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Advisory Board on Radiation and Worker Health
National Institute for Occupational Safety and Health

Review of Documentation Provided by CORE Advocacy Related to the Evaluation of SEC-00235 at the Santa Susana Field Laboratory

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SC&A, Inc. Technical Support for the Advisory Board on Radiation and Worker Health's Review of NIOSH Dose Reconstruction Program

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Table of Contents

Abbreviations and Acronyms

ABRWH, Board	Advisory Board on Radiation and Worker Health
Am	americium
BZ	breathing zone
CEP	Controls for Environmental Pollution
CH	contact-handled
CORE Advocacy	CORE Advocacy for Nuclear and Aerospace Workers
CRIEPI	Central Research Institute of Electric Power Industry (Japan)
CT	computer tomography
DAC	derived air concentration
DOE	U.S. Department of Energy
DOELAP	Department of Energy Laboratory Accreditation Program
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
FOIA	Freedom of Information Act
GA	general area
KHI	Kawasaki Heavy Industries
mrem	millirem
MURR	Missouri University Research Reactor
NIOSH	National Institute for Occupational Safety and Health
NMDF	Nuclear Materials Development Facility
Np	neptunium
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical information bulletin
Pu	plutonium
PWR	pressurized-water reactor
RH	remote-handled
RIHL	Rockwell International Hot Laboratory
RMDF	Radioactive Material Disposal Facility
RMHF	Remote Materials Handling Facility
SEC	Special Exposure Cohort
SRDB	Site Research Database
SSFL	Santa Susana Field Laboratory

TRU	transuranic
TRUMP-S	Transuranic Management by Pyropartitioning-Separation
UMC	University of Missouri at Columbia
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant

1 Introduction and Background

In May 2017, the National Institute for Occupational Safety and Health (NIOSH) issued an evaluation report for Special Exposure Cohort (SEC) Petition SEC-00235 for Area IV of the Santa Susana Field Laboratory (SSFL) for the period August 1, 1991, to June 30, 1993 (NIOSH, 2017). SEC-00235 was qualified for evaluation because of compromised bioassay samples analyzed by the vendor Controls for Environmental Pollution (CEP) during this time period (referred to as the "CEP period" in this report). NIOSH does not use the bioassay results from CEP because they were implicated in data falsification at another site (not SSFL-affiliated). NIOSH found that, despite the lack of roughly 2 years' worth of in vitro bioassay data, there was no dose reconstruction infeasibility for the evaluated period and did not recommend that a class be added to the SEC. In order to perform internal dose reconstruction during this period, NIOSH recommends use of the coworker models developed for Area IV and documented in ORAUT-OTIB-0080 (NIOSH, 2014). However, two issues subsequently arose during SSFL work group discussions:

- Issue 1: The possible presence of thorium and americium isotopes that may represent a significant internal exposure hazard.
- Issue 2: The evaluation and comparison of air sampling data during the operational period and CEP period in order to demonstrate that the general radiological conditions during the CEP period are sufficiently similar to, or bounded by, the operational conditions.

These two issues were discussed during the Area IV SSFL work group meeting held on December 4, 2017, at which time NIOSH was tasked with evaluating each concern. NIOSH delivered two separate white papers on these subjects to the Area IV SSFL work group on November 1, 2018. SC&A reviewed these two white papers[1] and available documentation, issuing a draft report with the following conclusions:

- Issue 1: "SC&A did not identify evidence of internal exposure potential to americium and/or thorium sources that would preclude dose reconstruction feasibility. . . . NIOSH might consider establishing an occupational exposure model, in place of an environmental intake model that uses available air sampling results (BZ and GA) or some fraction of the administrative limits in place at the time" (SC&A, 2019a, p. 23).

- Issue 2: "SC&A found no evidence in either the available documentation or GA air sample data that radiological conditions were significantly different from the operational period that would preclude the use of coworker intake models developed for uranium, plutonium, and fission/activation products (strontium and cesium) during the CEP Period" (SC&A, 2019a, p. 23).

The SEC petitioner for SSFL (CORE Advocacy for Nuclear and Aerospace Workers, hereafter "CORE Advocacy") notified NIOSH on January 28, 2019, that approximately 1,463 boxes of U.S. Department of Energy (DOE) records relevant to SSFL were scheduled to be made

[1] Although NIOSH issued two separate white papers on these subjects, due to the general overlap of these two issues, SC&A elected to combine its review into a single report.

available no later than fall 2019. The SEC petitioner discussed some of the content of these records at the meeting of the Advisory Board on Radiation Worker Health (ABRWH or "Advisory Board") held in Knoxville, TN on August 21, 2019. These documents were made available to NIOSH and SC&A reviewers in August and September 2019. During the ABRWH meeting on August 21, the SEC petitioner contended that the submitted documents confirm "operations with americium and thorium at Area IV until 2008. . . . [and] another document today that potentially puts processes with these materials at the site until 2010" (ABRWH, 2019, p. 87). More specifically:

- The documentation provides "new evidence that suggest site remediation workers were, and currently are, insufficiently monitored. . . . under the FOIA [Freedom of Information Act] we obtained several of the requests from Boeing to be exempted from Department of Energy's requirements to monitor site remediation workers" (ABRWH, 2019, pp. 90–91).

- The documentation contains "a Boeing technical progress report that details TRUMP-S operations Area IV from 1993 until 1998," with it appearing to the petitioner that "they brought the program back" (ABRWH, 2019, p. 90).

- The documentation contains "several . . . acceptable knowledge summaries that describe transuranic waste generation and processes between 2002 to 2008, and the storage of transuranics for up to 20 years . . . the plutonium content was quickly decaying to rising levels of americium" (ABRWH, 2019, p. 90).

In this report, SC&A has reviewed the documentation submitted by the SEC petitioner to ascertain the effect of such new information on dose reconstruction feasibility. The documentation consisted of nine computer files. One of the files was a technical progress report for the period 1993 through 1998 regarding the Transuranic Management by Pyropartitioning-Separation (TRUMP-S) program. Four files were related to the storage, processing, and management of transuranic (TRU) waste (including three files associated with acceptable knowledge summary reports for specific TRU waste streams). One file contained 1,276 pages of documentation, much of which was related to radiological monitoring of workers and the Department of Energy Laboratory Accreditation Program (DOELAP) certification of SSFL's internal dosimetry monitoring program. One file was a copy of a worker performance review. The two remaining documents were summaries of the SEC petitioner's findings associated with the recently submitted material.

