NIOSH Response to SC&A's Review of the SEC-00109 LANL Addendum

Response Paper

National Institute for Occupational Safety and Health

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SUMMARY

In the SEC-00109 Evaluation Report Addendum, NIOSH relied heavily on a presumption of compliance with 10 CFR Part 835 to conclude that unmonitored workers were unlikely to have received intakes of radioactive materials that would have resulted in 100 mrem CEDE per year. NIOSH concurs with SC&A's assessment (SC&A, 2017) that compliance with the 10 CFR 835 milestone may not be sufficient for demonstrating actual implementation of the corresponding radiation monitoring program requirements. NIOSH also concurs that reliance on oversight findings may not be sufficient for validating that LANL had fully implemented 10 CFR Part 835. Since the issuance of SC&A's review, NIOSH has compared the available bioassay data for monitored LANL workers to the 100 mrem CEDE monitoring threshold and found that monitored workers were unlikely to receive 100 mrem CEDE intakes. Also, in response to SC&A's concerns, NIOSH re-emphasizes the significance of LANL's field monitoring programs, which were intended to ensure that unmonitored individuals were unlikely to receive intakes of 100 mrem CEDE. These two topics are discussed herein under "NIOSH: Review Completed That Supports the Assumption That Unmonitored Worker Intakes Were Not Likely to Have Exceeded 100 mrem CEDE." In conclusion, NIOSH finds that the weight of the evidence supports the assumption that unmonitored LANL workers were unlikely to have received intakes greater than 100 mrem CEDE per year. For purposes of dose reconstruction for unmonitored LANL workers during the 10 CFR 835 era, the assignment of 100 mrem CEDE intakes appears to be claimant favorable.

BACKGROUND

On May 4, 2017, SC&A was tasked with reviewing the *Addendum to Los Alamos National Laboratory (SEC-00109) Special Exposure Cohort Evaluation Report*, issued April 24, 2017 (NIOSH, 2017). This ER Addendum addresses "*post-1995 unmonitored intakes of the radionuclides for which dose reconstruction limitations were identified in Rev. 1 of the SEC-00109 ER,*" with the evaluated class remaining the same as in Rev. 1 (NIOSH, 2012) but with the start year changed from 1976 to 1996 (NIOSH, 2017). Thus, the evaluated class defined in the Addendum is:

> *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, rad technicians, and area work coordinators) who worked in any operational Technical Areas with a history of radioactive material use at the Los Alamos National Laboratory from January 1, 1996 through December 31, 2005.* (NIOSH, 2017, PDF p. 4)

In the *Los Alamos National Laboratory (SEC-00109) Special Exposure Cohort Evaluation Report*, Rev. 1, issued August 13, 2012 (NIOSH, 2012), the National Institute for Occupational Safety and Health (NIOSH) selected the class end date of December 31, 1995, based on a presumption of full compliance with the U.S. Department of Energy's (DOE's) newly-promulgated 10 CFR Part 835, "Occupational Radiation Protection," which took effect on January 1, 1996. In particular, NIOSH refers to 10 CFR 835.402, "Individual Monitoring," and 10 CFR 835.702, "Individual Monitoring Records."

10 CFR 835.402 states:

> *(c) For the purpose of monitoring individual exposures to internal radiation, internal dosimetry programs (including routine bioassay programs) shall be conducted for: (1) Radiological workers who, under typical conditions, are likely to receive a committed effective dose equivalent of 0.1 rem (0.001 sievert)* [100 mrem] *or more from all occupational radionuclide intakes in a year*" (10 CFR 835.402).

10 CFR 835.702 states:

> *(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* (10 CFR 835.702).

With full compliance, NIOSH assumes that all DOE work sites, including LANL, would have satisfied the monitoring requirements contained in the rule, thereby resolving any limitations that make dose reconstruction infeasible prior to that date. For LANL, these limitations included the "*inability to bound unmonitored intakes of exotic alpha-emitters, fission products, and activation products*" (NIOSH, 2017, PDF p. 3). Furthermore, with full compliance, NIOSH assumes that individual monitoring records would have been maintained and would be available for dose reconstruction.

PURPOSE AND SCOPE

This white paper serves two functions. It is:

1. NIOSH's response to SC&A's assessment of the LANL ER Addendum and their resulting conclusions; and

2. an expansion of NIOSH's original rationale with a focus on the field monitoring programs and existing bioassay data.

In its review, SC&A viewed the application of the 10 CFR 835 presumptive criterion (for LANL and other DOE sites) from two vantage points:

1. Is the use of 10 CFR Part 835 promulgation a valid basis for presumptive relief from the dose reconstruction limitations defined in preceding SEC classes for a site such as LANL?

2. Assuming January 1, 1996 as a reasonable milestone for internal dosimetry program progress, what metrics can be applied to confirm or validate that substantive implementation of 10 CFR Part 835 was achieved?

This white paper addresses the above two SC&A discussions in turn. NIOSH then expands its original rationale in light of those discussions followed by its conclusion. Appendix A contains a summary of petitioner issues with their corresponding resolutions.

SC&A: REVIEW OF THE USE OF 10 CFR 835 PRESUMPTIVE CRITERION

In its review, SC&A noted that prior to January 1, 1996, an SEC class was defined for 1976-1995 with dose reconstruction limitations identified for "*exotic alpha-emitters, fission products, and activation products*" (NIOSH, 2017). These limitations derived from inadequate monitoring records, process descriptions, and source-term data to complete internal dose reconstructions with sufficient accuracy (ABRWH, 2012a).

Based on a presumption of compliance with DOE's then newly-promulgated occupational radiation safety rule, 10 CFR Part 835, NIOSH found that dose reconstruction became feasible by the rule's effective date, January 1, 1996. This presumption was based on two key provisions of the rule:

1. Internal dosimetry programs shall be conducted "…*for radiological workers who, under typical conditions, are likely to receive a committed effective dose equivalent of 0.1 rem (0.001 sievert)* [100 mrem] *or more from all occupational intakes in a year*" (10 CFR 835.402)

2. "*…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.*" (10 CFR 835.702)

NIOSH'S presumption also relied on other advancements, including LANL's response to the 1990 Tiger Team findings and the 1992 development of a Technical Basis Standard for Internal Dosimetry.

SC&A concluded that NIOSH's presumption derives from an enforcement milestone, beginning in 1996, that would hold LANL accountable for monitoring all workers with a likelihood of receiving 100 millirem (mrem) of internal exposure in a year and maintaining corresponding records, thereby encompassing those potentially exposed to exotics, mixed activation products (MAPs), and mixed fission products (MFPs). This presumption, in turn, served as the basis for NIOSH's conclusion that:

> *"…given the presumption of compliance, the absence of internal dosimetry records indicates that unmonitored workers were deemed unlikely to have received intakes resulting in a CEDE 0.1 rem or more from all occupational radionuclide intakes in a year*" (NIOSH, 2017).

Given NIOSH's presumptions, SC&A responded with arguments in support of the following conclusions:

1. *…Program compliance with 10 CFR Part 835, while necessary under DOE's Price-Anderson regulatory framework, is not sufficient for demonstrating that actual radiation program practice is adequate. …*

   …Reliance on oversight findings based on non-compliances or incidents is likewise necessary, but not sufficient, for validating that LANL or any DOE contractor had implemented 10 CFR Part 835 in a complete and substantive manner.

2. *In summary, while 10 CFR Part 835 provides a clear regulatory milestone with the Department's first enforcement mechanism, it was one of several policy milestones for DOE's occupational RPP, with the basic provisions being first defined in DOE's 1989 Order 5480.11. By itself, this regulatory milestone does not necessarily guarantee conformance with program requirements and expectations for individual monitoring, no more than did Order 5480.11 and the Radiological Control Manual before it. If anything, core requirements for and change to how DOE internal dosimetry programs were implemented did not come until the internal dosimetry technical standard of 10 CFR Part 835 was coupled with an accreditation requirement (for overall dosimetry program*

functionality) under DOELAP in the 1998 amendments to the rule, which required all sites to achieve accreditation by January 1, 2002.

NIOSH Response:

1. NIOSH concurs with SC&A's assessment that program compliance may not be sufficient for demonstrating implementation of the radiation monitoring program. NIOSH also concurs that reliance on oversight findings may not be sufficient for validating that LANL had fully implemented 10 CFR Part 835. This appears particularly evident in the multiple pertinent findings identified in Noncompliance Report NC ID 484, as SC&A points out later in its memorandum.

   Although the focus of the SEC-00109 LANL Addendum is compliance with 10 CFR 835, NIOSH does not rely solely on 10 CFR 835 compliance for the conclusion that unmonitored workers were unlikely to have received intakes resulting in greater than 100 mrem CEDE. The field monitoring and contamination control programs at LANL were well-established and formalized by January 1, 1996. A description of these programs, along with a summary of associated data available to NIOSH, was included in Section 6.1.1 of the SEC-00109 ER Addendum; for the reader's convenience, this section is reproduced herein under "NIOSH: Review Completed That Supports the Assumption That Unmonitored Worker Intakes Were Not Likely to Have Exceeded 100 mrem CEDE." NIOSH also has a substantial amount of actual internal dosimetry data for LANL workers. These data show that, for the common radionuclides (tritium, uranium, and plutonium), intakes for monitored workers during the 1996-2005 time period were generally less than 100 mrem CEDE. NIOSH has not found any evidence suggesting that the case would be otherwise for unmonitored workers, or that intakes of exotic radionuclides would have been higher. A summary of available internal dosimetry data and an associated discussion are presented herein under "NIOSH: Review Completed That Supports the Assumption That Unmonitored Worker Intakes Were Not Likely to Have Exceeded 100 mrem CEDE."

2. NIOSH believes that the 10 CFR 835 era represents a paradigm shift in DOE operations. Earlier precursors, like DOE Order 5480.11 and the Radiological Control Manual, were guidelines and contractual obligations for the contractor. As of January 1, 1996, there was a legal requirement, violations of which were subject to criminal and civil penalties under Price-Anderson enforcement.

   Although 10 CFR 835 contains a lot of nuances and implementation guides that may have come out too late to impact RPP development by January 1, 1996, the important question is not overall implementation and compliance with 100 percent of 10 CFR 835, but rather, whether there was a program in place ensuring that unmonitored workers were unlikely to

receive intakes resulting in 100 mrem CEDE. This is a very narrow but important subset of 10 CFR 835. Although there were some bioassay deficiencies identified in LANL audits, NIOSH does not find that those issues preclude assigning two percent of the occupational exposure limit for workers as a bounding limit for workers who were not monitored.

