuclides were handled. A total of two alpha surveys exceeded 400 dpm/100 cm^2 in TA-53, or 0.01%. While the ORAU Team does not have specific documentation specifying the controlled contamination designations of areas in these three areas, all these areas were controlled under routine monitoring. An example is provided for each TA as follows: TA-3 [Costigan et al. 2000], TA-48 [Costigan 1997], and TA-53 [Salazar 2005]. Summary data on the number of smears that exceeded upper limits are given in Table 3-4. The

Table 3-1. Monitoring data by TA.[1]

TA	No. of survey results	Alpha smear results exceeding 20 dpm/100 cm^2	Alpha smear results exceeding 400 dpm/100 cm^2	Beta smear results exceeding 1,000 dpm/100 cm^2	Beta smear results exceeding 3,200,000 dpm/100 cm^2	No. of air monitoring results	Alpha air results exceeding 0.04 dpm/m^3	Beta air results exceeding 320 dpm/m^3
All	39,639	723	32	188	0	66,419	504	17
3	7,794	552	26	113	0	61,378	179	0
48	7,709	55	4	19	0	3,120	29	0
53	24,136	116	2	56	0	1,921	296	17

Table 3-2. Monitoring data by year.

Year	No. of survey results	Alpha smear results exceeding 20 dpm/100 cm^2	Alpha smear results exceeding 400 dpm/100 cm^2	Beta smear results exceeding 1,000 dpm/100 cm^2	Beta smear results exceeding 3,200,000 dpm/100 cm^2	No. of air monitoring results	Alpha air results exceeding 0.04 dpm/m^3	Beta air results exceeding 320 dpm/m^3
All	39,639	723	32	188	0	66,419	504	17
1996	3,937	61	2	28	0	186	51	1
1997	6,004	64	5	9	0	1,741	174	12
1998	587	0	0	0	0	1,617	46	2
1999	8,191	440	17	134	0	1,480	38	1
2000	4,624	54	5	8	0	12,940	60	1
2001	1,423	5	0	0	0	13,757	50	0
2002	497	0	0	0	0	12,045	72	0
2003	6,750	1	0	3	0	265	0	0
2004	5,007	90	2	3	0	13,437	8	0
2005	2,619	8	1	3	0	8,951	5	0

[1] Tables 3-1 through 3-5 report surface contamination survey data and air monitoring data from these three TAs for the period from January 1, 1996, to December 31, 2005, captured only during 2019. These tables demonstrate the effectiveness of the LANL contamination control programs.

Table 3-3. Breakdown of smear results above lower limits.

TA	Alpha smear results exceeding 20 dpm/100 cm^2	Beta smear results exceeding 1,000 dpm/100 cm^2	Total number of area smears[a]	Total results exceeding lower limit (alpha+beta)	% of single TA results (alpha+beta)[a]
All	723	188	39,639	911	1.2
3	552	113	7,794	665	4.27
48	55	19	7,709	74	0.48
53	116	56	24,136	172	0.36

a. The total number of smears is multiplied by 2 to represent alpha and beta results.

ORAU Team also tallied the number of air monitoring results above limits for alpha of 0.04 dpm/m^3 and for beta 320 dpm/m^3 (Table 3-5). Results used in this report are evidence that LANL controlled contamination in routine workplaces. Eight percent of air samples collected in TA-53 exceeded either alpha or beta limits; however, these results represent samples collected at or around the accelerator target or in Experimental Area A where isotope production work was performed in hot cells. Twelve of the 17 air sample results exceeding the air concentration beta limit were recorded in 1997 in TA-53 with spallation activities (see Section 3.3). These locations were not accessible by workers during beam generation and as such would not have contributed to intakes.

Table 3-4. Breakdown of results above upper surface contamination limits (100-mrem/yr limit).

TA	Alpha results exceeding 400 dpm/100 cm^2	Beta results exceeding 3,200,000 dpm/100 cm^2	Total number of area smears	Total results exceeding upper limit	% of single TA results (alpha+beta)[a]
All	32	0	39,639	32	0.04
3	26	0	7,794	26	0.17
48	4	0	7,709	4	0.03
53	2	0	24,136	2	0.00

a. The total number of smears is multiplied by 2 to represent alpha and beta results.

Table 3-5. Air concentrations above alpha and beta limits.

TA	Alpha air results exceeding 0.04 dpm/m^3	Beta air results exceeding 320 dpm/m^3	Total number of area air sample results	Total results exceeding limits	% of single TA results (alpha+beta)[a]
All	504	17	66,419	521	0.39
3	179	0	61,378	179	0.15
48	29	0	3,120	29	0.46
53	296	17	1,921	313	8.15

a. The total number of air samples is multiplied by 2 to represent alpha and beta results.

Based on the results above, it is clear that very few surveys exceeded either LANL limits or ORAU Team criteria, which indicates LANL had an effective contamination control program. As a reminder, workers exiting Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, RBAs, and CAs were required to frisk for contamination. The ORAU Team has provided examples of Health Physics response and followups to personnel monitor alarms in Section 2.3.2.

3.1 TECHNICAL AREA 3

TA-3 has contained a mixture of LANL activities that include 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. Much like a university campus, research facilities are scattered throughout the area. These range from small laboratories with bench-scale operations to activities involving radioactive materials in the CMR facility in Building 29 [Romero and Faust 1992; LANL 1998a].

Survey results for TA-3 were obtained for Building 29 (CMR) and the Sigma Complex (Building 66). All smears for alpha plus beta were taken from RBAs or CAs. Alpha surface contamination exceeded the lower limit in 552 individually smeared spots of 100 cm^2, and beta surface contamination exceeded the lower limit in 113 smears of 100 cm^2. Surface contamination was not found in the same location over more than two consecutive surveys. The most contaminated areas were in Building 29 Room 5023 where actinides were detected on a November 10, 1999 survey. In that survey, 34 smears exceeded the lower limit of 20 dpm/100 cm^2, and 1 smear exceeded 400 dpm/100 cm^2. In all, 171 smears revealed surface contamination above the lower limits in Building 29 over all surveys. Note that smears were part of an overall survey and that one survey can have many smears. The radionuclides used in these locations primarily included actinides and special nuclear material (SNM). Three hundred eighty-six smears revealed surface contamination above the lower limits in the Sigma Complex (primarily Building 66) where SNM comprised the primary radionuclides of interest. The set of individual smears exceeding lower surface contamination limits was 4.27% of the total smears available for TA-3 (alpha and beta smears tabulated as individual smears). Smear data for TA-3 are given in Attachment A, Table A-2.

Considering the upper limits for alpha and beta surface contamination, the ORAU Team found 26 spots that exceeded 400 dpm/100 cm^2 alpha. No spot surveys exceeded the 3,200,000 dpm/100 cm^2 beta limit (Table 3-1). Sixteen of the 26 spots were found in the Sigma Complex with uranium being the radionuclide of interest. The rest were found in Building 29 with actinides being the primary source term, and 99.67% of smears were at or below upper surface contamination limits. Surveyed spots with readings above the limits listed in Table 2-2 of the LANL RadCon Manual (Table 2-1 in this report) for surface contamination areas were posted and/or cleaned and resurveyed [LANL 1997a, p. 2]. Routine workers such as custodians would not have been exposed to these levels of surface contamination over time. They would typically not be monitored if their potential dose would not exceed 100 mrem/yr.

Airborne contamination results exceeding either the alpha or beta airborne contamination limit were found on 117 sets of airborne results for TA-3. All these were recorded for Building 29 due to alpha radiation exceeding 0.04 dpm/m^3. The most results over the alpha limit were obtained in Wing 5 (59 results), while the fewest were found in Wing 4 (3 results). In all, 179 individual air monitoring results exceeded 0.04 dpm/m^3. The set of individual air monitoring results that exceeded the alpha and beta limits in TA-3 is 0.15% of the total air monitoring results (alpha plus beta) available for TA-3; results are given in Attachment A, Table A-3.

3.2 TECHNICAL AREA 48

TA-48 is known as the Radiochemistry Site. The facilities at TA-48 support 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 sufficient radioactive materials to be considered hazardous because it is a Category 3 hazard based on the potential for only significant, localized consequences. During the period of evaluation, the RC-1 building was divided into an office wing, light chemistry laboratories for performing low-level radiochemistry, a hot cell complex to produce medical radioisotopes, an alpha wing for processing alpha-emitting radioactive and toxic materials, a "counting room" complex, and a secure data wing with a classified computer and vault containing historical data [LANL 1998a].