Section 2 of this report summarizes SC&A's review of the documentation in the context of the three general concerns reported to the Advisory Board by the SSFL petitioner in August 2019. Attachment A provides a more detailed review of the specific statements made by the SEC petitioner and their reported findings submitted to the Advisory Board.

2 Summary of SC&A Review

2.1 Monitoring of site remediation workers

The SEC petitioner states (ABRWH, 2010, p. 91):

> under the FOIA we obtained several of the requests from Boeing to be exempted from Department of Energy's requirements to monitor site remediation workers.
>
> Those are dated between 1991 into the 2000s. So they coincide with the site remediation processes and the transuranic work that we're talking about.
>
> The Department of Energy expected compliance from the contractor, but they gave Boeing a loophole to exemption.

SC&A reviewed the largest file of the petitioner's document submittal, consisting of 1,276 pages, that contains radiation protection program descriptions, procedures, incident reports, and other documents to determine if there was any information that would indicate SSFL workers were not being properly monitored and thus sufficiently accurate dose reconstruction may not be feasible.

Much of the documentation contained in the 1,276-page file consisted of radiation protection plans and procedures, letters related to compliance with DOE requirements, and program certification. Upon review of this documentation, SC&A did not identify information that would suggest that workers were not being monitored. Much of the documentation is related to DOE seeking to require SSFL to obtain certification for the DOELAP internal dosimetry program. However, SC&A did not identify information in the DOE correspondence to suggest that the monitoring program was otherwise inadequate. This is with the noted exception of the 2-year period in which bioassay results were invalidated due to the involvement of CEP as the bioassay vendor.

The submitted documents included a Boeing Company letter (Boeing, 2001) in which the Boeing Company (hereafter "Boeing") offered data to support its position that it does not meet the 100 millirem (mrem)/year committed effective dose equivalent limit requiring participation in the DOELAP program for internal dosimetry. The data provided represented alpha emitters in ambient conditions from 1991 to 2000. In building 20 (also known as the Rockwell International Hot Lab, or RIHL), the letter states, "the primary source of the airborne contamination was related to the cleaning and demolition of the cells, which had been used for decladding of nuclear fuels. This work was completed by mid-1996" (Boeing, 2001, p. 3). Boeing noted that, upon completion of the decontamination and decommissioning (D&D) work, "no alpha emitters have been detected in the facility" (Boeing, 2001, p. 6). Regarding the Remote Materials Handling Facility (RMHF), the letter states:

> "While some projects involve relatively low levels of alpha contamination, the media (drainline and tank debris) are of large particle size and are not readily respirable (as demonstrated by previous experience with the materials). As the facility nears the end of its life, it will be decontaminated and decommissioned. (Boeing, 2001, p. 7)

In addition, alpha contamination had not been found in Building 24 (Boeing, 2001, p. 8). Boeing noted that 236 persons participated in the bioassay program from 1989 through 1999 (Boeing, 2001, p. 5). Boeing asserted that because past D&D activities had not caused significant intakes of radioactive materials, and the nature of future projects would not cause such uptakes, the 100 mrem committed effective dose equivalent limit requiring participation in the DOELAP program for internal dosimetry would not be exceeded; therefore, Boeing's participation in the DOELAP program was not required. However, Boeing did note that "we consider it prudent to monitor personnel we consider most likely to receive internal exposures" (Boeing, 2001, pp. 8–9).

Regarding the presence of thorium, a radiation protection activity report for November 1994 states the following:

> Numerous laboratory containers of chemical compounds that contain uranium and thorium, ("generally licensed" radioactive materials), are being discovered in various Rocketdyne laboratories. A search and collection is being done for these items, and 25 items have been collected, inventoried, and transferred to RP&HPS [Radiation Protection and Health Physics Services] control. Possible beneficial recycling/disposal options are being investigated." (Rockwell, 1994, p. 3)

SC&A reviewed all of the activity reports for the subsequent year (1995) to see if there was any followup information regarding containers holding uranium and thorium but did not discover any additional information. More importantly, SC&A did not identify evidence of operational activities involving thorium. The discovery of waste packages containing uranium and thorium is consistent with D&D activities known to have occurred at SSFL. Dose reconstruction methods for thorium to such exposures are currently in development by NIOSH and will be taken under consideration by the SSFL work group as well as the full Advisory Board. Intakes of uranium are currently reconstructed using individual bioassay results or, in the absence of such results, coworker intakes developed in ORAUT-OTIB-0080 based on operational urinalysis data.

Another activity report from 1995 shows that there was a plutonium inventory in the Radioactive Material Disposal Facility (RMDF), including in waste packages, RIHL drainline debris, and the former RIHL Liquid Waste Holdup Tank (Rockwell, 1995b, p. 3). Such an inventory is consistent with the D&D activities that were occurring at SSFL during this period. SC&A notes that coworker intakes of plutonium have been developed in ORAUT-OTIB-0080 for workers who were not monitored directly.

Nothing in the provided documentation suggests that there was an inadequate internal dosimetry program at SSFL, or that the overall radiation program was not in compliance with regulatory requirements. In a DOE letter dated August 14, 1998, DOE stated that SSFL's internal dosimetry program is in compliance with DOE requirements (DOE, 1998, PDF p. 108). A 1995 letter from Rockwell International shows that, with some minor adjustments to the checklists and courses (not specified in the letter), the SSFL radiation worker training programs met DOE Rad Worker II training requirements (Rockwell, 1995a, p. 1).