NIOSH does not agree that DOELAP accreditation is relevant for full compliance with 835.402 and 835.702. DOELAP is not a dosimetry standard; it is a performance standard tied to ANSI 13.30, *Performance Criteria for Radiobioassay*. It has nothing to do with the 100 mrem monitoring requirement; it has to do with how well a laboratory measures an analyte in a bioassay sample.

SC&A: REVIEW OF 10 CFR 835 AND INTERNAL DOSIMETRY PROGRAM IMPLEMENTATION

In the second part of its review of the LANL ER Addendum, SC&A evaluated NIOSH's presumption that full 10 CFR 835 compliance equated to an occupational radiation program operating in 1996–2005 that demonstrably resolves the dose reconstruction limitations previously identified for the site. Toward this end, SC&A asked three question ns and provided their conclusions (summarized below).

Q1: Was the LANL occupational radiation program that was deemed compliant with 10 CFR 835 fully defined, evaluated, and independently reviewed and certified prior to January 1, 1996?

SC&A concludes that both LANL and DOE followed a deliberate review and verification process for validating compliance with 10 CFR Part 835 prior to final enactment on January 1, 1996. However, it is apparent that uniform acceptance criteria (i.e., implementation guidance) were not available in time for use in the field and that wide latitude was apparently given to LANL and other DOE sites to interpret how 10 CFR Part 835 was to be applied to occupational RPPs. Therefore, that compliance review, at the time, may not have been adequate to validate the conformity of existing LANL dosimetry programs to corresponding dosimetry requirements in the rule.

NIOSH Response:

NIOSH concurs with SC&A's assessment that compliance review, at the time, may not have been adequate to validate total conformity of existing LANL dosimetry programs to corresponding dosimetry requirements in 10 CFR 835. However, NIOSH does not find that the potential lack of complete conformity precludes assigning two percent of the occupational exposure limit for workers as a bounding limit for workers who were not monitored. Again, existing data for monitored workers during this time period indicate that

monitored workers were unlikely to receive intakes resulting in 100 mrem CEDE. NIOSH believes that the unmonitored worker population would have had a lower potential for exposure than the monitored population. This issue is discussed in more depth herein under "NIOSH: Review Completed That Supports the Assumption That Unmonitored Worker Intakes Were Not Likely to Have Exceeded 100 mrem CEDE."

Q2: Is there any evidence of site-specific or general non-conformances with 10 CFR 835 that would have substantive implications for dose reconstruction within the LANL occupational RPP following the effective implementation of the rule on January 1, 1996?

SC&A's review scope went beyond site-specific findings to include more general 10 CFR 835 non-conformance issues stemming from experiences at other DOE sites that may have implications for LANL.

SC&A reviewed LANL self-assessments, DOE and DNFSB oversight reviews, non-conformance reports from the DOE Office of Enforcement, and contractor and DOE reporting systems, such as the DOE ORPS and DOE NTS. Non-conformance Report NC ID 484 was specifically identified as having substantive implications for dose reconstruction:

Noncompliance report NC ID 484 was based on an assessment of the LANL internal dose evaluation program conducted by representatives from Savannah River Site (SRS), MJW Corporation, LANL's Radiation Protection Services Group (ESH-12), and Quality Assurance Group (ESH-14) on March 22–25, 1999. The assessment had 10 noncompliance findings, summarized as follows (DOE/NTS 2017), the first three of which impaired LANL's ability to monitor individuals "likely to receive a committed effective dose equivalent of 0.1 rem (0.001 sievert) or more from all occupational radionuclide intakes in a year" (10 CFR 835.402(c)(1)).

The three findings that SC&A identified as particularly problematic are:

1. *Some workers and their supervisors are not accurately completing the "health physics checklist" (utilized for enrolling workers into dosimetry programs) to the extent that these checklists may not identify those radionuclides actually handled by the worker. Thus, some workers are not being assigned to the appropriate routine bioassay program in accordance with site requirements. [835.402(c)(1)]*

2. *Some radiological workers are not complying with specific RWPs that require them to participate in a bioassay program. As an example, two out of five workers who performed work under a specific RWP did not participate in the bioassay program in accordance with requirements of the RWP. [835.402(c)(1)]*

3. *Johnson Controls of Northern New Mexico (JCNNM), the principle [sic] subcontractor to Los Alamos National Laboratory, may not be enrolling all workers who are potentially exposed to radionuclides into the appropriate bioassay program in accordance with site requirements. [835.402(c)(1)]*

SC&A noted the subsequent corrective actions were undertaken and closed by 2000. In SC&A's view, the above non-compliances and subsequent corrective actions are important to the LANL bioassay program, quite apart from 10 CFR 835 compliance, and evince likely longstanding implementation issues with that program:

SC&A concludes that the 1999 LANL noncompliance notwithstanding (which derived from an independent review with outside reviewers), solely relying on the lack of Notices of Violation (NOVs) and other recorded non-conformances as a benchmark of effective RPP implementation is questionable. Key provisions of 10 CFR Part 835, e.g., application of the 100 mrem criterion under 835.402(c)(1), do not lend themselves easily to assessment and verification by external compliance reviews, incident occurrences, or procedure reviews. Traditional validation and verification sampling for adequacy and completeness, and interviews with workers and radiation protection personnel, have proven effective in the past to establish the status of program implementation.

NIOSH Response:

NIOSH concurs with SC&A's assessment that solely relying on the lack of Notices of Violation (NOVs) and other recorded non-conformances as a benchmark of effective RPP implementation is questionable. This appears particularly evident in the 1999 independent review (Assessment, 1999) that resulted in the pertinent findings identified in Non-compliance Report NC ID 484 (Non-conformance, 1999).

Although the focus of the SEC-00109 LANL ER Addendum is compliance with 10 CFR 835, NIOSH does not rely solely on 10 CFR 835 compliance for the conclusion that unmonitored workers were unlikely to have received intakes resulting in greater than 100 mrem CEDE. LANL's field monitoring programs were designed and implemented for the purpose of ensuring that unmonitored individuals were unlikely to receive intakes of 100 mrem CEDE. Also, as mentioned previously, NIOSH has a substantial amount of internal

dosimetry data for LANL workers. These data show that intakes for monitored workers during the 1996-2005 time period were generally less than 100 mrem CEDE and NIOSH believes that intakes for unmonitored workers would likely be even lower. Discussions regarding LANL's field monitoring programs and available bioassay data for monitored LANL workers are included herein under "NIOSH: Review Completed That Supports the Assumption That Unmonitored Worker Intakes Were Not Likely to Have Exceeded 100 mrem CEDE."

Q3: Are there any LANL occupational protection program or internal dosimetry program implementation issues identified after January 1, 1996 that may hamper or preclude dose reconstruction? These would include concerns identified in the ER, including neptunium and special tritium compounds.

SC&A originally raised concerns about exotic alpha-emitters, fission products, and activation products in its 2010 focused review of the LANL evaluation report (SC&A 2010). That review noted that as far back as in its 2006 site profile review, SC&A had found that "inadequate consideration was given to potential exposure and missed dose from radionuclides other than the 'well documented' ones cited in the TBD (e.g., plutonium, polonium, tritium, etc.)" (SC&A 2010, page 8). This was borne out in terms of LANL practice from interviews with LANL staff and other experts; a summary of findings from those interviews is provided below (SC&A 2010):

- *It is fairly well recognized that most DOE facilities, such as LANL, Rocky Flats Plant (RFP), etc., had the capability to detect, identify, and quantify MFP/MAP in workers beginning in the early 1970s. However, it is not as certain (or as well documented) that it was standard practice to actually analyze and record the activity from these radionuclides in the worker's file.*

- *MFP/MAP activities appear to have been investigated in certain situations, but it has not been documented that it was performed on a routine basis at LANL.*

- *Prior to 1998, LANL primarily relied upon the Phoswich detectors for in-vivo (whole-body or lung-counting) measurements. An in-vivo count spectrum was typically not analyzed for fission or activation product radionuclides, unless a peak associated with a certain nuclide was visible in the spectrum, or LANL knew or suspected that an exposure had occurred. When that peak was identified, the nuclide was added to the radionuclide library, and the spectrum*

was converted to activity and reported in the record. Identification of a peak could be subjective at times and not directly correlated to MDA [minimum detectable activity] or critical levels, especially with the broad peaks that appeared in the photon spectra, because of the low resolution of these scintillation-type detectors.

- *Phoswich detectors were unable to resolve peaks for exotic and MFP or MAP radionuclides, particularly those that emitted low-energy photons.*

- *To overcome the detector's inability to resolve peaks, LANL set up regions of interest for the photon spectra, and used control groups of non-nuclear workers to estimate body and room background contributions, and to statistically determine net counts above background and identify peaks of interest.*

- *After germanium detectors became available, if a known or suspected exposure had occurred, then measurements were repeated with high-resolution germanium detectors to verify and identify the presence of a radionuclide if the peak was determined not to be one of the primary radionuclides. If detected, the radionuclide was added to the analysis library and confirmed as a positive identification that needed a dose assessment. In most of the cases, in-vitro bioassay samples were also collected.*

- *There is a higher likelihood that peaks could have been missed when the germanium detectors were not in operation or had not yet been installed (i.e., before 1998).*

- *A programmatic assessment of the internal dosimetry program by DOE in 2001 found that thorium-232 and the short-lived MAP radionuclides generated at the Los Alamos Neutron Science Center (LANSCE), although required for routine internal dosimetry evaluation, were not included in the in-vivo program library (DOE, 2001). The absence of this routine monitoring capability as late as 2001 brings into question the ability of the LANL program to detect these and other exotics on a routine basis as a matter of practice (vs. technical capability). As DOE noted in its finding, "Without this information, the in-vivo laboratory cannot identify monitoring strategies or ensure adequate energy calibrations;" and that "interviews with the in-vivo staff indicated that they were not aware of the need for this capability."*

SC&A contends that these and related concerns likely contributed to the lack of monitoring records for MFPs and MAPs.

In discussing the oversight finding that Th-232 and MAPs generated at LANSCE were not included in the *in-vivo* program library, SC&A closed with the following statement:

This may not have been of great consequence after the introduction of more sensitive germanium detectors in 1998, but it clearly may have hampered in vivo monitoring for these radionuclides before that time when Phoswich detectors were being relied upon.