Activities at Building RC-1 included small-scale radiochemistry in the laboratories area, chemical research of high alpha activity materials in the alpha facility, final analysis of samples in the counting room, and small-scale production of medical radioisotopes in the hot cells area. The dissolution area housed a high-activity chemistry area. The activities conducted there involved the largest amounts of beta/gamma radioactivity outside of the hot cells area. Both alpha materials and FPs were handled and separated in this building [LANL 1998a].

Surface contamination results exceeding either the lower alpha or beta contamination limit were found in 50 surveys performed in TA-48 across 1997, 1999, 2004, and 2005, all in Building RC-1. From these 50 surveys, alpha surface contamination was found on 55 individual smears while beta surface contamination was found on 19 individual smears. The radionuclides used in these locations primarily included actinides and mixed fission and activation products (MFAPs). All smears exceeding the lower limits of surface contamination were collected in RBA or CA locations. The set of individual smears exceeding lower surface contamination limits is 0.48% of the total smear results available for TA-48; results are given in Attachment A, Table A-4.

Considering the upper limits for alpha and beta surface contamination, the ORAU Team found only four smeared spots that exceeded 400 dpm/100 cm^2 alpha. No spots exceeded 3,200,000 dpm/100 cm^2 beta (Table 3-1). All four surveyed spots were in Building RC-1; 99.9% of evaluated smears were at or below upper surface contamination limits. Surveyed spots with readings above the limits listed in Table 2-2 of the LANL RadCon Manual (Table 2-1 in this report) for surface contamination areas were posted and/or cleaned and resurveyed [LANL 1997a, p. 2]. Routine workers such as custodians would not have been exposed to these levels of contamination over time. They would typically not be monitored if their potential dose would not exceed 100 mrem/yr.

Airborne contamination results exceeding either the alpha or beta airborne contamination limit were found on 10 sets of airborne results for TA-48. All these were recorded for Building RC-1 around the hot cell and supporting rooms. Twenty-nine individual air monitoring results exceeded 0.04 dpm/m^3 alpha. The set of air monitoring results that exceeded the alpha and beta limits in TA-48 is 0.46% of the total air monitoring results available. These data are presented in Attachment A, Table A-5.

3.3 TECHNICAL AREA 53

TA-53 housed the LANSCE. During the period of this evaluation, TA-53 had approximately 400 buildings and other structures and housed about 800 personnel. That population could have increased by several hundred when the linear accelerator was in operation as visiting scientists from around the globe came to Los Alamos to monitor and participate in experiments. Site workers were protected by shielding, fencing, access controls, sweep procedures, beam shutoff mechanisms, monitoring devices, dosimetry, posted safety information, training, administrative controls, and emergency response mechanisms [LANL 1998a].

Surface contamination results exceeding either the lower alpha or beta contamination limit were found in 42 surveys performed in TA-53. These surveys were collected at the target area, along the beam line, and in the beam service area, PSR, and ancillary support facilities. All smeared locations were within Health Physics regulated areas that LANL monitored for external exposures and intakes. From these 42 surveys, alpha surface contamination was found on 116 smeared spots, and beta surface contamination was found on 56 smeared spots. The radionuclides in these locations primarily included actinides and MFAPs. The set of individual smears (alpha plus beta) exceeding lower surface contamination limits is 0.36% of the total smears available for TA-53; results are given in Attachment A, Table A-6.

Considering the upper limits for alpha and beta surface contamination, the ORAU Team found two spots that exceeded 400 dpm/100 cm^2 alpha (Table 3-4). No spot survey exceeded the 3,200,000 dpm/100 cm^2 beta; 99.9% of smears were at or below upper surface contamination limits. One of the spots in TA-53 was found in the experimental area in MPF-3M, and the other one was found in the beam target area. None of 24,136 smeared spots exceeded the upper limit for beta. Surveyed spots with readings above the limits listed in Table 2-2 of the LANL RadCon Manual (Table 2-1 in this report) for surface contamination areas were posted and/or cleaned and resurveyed [LANL 1997a, p. 2]. Routine workers such as custodians would not have been exposed to these levels of surface contamination over time. They would typically not be monitored if their potential dose would not exceed 100 mrem/yr.

For air monitoring samples analyzed for gross alpha and beta contamination, 296 individual air monitoring results exceeded 0.04 dpm/m^3 alpha, and 17 individual results exceeded the beta limit of 320 dpm/m^3. The set of air monitoring results that exceed the alpha and beta limits in TA-53 is about 8.15% of the total available air monitoring results (alpha plus beta). Air monitoring results represent sampling at the target area, along the beam line, and at the beam service area, PSR, and ancillary support facilities. A majority of these results were reported for Experimental Area A where 244 individual air monitoring results exceeded 0.04 dpm/m^3 alpha and 12 individual results exceeded the beta limit of 320 dpm/m^3, the latter not unexpected given activation products arising from the spallation processes. The set of air monitoring results that exceed the alpha and beta limits in TA-53 is given in Attachment A, Table A-7.

3.4 SUMMARY OF TECHNICAL AREA EVALUATION

While the analysis included limited survey and air monitoring data for three TAs, results of smear surveys and air monitoring demonstrate that LANL controlled radioactive contamination. Radionuclides of interest for the period of evaluation were primarily actinides (uranium, plutonium, and americium) in all three TAs but included activation and FPs in TA-48 and TA-53.

4.0 CONCLUSIONS

In this report, the ORAU Team has discussed the LANL radiological control program and demonstrated that contamination was well controlled in TA-3, TA-48, and TA-53. Data evaluated in Section 3.0 shows that LANL controlled routine contamination that could lead to doses greater than 100 mrem/yr at all three TAs. While data used in the report are not the total set of data collected by LANL, the weight of evidence supports the premise that unmonitored doses can be bounded at 100 mrem/yr. The ORAU Team has shown that LANL operated a radiation protection and control program that included the use of portal monitors to identify and remediate workplace radiological contamination.

The ORAU Team criteria defined and discussed in Section 3.0 were developed using conservative worst case assumptions. All alpha emitting radionuclides are assumed to be ^{227}Ac type F and all beta emitting radionuclides are assumed to be ^{90}Sr type S. Furthermore, it was assumed that areas were uniformly contaminated at these levels and that unmonitored workers spent 2,000 hours per year in the contaminated areas to receive a dose of 100 mrem/yr. These are bounding, rather than realistic, assumptions.

LANL Health Physics responded to even small levels of contamination. When contamination was identified through routine monitoring programs, LANL Health Physics took actions to minimize worker exposures, such as identifying the source of contamination and either decontaminating the source or posting and restricting worker access into such areas. In many cases, the discovery of contamination would result in workers being monitored by nasal smears or bioassay. Primary radionuclides of interest were fission and activation products and actinides (primarily uranium and plutonium) in TA-3 and TA-48 and spallation products in TA-53.

A crucial part of the LANL radiological control program required workers exiting Contamination Areas, High Contamination Areas, Airborne Radioactivity Areas, and RBAs to frisk for contamination. The ORAU Team has provided examples of Health Physics' response and followup to personnel monitor alarms in Section 2.3.2.

The ORAU Team concludes the weight of the evidence clearly indicates that worker doses to unmonitored exotic radionuclides would not have exceeded 100 mrem/yr. Doses for workers monitored by bioassay can be bounded using bioassay results. Doses for unmonitored workers can be bounded at 100 mrem/yr because no evidence was found that would contradict these conclusions. Therefore, the conclusion, based on data and facts provided in the report, is that no unmonitored workers received a dose above 100 mrem/yr during normal operations.