2.2 TRUMP-S program

As part of its review of petitioner-provided documents, SC&A reviewed the provided "Technical Progress Report Private Sector Initiative Between the United States and Japan January 1993-

September 1998" (Boeing, 1998). The Private Sector Initiatives Program began in mid-1987 to, in part, "provide a basis for U.S. vendor participation in advanced Japanese liquid metal reactor (LMR) designs" (Boeing, 1998, p. v). From 1994 through September 1997, the TRUMP-S process was demonstrated at a 1/6000 and 1/2000 scale. The TRUMP-S process:

> was demonstrated at MURR [Missouri University Research Reactor] by MURR, UMC [University of Missouri at Columbia], CRIEPI [Central Research Institute of Electric Power Industry (Japan)], KHI [Kawasaki Heavy Industries] and Boeing personnel. The demonstration tests utilized simulated PUREX wastes consisting of nonradioactive components with actinides added in the proper proportions to simulate the waste generated when Japan's PUREX plant is processing 48,000 megaWatt day/tonne burnup PWR fuel. [Boeing, 1998, p. 1]

The TRUMP-S program objectives after 1988 were as follows:

1. 1988–1990: Measure chemical and electrochemical properties of actinides and rare earths to predict actinide separation efficiency and purity for pyrochemical partitioning.

2. 1991–1993: Determine the americium electrochemical properties and measured actinide separation efficiency and product purity for pyrochemical partitioning of PUREX waste.

3. 1994–1997: Process demonstration of pyropartitioning steps and develop a computer code to model the process as developed and to perform a pyropartitioning process engineering feasibility study.

Although the progress report did not identify the specific location at which these objectives were met, or who performed them, the report clearly states that the process was demonstrated at MURR. Per the report, Boeing personnel were present during the tests at MURR (Boeing, 1998, p. 1).

The progress report references six previous technical progress reports that date back to July 1987. Four of these reports are in the Site Research Database (SRDB), available to SC&A, NIOSH and the Advisory Board. One of reports, for the period January 1989–December 1989, is discussed in the SC&A memorandum dated July 25, 2019, "Evaluation of Petitioner-Specific Concerns Regarding SEC-00235" (SC&A, 2019b), and therefore is not discussed further in this report.

Based on the technical progress report for 1990 (Rockwell, 1993a), there were some TRUMP-S tests performed in Japan, but planned activities at SSFL were not conducted due to public pressure regarding the RIHL. Instead, an alpha lab including gloveboxes was constructed at MURR to perform the work. This is confirmed in the 1991 progress report (Rockwell 1993b), which states:

> Electrochemical test cells and methodology were developed at the Rockwell Santa Susana Field Laboratory (SSFL) using rare earths in the inert atmosphere glovebox. This technology was transferred to the [MURR] Alpha Laboratory for use with actinides by interchange of laboratory personnel. [Rockwell, 1993b, p. 3]

A computer program on an IBM system was installed at SSFL and MURR. Safety upgrades were made at MURR. These activities match the 1988–1990 TRUMP-S program objectives; however, no information is currently available that suggests the actual tests involving the handling of TRU material occurred at SSFL.

As described in the technical progress report for 1992 (Rockwell 1993c, p. vi), data interpretation was conducted and several studies were performed, but the location is not specifically identified. However, current documentation does note that TRU waste was generated at MURR ("Appendix 4.10.2.2," 2002, PDF p. 3).

According to the 1998 Boeing report provided by the petitioner, during 1994 through September 1997, the TRUMP-S process "was demonstrated at MURR by MURR, UMC, CRIEPI, KHI, and Boeing personnel" (Boeing, 1998, p. 1) The report continues (p. 1) that "a consistent set of electrochemical and physical data were required to develop the pyropartitioning process; these data were measured and the TRUMP-S pyropartitioning process was developed and tested to show that actinides could be separated from PUREX wastes"; these activities match the TRUMP-S program objectives for 1991–1993. Finally, the report states (p. 2) that "computer programs were developed to simulate the pyropartitioning process." This confirms that the TRUMP-S program objectives for 1994–1997 were accomplished. Taken together, these quoted passages demonstrate that the TRUMP-S process was demonstrated at MURR, with some supporting nonradiological activities possibly occurring at SSFL.

SC&A identified a document (Schrag, n.d.) summarizing a meeting at SSFL regarding TRU/mixed waste that was planned to be generated in late 1989/early 1990 from TRU partitioning tests. The meeting summary is a planning document; therefore, it does not state that such tests involving generation of TRU waste had yet occurred. The purpose of the meeting was to develop the necessary steps on how to plan for the management and disposal of the waste. This document did not identify where the waste would be generated.

SC&A identified another document ("Appendix 4.10.2.2," 2002) that provides the compliance methodology for TRU waste generated at MURR, but it did not identify where the waste would be sent to be managed, stored, and prepared for eventual disposal.

SC&A concludes, after reviewing the status reports, that radiological operations associated with TRUMP-S were conducted at MURR and not at SSFL for the duration of the project. SSFL personnel were present at MURR to observe and take part in the technology demonstration activities. While it is not clear from the available documentation where the TRUMP-S equipment and radiological waste was sent at the end of the project for dispositioning and eventual disposal, SC&A did not identify evidence that it was sent back to SSFL. Nonetheless, TRU waste was present at SSFL as a result of legacy waste management and D&D activities. This TRU waste is discussed in the next section.

2.3 Transuranic waste management at SSFL

The SEC petitioner stated at the August 21, 2019, ABRWH meeting that TRU waste was generated between 2002 and 2008 and that TRU waste has been stored up to 20 years. The petitioner states that the documentation that was submitted "shows the presence of americium and thorium onsite well into the 2000s" (ABRWH, 2019, p. 91).

The documentation that the SEC petitioner submitted to the Advisory Board and NIOSH included three acceptable knowledge summaries that describe TRU waste streams that were managed at SSFL. One acceptable knowledge report shows that, between 1993 and 1995, a new TRU waste stream, "consisting of residue removed from the hot cell drain lines, was accumulated between 1993 and 1995 during the D&D of the Hot Laboratory" (Boeing, 2002, PDF p. 21). Legacy TRU wastes from past SSFL operations also were managed at SSFL after 1988. Waste characterization and repackaging took place at SSFL in a temporary sampling and repackaging facility that is described as follows:

> The facility consisted of a HEPA-filtered, fire-retardant plastic enclosure that was located at the bottom of a HEPA-ventilated storage vault within a radiologically controlled facility. . . . This configuration provided a double-containment working environment.
>
> The specific-activity of all materials, including the RH waste, was sufficiently low that personnel could work with the material directly. All TRU characterization and repackaging activities were performed within this facility by personnel using double layers of personal protective clothing, full respirators with air lines, shielded work areas, and procedures that minimized exposures were based on pre-operations mockup testing and process hazards analyses. Other protective measures included continuous air monitoring, frequent surveys, extensive personal dosimetry, and a clear tent top for observation. Multiple plastic layers were used within the enclosure to allow change-out for contamination control, and five video cameras were installed to document operations. [Kneff et al., 2004, p-. 8–9]

All TRU waste was transported to Hanford in December 2002 in one shipping campaign, eliminating the TRU waste inventory at SSFL.