The section concluded with the following statement:

SC&A concludes that there is no evidence that the internal dosimetry and monitoring shortfalls cited in deliberations that led to the recommendation by the Advisory Board to define an SEC class for 1976–1995 (ABRWH 2012b) have been resolved for the time period after 1995.

NIOSH Response:

NIOSH does not share many of the concerns identified by SC&A in this section. It appears that SC&A was not aware of the extensive use of high-resolution germanium detectors for *in-vivo* counting at LANL throughout the period evaluated in the SEC-00109 ER Addendum. Germanium detectors had been widely used at LANL for *in-vivo* measurements since the mid-1970s, long before the period under evaluation in the addendum. The configuration of the lung-counting system is illustrated in the 1984 LANL document LA-9979-MS, *In Vivo Assessment of Lung Burdens at the Los Alamos National Laboratory* (LANL, 1984). Although it is true that Phoswich detectors were used as late as 1998, they were used in conjunction with germanium detectors and not exclusively relied upon.

NIOSH acknowledges that there were very few bioassay or other internal dose assessments for exotic radionuclides. This is true for the entire period of LANL operations. This was the primary driver for NIOSH's recommendation to extend the LANL SEC through 1995 in Rev. 1 of the SEC-00109 ER. The ER Addendum presents a methodology for performing dose reconstructions for exotic radionuclides for LANL workers in the absence of bioassay during the 10 CFR 835 era. Based on the available information that NIOSH has collected regarding LANL operations, use of exotic radionuclides at LANL was relatively rare, not nearly as prevalent as the use of the primary radionuclides (plutonium, uranium, and tritium), for which there is an abundance of bioassay data. As pointed out in SC&A's memorandum, LANL noted that its internal dosimetry monitoring programs are established on an as-needed basis and that monitoring is only required for radiological

workers likely to receive 100 mrem annually from internal exposure (LANL 2013). LANL further notes:

LANL has an in vivo monitoring program established for fission products and activation products, and has historically used in vivo monitoring for these radionuclides. A spectral analysis of each count was performed by the in vivo staff. During this review, all peaks were identified and quantified. [LANL 2013, page 3]

Regarding the 2001 DOE oversight finding concerning LANL's capability to monitor for MAPs generated at LANSCE, NIOSH does not share SC&A's concern. LANL has used germanium detectors extensively for body counts for LANSCE workers beginning in March 1979. A summary of the bioassay data available to NIOSH is presented in the LANL Bioassay Repository Database (ORAUT-OTIB-0063). This database includes 106,950 *in-vivo* records. The vast majority of these are counts for Am-241 (41%) and Pu-239 (41%). The next largest contributors to the total number of *in-vivo* records are U-235 and Th-234 (5% each). The bulk of the remaining 7000+ records is primarily comprised of fission and activation product radionuclides for LANSCE employees that were acquired via germanium detectors. The *in-vivo* records in the LANL bioassay database specify 81 different analytes. A summary of the *in-vivo* counting records from 1969 through 2005 are listed below.

Analytes Listed for *In-Vivo* Counting Records in the ORAU Team's Database

Analyte	Total Records for 1969-2005	Records with Count Dates from 1969-1995	Records with Count Dates from 1996-2005
Am-241	40796	28712	12084
As-72	3	3	0
Ba-140	0	0	0
Be-7	819	690	129
Bi-213	14	0	14
Bi-214	6	6	0
Br-76	12	11	1
Br-77	17	16	1
C-11/N-13	1308	758	550
Cd-109	19	18	1
Ce-141	8	7	1
Cf-249	9	9	0
Cm-244	1	0	1
Co-56	1	1	0
Co-57	8	8	0
Co-57/Co-58	1	1	0
Co-58	6	6	0
Co-60	73	43	30
Cr-51	1	1	0
Cs-134	127	127	0
Cs-137	436	353	83
Cu-64	1	1	0
Cu-67	1	1	0
Eu-152	451	27	424
Fe-59	1	1	0
Fission prods	1	1	0
Gd-146	0	0	0
Gd-153	0	0	0
Ge-67/Ga-67	1	1	0
Ge-68/Ga-68	5	5	0
Hf-173	3	0	3

Analyte	Total Records for 1969-2005	Records with Count Dates from 1969-1995	Records with Count Dates from 1996-2005
Hf-175	5	0	5
Hg-195M	8	7	1
Hg-197	40	39	1
Hg-197M	8	7	1
Hg-203	25	24	1
I-123	2	2	0
I-125	159	159	0
I-131	13	13	0
I-132	1	1	0
La-140	0	0	0
Lu-172	0	0	0
Lu-173	0	0	0
Mn-54	773	649	124
Na-22	1178	636	542
Na-24	6	6	0
Nb-95	0	0	0
Nd-147	8	7	1
Os-185	11	10	1
P-32	2	2	0
Pb-212	15	1	14
Pb-214	14	0	14
Pu-238	109	109	0
Pu-238/Pu-239	2	2	0
Pu-239	39848	27863	11985
Ra-226	4	3	1
Rb-83	13	12	1
Rb-84	11	10	1
Sb-124	11	10	1
Sc-46	8	8	0
Se-72/As-72	1	1	0
Se-75	32	31	1
Sm-145	8	7	1

Analyte	Total Records for 1969-2005	Records with Count Dates from 1969-1995	Records with Count Dates from 1996-2005
Ta-179	9	8	1
Ta-182	0	0	0
Te-132	1	1	0
Th-234	2567	0	2567
Tl-201	11	10	1
Tl-202	14	13	1
Tungsten	1	1	0
U-235	2572	1	2571
U-237	7	7	0
U-238	3	2	1
Unidentified	2	2	0
V-48	4	4	0
Yb-169	0	0	0
Zn-65	11	11	0
Zr-95	1	1	0
Zr-95/Nb-95	3	3	0

The SC&A memorandum also expressed concern about the 2001 DOE oversight finding regarding LANL's ability to monitor for Th-232. In response to NIOSH requests for information to demonstrate LANL's capability to monitor for various radionuclides (including Th-232), LANL indicated that there are no workers on a routine thorium bioassay program because it is not warranted (i.e., workers are unlikely to receive thorium intakes resulting in greater than 100 mrem CEDE). LANL also provided an example of "targeted" *in vivo* Th-232 bioassay for an international traveler in 1999 (Th-232 Bioassay, 1999). This whole-body count result from March 1999 clearly demonstrates LANL's capability to monitor for Th-232 using *in-vivo* methods prior to the 2001 DOE oversight finding. NIOSH concludes that this capability was likely present for the duration of the period under evaluation (1996-2005).

Special Tritium Compounds and Neptunium

For special tritium compounds (STCs), SC&A agreed with NIOSH's assessment that LANL was aware of their presence in the late 1990s and took measures to communicate appropriate dose assessment considerations within the LANL health physics program and to DOE. The potential for significant exposure was deemed small and handled on a case-by-case basis. The capability for NIOSH to bound intakes of STCs exists, if found necessary, and methods are available (e.g., ORAUT-OTIB-0066) by which dose reconstruction can be performed.

For neptunium, SC&A did not necessarily agree with NIOSH's conclusion that the RPP inadequacies found by the DOE Office of Independent Oversight (LANL Inspection, 2005) "*do not indicate that unmonitored intakes occurred*" (NIOSH, 2017). SC&A found premature any conclusion regarding potential exposure from, and monitoring for, neptunium founded on findings from one facility and a particular oversight investigation, without ascertaining site-wide inventories and the full scope of operations that may have handled neptunium.

NIOSH Response:

NIOSH has fully evaluated the neptunium operations of concern to the petitioner. This evaluation was summarized in the ER Addendum (NIOSH, 2017). The possibility that there may have been other neptunium operations of which NIOSH is unaware cannot be dismissed. However, given LANL's awareness of this issue and its limited case-by-case exposure potential, NIOSH maintains that intakes resulting in 100 mrem CEDE would likely be bounding for any such operation.

NIOSH: REVIEW COMPLETED THAT SUPPORTS THE ASSUMPTION THAT UNMONITORED WORKER INTAKES WERE NOT LIKELY TO HAVE EXCEEDED 100 MREM CEDE

In response to SC&A's concerns, NIOSH re-emphasizes the significance of LANL's field monitoring programs, which were intended to ensure that unmonitored individuals were unlikely to receive intakes of 100 mrem CEDE. Also, since the issuance of SC&A's review, NIOSH has compared the available bioassay data for monitored LANL workers to the 100 mrem CEDE monitoring threshold and found that monitored workers were unlikely to receive 100 mrem CEDE intakes. These two topics are discussed below.

LANL Field Monitoring and Contamination Control Programs

The field monitoring and contamination control programs at LANL were well-established and formalized by January 1, 1996. A description of these programs, along with a summary of associated data available to NIOSH, was included in Section 6.1.1 of the SEC-00109 ER Addendum. For the reader's convenience, this section is reproduced below.

ER Addendum, Section 6.1.1: Field Monitoring Program and Associated Data

By January 1, 1996, the health physics field monitoring and contamination control programs at LANL were well established and formalized, with over 60 procedures addressing various aspects of radiological protection (LANL Procedures, 1996), as well as an established process for tracking and notifying staff of revisions (Procedure Revisions, 1996). These procedures cover program administration, exposure and contamination control, monitoring, instrumentation, protective equipment, emergency response, and the As Low As Reasonably Achievable (ALARA) program.

In addition to site-wide procedures, area-specific procedures and instructions were also in effect. For example, the stated purpose of the ESH-1/TA-55 Radiation Monitoring Instructions is "to provide survey frequencies which are to be used by the ESH-1 Radiological Control Technicians (RCTs) and Health Protection Technicians (HPTs) in assisting the NMT Division in the implementation of the radiological control program at TA-55" (TA-55 Instructions, 2000). This document defines the routine monitoring tasks of the RCTs assigned to TA-55 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, as well as air monitoring and TA-55 Technical Safety Requirements (TSRs), which include annual CAM system calibration, monthly performance tests, and daily operability checks.