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Table A-1. Smear and air monitoring source documents.[a]

Year	Title	SRDB Ref ID
1996	*Air Samples TA-53 1996*	176863
1996	*Smear Surveys TA-53 May and June 1996*	178723
1996	*Smear Surveys TA-53 July and August 1996*	178740
1996	*Smear Surveys TA-53 August–November 1996*	178790
1996	*Smear Surveys TA-53 March 29–May 17, 1996*	180912
1996	*Direct and Smear Surveys TA-3 1996*	180957
1996	*Smear and Contamination Surveys TA-3 1996*	180987
1996	*Smear Surveys TA-53 February 13–March 29, 1996 and May 10, 1997*	180906
1997	*Portable Air Samples TA-53 1997*	176864
1997	*Smear Surveys TA-53 September–November 1997 and January 1998*	180852
1997	*Air Samples TA-48 Building 1 January–November 1997*	180854
1997	*Weekly and Monthly Routine Surveys TA-48 Building 1 1997*	180884
1997	*Smear Surveys TA-53 1996*	180893
1997	*Smear Surveys TA-53 Third and Fourth Quarter 1997*	180905
1997	*Smear and Counter Surveys TA-53 April, May, July 1997*	180927
1997	*Radiation and Contamination Surveys in LANSCE Beam Area 1997*	178711
1998	*Hot Cell Air Samples TA-48 1998*	178786
1998	*Smear and Counter Surveys TA-53 January–April 1998*	180840
1998	*Air Samples TA-48 Hot Cell December 1996–January 1998*	180886
1998	*Smear and Counter Surveys TA-53 September–November 1998*	180947
1998	*Fixed Air Samples TA-48 Building 1 1998*	181015
1999	*Hot Cell Wing Monthly Surveys TA-48 January–November 1999*	176856
1999	*Smear Surveys TA-53 First, Second, Third Quarter 1999*	178731
1999	*Hot Cell Wing Air Samples TA-48 1999*	178769
1999	*Monthly Routine Smear Surveys TA-48 1999*	178770
1999	*RWPs TA-53 1999*	178775
1999	*Air, Contamination and Smear Surveys TA-53 June–August 1999*	180830
1999	*Smear and Counter Surveys TA-53 December 1999*	180841
1999	*Smear and Counter Surveys TA-53 May, June, July 1999*	180843
1999	*Smear and Counter Surveys TA-53 January–April 1999*	180846
1999	*Smear and Counter Surveys TA-53 July–October 1999*	180847
1999	*Smear and Contamination Surveys TA-3 January 1999–January 2000*	180849
1999	*Smear Surveys TA-3 January–September, November, December 1999*	180850
1999	*Smear Surveys TA-3 Building 2008-2010, 1734, 130, SM-65 August–September 1999*	180982
1999	*Fixed Contamination, Direct, Smear and Nasal Surveys TA-3 Building 29 Wing 5 1999*	180992

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Year	Title	SRDB Ref ID
1999	*Giraffe Air Samples TA-53 1999*	180993
1999	*RWPs TA-3 CY1999 (Ten Notable RWPs)*	183678
2000	*Smear Surveys TA-53 2000*	176870
2000	*Fixed Air Head Results TA-3 CMR 2000*	178725
2000	*Fixed Head Air Sample Results TA-3 2000*	178736
2000	*Air Sample Results TA-3 Building 29 2000*	178801
2000	*Radiological Surveys TA-3 Building 29 2000*	178803
2000	*Giraffe Air Samples TA-53 2000*	178812
2000	*Radiological Incident Reports, Nasal Swipes, Smear, LAS and Direct Surveys TA-3 Building 29*	180915
2000	*Air Samples TA-3 Building 29 Wing 2 December 1999 and January, April–November 2000*	180916
2000	*Air Samples TA-3 Building 29 2000*	180930
2000	*Air Samples TA-3 Building 2000*	180950
2000	*Smear, Counter, Radiation and Contamination Surveys TA-53 April, May, July–September 2000*	180971
2000	*Fixed Head Air Samples TA-3 Building 29 Wing 4 2000*	181009
2000	*Smear and Counter Surveys TA-53 February–May 2000*	181010
2000	*Fixed Head Air Samples TA-3 Building 29 Wing 7 2000*	181343
2001	*Smear Surveys TA-53 February, March, July, August, October 2001*	180863
2001	*Fixed Air Samples and Radiological Surveys TA-3 Building 29 January–September 2001*	180903
2001	*Air Samples and CAM Filter Surveys TA-53 Building 29 2001*	180907
2001	*Air and Smear Samples TA-3 Building 29 2001*	180917
2001	*Air Samples TA-3 Building 29 2001*	180945
2001	*Smear and Counter Surveys TA-53 Building 3 May–December 2001*	180949
2001	*Air Samples TA-3 Building 29 Wing 7 2001*	180986
2001	*Air Samples TA-3 Building 29 Wing 5 2001*	181005
2002	*Fixed Head Air Sample Results TA-3 CMR 2002*	178716
2002	*Fixed Head Air Sample Results TA-3 Building 29 2002*	178727
2002	*Smear and LAS Surveys TA-53 March, April, December 2002*	180871
2002	*Smear and LAS Surveys TA-53 August–December 2002*	180875
2002	*Smear and Counter Surveys TA-53 January–April 2002*	180887
2002	*Air Samples TA-3 Building 29 July–October 2002*	180896
2002	*Air Samples TA-3 Building 29 2001 and January 2002*	180913
2002	*Air Samples TA-3 CMR Building 2002*	180968
2002	*Fixed Air Samples TA-3 Building 29 Wing 2 2002*	180974
2002	*Air Surveys TA-3 Building 29 2002*	181011
2002	*Smear and LAS Surveys TA-53 May–August, November, December 2002*	181027
2002	*UCNI - Smear Surveys Performed in TA-3 2002*	183590

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Year	Title	SRDB Ref ID
2003	*Direct, Smear, Radiation Routine Monthly Surveys TA-3 2003*	178887
2003	*Smear Surveys TA-53 February, March, May–July, August–December 2003*	180862
2003	*Smear Surveys TA-53 February, March, April 2003*	180864
2003	*Smear Surveys TA-53 2003*	180889
2003	*Smear and Semi-Annual Site Surveys TA-53 February, March, June, August–October 2003*	180890
2003	*Air Samples TA-3 2002 and January 2003*	180904
2004	*HSR-1 Smear Surveys TA-53 2004*	178706
2004	*Air Analysis Reports TA-53 Building 7 2004*	178707
2004	*Direct, Smear, Radiological Surveys TA-3 2004*	178817
2004	*Fixed Head Air Sample Results TA-3 Building 29 2004*	178820
2004	*Smear Surveys TA-53 2004*	178821
2004	*Routine Monthly Direct and Smear Contamination Surveys TA-3 2004*	178822
2004	*Air Samples TA-48 RC-1 Alpha Wing January–March 2004*	180922
2004	*Smear and External Radiation Surveys TA-48 Alpha and Dissolving Wings January–March, June, December 2004*	180923
2004	*Smear Surveys TA-48 March, May–July, September, October, December 2004*	180928
2004	*Fixed Air Samples TA-3 Building 29 Wing 7 2004*	180939
2004	*Fixed Air Samples TA-3 Building 29 Wing 5 2004*	180941
2004	*Fixed Air Samples TA-3 Building 29 2004*	180969
2004	*Fixed Air Samples TA-3 Building 29 2004*	180976
2004	*Fixed Head Air Samples TA-3 2004*	181006
2004	*Smear Surveys TA-3 Building 29 February, July–October 2004*	181007
2004	*UCNI - RWPs TA-3 February–December 2004*	181147
2004	*Radiological Incident Reports TA-3 Building 29 2004*	181206
2004	*RWPs TA-3 CY2004*	181134
2005	*Hot Cell Radiation and Smear Surveys TA-48 Building RC-1 January–November 2005*	180820
2005	*Air Samples TA-3 Building 29 January 2005–January 2006*	180900
2005	*Routine Monthly Direct, Smears and Tritium Contamination Surveys TA-3 Buildings*	180909
2005	*Fixed Air Samples TA-3 Building 29 Wing 3*	180943
2005	*Daily RCA Exit Large Area Swipe, Smear and Direct Surveys and RWPs TA-3 Building 29 Wing 3 2005*	180948
2005	*Smear Surveys TA-53 January, March, April, September, December 2005*	180961
2005	*LAS, Direct and Smear Surveys TA-3 Building 29 August–December 2005*	180965
2005	*Fixed Air Samples and Monthly Routine Radiological Surveys TA-3 Building 29 2005*	180980
2005	*Smear and Radiological Surveys TA-53 Building 54 July 2005*	180990
2005	*Smear, LAS and Radiological Surveys TA-53 January, February, May, September, October 2005*	180991
1995–2005	*Smear and Air Samples TA-3 Building 29 Wing 7 1995-2005*	180834
1996–1997	*Smear and Counter Surveys TA-53 February and March 1996 and March 1997*	180955

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Year	Title	SRDB Ref ID
1997–1998	*Direct and Smear Surveys TA-3, TA-48, TA-59 December 1997–December 1998*	181014
1999–2000	*Smear and Counter Surveys TA-53 December 1999–February 2000*	181013
2004–2005	*Fixed Air Samples TA-3 Building 29 October 2004–January 2005*	180964

a. RCA = Radiological Control Area; UCNI = uncontrolled classified nuclear information.

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Table A-2. Smear results exceeding contamination limits, TA-3.

Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start page
06/26/1996	66	D5A	SNM	30	1	0	0	0	LANL 1996a	99
12/17/1997	2009	Rm-132	SNM	100	2	1	0	0	LANL 1997–1999	10
01/05/1999	66	B-100, 107	SNM	20	4	0	0	0	LANL 1999e	207
01/11/1999	66	B-100, 107	SNM	20	8	0	2	0	LANL 1999e	203
01/19/1999	66	B-107, B-3 Vault	SNM	20	3	0	0	0	LANL 1999e	199
01/25/1999	66	B-100, 107, B-3 Vault	SNM	20	7	0	0	0	LANL 1999e	195
01/28/1999	66	B-100	SNM	90	13	1	1	0	LANL 1999–2000a	174
02/01/1999	66	B-100, B-3 Vault	SNM	20	18	3	11	0	LANL 1999e	191
02/09/1999	66	B-100, B-3 Vault	SNM	20	10	3	5	0	LANL 1999e	187
02/17/1999	66	B-100, B-3 Vault	SNM	20	19	5	11	0	LANL 1999e	183
02/24/1999	66	B-100, B-3 Vault	SNM	20	8	0	3	0	LANL 1999e	179
02/26/1999	66	B-100	SNM	75	2	0	0	0	LANL 1999–2000a	159
03/01/1999	66	B-100, B-3 Vault	SNM	20	8	0	2	0	LANL 1999e	175
03/09/1999	66	B-100, B-3 Vault	SNM	20	11	0	5	0	LANL 1999e	171
03/15/1999	66	B-100, B-3 Vault	SNM	20	10	0	0	0	LANL 1999e	166
03/22/1999	66	B-100, B-3 Vault	SNM	20	9	0	0	0	LANL 1999e	162
03/29/1999	66	B-100	SNM	20	3	0	1	0	LANL 1999e	158
03/30/1999	66	B-101	DU[a]	80	1	0	0	0	LANL 1999–2000a	20
04/05/1999	66	B-100	SNM	20	2	0	1	0	LANL 1999e	154
04/12/1999	66	B-100	SNM	20	3	0	0	0	LANL 1999e	150
04/19/1999	66	B-100, B-3 Vault	SNM	20	4	0	1	0	LANL 1999e	146
04/26/1999	66	B-100, B-3 Vault	SNM	20	3	0	1	0	LANL 1999e	142
05/03/1999	66	B-100, B-3 Vault	SNM	20	5	0	1	0	LANL 1999e	138
05/10/1999	66	B-100	SNM	20	3	0	2	0	LANL 1999e	134
05/17/1999	66	B-100	SNM	20	5	0	0	0	LANL 1999e	126
05/24/1999	66	B-100	SNM	20	5	0	2	0	LANL 1999e	122
06/01/1999	66	B-100, B-3 Vault	SNM	20	7	0	3	0	LANL 1999e	130
06/07/1999	66	B-100	SNM	20	3	0	1	0	LANL 1999e	118
06/14/1999	66	B-100, B-3 Vault	SNM	20	7	0	1	0	LANL 1999e	115
06/15/1999	66	B-101, 108	SNM	110	2	0	0	0	LANL 1999–2000a	124
06/24/1999	66	B-100, B-3 Vault	SNM	20	7	0	2	0	LANL 1999e	111
06/28/1999	66	B-100	SNM	20	3	0	0	0	LANL 1999e	107
07/06/1999	66	B-100, B-3 Vault	SNM	20	7	0	2	0	LANL 1999e	103
07/12/1999	66	B-100, B-3 Vault	SNM	20	5	0	0	0	LANL 1999e	99
07/14/1999	66	B-100	SNM	110	3	0	1	0	LANL 1999–2000a	107

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Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start page
07/19/1999	66	B-100, B-3 Vault	SNM	20	8	0	0	0	LANL 1999e	95
07/26/1999	66	B-100	SNM	20	3	0	0	0	LANL 1999e	91
08/02/1999	66	B-100, B-3 Vault	SNM	20	5	0	0	0	LANL 1999e	87
08/09/1999	66	B-100, B-3 Vault	SNM	20	7	0	1	0	LANL 1999e	83
08/16/1999	66	B-100, B-3 Vault	SNM	20	7	1	1	0	LANL 1999e	79
08/24/1999	66	B-100	SNM	20	4	0	0	0	LANL 1999e	75
08/25/1999	66	B-100	SNM	98	1	0	0	0	LANL 1999–2000a	90
08/30/1999	66	B-100	SNM	20	4	0	0	0	LANL 1999e	71
09/07/1999	66	B-100, B-3 Vault	SNM	20	4	0	0	0	LANL 1999e	67
09/13/1999	66	B-100, B-3 Vault	SNM	20	6	0	1	0	LANL 1999e	63
09/20/1999	66	B-100	SNM	20	3	0	1	0	LANL 1999e	59
09/21/1999	66	B-100	SNM	98	2	0	0	0	LANL 1999–2000a	73
09/27/1999	66	B-100	SNM	20	3	0	1	0	LANL 1999e	43
09/27/1999	29	5130	Actinides	50	1	0	0	0	LANL 1999f	89
09/29/1999	29	5116, 5126	Actinides	56	4	0	0	0	LANL 1999f	84
10/04/1999	66	B-100	SNM	20	3	0	2	0	LANL 1999e	55
10/12/1999	66	B-100	SNM	20	3	0	0	0	LANL 1999e	51
10/18/1999	66	B-100	SNM	20	3	0	0	0	LANL 1999e	47
10/25/1999	66	B-100	SNM	20	4	0	3	0	LANL 1999e	39
11/01/1999	66	B-100, B-3 Vault	SNM	20	7	1	5	0	LANL 1999e	25
11/03/1999	29	5114, 5116, 5125	Actinides	56	4	0	0	0	LANL 1999f	79
11/08/1999	66	B-100, B-3 Vault	SNM	20	7	0	5	0	LANL 1999e	35
11/10/1999	29	5023	Actinides	40	34	1	0	0	LANL 1999f	2
11/15/1999	66	B-100, B-3 Vault	SNM	20	10	0	3	0	LANL 1999e	30
11/22/1999	66	B-100, B-3 Vault	SNM	20	10	0	2	0	LANL 1999e	21
11/24/1999	29	Wing 5	Actinides	27	4	1	0	0	LANL 1999f	16
11/29/1999	66	B-100, B-3 Vault	SNM	20	8	0	1	0	LANL 1999e	7
12/07/1999	66	B-100, B-3 Vault	SNM	20	12	0	6	0	LANL 1999e	17
12/13/1999	66	B-100, B-3 Vault	SNM	20	17	0	10	0	LANL 1999e	13
12/20/1999	66	B-100, B-3 Vault	SNM	20	11	0	9	0	LANL 1999e	11
12/21/1999	66	B-100	SNM	98	9	1	0	0	LANL 1999–2000a	2
01/03/2000	66	B-100, B-3 Vault	SNM	20	10	0	3	0	LANL 1999e	2
01/25/2000	66	B-100	SNM	98	6	1	0	0	LANL 1999–2000a	37
04/05/2000	29	5113, 5121, 5125	Actinides	100	3	0	0	0	LANL 2000d	446
04/05/2000	29	5116, 5120, 5126	Actinides	100	3	1	0	0	LANL 2000d	466
04/13/2000	29	2130, 2134	Actinides	80	3	0	0	0	LANL 2000c	8
04/17/2000	29	2114	Actinides	90	7	1	0	0	LANL 2000c	17