All TRU waste streams that contain plutonium are expected to contain americium. Such D&D activities were to be expected at SSFL, and dose reconstruction methods for americium are currently under development by NIOSH and will be taken under consideration by the SSFL work group and the Advisory Board. As noted in section 2.1, coworker intakes of plutonium have been developed in ORAUT-OTIB-0080 for workers who were not monitored directly.

In summary, SC&A found no evidence that TRU waste was generated after 1988 due to post-1988 operations other than remediation activities. TRU wastes generated and managed at SSFL after 1988 are related to legacy (pre-1989) operations as well as D&D activities that occurred after 1988.

3 Summary Conclusions

SC&A reviewed the documentation provided to NIOSH by the SEC petitioner in August 2019 to address petitioner comments in the following areas: monitoring of site remediation workers, exposures related to the TRUMP-S program, and exposures related to the management of TRU waste at SSFL.

SC&A found no evidence in the documentation that the SSFL operating contractor did not monitor remediation workers who needed monitoring or that such monitoring was inadequate (with the exception of the 2-year period when CEP operated as the bioassay contractor for SSFL). While Boeing was contesting DOE's determination that they needed to certify the internal dosimetry monitoring program through DOELAP, the internal dosimetry monitoring program at SSFL did not cease. In fact, in 1998 DOE stated that SSFL's internal dosimetry program was in compliance with DOE requirements. SC&A also did not find any evidence that the radiation worker training programs did not meet DOE requirements. Regarding the presence of americium, residual amounts of americium would be expected after 1988 due to the plutonium inventory present at SSFL that had to be managed during the process of facility decommissioning. Regarding the presence of thorium, some containers containing thorium materials were found (Rockwell, 1994), but no other information about these containers was identified. Such thorium inventory would be expected during the facility D&D period, and the presence of such material does not necessarily indicate that operations-related thorium activities and exposures continued at SSFL post 1988.

SC&A found no evidence in the documentation that radiological operations occurred at SSFL that were related to TRUMP-S. All radiological activities associated with TRUMP-S appear to have occurred at MURR, with some SSFL personnel present to observe the activities. Such exposures are not relevant to SEC-00235. SC&A could not find specific information concerning the disposition of equipment and wastes generated as a result of the TRUMP-S program. However, no evidence was identified that the material was sent back to SSFL for any reclamation or processing activities that would represent a different exposure potential than typical D&D activities.

In summary, SC&A found no evidence in the currently available documentation that TRU waste was generated after 1988 due to post-1988 operations. TRU waste generated and managed at SSFL after 1988 appears solely related to legacy (pre-1989) operations and D&D activities that occurred after 1988. Management activities related to TRU waste would have included packaging any TRU waste generated during decommissioning activities, managing TRU waste generated during pre-1988 operations, performing nondestructive assays of TRU waste packages, and repackaging and shipping of the TRU waste packages. Because TRU waste packages contain plutonium, it is expected that a buildup of americium would occur in the waste packages. Dose reconstruction methods for americium and thorium are currently under development by NIOSH and will be taken under consideration by the SSFL work group and the Advisory Board. Methods for reconstructing intakes to plutonium, uranium, and fission products have been developed based on operational urinalysis data and are discussed in ORAUT-OTIB-0080.

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Attachment A: Responses to Specific SSFL Petitioner Concerns Presented during the 2019 Advisory Board Meeting and Provided with the Document Submittal

Comment 1 [2]

Petitioner comment

> And it's my understanding that the Site Profile does not reference transuranic waste combustion practices, which is a process that began at the site in 1974. And documentation suggests that it continued until 1998. [ABRWH, 2019, p. 88]

Response

SC&A was unable to determine from the documents submitted by CORE Advocacy what is being referred to in this comment. It is possible the comment was intended to refer to the TRUMP-S program, which is discussed in section 2.2 of this report as well as previous SC&A analyses (2019a, 2019b).

References: SC&A (2019a, 2019b)

Comment 2

Petitioner comment

> SC&A has already acknowledged that there were americium separation processes at the site until 1993. In their own document. [ABRWH, 2019, p. 89]

Response

SC&A assumes that this comment was made in reference to its review of ORAUT-OTIB-0080, which provides the internal dose reconstruction methods for unmonitored workers at SSFL (SC&A, 2014). In that review, SC&A noted that 24 americium bioassay results were noted for the period from the late 1960s through 1993. There were americium bioassay samples for three individuals after 1988. One individual was a claimant, and a document in the claim file notes that the worker was at Argonne National Laboratory – East during the period when the americium samples were taken. Therefore, the exposure was not likely related to SSFL. Further information is not currently available for the other two individuals, though it is possible the individuals were sampled due to involvement in the TRUMP-S radiological tests occurring at MURR. None of the americium bioassay samples after 1988 were reported as positive.

Reference: SC&A (2014)

[2] Comments numbers are arbitrarily assigned to facilitate discussion.

Comment 3

Petitioner comment

> And NIOSH has already acknowledged DAC emissions data in 1995 that were positive for americium and thorium, which suggests an operational use for those materials. [ABRWH, 2019, p. 89]

Response

The "Activity Report for Radiation Protection and Health Physics Services, month ending 11/30/94" (Rockwell, 1994, PDF p. 1006), states the following regarding uranium and thorium chemicals:

> Numerous laboratory containers of chemical compounds that contain uranium and thorium, ("generally licensed" radioactive materials), are being discovered in various Rocketdyne laboratories. A search and collection is being done for these items, and 25 items have been collected, inventoried, and transferred to RP&HPS control. Possible beneficial recycling/disposal options are being investigated. [Rockwell, 1994, p. 3, PDF p. 1006]

SC&A was unable to identify any followup information regarding this material.