NIOSH has obtained hundreds of radiological protection documents from LANL for the time period under evaluation. Examples include:

- Radiological Work Permits requiring contamination surveys and air monitoring (RWPs, 1997; RWPs, 2003)
- Monthly contamination surveys (Monthly Surveys, 1998; Monthly Surveys, 1999)
- Area-specific contamination surveys (TA-3 Survey Results, 1999; TA-18 Survey Results, 1997)

- Quarterly contamination survey summaries (Quarterly Summaries, 1999; Quarterly Summaries, 2003)
- Area-specific monitoring data quarterly reviews (CMR Quarterly Review, 1996; TA-55 Quarterly Review, 1995-1996)
- Air sample analysis data (Air Data, 1996-1997; Air Data, 2001)
- Air sampling/monitoring technical evaluations (Air Sampling Evaluation, 2001a; Air Sampling Evaluation, 2001b)
- Airborne radioactivity investigation reports (Airborne Radioactivity, 2001; Airborne Radioactivity, 2002)
- Task-specific radiological protection assessments/checklists (ESH-1 Checklist, 2001; Rad Protection Checklist, 1995)
- Standard operating procedures (SOP) tracking (SOP Matrices, 1996; SOP Revisions, 1996)

[End ER Addendum, Section 6.1.1]

During multiple data capture efforts, NIOSH found many boxes of LANL RWP records. Although it did not attempt to capture or review each and every one of these records, NIOSH did capture what it feels is a representative sample. Consequently, the NIOSH database contains several hundred LANL RWPs for the 1996-2005 time period, consisting of thousands of pages of records. Much of the focus during these data capture efforts was on finding RWPs that involved non-routine radionuclides (i.e., other than plutonium, uranium, and tritium), although many RWPs involving these more common nuclides were also collected.

Some general statements can be made regarding the LANL RWPs issued during the time period under evaluation:

- Most of these RWPs required pre-job and/or post-job contamination surveys, and the associated smear records are included in the captured documentation.
- Most of them specified PPE to be worn.
- Many of them specified respiratory protection.
- Most of them required at least some RCT coverage and included stop work or hold points that would invoke re-evaluation.

- Most of the work was conducted in areas where continuous air monitors (CAMs) were in operation.

- Many of the RWPs required other job-specific air monitoring or breathing-zone air monitoring, and the associated monitoring records are included in the captured documentation.

- Several of them required nasal smears to be taken.

In general, bioassay requirements were not routinely specified on RWPs. The RWPs appear to have been designed to minimize the likelihood of intakes via engineering controls, PPE, and respiratory protection. The RWPs were also designed to detect material release via air monitoring and smear surveys. Elevated surface or airborne contamination would trigger an assessment for the need for bioassay.

Occurrence Report No. DP-ALO-LA-LANL-TA55-2002-0003 describes an event in TA-55 in 2002 that resulted in airborne release of radioactive material and internal exposure to employees (ORPS, 2002). The operation was performed under RWP 02-55-319-7 (not available in the NIOSH database). The description provided in the occurrence report (reproduced below) clearly shows a scenario whereby field indicators, including a CAM alarm, personnel contamination surveys, and nasal smears led to bioassay assessments.

> *MANAGEMENT SYNOPSIS: On Wednesday, March 13, 2002, at approximately 1540 hours, at Technical Area 55, Building 4 (TA-55-4), two employees were detected with contamination in their nasal passages, as indicated by nasal swipes, one of whom also had skin contamination, after evacuating Room 319 after a Continuous Air Monitor (CAM) alarmed indicating airborne contamination. All contamination was alpha. The first employee (E1), from Weapons Component Technology (NMT-5), had skin and hair contamination up to 5,000 disintegrations per minute (dpm) and nasal smear readings of 1,389/No Detectable Activity (NDA) dpm. The second employee (E2), from Engineering Sciences and Applications (ESA), had no skin contamination but nasal smear readings of 32/92 dpm. E2 had been working approximately 5-10 feet from E1. Thirteen employees were in the room at the time of the CAM alarm. No other personnel contamination was detected. E1 and E2 were placed on prompt bioassay on Thursday, March 14, 2002. Field indicators were evaluated to determine appropriate special bioassay requirements for all other employees present in Room 319 at the time of the release. Based on the pattern of the release, as indicated by FAS filter analysis, additional employees were placed on special bioassay. A total of seven employees were placed on bioassay. The preliminary results of the bioassays were received on Wednesday, April 17, 2002. The preliminary estimates indicated 50-year Committed Effective Dose Equivalent (CEDE) ranging from 2 mrem to 14 mrem.*

In a 1998 Occurrence Report, ALO-LA-LANL-CMR-1998-0041, from the CMR facility, the description (reproduced below) shows another scenario in which field monitoring led to bioassay assessment (ORPS, 1998). This operation was performed under RWP Number 98-3-29-2114-285 (not available in the NIOSH database).

> *MANAGEMENT SYNOPSIS: On November 10, 1998, at 1600, Chemistry and Metallurgy Research (CMR) facility management was notified that alpha activity measuring up to 56,000 disintegrations per minute/100 square centimeters (cm[2]) had been detected on a Material Research & Processing (NMT-11) employee's personal clothing. The NMT-11employee had been removing legacy items from a chemical fume hood in Wing 2, room 2114, of the CMR facility. The principal contaminant was subsequently determined to be americium-241.*
>
> *Radiological control technicians (RCTs) assisted the NMT-11 employee with changing into clean clothing. The contaminated clothing will be properly discarded. The NMT-11 employee submitted nasal smears; results were 36/0 dpm-alpha. Based on the nasal smear results, the employee was placed on a special bioassay program and restricted from working in radiologically controlled areas pending preliminary bioassay results and radiation dose assessment.*

Available Bioassay Data for Monitored LANL Workers

Radiation dosimetry monitoring requirements for LANL workers were well-established prior to the implementation of 10 CFR 835. The 1991 LANL Environment, Safety, and Health Manual indicates the need for bioassay monitoring of personnel in order to demonstrate compliance with radiation protection standards (ES&H Manual, 1991). That document includes action levels for worker monitoring that required routine bioassay for workers with the potential to receive "0.1 rem annual effective dose equivalent from internal sources" or "5 rem annual dose equivalent to any organ or tissue from internal sources." LANL's 1994 Radiation Dosimetry Monitoring Laboratory Standard (LANL Dosimetry, 1994) specifies bioassay monitoring requirements. It includes operations that would trigger bioassay and determinations based on quantities and forms of radioactive materials at risk. A table presented in that document indicates that any positive *in vivo* whole-body count will require an assessment of intake. The table shows the recommended counting interval necessary to detect 2% of an ALI for 26 different gamma-emitting radionuclides. Routine contamination survey and air monitoring programs were in place to ensure that personnel monitoring was appropriate for the various areas, and boundaries were established so that unmonitored personnel would not likely receive 100 mrem CEDE.

NIOSH reviewed the DOE Occurrence Reporting System for LANL 10 CFR 835 violations, site responses, and corrective actions. A total of 159 documents were accessed (ORPS Reports, 1993-2015). NIOSH also reviewed the DOE Non-conformance Tracking System for LANL

10 C.F.R. pt. 835 violations, site responses, and corrective actions. A total of 384 documents were captured (NTS List, 2016). As a consequence of the field monitoring programs, workers were often required to undergo bioassay. This was clearly evident from the numerous ORPS reports reviewed by NIOSH.

A class of LANL workers has been added to the Special Exposure Cohort due to a lack of available bioassay data for "exotic" radionuclides. This class includes all workers from the beginning of site operations in 1942 through 1995. This lack of bioassay data for "exotic" radionuclides has continued to persist to the present time. LANL has contended that bioassay data for exotic radionuclides are scarce because it is and has been unwarranted, especially during the 10 CFR 835 era. It is deemed unwarranted, according to LANL health physics professionals, because workers are unlikely to have received intakes resulting in 100 mrem CEDE from these radionuclides in any given year; therefore, workers were not required to have been monitored for them.

In the SEC-00109 LANL ER Addendum, NIOSH proposed a method for assigning bounding intakes of these exotic radionuclides for LANL workers in the absence of bioassay data. The method proposed was to assign annual intakes for these radionuclides that would have resulted in 100 mrem CEDE. The primary basis for this proposed method was the legal requirements set forth in 10 CFR 835 that went into effect on January 1, 1996.

In SC&A's review of the SEC-00109 LANL ER Addendum, SC&A pointed out multiple issues regarding LANL's technical ability to monitor for various radionuclides and examples of oversight findings where perhaps workers should have been monitored for internal dose according to the 10 CFR 835 rule, but apparently were not. NIOSH shares some of the concerns from the oversight findings, as discussed above in this document. In light of these concerns, the primary question still remains. Is the assignment of 100 mrem CEDE intakes for unmonitored workers likely to be bounding?

In an attempt to help answer this question, NIOSH believes it useful to take a look at the primary LANL radionuclides, tritium, plutonium isotopes, and uranium isotopes - radionuclides for which bioassay data are abundant. There are over 450,000 LANL urinalysis records available to NIOSH for the period 1945 through 2008. These include data for plutonium, polonium, uranium, and tritium. In addition, there are over 100,000 *in-vivo* records. These data are presented and evaluated in the *Internal Dosimetry Coworker Data for Los Alamos National Laboratory* (ORAUT-OTIB-0062).

The following six tables, reproduced from ORAUT-OTIB-0062, give intake values to be used in dose reconstruction for unmonitored LANL workers for any given year. The values are based on the available co-worker bioassay data, and represent 50th percentile exposures. For tritium, the actual annual dose equivalent (mrem) is provided. For isotopes of plutonium and uranium, intake rates in units of picocurie per day (pCi/d) are provided.

Note: A feature worth noting in these tables is that intake rates have trended lower over the years at LANL. Post-1995 intakes for monitored workers can be seen to be relatively low in comparison to intakes during LANL's earlier years.