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Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start page
05/26/2000	29	Wing 5	Actinides	50	1	0	0	0	LANL 2000d	476
08/16/2000	29	2114, 2129	Actinides	5	2	2	0	0	LANL 2000e	307
12/13/2000	29	5047	Actinides	100	1	0	0	0	LANL 2000d	433
12/13/2000	29	5012	Actinides	30	3	0	0	0	LANL 2000f	107
06/14/2001	29	2124, 2131	Actinides	100	3	0	0	0	LANL 2000f	395
12/21/2001	29	2113, 2128	Actinides	100	2	0	0	0	LANL 2000f	386
02/04/2004	29	4130	SNM	20	1	0	0	0	LANL 2004a	53
04/26/2004	29	2114	Actinides	12	1	0	0	0	LANL 2004b	88
05/10/2004	29	2134	Actinides	12	1	0	0	0	LANL 2004b	74
05/17/2004	29	2112, 2136	Actinides	12	2	0	0	0	LANL 2004b	67
06/07/2004	29	2136	Actinides	12	1	0	0	0	LANL 2004b	46
06/14/2004	29	2136	Actinides	12	1	0	0	0	LANL 2004b	39
06/30/2004	29	3158, 3024, 3034	Actinides	66	4	1	0	0	LANL 2004c	650
07/13/2004	29	4160	Uranium	20	1	0	0	0	LANL 2004a	101
07/13/2004	29	4161	Uranium	48	2	0	0	0	LANL 2004a	105
07/30/2004	2008	124	SNM	65	1	0	0	0	LANL 2004d	71
08/02/2004	29	4130	SNM	100	1	0	0	0	LANL 2004a	2
08/03/2004	29	4110	SNM	100	1	0	0	0	LANL 2004a	25
08/10/2004	29	4125, 4129, 4131	SNM	100	4	0	0	0	LANL 2004a	36
08/12/2004	29	4066	SNM	100	1	0	0	0	LANL 2004a	45
08/13/2004	29	4034, 4064	SNM	100	22	0	0	0	LANL 2004a	11
08/13/2004	29	4023	SNM	77	12	1	0	0	LANL 2004a	19
09/23/2004	29	4295	SNM	70	8	0	0	0	LANL 2004a	58
09/27/2004	29	4177, 4195	SNM	100	4	0	0	0	LANL 2004a	70
09/28/2004	29	Wing 4	SNM	100	7	0	0	0	LANL 2004a	78
09/29/2004	29	Wing 4	SNM	100	6	0	0	0	LANL 2004a	86
10/29/2004	2010	47	SNM	65	1	0	0	0	LANL 2004d	108
01/03/2005	29	2112	Actinides	18	1	0	0	0	LANL 2005–2006	336
01/11/2005	29	2136	Actinides	18	1	0	0	0	LANL 2005–2006	344
06/24/2005	29	2129	Actinides	15	1	1	0	0	LANL 2005–2006	319
08/08/2005	29	4137	SNM	100	1	0	0	0	LANL 2005a	137
08/10/2005	29	4034, 4064	SNM	100	2	0	0	0	LANL 2005a	143
08/10/2005	29	4064	SNM	20	1	0	0	0	LANL 2005a	150

a. DU = depleted uranium.

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Table A-3. Air monitoring results exceeding airborne contamination limits, TA-3.

Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
01/26/2000	29	Wing 5	Actinides	67	1	0	LANL 2000d	187
02/02/2000	29	Wing 5	Actinides	67	3	0	LANL 2000d	195
02/02/2000	29	Wing 2	Actinides	62	3	0	LANL 2000e	257
02/09/2000	29	Wing 5	Actinides	67	3	0	LANL 2000d	2
02/16/2000	29	Wing 5	Actinides	67	3	0	LANL 2000d	10
03/01/2000	29	Wing 5	Actinides	68	2	0	LANL 2000d	26
03/08/2000	29	Wing 7	Actinides	58	2	0	LANL 2000–2001	115
03/15/2000	29	Wing 5	Actinides	68	1	0	LANL 2000d	42
03/15/2000	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 1999–2001	21
03/15/2000	29	Wing 7	Actinides	58	1	0	LANL 2000–2001	127
03/22/2000	29	Wing 7	Actinides	20	6	0	LANL 2000–2001	146
04/12/2000	29	Wing 2	Actinides	64	1	0	LANL 1999–2000b	147
04/12/2000	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 1999–2001	12
04/19/2000	29	Wing 2	Actinides	64	1	0	LANL 1999–2000b	140
04/26/2000	29	Wing 5	Actinides	64	3	0	LANL 1999–2000b	137
05/31/2000	29	Wing 2	Actinides	64	3	0	LANL 1999–2000b	112
06/14/2000	29	Wing 5	Actinides	68	1	0	LANL 2000d	129
06/21/2000	29	Wing 5	Actinides	1	1	0	LANL 2000d	137
06/21/2000	29	Wing 5	Actinides	68	1	0	LANL 2000d	139
06/28/2000	29	Wing 5	Actinides	68	1	0	LANL 2000d	203
10/11/2000	29	Wing 9	MAP/MFP/Actinides	28	2	0	LANL 1999–2001	2
10/18/2000	29	Wing 5	Actinides	69	2	0	LANL 2000d	322
11/01/2000	29	Wing 5	Actinides	69	2	0	LANL 2000d	336
11/15/2000	29	Wing 7	Actinides	58	1	0	LANL 2000–2001	11
12/20/2000	29	Wing 5	Actinides	69	1	0	LANL 2001c	87
01/03/2001	29	Wing 5	Actinides	69	2	0	LANL 2001c	80
01/24/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	59
02/28/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	23
03/07/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	250
03/14/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	9
04/04/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	185
04/25/2001	29	Wing 5	Actinides	69	2	0	LANL 2001c	163
05/02/2001	29	Wing 4	Actinides	10	1	0	LANL 2001d	69
05/02/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	155
05/09/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	185

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Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
05/09/2001	29	Wing 9	MAP/MFP/Actinides	28	2	0	LANL 2001–2002a	115
05/16/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	178
05/23/2001	29	Wing 9	MAP/MFP/Actinides	28	2	0	LANL 2001–2002a	111
05/30/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	123
06/06/2001	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 2001–2002a	107
06/06/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	115
06/20/2001	29	Wing 4	Actinides	10	2	0	LANL 2001d	53
06/20/2001	29	Wing 5	Actinides	59	2	0	LANL 2001c	94
06/27/2001	29	Wing 2	Actinides	66	1	0	LANL 2001b	134
07/04/2001	29	Wing 5	Actinides	69	2	0	LANL 2001c	287
07/11/2001	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 2001–2002a	91
07/18/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	271
07/25/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	263
08/01/2001	29	Wing 5	Actinides	69	2	0	LANL 2001c	255
08/15/2001	29	Wing 7	Actinides	58	1	0	LANL 2001–2002b	92
08/22/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	94
08/29/2001	29	Wing 7	Actinides	58	1	0	LANL 2001–2002b	82
09/05/2001	29	Wing 7	Actinides	58	1	0	LANL 2001–2002b	77
09/12/2001	29	Wing 3	Actinides	32	2	0	LANL 2001–2002c	51
09/12/2001	29	Wing 7	Actinides	58	3	0	LANL 2001–2002b	72
09/12/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	207
09/19/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	199
10/03/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	372
10/10/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	55
10/10/2001	29	Wing 7	Actinides	58	1	0	LANL 2001–2002b	38
10/10/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	364
10/24/2001	29	Wing 2	Actinides	64	1	0	LANL 2001b	49
11/20/2001	29	Wing 5	Actinides	69	1	0	LANL 2001c	324
12/12/2001	29	Wing 7	Actinides	60	1	0	LANL 2001–2002b	2
01/09/2002	29	Wing 7	Actinides	60	1	0	LANL 2002d	261
02/06/2002	29	Wing 7	Actinides	60	2	0	LANL 2002d	240
02/13/2002	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 2002b	176
02/27/2002	29	Wing 2	Actinides	64	1	0	LANL 2002–2003	229
03/06/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	277
03/20/2002	29	Wing 7	Actinides	60	1	0	LANL 2002d	208
04/03/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	249

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Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
04/10/2002	29	Wing 2	Actinides	64	1	0	LANL 2002–2003	196
05/08/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	214
05/29/2002	29	Wing 9	MAP/MFP/Actinides	28	1	0	LANL 2002b	113
05/29/2002	29	Wing 7	Actinides	61	6	0	LANL 2002d	155
06/05/2002	29	Wing 2	Actinides	64	1	0	LANL 2002–2003	156
06/12/2002	29	Wing 7	Actinides	61	7	0	LANL 2002d	144
06/19/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	169
07/03/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	128
07/03/2002	29	Wing 2	Actinides	64	1	0	LANL 2002–2003	127
07/10/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	122
07/24/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	138
07/31/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	79
07/31/2002	29	Wing 2	Actinides	64	2	0	LANL 2002–2003	104
08/07/2002	29	Wing 9	MAP/MFP/Actinides	29	3	0	LANL 2002b	75
08/07/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	122
08/14/2002	29	Wing 7	Actinides	61	2	0	LANL 2002d	97
08/21/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	108
08/28/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	64
09/04/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	60
09/04/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	82
09/11/2002	29	Wing 7	Actinides	61	4	0	LANL 2002d	76
09/18/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	52
09/18/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	70
09/25/2002	29	Wing 9	MAP/MFP/Actinides	29	2	0	LANL 2002b	48
09/25/2002	29	Wing 7	Actinides	61	3	0	LANL 2002d	64
09/25/2002	29	Wing 2	Actinides	65	1	0	LANL 2002–2003	63
10/02/2002	29	Wing 9	MAP/MFP/Actinides	29	2	0	LANL 2002b	44
10/02/2002	29	Wing 7	Actinides	61	2	0	LANL 2002d	58
10/09/2002	29	Wing 9	MAP/MFP/Actinides	29	2	0	LANL 2002b	40
10/09/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	53
10/09/2002	29	Wing 2	Actinides	65	1	0	LANL 2002–2003	52
10/23/2002	29	Wing 7	Actinides	61	4	0	LANL 2002d	42
10/30/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	30
10/30/2002	29	Wing 7	Actinides	61	1	0	LANL 2002d	37
11/20/2002	29	Wing 5	Actinides	69	1	0	LANL 2002c	18
11/27/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	14