The "Activity Report for Radiation Protection and Health Physics Services, month ending 8/31/95" (Rockwell, 1995b, PDF p. 55), states that an evaluation was conducted to determine the mass of plutonium contained in the RMDF. This included waste packages, the RIHL drainline debris, and the former RIHL Liquid Waste Holdup Tank. This activity report reevaluates the amount of plutonium in a drum, with a result of 79 microcuries cesium-137, which led the personnel to conclude that the previous estimate was too high. In a previous activity report for May 31, 1995 (Rockwell, 1995c, PDF p. 74), it was estimated that the plutonium inventory in the building could range from 2 grams to 29 grams. In the following month (June) (Rockwell, 1995d, PDF p. 81), a re-estimate showed the plutonium inventory to be about 4.8 grams, not including the drainline debris.

SC&A agrees that thorium and americium materials were present at SSFL in the post-1988 period. Furthermore, SC&A agrees that exposure to such materials via stewardship of waste materials and typical D&D activities at the time presents a source of exposure that must be taken into account during dose reconstruction. Dose reconstruction methods for americium and thorium are under development and will be taken under consideration by the SSFL work group and the Advisory Board.

References: Rockwell (1994, 1995b, 1995c, 1995d)

Comment 4

Petitioner comment

> And we've just been talking about whole body count data, but I've already supplied the documentation showing that they didn't report whole body counting from Helgeson. [ABRWH, 2019, p. 89]

Response

SC&A was unable to determine from the documents submitted by CORE Advocacy what is being referred to in this comment. However, SC&A notes that the coworker intakes for plutonium, uranium, and mixed fission products are based on urinalysis results rather than whole body counts. Dose reconstruction methods for americium and thorium are under development and will be taken under consideration by the SSFL work group and the Advisory Board.

Reference: NIOSH (2014)

Comment 5

Petitioner comment

> And I think that the information that we've located establishes operations to at least 2008, potentially 2010, along with the new evidence that suggest site remediation workers were, and currently are, insufficiently monitored. [ABRWH, 2019, pp. 89–90]

Response

As discussed in section 2.1 of this report, SC&A did not identify evidence that SSFL remediation workers were insufficiently or inadequately monitored, with the exception of the period during which CEP was the bioassay contractor for SSFL. Unmonitored intakes have been developed for plutonium, uranium, and fission products in ORAUT-OTIB-0080. Dose reconstruction methods for americium and thorium are under development.

Comment 6

Petitioner comment

> So, the documentation that I'll be submitting today is a Boeing technical progress report that details TRUMP-S operations Area IV from 1993 until 1998. And apparently what it looks like is that after the public scrutiny died down and things weren't so heated, they brought the program back. That document provides a DOE contract number. And indicates that Boeing participated in Steps 4, 5 and 6 of the TRUMP-S transuranic separation processes. Which involve the reductive extraction and removal of metals from the molten salt phase of the process, the reductive extraction to remove actinides and rare earths from the active metals, followed by electro-refining, and the reductive extraction followed by electrode disposition to separate remaining transuranics from rare earths. So it doesn't look like their activities were just confined to non-radioactive processes. [ABRWH, 2019, p. 90]

Response

SC&A reviewed the provided report, “Technical Progress Report Private Sector Initiative between the United States and Japan January 1993-September 1998” (Boeing, 1998), that is the subject of the petitioner’s comment. As stated in section 2.2 of this report, program objectives for the time period after 1988 were: (1) for 1988–1990, measure chemical and electrochemical properties of actinides and rare earths to predict actinide separation efficiency and purity for

pyrochemical partitioning; (2) for 1991–1993, determine the americium electrochemical properties and measured actinide separation efficiency and product purity for pyrochemical partitioning of PUREX waste; and (3) for 1994–1997, process demonstration of pyropartitioning steps, and develop a computer code to model the process as developed and to perform a pyropartitioning process engineering feasibility study (Boeing,1998, p. 3).

Based on the technical progress report for 1990 (Rockwell, 1993a), there were some tests performed in Japan, but planned activities at SSFL were not conducted due to public pressure, and instead an alpha lab including gloveboxes was constructed at MURR to perform the work. This is confirmed in the 1991 report, which states that "electrochemical test cells and methodology were developed at the Rockwell Santa Susana Field Laboratory (SSFL) using rare earths in the inert atmosphere glovebox. This technology was transferred to the [MURR] Alpha Laboratory for use with actinides by interchange of laboratory personnel" (Rockwell 1993b, p. 3). A computer program on an IBM system was installed at SSFL and MURR. Safety upgrades were made at MURR. These activities meet the 1988–1990 TRUMP-S program objectives.

As described in the technical progress report for 1992 (Rockwell, 1993c), data interpretation was conducted and several studies were performed, but the location is not identified. Evidence suggests that TRU waste associated with TRUMP-S was generated at MURR ("Appendix 4.10.2.2," 2002, PDF p. 3).

According to the report provided by the petitioner, during 1994 through September 1997, the TRUMP-S process "was demonstrated at MURR by MURR, UMC, CRIEPI, KHI, and Boeing personnel" (Boeing, 1998, p. 1). Later, "a consistent set of electrochemical and physical data were required to develop the pyropartitioning process; these data were measured and the TRUMP-S pyropartitioning process was developed and tested to show that actinides could be separated from PUREX wastes" (Boeing, 1998, p. 1). These activities match the 1991–1993 TRUMP-S program objectives. Finally, the report states that "computer programs were developed to simulate the pyropartitioning process," which matches the 1994–1997 TRUMP-S program objectives.

According to TRUMP-S project waste highlights from 1989–1990 (Schrag, n.d., PDF p. 2):

> A meeting was held with [redacted] to discuss the disposition of the waste to be generated from the TRU partitioning tests. Since the waste will contain transuranics (Pu, Am, Np)) and cadmium, the waste generated in late 1989/early 1990 will be TRU/mixed waste. [redacted] will be in contact with [redacted] to determine what steps are needed to get a head start on the planning/disposal process. These steps were requested by [redacted] as a requirement for the isotopes committee approval of the application to use radioactive materials.