Table 5-1 from ORAUT-OTIB-0062: Tritium Annual Doses (mrem) and GSDs

Year	Dose	GSD
1950	33	7.2
1951	36	5.9
1952	25	4.2
1953	26	6.7
1954	16	6.2
1955	43	6.5
1956	33	6.9
1957	35	6.9
1958	26	5.7
1959	22	5.5
1960	27	5.2
1961	20	4.7
1962	17	4.7
1963	18	3.7
1964	17	3.5
1965	18	3.5
1966	19	4.2
1967	23	6.0
1968	16	4.6
1969	21	5.0
1970	25	7.0
1971	16	4.9
1972	14	5.4
1973	16	5.3
1974	25	6.7
1975	19	6.2
1976	13	4.1
1977	20	5.5
1978	20	5.2
1979	12	4.9
1980	15	4.1
1981	17	4.1

Year	Dose	GSD
1982	21	4.5
1983	18	4.8
1984	16	3.4
1985	18	3.3
1986	21	3.8
1987	17	4.3
1988	7	4.4
1989	7	3.5
1990	6	3.2
1991	2	3.0
1992	5	3.5
1993	6	3.4
1994	3	3.0
1995	5	3.0
1996	5	3.0
1997	4	3.0
1998	7	3.0
1999	4	3.0
2000	9	4.1
2001	6	3.0
2002	6	3.5
2003	5	3.3
2004	3	3.0
2005	3	3.0
2006	4	3.0
2007	4	3.0
2008	6	3.3

Table 5-2 from ORAUT-OTIB-0062: Plutonium-238 Intake Rates (pCi/d)

Start	End	Type M 50th Percentile	Type M GSD	Type S 50th Percentile	Type S GSD
1/1/1968	12/31/1971	1.8	5.63	43	5.74
1/1/1972	12/31/1972	14.	3.13	765	3.13
1/1/1973	12/31/1974	2.0	4.31	72	4.17
1/1/1975	12/31/1977	0.67	3.59	5.2	8.47
1/1/1978	12/31/1981	0.32	7.56	5.2	8.47
1/1/1982	12/31/1988	0.084	8.73	1.8	8.47
1/1/1989	12/31/1993	0.44	4.31	9.7	4.17
1/1/1994	12/31/2008	0.048	6.82	0.72	6.58

Table 5-3 from ORAUT-OTIB-0062: Plutonium-239 Type M Intake Rates (pCi/d)

Start	End	Type M 50th Percentile	Type M GSD
1/1/1944	12/31/1945	248	5.05
1/1/1946	12/31/1946	95	6.24
1/1/1947	12/31/1953	10	5.16
1/1/1954	12/31/1954	3.1	17.2
1/1/1955	12/31/1956	3.1	12.4
1/1/1957	12/31/1966	0.38	12.4
1/1/1967	12/31/1972	3.3	4.81
1/1/1973	12/31/1975	1.5	6.21
1/1/1976	12/31/1993	0.16	6.83
1/1/1994	12/31/2008	0.013	12.2

Columns 1-4 from Table 5-4 from ORAUT-OTIB-0062:Pu-239
Type S and Super S Systemic Intake Rates (pCi/d)

Start	End	50th Percentile	GSD
1/1/1944	12/31/1945	8,651 [a]	5.05
1/1/1946	12/31/1946	5,125 [a]	6.24
1/1/1947	12/31/1953	200 [a]	4.87
1/1/1954	12/31/1954	88[a]	11.12
1/1/1955	12/31/1956	88[a]	15.3
1/1/1957	12/31/1966	6.3[a]	11.91
1/1/1967	12/31/1972	73[a]	4.62
1/1/1973	12/31/1975	41 [a]	6.34
1/1/1976	12/31/1993	2.3 [a]	6.34
1/1/1994	12/31/2008	0.14 [a]	12.8

a. Urinalysis-based intake rates.

Columns 5-8 from Table 5-4 from ORAUT-OTIB-0062: Pu-239
Type S and Super S Non-Systemic Intake Rates (pCi/d)

Start	End	50th Percentile	GSD
1/1/1944	12/31/1945	8,651[a]	5.05
1/1/1946	12/31/1946	5,125[a]	6.24
1/1/1947	12/31/1953	200[a]	4.87
1/1/1954	12/31/1954	88[a]	11.12
1/1/1955	12/31/1956	88[a]	15.3
1/1/1957	12/31/1966	6.3[a]	11.91
1/1/1967	12/31/1968	73[a]	4.62
1/1/1969	12/31/1971	27.66[b]	4.50
1/1/1972	12/31/1974	29.43[b]	4.50
1/1/1975	12/31/1975	505.4[b]	3.00
1/1/1976	12/31/1977	96.07[b]	3.90
1/1/1978	12/31/1979	19.55[b]	6.24
1/1/1980	12/31/1993	2.3[a]	6.34
1/1/1994	12/31/2008	0.14[a]	12.8

a. Urinalysis-based intake rates.
b. Lung count-based intake rates.

Table 5-7 from ORAUT-OTIB-0062: Uranium Intake Rates (pCi/d)

Start	End	Type F 50th P Percentile	Type F GSD	Type M 50th Percentile	Type M GSD	Type S 50th Percentile	Type S GSD
1/1/1947	12/31/1949	21.3[a]	3.36	88.7[a]	3.36	1,520[a]	3.24
1/1/1950	12/31/1955	21.3	3.36	88.7	3.36	1,520	3.24
1/1/1956	12/31/1957	5.36	3.36	16.0	3.36	656	3.24
1/1/1958	12/31/1965	1.98	4.81	7.95	4.90	141	4.71
1/1/1966	12/31/1973	0.909	6.84	3.53	7.03	59.3	6.59
1/1/1974	12/31/1982	0.227	11.31	1.03	10.6	19.7	9.27
1/1/1983	12/31/1989	1.53	4.81	6.29	4.90	105	4.44
1/1/1990	12/31/2000	0.201	4.03	0.756	4.06	11.0	4.57
1/1/2001	12/31/2001	1.019	3.00	4.70	3.00	92.0	3.00
1/1/2002	12/31/2008	0.201	4.03	0.756	4.06	11.0	4.57

a. Intakes for 1947 through 1949 are based on the 1950 through 1955 intakes.

The SEC-00109 LANL ER Addendum proposed annual intakes of 2% SALI as bounding intake quantities for unmonitored workers with access to controlled areas. Those proposed annual intake quantities were presented in units of becquerel (Bq) (see ER Addendum Table 7-1). For ease of comparison to the values presented in ORAUT-OTIB-0062, the units for the primary radionuclides, those for which bioassay data are abundant, have been converted to pCi/d in the table below.

Conversion of LANL ER Addendum Annual Intake Values (Bq) to Daily Intake Values (pCi/d)

Radionuclide	Lung Clearance Class	Annual Intake Quantity, 2% SALI (Bq) (from ER Addendum)	Daily Intake Quantity, 2% SALI (pCi/d)
U-234	D	1.36 x 103	100
U-234	W	4.69 x 102	35
U-234	Y	3.88 x 101	2.9
Pu-238	W	9.43 x 100	0.70
Pu-238	Y	1.28 x 101	0.95
Pu-239	W	8.62 x 100	0.64
Pu-239	Y	1.20 x 101	0.89

An intake value for tritium was not included in the above table because the values given, ORAUT-OTIB-0062, Table 5-1, are already in units of mrem per year, which may be compared directly to the 100 mrem CEDE proposed intake quantity. Table 5-1 from ORAUT-OTIB-0062 shows annual tritium doses gradually trending lower from 1950 through 1988, at which time they

stabilized and remained relatively low. The 50th percentile annual doses for the applicable period, 1996-2005, based on actual bioassay data, range from 3 to 9 mrem per year. Assignment of 100 mrem per year for unmonitored workers potentially exposed to tritium appears to be bounding.

For U-234, Pu-238, and Pu-239, the comparisons are not as straightforward. For these, intake quantities proposed in the ER Addendum for lung clearance classes D, W, and Y are compared to the 50th percentile intake rates presented in ORAUT-OTIB-0062 for lung clearance types F, M, and S, respectively.

The following table shows a side-by-side comparison of ORAUT-OTIB-0062 uranium intakes to ER Addendum-proposed uranium intake rates, for the applicable time period.

Comparison of ORAUT-OTIB-0062 vs. ER Addendum Uranium Intake Rates (pCi/d)

Time Period	OTIB-0062 Type F	ER Add. Class D	OTIB-0062 Type M	ER Add. Class W	OTIB-0062 Type S	ER Add. Class Y
1996-2000	0.201	100	0.756	35	11.0	2.9
2001	1.019	100	4.70	35	92.0	2.9
2002-2005	0.201	100	0.756	35	11.0	2.9

A comparison of the OTIB-0062 Type F uranium intake rates to those proposed in the ER Addendum for Class D U-234 suggests that the ER Addendum intake rates are bounding. The same is true when comparing OTIB-0062 Type M intakes to Addendum Class W. This is not the case when comparing OTIB-0062 Type S to ER Addendum Class Y. It is important to keep in mind, however, the method by which the OTIB-0062 values were derived for Type S uranium. These values were produced from urine bioassay results. The underlying assumption is that the uranium found in the urine resulted from intakes of 100% pure Type S (highly-insoluble) material. In this case, a small amount of uranium in urine corresponds to a relatively large intake. It is also important to keep in mind here that no dose reconstruction infeasibilities have been identified for uranium intakes at LANL. For the case of uranium, bioassay data are available for monitored workers and ORAUT-OTIB-0062 (not necessarily 2% SALI) could be used to assign intakes for unmonitored workers with potential for exposure. This is also the case for tritium and plutonium intakes discussed in this section. The purpose for presenting these data and making these comparisons here is simply to show how intakes derived from actual bioassay results for the primary radionuclides would compare to 2% SALI intakes for these nuclides. Use of the 2% SALI (or 100 mrem CEDE) intake assumption would only be necessary for radionuclides for which dose reconstruction infeasibilities have been identified in *Los Alamos National Laboratory (SEC-00109) Special Exposure Cohort Evaluation Report*, Rev. 1, issued August 13, 2012 (NIOSH, 2012).

The OTIB-0062 50th percentile intake rates for Pu-238 for the 1996-2005 period are 0.048 and 0.72 pCi/d for lung clearance Type M and S, respectively. The ER Addendum values for Class W and Y are 0.70 and 0.95. By this comparison, the proposed ER Addendum intake rates would appear to be bounding.

For Pu-239, the OTIB-0062 50th percentile intake rates for the 1996-2005 period are 0.013 pCi/d for Type M material and 0.14 pCi/d for Type S and Super S. The ER Addendum values for Class W and Y are 0.64 and 0.89. By this comparison, the proposed ER Addendum intake rates would appear to be bounding for Pu-239.

CONCLUSION

NIOSH agrees with many of the issues identified by SC&A in its review of the LANL ER Addendum. Specifically, NIOSH agrees that LANL may not have been in full compliance with all aspects of 10 CFR 835 during the entire period under evaluation (1996-2005). NIOSH further acknowledges the possibility that some workers who should have been monitored according to procedure, may not have been.

NIOSH does not share many of SC&A's technical concerns. Specifically, NIOSH did not identify any significant technical shortfalls with regard to LANL's *in-vivo* program during the period of this evaluation. During the 10 CFR 835 era, the LANL *in-vivo* operation was equipped with state-of-the-art counting equipment and was staffed with competent professionals. As evidenced by available *in-vivo* measurement results, LANL used high-resolution germanium detectors throughout the entire evaluation period to monitor for fission and activation products for workers at the LANSCE facility and throughout the laboratory.