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Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
12/11/2002	29	Wing 9	MAP/MFP/Actinides	29	1	0	LANL 2002b	6
01/21/2004	29	Wing 3	Actinides	34	1	0	LANL 2004e	12
01/28/2004	29	Wing 3	Actinides	33	2	0	LANL 2004e	15
04/21/2004	29	Wing 7	Actinides	67	1	0	LANL 2004–2005a	142
12/01/2004	29	Wing 2	Actinides	66	1	0	LANL 2004–2005b	10
02/16/2005	29	Wing 2	Actinides	66	1	0	LANL 2005–2006	30
03/09/2005	29	Wing 2	Actinides	66	1	0	LANL 2005–2006	43
05/04/2005	29	Wing 5	Actinides	69	1	0	LANL 2005–2006	135
10/05/2005	29	Wing 5	Actinides	69	1	0	LANL 2005–2006	46
11/09/2005	29	Wing 2	Actinides	66	1	0	LANL 2005–2006	257

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Table A-4. Smear results exceeding contamination limits, TA-48.

Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start Page
02/04/1997	RC-1	423	MAP/MFP/Actinides	53	1	0	0	0	LANL 1997b	458
03/13/1997	RC-1	322	MAP/MFP/Actinides	46	1	0	0	0	LANL 1997b	627
04/07/1997	RC-1	326	MAP/MFP/Actinides	46	1	0	0	0	LANL 1997b	632
05/29/1997	RC-1	338	MAP/MFP/Actinides	46	1	1	1	0	LANL 1997b	637
06/18/1997	RC-1	326	MAP/MFP/Actinides	46	1	0	0	0	LANL 1997b	644
07/24/1997	RC-1	322	MAP/MFP/Actinides	46	1	0	0	0	LANL 1997b	649
08/06/1997	RC-1	326	MAP/MFP/Actinides	46	1	0	0	0	LANL 1997b	654
09/25/1997	RC-1	305	MAP/MFP/Actinides	36	1	0	0	0	LANL 1997b	89
09/25/1997	RC-1	306	MAP/MFP/Actinides	17	1	0	0	0	LANL 1997b	94
09/25/1997	RC-1	309	MAP/MFP/Actinides	40	1	0	0	0	LANL 1997b	142
09/25/1997	RC-1	312	MAP/MFP/Actinides	36	2	0	0	0	LANL 1997b	201
09/30/1997	RC-1	408	MAP/MFP/Actinides	32	2	0	2	0	LANL 1997b	276
09/30/1997	RC-1	412	MAP/MFP/Actinides	18	1	0	0	0	LANL 1997b	354
09/30/1997	RC-1	421	MAP/MFP/Actinides	29	1	0	0	0	LANL 1997b	442
10/26/1997	RC-1	308	MAP/MFP/Actinides	32	1	0	0	0	LANL 1997b	134
10/28/1997	RC-1	305	MAP/MFP/Actinides	36	2	0	0	0	LANL 1997b	77
10/29/1997	RC-1	310	MAP/MFP/Actinides	16	1	0	0	0	LANL 1997b	162
10/29/1997	RC-1	312	MAP/MFP/Actinides	38	1	1	0	0	LANL 1997b	196
10/30/1997	RC-1	402	MAP/MFP/Actinides	28	1	0	0	0	LANL 1997b	254
10/31/1997	RC-1	421	MAP/MFP/Actinides	29	1	0	0	0	LANL 1997b	438
11/19/1997	RC-1	314	MAP/MFP/Actinides	70	3	0	0	0	LANL 1997b	677
11/25/1997	RC-1	309	MAP/MFP/Actinides	36	1	0	0	0	LANL 1997b	151
11/25/1997	RC-1	310	MAP/MFP/Actinides	16	1	0	0	0	LANL 1997b	166
11/25/1997	RC-1	402	MAP/MFP/Actinides	28	1	0	0	0	LANL 1997b	250
11/26/1997	RC-1	309	MAP/MFP/Actinides	16	1	0	0	0	LANL 1997b	300
11/26/1997	RC-1	415	MAP/MFP/Actinides	28	1	0	0	0	LANL 1997b	395
11/26/1997	RC-1	421	MAP/MFP/Actinides	29	1	0	0	0	LANL 1997b	446
12/01/1997	RC-1	315	MAP/MFP/Actinides	70	5	0	0	0	LANL 1997b	682
12/17/1997	RC-1	309	MAP/MFP/Actinides	32	2	1	0	0	LANL 1997b	155
12/17/1997	RC-1	312	MAP/MFP/Actinides	32	1	0	0	0	LANL 1997b	188
12/18/1997	RC-1	402	MAP/MFP/Actinides	28	1	0	0	0	LANL 1997b	246
12/18/1997	RC-1	415	MAP/MFP/Actinides	28	1	0	0	0	LANL 1997b	391
12/19/1997	RC-1	4B	MAP/MFP/Actinides	15	1	0	0	0	LANL 1997b	226
12/19/1997	RC-1	6	MAP/MFP/Actinides	32	1	0	0	0	LANL 1997b	229

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Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start Page
12/19/1997	RC-1	409	MAP/MFP/Actinides	16	1	0	0	0	LANL 1997b	296
12/19/1997	RC-1	421	MAP/MFP/Actinides	29	1	1	0	0	LANL 1997b	450
01/04/1999	RC-1	315	MAP/MFP/Actinides	70	0	0	1	0	LANL 1999g	2
03/01/1999	RC-1	Hot Cell	MAP/MFP/Actinides	79	0	0	8	0	LANL 1999g	16
04/01/1999	RC-1	430	MAP/MFP/Actinides	60	1	0	0	0	LANL 1999h	21
04/08/1999	RC-1	314, 326	MAP/MFP/Actinides	70	2	0	0	0	LANL 1999g	22
06/01/1999	RC-1	606	MAP/MFP/Actinides	50	1	0	0	0	LANL 1999h	247
07/01/1999	RC-1	315, 338	MAP/MFP/Actinides	70	0	0	2	0	LANL 1999g	36
08/03/1999	RC-1	315	MAP/MFP/Actinides	70	0	0	1	0	LANL 1999g	45
09/01/1999	RC-1	430	MAP/MFP/Actinides	60	1	0	0	0	LANL 1999h	46
10/01/1999	RC-1	606	MAP/MFP/Actinides	50	1	0	1	0	LANL 1999h	188
09/16/2004	RC-1	414	MAP/MFP/Actinides	95	1	0	0	0	LANL 2004f	2
12/08/2004	RC-1	414	MAP/MFP/Actinides	95	1	0	0	0	LANL 2004f	21
05/31/2005	RC-1	315	MAP/MFP/Actinides	40	1	0	0	0	LANL 2005b	54
07/26/2005	RC-1	314	MAP/MFP/Actinides	50	0	0	1	0	LANL 2005b	66
09/28/2005	RC-1	315	MAP/MFP/Actinides	50	0	0	2	0	LANL 2005b	96

Table A-5. Air monitoring results exceeding airborne contamination limits, TA-48.

Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
03/18/1997	RC-1	332-D	MAP/MFP/Actinides	18	1	0	LANL 1996–1998	172
05/27/1997	RC-1	Hot Cell	MAP/MFP/Actinides	4	3	0	LANL 1996–1998	301
08/05/1997	RC-1	332, 344	MAP/MFP/Actinides	18	5	0	LANL 1996–1998	222
10/01/1997	RC-1	332	MAP/MFP/Actinides	18	3	0	LANL 1996–1998	235
11/05/1997	RC-1	332	MAP/MFP/Actinides	18	1	0	LANL 1996–1998	239
01/05/1998	RC-1	332	MAP/MFP/Actinides	18	3	0	LANL 1998b	6
01/28/1998	RC-1	332	MAP/MFP/Actinides	18	4	0	LANL 1998b	11
02/17/1998	RC-1	606	MAP/MFP/Actinides	15	4	0	LANL 1998–1999	30
03/01/1999	RC-1	332	MAP/MFP/Actinides	18	4	0	LANL 1999i	12
08/03/1999	RC-1	332	MAP/MFP/Actinides	18	1	0	LANL 1999i	31

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Table A-6. Smear results exceeding contamination limits, TA-53.

Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start page
01/04/1996	MPF-3M	Area A	MAP/Rn/Tn	60	0	0	1	0	LANL 1996–1997a	70
02/01/1996	MPF-3M	Switchyard	MAP/Rn/Tn	26	7	1	4	0	LANL 1996–1997a	574
02/06/1996	MPF-3M	Area A	MAP/Rn/Tn	50	1	0	1	0	LANL 1996–1997a	704
02/07/1996	MPF-3M	Area A	MAP/Rn/Tn	86	0	0	1	0	LANL 1996–1997a	850
02/13/1996	MPF-3M	Area A	MAP/Rn/Tn	70	11	0	2	0	LANL 1996–1997b	2
02/15/1996	MPF-3M	Area A	MAP/Rn/Tn	50	1	0	2	0	LANL 1996–1997b	92
03/15/1996	MPF-3M	Area A	MAP/Rn/Tn	50	3	0	2	0	LANL 1996–1997b	553
03/26/1996	MPF-3M	Area A	MAP/Rn/Tn	100	8	0	7	0	LANL 1996–1997b	765
03/26/1996	MPF-25	Aberdeen Steel	MAP/Rn/Tn	100	2	0	0	0	LANL 1996–1997b	835
04/05/1996	MPF-3M	Area A	MAP/Rn/Tn	70	3	0	4	0	LANL 1996b	141
04/19/1996	MPF-3M	Area A	MAP/Rn/Tn	100	1	0	0	0	LANL 1996b	381
04/24/1996	MPF-7	1LSA	MAP/Actinides/Rn/Tn	60	10	1	2	0	LANL 1996b	475
04/30/1996	MPF-7	1LSA	MAP/Actinides/Rn/Tn	42	6	0	1	0	LANL 1996b	569
05/03/1996	MPF-3M	Area A	MAP/Rn/Tn	100	2	0	0	0	LANL 1996b	613
05/15/1996	MPF-3M	Area A	MAP/Rn/Tn	70	1	0	0	0	LANL 1996c	259
05/25/1996	MPF-7	ER-1	MAP/Actinides/Rn/Tn	30	2	0	0	0	LANL 1996c	19
05/28/1996	MPF-3M	Area A	MAP/Rn/Tn	100	1	0	1	0	LANL 1996c	87
05/31/1996	MPF-3M	Area A	MAP/Rn/Tn	70	1	0	0	0	LANL 1996c	459
03/14/1997	MPF-3M	Area A	MAP/Rn/Tn	90	3	0	0	0	LANL 1996–1997c	32
05/18/1997	MPF-8	PSR	MAP/Rn/Tn	30	1	0	1	0	LANL 1997c	56
07/14/1997	MPF-3P	HRS	MAP/Rn/Tn	40	3	0	4	0	LANL 1997d	19
10/24/1997	MPF-7	1LTC	MAP/Actinides/Rn/Tn	10	9	0	0	0	LANL 1997–1998	326
11/06/1997	MPF-3M	Area A	MAP/Rn/Tn	10	0	0	1	0	LANL 1997–1998	278
02/03/1999	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	2	0	1	0	LANL 1999j	251
12/14/1999	MPF-30	ER-2	MAP/Actinides/Rn/Tn	100	4	0	3	0	LANL 1999k	15
12/15/1999	MPF-7	Blue Room	MAP/Actinides/Rn/Tn	20	12	0	7	0	LANL 1999k	8
01/13/2000	MPF-7	ER-1	MAP/Actinides/Rn/Tn	25	1	0	0	0	LANL 1999–2000c	78
02/03/2000	MPF-8	PSR	MAP/Rn/Tn	100	2	0	0	0	LANL 1999–2000c	280
08/30/2000	MPF-7	Blue Room	MAP/Actinides/Rn/Tn	6	0	0	5	0	LANL 2000g	210
09/21/2000	MPF-27	Exit Light 28	MAP/Rn/Tn	100	1	0	0	0	LANL 2000g	36
10/14/2000	MPF-25	Aberdeen Steel	MAP/Rn/Tn	100	8	0	0	0	LANL 2000g	603
10/24/2000	MPF-1	LOB	MAP/Rn/Tn	90	2	0	0	0	LANL 2000g	535
12/12/2000	MPF-30	ER-2	MAP/Actinides/Rn/Tn	100	1	0	0	0	LANL 2000g	338
02/18/2003	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	0	0	1	0	LANL 2003b	47
06/12/2003	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	0	0	1	0	LANL 2003b	143

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Date	Building number	Location	Primary source	Number of results	Exceeded lower limit alpha	Exceeded upper limit alpha	Exceeded lower limit beta	Exceeded upper limit beta	Source	Start page
08/26/2003	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	0	0	1	0	LANL 2003c	337
10/07/2003	MPF-3S	Switchyard	MAP/Rn/Tn	95	1	0	0	0	LANL 2003c	175
07/02/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	0	0	1	0	LANL 2004g	120
09/13/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	1	0	1	0	LANL 2004g	113
12/16/2004	MPF-3M	Area A	MAP/Rn/Tn	100	2	0	1	0	LANL 2004h	285
12/18/2004	MPF-3M	Area A	MAP/Rn/Tn	92	1	0	0	0	LANL 2004h	210
12/18/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	100	2	0	0	0	LANL 2004h	222

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Table A-7. Air monitoring results exceeding airborne contamination limits, TA-53.[a]

Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
01/02/1996	MPF-3M	Area A	MAP/Rn/Tn	2	2	0	LANL 1996d	34
01/08/1996	MPF-3M	Area A	MAP/Rn/Tn	2	2	0	LANL 1996d	30
01/16/1996	MPF-7	1LTC	MAP/Actinides/Rn/Tn	10	1	0	LANL 1996d	27
01/22/1996	MPF-3M	Area A	MAP/Rn/Tn	7	5	0	LANL 1996d	14
02/12/1996	MPF-3M, 7	1LTC, Area A	MAP/Actinides/Rn/Tn	6	4	0	LANL 1996d	18
02/20/1996	MPF-3M	Area A	MAP/Rn/Tn	2	2	0	LANL 1996d	11
02/26/1996	MPF-3M, 7	Area A, ER-1	MAP/Actinides/Rn/Tn	8	2	0	LANL 1996d	93
03/04/1996	MPF-3M, 7	Area A, ER-1	MAP/Actinides/Rn/Tn	9	5	0	LANL 1996d	94
03/11/1996	MPF-3M, 7	1LSA, Area A	MAP/Actinides/Rn/Tn	7	4	0	LANL 1996d	89
03/22/1996	MPF-3M	Area A	MAP/Rn/Tn	8	5	0	LANL 1996d	77
03/28/1996	MPF-3M, 7	Area A, 1LSA, 1LTC	MAP/Actinides/Rn/Tn	14	9	1	LANL 1996d	80
04/01/1996	MPF-3M	Area A	MAP/Rn/Tn	3	3	0	LANL 1996d	84
04/08/1996	MPF-3M	Area A	MAP/Rn/Tn	8	2	0	LANL 1996d	67
04/15/1996	MPF-3M	Area A	MAP/Rn/Tn	7	1	0	LANL 1996d	64
12/24/1996	MPF-3M	Area A	MAP/Rn/Tn	9	3	0	LANL 1997e	40
12/30/1996	MPF-3M	Area A	MAP/Rn/Tn	2	1	0	LANL 1996d	103
01/13/1997	MPF-3M	Area A	MAP/Rn/Tn	24	2	1	LANL 1997e	44
01/31/1997	MPF-3M	Area A	MAP/Rn/Tn	14	1	0	LANL 1997e	56
02/10/1997	MPF-3M	Area A	MAP/Rn/Tn	1	1	1	LANL 1997e	60
02/13/1997	MPF-3M	Area A	MAP/Rn/Tn	17	2	0	LANL 1997e	66
02/20/1997	MPF-3M	Area A	MAP/Rn/Tn	6	3	0	LANL 1997e	70
02/25/1997	MPF-3M	Area A	MAP/Rn/Tn	10	5	0	LANL 1997e	75
03/03/1997	MPF-3M	Area A	MAP/Rn/Tn	14	1	0	LANL 1997e	81
03/10/1997	MPF-3M	Area A	MAP/Rn/Tn	8	1	0	LANL 1997e	84
03/17/1997	MPF-3M	Area A	MAP/Rn/Tn	6	4	0	LANL 1997e	87
03/17/1997	MPF-3M, 30	Area A, ER-2	MAP/Actinides/Rn/Tn	8	2	0	LANL 1997e	93
03/24/1997	MPF-3M, 7, 30	Area A, ER-1, 2	MAP/Actinides/Rn/Tn	5	4	0	LANL 1997e	90
04/03/1997	MPF-3M	Area A	MAP/Rn/Tn	10	1	0	LANL 1997e	97
04/10/1997	MPF-3M	Area A	MAP/Rn/Tn	5	1	0	LANL 1997e	101
04/16/1997	MPF-3M, 29	Area A, Not available	MAP/Actinides/Rn/Tn	6	2	0	LANL 1997e	125
04/21/1997	MPF-3M, 7	Area A, ER-1	MAP/Actinides/Rn/Tn	9	7	2	LANL 1997e	105
04/30/1997	MPF-3P	HRS	MAP/Rn/Tn	7	1	0	LANL 1997e	113
06/04/1997	MPF-3M	Area A	MAP/Rn/Tn	8	2	0	LANL 1997e	132
06/13/1997	MPF-3M, 30	Area A, ER-2	MAP/Actinides/Rn/Tn	14	3	1	LANL 1997e	136
06/22/1997	MPF-3M	Area A	MAP/Rn/Tn	9	1	0	LANL 1997e	139