This highlight does not mention the location of where the wastes would be generated (at SSFL or at MURR). Because radiological operations associated with SSFL's participation in the

TRUMP-S program were moved to MURR, it is logical to assume that the waste generated would also be packaged at MURR for eventual disposal.

Another document "presents how records and database information (process knowledge) have been used to qualify seven drums of Missouri University Research Reactor (MURR) contact-handled (CH) transuranic (TRU) waste as payload for transport in the CNS 10-160B cask" ("Appendix 4.10.2.2," 2002, PDF p. 3). This document also states (PDF p. 7) that "The CH-TRU waste was generated over eight years using a total of 3.5627 grams of Neptunium-237, 1.4701 grams of Plutonium-239, 2.4125 grams of Americium-241 and 6.097 grams of depleted Uranium." Based on a later sentence discussing the weight to be packaged (PDF p. 10), it appears that the waste was located at MURR: "Based on the total measured weight of the individual payload containers and the 3 dunnage drums needed to complete the 10-drum payload, the MURR shall calculate total assembly weight and evaluate compliance with the maximum cask payload weight limit." Attachment A of this document is titled, "MR 121A Transuranic Content Code and Chemical List for Missouri University Research Reactor" ("Appendix 4.10.2.2," 2002, PDF p. 12).

SC&A concludes, after reviewing the status reports, that radiological operations associated with TRUMP-S were conducted at MURR and not at SSFL for the duration of the project. SSFL personnel were present at MURR to observe and take part in the technology demonstration activities. Although it is not clear where equipment was sent at the end of the project, and where radiological waste, such as TRU waste, was sent for dispositioning, SC&A could not find evidence that the material was sent back to SSFL. However, as described in section 2.3, other TRU waste was generated, stored, and eventually repackaged at SSFL during the period of interest. Radiological controls to limit exposure included double layers of personal protective clothing, air supplied respirators, and shielded work locations. Contamination control was achieved using multiple plastic enclosures, frequent surveys, and continuous air monitoring. Direct radiological monitoring of the personnel involved was described as "extensive" (Kneff et al., 2004, p. 8).

References: "Appendix 4.10.2.2" (2002), Boeing (1998), Kneff et al. (2004), Rockwell (1993a, 1993b, 1993c), Schrag (n.d.)

Comment 7

Petitioner comment

> We'll also be submitting several accepted -- acceptable knowledge summaries that describe transuranic waste generation and processes between 2002 to 2008, and the storage of transuranics for up to 20 years, prior to the repacking operations that happened at Area IV. Which constituted an entire program that they started to deal with the site closure demands.
>
> While the waste was sitting at Santa Susana during waste shipping moratoriums, the plutonium content was quickly decaying to rising levels of americium. And that's expressed in this report.
>
> We have a 2003 photograph of large transuranic cask in the site closure team at the Area IV radioactive materials handling facility and a 2003 employment

> performance development summary which acknowledges workers participation in waste management and repacking processes.
>
> So those documents will be supplied to the Work Group, NIOSH, and SC&A. And that shows the presence of americium and thorium onsite well into the 2000s. And processes that involve those materials. [ABRWH, 2019, pp. 90–91]

Response

SC&A acknowledges that TRU waste was stored and managed at SSFL after 1988. A paper by Kneff et al. (2004) describes the challenges of managing TRU waste and how they were resolved. Waste characterization and repackaging took place at SSFL in a temporary sampling and repackaging facility. According to Kneff et al. (2004, pp. 8–9):

> The facility consisted of a HEPA-filtered, fire-retardant plastic enclosure that was located at the bottom of a HEPA-ventilated storage vault within a radiologically controlled facility . . . This configuration provided a double-containment working environment.
>
> The specific-activity of all materials, including the RH waste, was sufficiently low that personnel could work with the material directly. All TRU characterization and repackaging activities were performed within this facility by personnel using double layers of personal protective clothing, full respirators with air lines, shielded work areas, and procedures that minimized exposures and were based on pre-operations mockup testing and process hazards analyses. Other protective measures included continuous air monitoring, frequent surveys, extensive personal dosimetry, and a clear tent top for observation. Multiple plastic layers were used within the enclosure to allow change-out for contamination control, and five video cameras were installed to document operations.

Such activities are consistent with the D&D activities occurring at SSFL during this time. SC&A agrees that because the TRU waste contains plutonium, americium would increase in concentration over time in the TRU waste packages. SC&A agrees that TRU exposures, primarily from americium and plutonium, must be adequately addressed at SSFL to assure the feasibility of sufficiently accurate dose reconstruction. Unmonitored intakes have been developed for plutonium, uranium, and fission products in ORAUT-OTIB-0080. Dose reconstruction methods for americium and thorium are under development.

Refer also to the responses to petitioner comments 11 through 21.

Reference: Kneff et al. (2004)

Comment 8

Petitioner comment

> And then just to touch on the site remediation workers, under the FOIA we obtained several of the requests from Boeing to be exempted from Department of Energy's requirements to monitor site remediation workers.

> Those are dated between 1991 into the 2000s. So they coincide with the site remediation processes and the transuranic work that we're talking about.
>
> The Department of Energy expected compliance from the contractor, but they gave Boeing a loophole to exemption by basically letting them know, if an employee is affiliated with a non-radiological location, like Area I, II or III, or has a job title that is inconsistent with radiation work, then that employee is not required to be monitored.
>
> Site remediation subcontractor employees are currently administratively affiliated with an Area II dispatch location. They're routinely performing Area IV site remediation duties at radiological locations where historically radiation monitoring was required. [ABRWH, 2019, p. 91]

Response

In a letter dated April 20, 2001 (Boeing, 2001), Boeing offered data to support its position that it did not meet the 100 mrem/year committed effective dose equivalent limit requiring participation in the DOELAP program for internal dosimetry. The data represents alpha emitters in ambient conditions from 1991 to 2000. In building 20 (RIHL), "the primary source of the airborne contamination was related to the cleaning and demolition of the cells, which had been used for decladding of nuclear fuels. This work was completed by mid-1996" (Boeing, 2001, p. 3). No alpha emitters have been detected in building 59 or building 24. In the RMHF, "while some projects involve relatively low levels of alpha contamination, the media (drainline and tank debris) are of large particle size and are not readily respirable (as demonstrated by previous experience with the materials). As the facility nears the end of its life, it will be decontaminated and decommissioned" (Boeing, 2001, p. 3). Boeing also states that 236 persons participated in the bioassay program from 1989 through 1999 (Boeing, 2001, p. 5).