The field monitoring and contamination control programs at LANL were well-established and formalized by January 1, 1996. These programs, which were intended to ensure that unmonitored individuals were unlikely to receive intakes of 100 mrem CEDE, were in place and being implemented during the period of this evaluation.

Based upon its review of existing bioassay results, NIOSH finds that workers who were monitored for the primary radionuclides (uranium, plutonium, and tritium) were unlikely to have received intakes exceeding 2% of the SALI (or intakes that would have resulted in 100 mrem CEDE). NIOSH also believes that intakes to the unmonitored population would have been lower than that of the monitored population. NIOSH therefore concludes that unmonitored workers were unlikely to have received intakes of 2% of the SALI, and the assignment of 2% SALI intakes for unmonitored workers with access to controlled areas is bounding. NIOSH further finds no reason to believe that intakes of exotic radionuclides by unmonitored workers would be substantially different. In summary, NIOSH concludes that the weight of the evidence supports

assignment of 2% SALI intakes for unmonitored workers, as proposed in the ER Addendum, is sufficiently bounding and claimant favorable.

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APPENDIX A: SEC-00109 LANL PETITIONER ISSUES AND RESOLUTIONS

This appendix provides a compilation of all the issues identified by the SEC-00109 LANL petitioner along with their corresponding resolutions. The SEC-00109 petitioner has, over the course of several years, identified an extensive array of concerns. These concerns involve monitoring, dosimetry, bioassay, data sufficiency, data integrity, site characteristics, exotic radionuclides, dose modeling, sites policies, and the role and attendant risks of Support Service Workers.

When the petitioner filed his Form B petition in 2008, he provided a 102-page written narrative that discusses in detail a wide range of issues. He also provided a CD containing an enormous volume of site and third-party documentation that provides background information intended to support his concerns. Subsequent to the original submission, the petitioner physically attended, or called in, to meetings of the Advisory Board Work Group on LANL that were held on:

- April 29, 2010;
- November 3, 2010;
- May 2, 2011;
- May 14, 2012;
- September 11, 2012; and
- August 15, 2017.

During these sessions, the petitioner identified additional concerns or elaborated on previous issues.

Following a page-by-page review of the original narrative and the transcripts of the Work Group meetings, NIOSH has compiled the petitioner's issues in the following table. NIOSH then assessed whether each issue has been addressed in the appropriate manner in some document or venue. The issues are presented in the chronological order in which they were raised, beginning with the original narrative and going through the six meeting transcripts.

SEC-00109 LANL Petitioner Issues

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
1	Multiple documented admissions by NIOSH that there are still unresolved issues at the site after 1975	SEC-00109 Petition Attached Narrative, PDF pp. 11-12, 51	Received 04-03-08	SEC-00051, PDF pp. 74, 110 May 3, 2007 Board meeting, PDF pp. 274, 302-304	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995.
2	Poor monitoring or lack of monitoring of the support service workers	SEC-00109 Petition Attached Narrative, PDF pp. 12, 44-46	Received 04-03-08	SEC-00051, PDF pp. 74, 110 LANL's Air Emissions Monitoring Program, pp. 8-14	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995.
3	Dosimetry deficiencies	SEC-00109 Petition Attached Narrative, PDF p. 13	Received 04-03-08	None provided or referenced	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995.
4	Bioassay deficiencies	SEC-00109 Petition Attached Narrative, PDF p. 13	Received 04-03-08	None provided or referenced	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995.
5	Insufficient data and poor methodology for reconstructing environmental dose	SEC-00109 Petition Attached Narrative, PDF p. 13	Received 04-03-08	None provided or referenced	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995.
6	The site is very large (8.6 M sq. ft. in about 2000 structures), which makes analysis a challenge	SEC-00109 Petition Attached Narrative, PDF p. 13	Received 04-03-08	None provided or referenced	NIOSH acknowledges that LANL is a large site. This fact, however, would not likely affect the ability to reconstruct dose for monitored workers.
7	LANL is topographically complex, which makes site meteorology highly variable	SEC-00109 Petition Attached Narrative, PDF p. 16	Received 04-03-08	None provided or referenced	NIOSH acknowledges that LANL is topographically complex. This fact, however, would not likely affect the ability to reconstruct dose for monitored workers.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
8	LANL climate and terrain make radionuclide dispersion highly variable	SEC-00109 Petition Attached Narrative, PDF pp. 16, 26	Received 04-03-08	None provided or referenced	NIOSH agrees. This issue affects the accuracy of dispersion modeling; however does not affect the ability to reconstruct worker intakes based upon workplace sampling.
9	The LANL Site Profile assumes that outdoor explosives testing is an area source. The column of entrainment should be considered a point source, which should be modeled differently.	SEC-00109 Petition Attached Narrative, PDF pp. 24, 28-29	Received 04-03-08	Final Environmental Impact Statement for the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility	The Occupational Environmental Dose volume of the Site Profile, ORAUT-TKBS-0010-4, mentions "…area sources (such as contaminated soil)..." (PDF p. 50). This is the only mention of area sources in the profile. Worker intake estimates do not rely upon plume dispersion models. Environmental intake estimates in outdoor explosives testing areas are based on air monitoring data. Post-1995, workers likely to receive intakes resulting in 100 mrem CEDE should have been monitored. (Note: The LANL Site Profile was revised in 2010.)
10	Buildings influence dispersion	SEC-00109 Petition Attached Narrative, PDF p. 24	Received 04-03-08	None provided or referenced	Worker intake estimates do not rely on plume-dispersion models. Environmental intake estimates in outdoor areas are based on air monitoring data. Post-1995, workers likely to receive intakes resulting in 100 mrem CEDE should have been monitored.
11	The CAP-88 Model has limitations that affect accuracy when applied to LANL.	SEC-00109 Petition Attached Narrative, PDF pp. 34-36	Received 04-03-08	None provided or referenced	Worker intake estimates do not rely on plume-dispersion models. Environmental intake estimates in outdoor areas are based on air monitoring data. Post-1995, workers likely to receive intakes resulting in 100 mrem CEDE should have been monitored. (Note: The LANL Site Profile was revised in 2010. There is no mention of the CAP-88 Model in the current version.)

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
12	Few AIRNET samplers are placed in locations that would determine employee exposures. They are located to estimate off-site exposure.	SEC-00109 Petition Attached Narrative, PDF p. 38	Received 04-03-08	SC&A's LANL Site Profile Review, SCA-TR-Task1-0011	The cited SC&A review of the 2004 Site Profile was completed in 2006. The 2010 revised LANL Site Profile addressed this issue.
13	In the DOE environmental surveys of all its sites, LANL was the 4th highest in problems with 59.	SEC-00109 Petition Attached Narrative, PDF p. 39	Received 04-03-08	GAO 90-101, ES&H Problems at DOE Sites, p. 20	NIOSH does not disagree that there were environmental problems at LANL, as identified in the cited 1987 report. However, these problems would not affect NIOSH's ability to reconstruct worker doses that are based on monitoring data.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
14	There were a number of findings by the Tiger Team that relate to monitoring, dose, and missed dose.	SEC-00109 Petition Attached Narrative, PDF p. 40	Received 04-03-08	GAO 93-66, Corrective Actions on Tiger Team Findings Progressing Slower than Planned, p. 5	This issue was addressed in SEC-00109 ER, Rev. 0 (01-22-09), and in SEC-00109 ER, Rev. 1 (08-13-12). The Tiger Team Assessment Report (submitted by the petitioner) made a number of observations about the LANL site that are pertinent to the potential for unmonitored intakes (Tiger Team, 1991). In summary, the report observed that: 1. radiation surveys sometimes did not conform to LANL policies and documented schedules; 2. contamination control programs did not ensure complete control of the spread of contamination; 3. there were instances in which barriers had been removed or signage was inappropriate or missing; 4. posting was inconsistent throughout the site; 5. the frequency of surveys mandated by procedures was not consistently followed; 6. signs and labels throughout the plutonium and uranium facilities did not indicate radiological conditions, were not accurate, or had other problems that could lead to unsafe practices; 7. documentation of smear surveys was not consistently performed; 8. the use of open-front hoods led to an increased frequency of radioactive material contamination incidents; 9. cracked glovebox gloves were observed; 10. removable and fixed surface contamination limits for tritium and pure gamma-emitting nuclides were not in compliance with DOE Order 5480.11; (continued on next page)

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
14	(continued)	(continued)	(continued)	(continued)	(continued) 11. calibration and response-checking of fixed instruments and tritium monitors did not reflect the same level of attention and commitment given to portable instrumentation; 12. out-of-calibration instruments, such as glovebox hand and foot monitors and tritium monitors, were not placed out of service; 13. placement of air monitoring instruments at the DU sites was not based on studies of flow patterns; 14. facility air monitor alarm points, used per DOE Order 5480.11 to warn workers that airborne radioactive material contamination levels had exceeded an action level, were not always set at a uniform level, with the set points varying from monitor to monitor even in the same building; and 15. training programs had not been established to ensure that routine dose rate and contamination surveys were conducted in a consistent manner. None of the numerous Tiger Team findings and observations pertains to the adequacy of the internal or external dose personnel monitoring programs; therefore, they do not compromise NIOSH's ability to conduct dose reconstruction with sufficient accuracy. Dose reconstructions for LANL employees are based on internal and external dose monitoring data. These data are also employed in co-worker studies to estimate unmonitored worker intakes.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
15	The LANL ES&H Self-Assessment identified problems with stack monitoring and LANL lost a Clean Air Act lawsuit as a result.	SEC-00109 Petition Attached Narrative, PDF p. 41	Received 04-03-08	LA-12200-MS, Finding/AX.2-1	NIOSH does not disagree that there were stack-monitoring problems at LANL, as identified in the cited 1991 ES&H Self-Assessment report. However, these problems would not affect NIOSH's ability to reconstruct worker doses using methodologies that do not rely on stack monitoring.
16	The EPA found that LANL was not in compliance in regard to identifying emission sources, installation of stacks, and stack monitoring.	SEC-00109 Petition Attached Narrative, PDF p. 42	Received 04-03-08	None provided or referenced	NIOSH does not disagree that there were stack-monitoring problems at LANL. However, these problems would not affect NIOSH's ability to reconstruct worker doses using methodologies that do not rely on stack monitoring.
17	An EPA audit the following year found continuing violations. 31 of 33 radionuclide-emitting stacks were out of compliance. LANL was fined and had to submit 3 independent audits of its air quality.	SEC-00109 Petition Attached Narrative, PDF pp. 42-43	Received 04-03-08	Memorandum Opinion and Order, p. 8	See response to Issue 16.
18	The main resources for the dosing tables in ORAUT-TKBS-0010-4 were the CDC's LAHDRA report and the LANL Environmental Surveillance Report, both of which only address airborne concentrations that would affect people off-site.	SEC-00109 Petition Attached Narrative, PDF p. 47	Received 04-03-08	ORAUT-TKBS-0010-4 SEC-00051 ER, PDF p. 81	This issue is from the 2004 Site Profile. The profile was revised in 2010. Section 4.2.1.1 of ORAUT-TKBS-0010-4 (03-26-10) states: *For earlier years (1943 to 1970), the effluent releases in this document rely on data from the Centers for Disease Control and Prevention Los Alamos Historical Document Retrieval and Assessment (LAHDRA) project (ENSR 2002), including unpublished data; however, these data were determined to be insufficient for reconstruction of environmental internal doses.*