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SUPPORTING TABLES (continued)

Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
06/27/1997	MPF-3M, 7	Area A, ER-1	MAP/Actinides/Rn/Tn	4	2	0	LANL 1997e	143
07/20/1997	MPF-3M	Area A	MAP/Rn/Tn	4	1	0	LANL 1997e	153
08/15/1997	MPF-3M	Area A	MAP/Rn/Tn	21	1	0	LANL 1997e	161
08/25/1997	MPF-7	1LTC	MAP/Actinides/Rn/Tn	20	0	1	LANL 1997e	164
09/02/1997	MPF-7	1LTC	MAP/Actinides/Rn/Tn	11	2	2	LANL 1997e	167
09/03/1997	MPF-3M	Area A	MAP/Rn/Tn	9	1	0	LANL 1997e	172
09/22/1997	MPF-3M, 7	Area A, 1LTC	MAP/Actinides/Rn/Tn	15	4	0	LANL 1997e	178
09/29/1997	MPF-3M	Area A	MAP/Rn/Tn	24	3	0	LANL 1997e	181
10/03/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	36	7	0	LANL 1997e	184
10/10/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	31	8	0	LANL 1997e	187
10/17/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	34	16	0	LANL 1997e	190
10/27/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	32	12	0	LANL 1997e	193
11/03/1997	MPF-3M, 7	Area A, 1L TGT, ER-1	MAP/Actinides/Rn/Tn	33	22	1	LANL 1997e	196
11/07/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	19	12	1	LANL 1997e	199
11/17/1997	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	23	7	0	LANL 1997e	202
11/22/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	11	7	0	LANL 1997e	205
11/25/1997	MPF-3M, 7	Area A, 1L TGT	MAP/Actinides/Rn/Tn	35	8	0	LANL 1997e	208
12/15/1997	MPF-3M	Area A	MAP/Rn/Tn	22	3	2	LANL 1997e	216
12/19/1997	MPF-3M	Area A	MAP/Rn/Tn	9	1	0	LANL 1997e	213
01/15/1998	MPF-3M	Area A	MAP/Rn/Tn	18	1	0	LANL 1998c	163
01/29/1998	MPF-3M	Area A	MAP/Rn/Tn	27	1	0	LANL 1998c	157
02/06/1998	MPF-3M	Area A	MAP/Rn/Tn	25	1	2	LANL 1998c	154
02/13/1998	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	10	2	0	LANL 1998c	152
02/17/1998	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	32	2	0	LANL 1998c	149
03/09/1998	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	15	3	0	LANL 1998c	143
03/12/1998	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	14	1	0	LANL 1998c	138
03/19/1998	MPF-7	1L TGT	MAP/Actinides/Rn/Tn	11	2	0	LANL 1998c	136
04/10/1998	MPF-7	1LSA	MAP/Actinides/Rn/Tn	21	4	0	LANL 1998c	127
05/11/1998	MPF-3M, 7	Area A, 1LSA, 1LTC	MAP/Actinides/Rn/Tn	15	2	0	LANL 1998c	116
05/18/1998	MPF-7	1LSA	MAP/Actinides/Rn/Tn	12	1	0	LANL 1998c	112
05/21/1998	MPF-3M	Area A	MAP/Rn/Tn	18	2	0	LANL 1998c	109
06/01/1998	MPF-3M	Area A, ES-3	MAP/Rn/Tn	22	2	0	LANL 1998c	106
06/12/1998	MPF-3M	Area A	MAP/Rn/Tn	15	2	0	LANL 1998c	100
06/19/1998	MPF-3M	Area A	MAP/Rn/Tn	24	1	0	LANL 1998c	97
07/01/1998	MPF-3M	Area A	MAP/Rn/Tn	8	1	0	LANL 1998c	94
08/04/1998	MPF-3M	Area A	MAP/Rn/Tn	12	1	0	LANL 1998c	80

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SUPPORTING TABLES (continued)

Date	Building number	Location	Primary source	Number of results	Exceeded limit alpha	Exceeded limit beta	Source	Start page
08/10/1998	MPF-3M	Area A	MAP/Rn/Tn	15	1	0	LANL 1998c	77
08/25/1998	MPF-3M	Area A	MAP/Rn/Tn	15	3	0	LANL 1998c	71
09/08/1998	MPF-3M	Area A	MAP/Rn/Tn	12	1	0	LANL 1998c	65
10/26/1998	MPF-29	WNR	MAP/Actinides/Rn/Tn	10	1	0	LANL 1998c	43
09/08/1999	MPF-3M	Area A	MAP/Rn/Tn	6	4	0	LANL 1999l	100
09/14/1999	MPF-3M	Area A	MAP/Rn/Tn	10	1	0	LANL 1999l	98
09/20/1999	MPF-3M	Area A	MAP/Rn/Tn	5	1	0	LANL 1999l	96
10/24/1999	MPF-7, 28	ER-1, Not available	MAP/Actinides/Rn/Tn	6	3	0	LANL 1999l	66
11/05/1999	MPF-3M, 8, 28	Area A, Not available, PSR	MAP/Actinides	20	4	0	LANL 1999l	56
11/05/1999	MPF-29	Not available	MAP/Actinides/Rn/Tn	14	1	0	LANL 1999l	63
11/08/1999	MPF-3M, 7, 28	Area A, ER-1, PSR	MAP/Actinides/Rn/Tn	25	13	0	LANL 1999l	5
11/19/1999	MPF-3M	Area A	MAP/Rn/Tn	9	1	0	LANL 1999l	49
12/07/1999	MPF-7, 28	ER-2, PSR	MAP/Actinides/Rn/Tn	8	2	1	LANL 1999l	39
12/10/1999	MPF-7, 28	ER-2, PSR	MAP/Actinides/Rn/Tn	15	3	0	LANL 1999l	32
01/10/2000	MPF-7, 28	ER-1, PSR	MAP/Actinides/Rn/Tn	8	3	1	LANL 2000h	133
02/07/2000	MPF-7	ER-1	MAP/Actinides/Rn/Tn	5	1	0	LANL 2000h	124
02/17/2000	MPF-7	ER-1	MAP/Actinides/Rn/Tn	29	1	0	LANL 2000h	112
03/06/2000	MPF-28	PSR	MAP/Rn/Tn	6	1	0	LANL 2000h	105
03/15/2000	MPF-7, 28	ER-1, Not available	MAP/Actinides/Rn/Tn	24	3	0	LANL 2000h	97
03/27/2000	MPF-28	PSR	MAP/Rn/Tn	31	1	0	LANL 2000h	94
04/04/2000	MPF-28	PSR	MAP/Rn/Tn	22	1	0	LANL 2000h	91
07/21/2000	MPF-29	WNR	MAP/Actinides/Rn/Tn	2	2	0	LANL 2000h	72
10/12/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	2	1	0	LANL 2004i	52
11/01/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	1	1	0	LANL 2004i	46
11/22/2004	MPF-7	1LSA	MAP/Actinides/Rn/Tn	1	1	0	LANL 2004i	37

a. TGT = target; WNR = Weapons Neutron Research Facility.