PDF pages 108 through 128 of "09_DOELAP_COMPLIANCE_emcbc-2018-00694-f blaze.pdf" provided by the petitioner is a DOE letter dated August 14, 1998 (DOE, 1998), with an attached review report stating that SSFL's internal dosimetry program is in compliance with DOE requirements. PDF pages 129 through 132 of the same petitioner-provided file is a Rockwell International internal letter from October 11, 1995, that shows that, with some adjustments, the SSFL radiation worker training programs meet DOE Rad Worker II Training requirements (Rockwell, 1995a). Other documents in this petitioner-provided file include radiation procedures, radiation protection plans, analyses to determine whether SSFL's radiation protection program meets DOE requirements, and approvals of these documents that indicate a well-documented radiation protection program was in place that was consistent with DOE requirements. SC&A is not in a position to comment on any specific remediation worker's monitoring protocol. However, SC&A acknowledges that workers would often rotate between SSFL site areas as needed, and so their affiliation with a specific area may not reflect the day-to-day operations.

References: Boeing (2001b), DOE (1998), Rockwell (1994, 1995a)

Comment 9

Petitioner comment

> They are not currently being monitored for radiation. But the waste that is being generated from their activities, is surveyed for radioactivity.
>
> DOE and Boeing have abandoned these subcontractor employees. They refuse to acknowledge that this subcontractor is even present at the work site. And these workers are summarily disqualified from EEOICPA today.
>
> Even when they submit photos showing that they're performing site remediation at Area IV radiological locations. One of them was transitioned to subcontractor status, sent in to Area II to be administratively affiliated with that. And his radiation protection ended within a few weeks of filing his initial EEOICPA claim. Right now today, while we're having this meeting, he's doing site remediation at Area IV. [ABRWH, 2019, pp. 91–92]

Response

SC&A is not in a position to comment on any specific individual, their radiation monitoring, or their potential for exposure while working at SSFL. Nor is it under SC&A's purview to comment on how any individual's eligibility or employment is established under the Energy Employees Occupational Illness Compensation Program Act (EEOICPA). However, section 2.1 discusses the SSFL monitoring program in the post-1988 time period, which is germane to a portion of the petitioner's concern.

Comment 10

Petitioner comment

> In conclusion, we believe that the new documentation shows that americium and thorium were used in an operational capacity to at least 2008. And that this information even more firmly supports the original Class Definition that was intended to acknowledge all Department of Energy contractor and subcontractor employees at the site, based on issues that have already been verified. [ABRWH, 2019, p. 92]

Response

SC&A concurs that thorium material and TRU waste was present and managed at SSFL after 1988. SC&A also concurs that measurable amounts of TRU nuclides were emitted after 1988. However, these activities are related to management of legacy facilities and wastes, the decommissioning of facilities, and environmental remediation activities. No post-1988 "operational" activities involving these radionuclides have been identified by SC&A. Nonetheless, exposure to these contaminants must be properly accounted for during dose reconstruction in a sufficiently accurate and scientifically defensible manner.

Dose reconstruction methods for americium and thorium are currently under development by NIOSH and will be taken under consideration by the SSFL work group and the Advisory Board.

Methods for reconstructing intakes to plutonium, uranium, and fission products have been developed based on operational urinalysis data and are discussed in ORAUT-OTIB-0080.

Comment 11

Petitioner comment

> Page 14, Paragraph 2: **1989** - There are references to drums of TRU waste that were opened and repackaged in 1989, after the current SEC period. [CORE Advocacy, 2019, p. 1]

Response

Section 2.1, page 14, of the referenced document states that, "The drums comprising this waste stream were repackaged in their current form in 1988-1989 based on the requirements of WIPP WAC Revision 2" (Boeing, 2002, PDF p. 17). However, section 2.2, page 14, states that, "Analytical data for this waste stream are limited to analyses conducted at the time the waste was packaged (1984-88) or repackaged (1988)" (Boeing, 2002, PDF p. 17). Section 4.1, page 22, states that 11 drums were reduced to four drums of solidified oil, with a fifth drum of TRU waste being repackaged in 1988. Shipment of all five of the drums in the waste stream was supposed to be completed in January 1989, but this did not occur due to a moratorium from the State of Idaho. Section 3.1, page 18, states that these drums were repackaged in December 1988 (PDF p. 21). It appears that repackaging was completed in 1988, with shipment planned in January 1989. Additional documentation suggests that such material was not repackaged and shipped offsite until the early 2000s (Kneff et al., 2004, p. 8). Radiological controls in place during the repackaging operation are described in section 2.3 of this report.

Reference: Boeing (2002), CORE Advocacy (2019), Kneff et al. (2004)

Comment 12

Petitioner comment

> Page 18, Paragraph 3: **1993 to 1995 -** Hot Lab D&D activities generated new TRU waste due to contaminated drain lines. [CORE Advocacy, 2019, p. 1]

Response

The cited paragraph states:

> Most product nuclear material, other nuclear material residue, and contaminated items were removed from the SSFL site by the end of 1989. The exceptions were several drums of transuranic-bearing waste from NMDF and Hot Laboratory operations, originally package for shipment to Rockwell Hanford and subsequently repackaged in December 1988 for shipment to the DOE Idaho site. One new waste stream, consisting of residue removed from the hot cell drain lines, was accumulated between 1993 and 1995 during the D&D of the Hot Laboratory. [Boeing, 2002, PDF p. 21)

Based on this paragraph, SC&A agrees that TRU waste was generated in 1993–1995 during typical D&D activities. This information is also confirmed and described by Kneff et al. (2004). Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

References: Boeing (2002), CORE Advocacy (2019), Kneff et al. (2004)