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
19	Prior to the Clean Air Act in 1969, LANL did not maintain effluent data.	SEC-00109 Petition Attached Narrative, PDF p. 50	Received 04-03-08	CDC's LAHDRA report	The SEC-00109 evaluation addressed the years 1976-2005. This pre-1969 issue is not relevant.
20	Current policies and procedures do not ensure compliance with DOE Order 5480.19.	SEC-00109 Petition Attached Narrative, PDF p. 53	Received 04-03-08	LANL ES&H Self-Assessment, OA.7-1, Document Control	This 1991 Self-Assessment identified compliance issues with DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities." NIOSH also found issues associated with written operating procedures. Expansion of the SEC class through 1995 was recommended in the SEC-00109 ER, Rev. 1 (08-13-12). Radiation protection and monitoring procedures improved by 1996, with the implementation of 10 C.F.R. 835.
21	LANL does not have a clearly articulated policy with standards for procedure development, document control, and records management.	SEC-00109 Petition Attached Narrative, PDF p. 54	Received 04-03-08	LANL ES&H Self-Assessment, OA.7-2, Document Control	This 1991 Self-Assessment identified compliance issues with DOE Order 5480.19, "Conduct of Operations Requirements for DOE Facilities." NIOSH also found issues associated with procedures and records management. Expansion of the SEC class through 1995 was recommended in the SEC-00109 ER, Rev. 1 (08-13-12). Radiation protection and records management procedures improved by 1996, with the implementation of 10 C.F.R. 835.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
22	There is a lack of data for the Cerro Grande Fire for a variety of reasons. Security guards were not provided with any breathing apparatus throughout the three weeks of the fire and evacuation and return and they worked 16 hrs/day 7 days/wk.	SEC-00109 Petition Attached Narrative, PDF pp. 55-63	Received 04-03-08	GAO/T-RCED-00-273 National Research Council Radiation report LA-UR-01-1132	SEC-00109 ER, Rev. 0 (01-22-09), and SEC-00109 ER, Rev. 1 (08-13-12), address the Cerro Grande Fire in Section 7.4.1. A study performed soon after the Cerro Grande fire included two dose calculations: 1. the hypothetical maximally-exposed firemen or volunteer who was working actively in the Los Alamos area throughout the worst of the burn duration; and 2. the maximally-exposed member of the public outside Los Alamos. Those calculations are updated in *Updated Calculations of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data* (Cerro Grande, 2001). In addition, a third calculation is added: a fireman or other worker in the vicinity of AIRNET (LANL's ambient air monitoring network) Station #23 in Mortandad Canyon where elevated levels of LANL-derived airborne uranium occurred during the peak of the fire. The incident information was reviewed by NIOSH and these data can be used to bound the dose for any Service Support Worker who might have been exposed during the fire.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
23	Support service workers were not monitored or adequately monitored during and after the Sigma Americium Contamination Incident.	SEC-00109 Petition Attached Narrative, PDF pp. 63-65	Received 04-03-08	Type B Investigation NCRP Report No. 87 SEC-00051 LANL ER, PDF pp. 67, 78	SEC-00109 ER, Rev. 0 (01-22-09), and SEC-00109 ER, Rev. 1 (08-13-12), address the Sigma American Contamination Incident in Section 7.4.2. The Type B Accident Investigation report on the July 14, 2005 americium contamination accident at the LANL Sigma Facility states that the maximum dose to Worker 1 (the maximally-exposed individual) was 500 mrem CEDE. Based on this assessment and its review by NIOSH, a maximum intake may be estimated, which could then be used to bound the dose for service workers.
24	*In-vitro* bioassay samples were not handled properly. They were stored in an unrefrigerated cabinet and analyzed once a week.	SEC-00109 Petition Attached Narrative, PDF pp. 65-66	Received 04-03-08	NCRP Report No. 87	NIOSH has not identified sample-handling issues that would invalidate bioassay results.
25	The LANL bioassay program was insufficient because support service workers were not routinely monitored and the records are inadequate or incomplete.	SEC-00109 Petition Attached Narrative, PDF pp. 66-68	Received 04-03-08	SEC-00051 LANL ER, PDF pp. 67, 78	NIOSH concurred with the petitioner. SEC-00109 ER, Rev. 1 (08-13-12), recommended expanding the SEC class through 1995. Post-1995, workers likely to receive intakes resulting in 100 mrem CEDE should have been monitored.
26	Because support service workers could work at several facilities in a day, and because NCFs varied by more than an order of magnitude across LANL facilities, data from the LANL 7776 type TLD cannot be used for DRs for these workers.	SEC-00109 Petition Attached Narrative, PDF pp. 68-69	Received 04-03-08	Hoffman and Mallett, p. S98	This issue was addressed in SEC-00109 ER, Rev. 0 (01-22-09) and SEC-00109 ER, Rev. 1 (08-13-12), in Section 7.4.4. Area-specific neutron correction factors (NCFs) are used at LANL to improve the accuracy of the neutron dose based on workplace instrument measurements (ORAUT-TKBS-0010-6). If workers frequented multiple facilities, or if the facilities frequented are unknown, NIOSH can bound neutron doses by applying the highest NCF for any of the buildings the worker may have entered.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
27	Regarding the validity of coworker data, I have concerns about the firing sites. There were explosions involving exotics. What workers are you using to represent the people who were there and who cleaned up? All site workers?	Transcript from the Board meeting of April 29, 2010, PDF pp. 240-242	April 29, 2010	None provided or referenced	The coworker models were derived from bioassay results from all monitored workers at LANL, not just glovebox workers.
28	Are the electronic data present to validate who was in an area and when?	Transcript from the Board meeting of April 29, 2010, PDF pp. 242-244	April 29, 2010	None provided or referenced	NIOSH does not rely on electronic data to determine who is in various LANL areas. NIOSH acknowledges that many workers frequented multiple unknown areas. For this reason, the SEC class definition in SEC-00109 ER, Rev. 1 (08-13-12), includes all workers. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
29	What about the checklist that workers fill out annually that is part of the occupational health program? It asks what radionuclides a worker is exposed to. If workers don't know, they will generally say No. Does this checklist determine who is identified for monitoring and the bioassay program?	Transcript from the Board meeting of April 29, 2010, PDF pp. 244-249	April 29, 2010	None provided or referenced	In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that the LANL programs for identifying individuals for bioassay during the post-1995 era were effective. NIOSH further concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE. This issue was identified by SC&A in their review of the LANL ER Addendum. It is being further evaluated and will be addressed in the White Paper being prepared in response to the SC&A review. This was one of the issues identified in the noncompliance report NC ID 484.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
30	I still don't feel all the source terms environmentally have been identified and examined. I related them in my report. I don't feel they were addressed in the ER.	Transcript from the Board meeting of April 29, 2010, PDF pp. 249-250	April 29, 2010	None provided or referenced	In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE. This determination includes contributions from environmental contamination source terms.
31	The New Mexico Environment Dept. and LANL are supposed to issue a joint report concerning contamination at the lab. They have determined that the DO need a federal investigation where it is compensable to surrounding lands.	Transcript from the Board meeting of April 29, 2010, PDF p. 249	April 29, 2010	None provided or referenced	In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE. This determination includes contributions from environmental contamination source terms.
32	Talking about LANSCE and the activation product issues, in my petition, there is a discrepancy between that and I believe the latest update to the environmental exposures in the TBD because basically they say the winds going to TA-72 are three percent. And in the petition, I provide documentation that says the winds going towards TA-72 are 26 percent.	Transcript from the Board meeting of April 29, 2010, PDF pp. 250-251	April 29, 2010	None provided or referenced	In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE. This determination includes contributions from environmental contamination source terms.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
33	LANL cited one air monitor in Mortandad Canyon they would use to determine dose for firefighter, guards, and other people on site. The RAC report stated that air monitors were shut off for 3 days during the fire. Particulate matter overwhelmed the filters so that accuracy was changed by an order of magnitude.	Transcript from the Board meeting of April 29, 2010, PDF pp. 252-255	April 29, 2010	None provided or referenced	See response to Issue 22. The report referenced in response to Issue 22, *Updated Calculations of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data* (Cerro Grande, 2001), concluded that the maximally-exposed individual from this fire received an intake resulting in a CEDE of only a fraction of a mrem. It is unlikely that unmonitored workers received intakes in excess of 100 mrem CEDE.
34	Worker records that did not record locations where people worked. They just recorded pay code and hours worked. Only in the last few years, were work locations recorded.	Transcript from the Board meeting of April 29, 2010, PDF pp. 257-258	April 29, 2010	None provided or referenced	NIOSH recognizes that claimants' specific work locations are often unknown. For this reason, the SEC class definition in SEC-00109 ER, Rev. 1 (08-13-12), includes all workers and all areas. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
35	It was revealed in the Clean Air Act lawsuit that there were several buildings with unmonitored stacks. Were there exotics in these buildings?	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 133-134	Nov. 3, 2010	None provided or referenced	NIOSH does not disagree that there were stack monitoring problems at LANL. However, these problems would not affect NIOSH's ability to reconstruct worker doses using methodologies that do not rely on stack monitoring.
36	The episodic nature of the release of exotics through unmonitored stacks.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 165-166	Nov. 3, 2010	None provided or referenced	See response to Issue 35.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
37	A guy inside a building has a glovebox and negative pressure. Where is contamination going? Out an unmonitored stack to a guy who is mowing the lawn.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 168-169	Nov. 3, 2010	None provided or referenced	Intakes by a person mowing the lawn would be accounted for by using methodologies given in the Site Profile for assigning environmental dose.
38	How do you place service workers at the firing sites before and after explosions (e.g., during clean-up)? There are problems with the badging process in making that determination.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 292-297	Nov. 3, 2010	None provided or referenced	NIOSH will use personal monitoring data when available to assign worker doses and intakes. NIOSH does not rely on knowledge of worker location during and after explosives tests. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
39	There is a question about the reliability of Occupational Health and Health Physics checklists. The OH checklist is self-reporting. The HP checklist is informing in regard to whether bioassay will be required. Are these considered administrative controls? Are we relying on these to determine where people worked and when?	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 299-310, 338-341	Nov. 3, 2010	None provided or referenced	The Board conversation seems to say that NIOSH is NOT using these documents to make these determinations. NIOSH does not rely on the HP checklists to determine when and where individuals worked. The checklists are used, in part, by LANL HP professionals to ensure that workers are placed on the appropriate personnel monitoring programs. Concerns regarding the effectiveness of the HP checklists for identifying appropriate bioassay programs for workers were raised by SC&A in their review of the LANL ER Addendum. The issue is being further evaluated and will be addressed in the White Paper being prepared in response to that SC&A review. This was one of the issues identified in the non-compliance report NC ID 484.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
40	There are a number of sites that are uncharacterized. They don't know what's in them. There is exposure potential there, at least for service workers.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 315-319	Nov. 3, 2010	None provided or referenced	For monitored workers at uncharacterized sites, NIOSH would use those monitoring results to assign doses and intakes. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
41	The National Academy of Sciences report says there is no mass balance for LANL. That raise the question: Have you captured the entire source term and potential exposure to workers?	Transcript from the Board meeting of Nov. 3, 2010, PDF p. 315	Nov. 3, 2010	None provided or referenced	Accurate knowledge of source terms can sometimes be helpful to bound potential intakes in the absence of monitoring data. For LANL, NIOSH relies on monitoring data to assign intakes, but also recognizes that some workers were not monitored. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
42	Cerro Grande fire discussion and Don Stewart's white paper.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 321-333	Nov. 3, 2010	None provided or referenced	See response to Issue 22.
43	The Tiger Team findings are programmatic. They call into question the reliability of the data for what you intend to use the data for.	Transcript from the Board meeting of Nov. 3, 2010, PDF pp. 336-344	Nov. 3, 2010	None provided or referenced	This issue was addressed in SEC-00109 ER, Rev. 0 (01-22-09). See response to Issue 14.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
44	Are uncharacterized areas (e.g., waste disposal sites) covered under environmental? There is a listing of sites that require further investigation to determine if the pose a threat. The petitioner lists many examples.	Transcript from the Board meeting of May 2, 2011, PDF pp. 286-293	May 2, 2011	None provided or referenced	For monitored workers in uncharacterized areas, NIOSH would use those monitoring results to assign doses and intakes. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
45	As a result of the Clean Air Act lawsuit, they had an audit team that determined that a lack of documentation regarding inventories precluded a thorough evaluation regarding the quality and completeness of the 1996 inventory. Also, they questioned the historical data on release and stack monitoring. Additional issue recited.	Transcript from the Board meeting of May 2, 2011, PDF pp. 293-298	May 2, 2011	None provided or referenced	This issue is unlikely to impact NIOSH's ability to reconstruct dose to workers. NIOSH utilizes personnel monitoring data for dose reconstruction at LANL, not inventories or stack monitoring data. In the SEC-00109 ER Addendum, 4/24/17, NIOSH concluded that unmonitored workers were unlikely to have received intakes that would have resulted in 100 mrem CEDE.
46	In discussions with the petitioner, the firefighters maintain they had no bioassay samples taken during or after the Cerro Grande fire.	Transcript from the Board meeting of May 2, 2011, PDF pp. 310-315	May 2, 2011	None provided or referenced	See response to Issue 22.
47	The issue of the size of the in vivo datasets in regard to exotics. There is a lot for U, Pu, and Am, but not for exotics. Are the datasets representative for exotics in terms of DR?	Transcript from the Board meeting of May 2, 2011, PDF pp. 318-322	May 2, 2011	None provided or referenced	NIOSH concurred with this issue in SEC-00109 ER, Rev. 1 (08-13-12), when it recommended an SEC class through 1995. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes from exotic radionuclides that would have resulted in 100 mrem CEDE.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
48	The issue of RWPs and SWPs and whether they are always used and properly used when they are used. What about service workers who are not on an RWP?	Transcript from the Board meeting of May 14, 2012, PDF pp. 137-150	May 14, 2012	None provided or referenced	NIOSH concurred with this issue in SEC-00109 ER, Rev. 1 (08-13-12), when it recommended an SEC class through 1995. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes from exotic radionuclides that would have resulted in 100 mrem CEDE. Concern regarding the effectiveness of RWPs for identifying appropriate bioassay programs for workers was raised by SC&A in their review of the LANL ER Addendum. This issue is being further evaluated and will be addressed in the White Paper being prepared in response to the SC&A review. This was one of the issues identified in the noncompliance report NC ID 484.
49	The measurement techniques for Pu don't translate for Np. A wide-ranging discussion revolving around unmonitored workers.	Transcript from the Board meeting of May 14, 2012, PDF pp. 207-221	May 14, 2012	None provided or referenced	This issue was addressed in a six-page response in the SEC-00109 ER Addendum (04-24-17).
50	In the 2008 report by DOE HSS (page 5), they said that at the institutional level, methods used to enroll workers in the bioassay program have not been adequate to ensure that workers are monitored for correct isotopes and at the required frequencies. Question about NIOSH's programmatic argument.	Transcript from the Board meeting of May 14, 2012, PDF pp. 244-246	May 14, 2012	None provided or referenced	Concern regarding the effectiveness of the methods used to enroll workers in the appropriate bioassay programs was raised by SC&A in their review of the LANL ER Addendum. This issue is being further evaluated and will be addressed in the White Paper being prepared in response to the SC&A review. This was one of the issues identified in the noncompliance report NC ID 484.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
51	At what point do you establish that the hole is too big and it seems you are not looking for these (exotic) radionuclides to begin with. If you are not looking for them, how do you establish a dose?	Transcript from the Board meeting of May 14, 2012, PDF pp. 249-252	May 14, 2012	None provided or referenced	NIOSH concurred with this issue in SEC-00109 ER, Rev. 1 (08-13-12), when it recommended an SEC class through 1995. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes from exotic radionuclides that would have resulted in 100 mrem CEDE.
52	Re the response doc: How is the co-worker model going to fly for the firing sites when the model deals with glovebox workers and the firing sites are open areas with resuspension issues?	Transcript from the Board meeting of May 14, 2012, PDF pp. 286-292	May 14, 2012	None provided or referenced	The co-worker models were derived from bioassay results from all monitored workers at LANL, not just glovebox workers.
53	More discussion of Cerro Grande.	Transcript from the Board meeting of May 14, 2012, PDF pp. 293-297	May 14, 2012	None provided or referenced	See response to Issue 22.
54	No issues discussed by petitioner during this meeting.	Transcript from the Board meeting of Sept. 11, 2012	Sept. 11, 2012	None provided or referenced	No issue, no resolution.

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
55	Concern about spallation products from the accelerator.	Transcript from the Board meeting of Aug. 15, 2017, PDF p. 87	Aug. 15, 2017	None provided or referenced	A 1975 assessment identifies spallation products in LAMPF waste water (LAMPF, 1975). It lists C-10, O-14, O-15, N-13, C-11, Be-7, and H-3 as spallation products. A 1982 memo discusses public doses from LAMPF (1983). C-11, N-13, and O-15 are identified as the major dose contributors. A health protection quarterly progress report for Q1 1988 summarizes the 1987 Area A stack releases (Quarterly Report, 1988), as follows: *The total quantity of gaseous radioactivity released to the atmosphere from the Area A stack during the 1987 operating period was 150,000 Curies. The composition of this gaseous effluent was as follows:* *Isotope* — *Half-Life* — *Percentage* *Nitrogen-16* — *7.1 s* — *3.7* *Carbon-10* — *19.3 s* — *1.4* *Oxygen-14* — *1.2 m* — *0.6* *Oxygen-15* — *2.0 m* — *43.7* *Nitrogen-13* — *10.0 m* — *15.1* *Carbon-11* — *20.4 m* — *35.1* *Argon-41* — *109.7 m* — *0.4* *In addition, approximately 13 Curies of tritium [H-3] as water vapor was released in 1987.* (continued on next page)

Issue	Petitioner Issue	Forum	Date	Supporting Document(s) Provided or Referenced by Petitioner	Resolution
55	(continued)	(continued)	(continued)	(continued)	(continued) For dose reconstruction purposes, NIOSH has numerous bioassay results for LANSCE that include assay for Be-7, C-11/N-13, and several other activation products (as shown in Table 4-1 in this white paper). Given the short half-lives of the spallation products (listed above), NIOSH considers that these products were unlikely to have been significant contributors to worker doses.
56	Question about Np. Was it only in TA-55 or were there other areas? If so, was 100 grams the maximum?	Transcript from the Board meeting of Aug. 15, 2017, PDF p. 87	Aug. 15, 2017	None provided or referenced	The neptunium issue was addressed in the SEC-0009 Addendum (04-24-17). This specific issue was also raised by SC&A in their *Review of SEC Petition Evaluation Report Addendum (SEC-00109) for Los Alamos National Laboratory* (07/27/17). NIOSH is currently preparing a White Paper response to that SC&A review. A response to this specific question will be included in that White Paper.
57	The catalog for the in vivo measurements is very limited or non-existent so you don't have the ability to determine if someone was exposed to an exotic as opposed to a common ROC.	Transcript from the Board meeting of Aug. 15, 2017, PDF p. 88	Aug. 15, 2017	None provided or referenced	Post-1995, LANL has maintained the technical capability to identify specific radionuclides in bioassay analyses for monitored workers. In the SEC-00109 ER Addendum (04-24-17), NIOSH concluded that unmonitored workers were unlikely to have received intakes from exotic radionuclides that would have resulted in 100 mrem CEDE.