Comment 13

Petitioner comment

> Page 22, Paragraph 1: During D&D, no distinction was made between waste materials that had been generated during various site programs. DOE / DOD waste was co-mingled. [CORE Advocacy, 2019, p. 1]

Response

SC&A acknowledges that wastes were comingled and that DOE determined that the waste was therefore acceptable for disposal at the Waste Isolation Pilot Plant (WIPP). TRU waste produced as a result of D&D activities was eventually sent to Hanford in the early 2000s. Any potential exposures to such material must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Reference: CORE Advocacy (2019)

Comment 14

Petitioner comment

> Page 22, Paragraph 3: **2002 to 2003 -** Waste scheduled for shipment in 1989 was delayed due to shipping moratoriums in Idaho. Requests to ship the drums in 1991 / 1992 were unsuccessful. As of 2002, the drums of TRU waste remained at SSFL. [Supportive documentation suggests the drums were transported to the Area IV RMHF for repacking by the SSFL Site Closure Team. See 2002 Photo of the Site Closure Team posing with a cask of TRU Waste, c. 2002 / 2003]. [CORE Advocacy, 2019, p. 1]

Response

SC&A acknowledges that TRU waste remained in storage at SSFL after 1988. Kneff et al. (2004) described the challenges associated with TRU waste storage, management, and eventual repackaging at SSFL. The radiological conditions associated with the repackaging operation are well documented and included double layers of personal protective clothing, air-supplied respirators, continuous air monitoring, frequent surveying, multiple plastic enclosures, and extensive personnel monitoring. The petitioner also submitted "acceptable knowledge" documents related to TRU wastes generated from 1980 to 1995 that were transported from SSFL to Hanford for storage in December 2002 (Fluor 2007, 2008; Kneff et al., 2004). All of these waste streams are expected to contain americium isotopes. Such exposures must be accounted for

in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

References: CORE Advocacy (2019), Fluor (2007, 2008), Kneff et al. (2004)

Comment 15

Petitioner comment

> Page 32, Section 5.2.3: There is a reference to **1995** CT Scans of TRU Waste Containers to verify the contents of "retrievably stored TRU drums at ETEC." This suggests that TRU waste storage / repacking operations were ongoing after 1988, and that there was the need to scan the drums to identify contents due to dubious record keeping and uncertainty about radionuclide content, in drums storage onsite since the 1980's. [CORE Advocacy, 2019, p. 1]

Response

Computed tomography (CT) scans are a noninvasive means of evaluating contents in waste packages. SC&A acknowledges that TRU waste packages were stored at SSFL and were prepared for shipment offsite after 1988. Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Comment 16

Petitioner comment

> Page 42 & 43: Flowchart / Sequence - There are references to removal of excess **Pu-U** as part of the process involving TRU waste handling. CORE Advocacy is uncertain whether this is a reference to TRU Waste Management and Separation Processes. However, if materials stored onsite since the 1980's contained **Plutonium (Pu)**, it seems that there may be some concern about rising levels of **Americium-241 (Am-241)**. The flowchart describes waste handling and transport between various Area IV locations, and processes that involved repackaging of the materials. [CORE Advocacy, 2019, p. 2]

Response

As part of qualifying TRU waste streams for disposal, the generator must provide an estimate of the radionuclide content of the waste. The generator must account for the decay of plutonium isotopes. Given that americium is a decay product of plutonium, it is expected that the americium content would increase over time. Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Comment 17

Petitioner comment

> Page 54, Section 13.2: **1994 to 2002 Pu / Am-241 -** The Report indicates that, in 2002, the measurements of Pu / Am in the onsite TRU waste had to be repeated, because the original source data from measurements that were taken in 1994 could not be located. "… a firm determination of the qualification of each of the drums cannot be made…" confirms that drum packaging and processes occurred at SSFL after 1998, and that the original measurements of radioactivity could not be located as of 2002. Additionally, the statement strongly suggests that **Boeing may not have had a good handle on the condition or contents of TRU waste drums that had been generated and packaged prior to Boeing's takeover of site operations in 1996.** [CORE Advocacy, 2019, p. 2]

Response

The development of the "acceptable knowledge" package is part of the waste certification process for TRU waste transportation and disposal. DOE uses acceptable knowledge and characterization technologies to assess the contents of TRU waste streams as part of the certification process for disposal. Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Comment 18

Petitioner comment

> Pages 55 & 56 Tables: Radionuclide Summaries for Drums at SSFL verify **Am-241, in 2002.** [CORE Advocacy, 2019, p. 2]

Response

SC&A acknowledges that TRU waste processed and stored at SSFL contains americium until such time as the waste is transported for disposal or to another DOE site for continued storage. Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Comment 19

Petitioner comment

> Pages 58-70: References
> Several documents that were used as references in the Report may contain useful information regarding the presence of Pu / Am / TRU materials and operations at SSFL Area IV, after 1988. Several verify that these materials and processes occurred, simply by the title and date of the document. Although several documents are listed, here are two examples [commenter lists two references]. [CORE Advocacy, 2019, p. 2]

Response

SC&A acknowledges that TRU waste was handled as part of typical D&D activities occurring at the site, waste material was also stored at SSFL until the waste was transported to the Hanford site for disposal. Such exposures must be accounted for in dose reconstruction. As stated previously, methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in OTIB-0080.

Comment 20

Petitioner comment

> Pages 74-81: Waste Road Maps - Provides brief summaries of source documents. [CORE Advocacy, 2019, p. 2]

Response

This list shows the documents the generator used in developing its acceptable knowledge report. SC&A acknowledges that the storage and management of waste materials (including TRU materials) occurred at SSFL post 1988. Furthermore, SC&A acknowledges that D&D activities would generate new streams of waste material, which must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.

Comment 21

Petitioner comment

> Page 82: Additional Documentation to be Reviewed - References TRU Materials / Processes, post-1988. [CORE Advocacy, 2019, p. 2]

Response

SC&A acknowledges that TRU waste was handled as part of typical D&D activities occurring at the site, and that waste material was also stored at SSFL until the waste was transported to the Hanford Site for disposal. Such exposures must be accounted for in dose reconstruction. Methods for reconstruction of americium exposure are currently under development. Methods for reconstructing plutonium exposure are contained in ORAUT-OTIB-0080.