SEC Petition Evaluation Report

Petition SEC-00235

Report Rev Number:	0
Report Submittal Date:	May 11, 2017
Subject Expert(s):	Monica Harrison-Maples, Roger Halsey
Site Expert(s):	None

Petition Administrative Summary

Petition Under Evaluation

Petition Number:	SEC-00235
Petition Type:	83.13
Petition Receipt Date:	August 9, 2016
Qualification Date:	February 1, 2017
DOE/AWE Facility Name:	Area IV of the Santa Susana Field Laboratory

Petition Class

Petitioner-Requested Class Definition:	All employees of North American Aviation, to include corporate successors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory (SSFL) from December 31, 1964 through the present.
Class Evaluated by NIOSH:	All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory in Ventura County, California, from August 1, 1991 through June 30, 1993.
NIOSH-Proposed Class to be Added to the SEC:	None

Related Petition Summary Information

SEC Petition Tracking Number(s):	SEC-00093 SEC-00156 SEC-00234
Petition Type:	83.13 83.14 83.14
DOE/AWE Facility Name:	Santa Susana Field Laboratory-Area IV Area IV of the Santa Susana Field Laboratory Area IV of the Santa Susana Field Laboratory
Petition Status:	Class added to the SEC for January 1, 1955 through December 31, 1958 Class added to the SEC for January 1, 1959 through December 31, 1964 Class added to the SEC for January 1, 1965 through December 31, 1988

Related Evaluation Report Information

Report Title:	SEC Petition Evaluation Report for Petition SEC-00093 SEC Petition Evaluation Report for Petition SEC-00156 SEC Petition Evaluation Report for Petition SEC-00234
DOE/AWE Facility Name:	Santa Susana Field Laboratory-Area IV Area IV of the Santa Susana Field Laboratory Area IV of the Santa Susana Field Laboratory

ORAU Preparation and Review

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Evaluation Report Summary: SEC-00235, Area IV of the Santa Susana Field Laboratory (SSFL)

The National Institute for Occupational Safety and Health (NIOSH) prepared this evaluation report in response to a petition to add a class of workers at Area IV of the Santa Susana Field Laboratory (SSFL) (often referred to as Area IV of the SSFL or just Area IV in this report) to the Special Exposure Cohort (SEC). The *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, (EEOICPA) and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort under the Energy Employees Occupational Illness Compensation Program Act of 2000,* describe the process for adding new classes to the SEC.

Petitioner-Requested Class Definition

NIOSH received petition SEC-00235 on August 9, 2016, and qualified it on February 1, 2017. The petitioner requested that NIOSH consider the following class: *All employees of North American Aviation, to include corporate successors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory (SSFL) from December 31, 1964 through the present.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH reduced the petitioner-requested class to include only the period during which the site contracted Controls for Environmental Pollution as a primary bioassay sample analysis vendor. NIOSH evaluated the following class: *All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory from August 1, 1991 through June 30, 1993.*

NIOSH Determination about the Proposed Class to be Added to the SEC

NIOSH has obtained internal monitoring data to include urinalysis sample results for uranium, plutonium, gross alpha, mixed fission products, strontium-90, and *in vivo* scan results all included with the scanned radiological exposure files of individual workers across the entire operational history of Area IV through 2000. NIOSH also has external dosimetry results for workers in radiological job assignments. NIOSH has developed both an internal coworker model (ORAUT-OTIB-0080) and an external coworker model (ORAUT-OTIB-0077) to assess doses to unmonitored workers at Area IV. NIOSH has reviewed facility plans, procedures, and activity reports to gain understanding of the scope of the potential exposure scenarios during the period under evaluation. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of the maximum dose. Information available from the site profile and additional resources is sufficient to estimate the maximum internal and external potential exposure to members of the evaluated class under plausible circumstances during the specified period.

The NIOSH dose reconstruction feasibility findings are based on the following:

- NIOSH finds that it is feasible to reconstruct occupational medical dose with sufficient accuracy for Area IV workers for the period from August 1, 1991 through June 30, 1993, using information and methods in *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006) and the Area IV site profile documents.

- Principal sources of internal radiation for members of the proposed class included exposures to airborne particulates of isotopes of uranium, plutonium, and mixed fission products generated during remediation activities, and waste reduction and handling operations.

- Although NIOSH has disqualified Area IV *in vitro* data analyzed by Controls for Environmental Pollution during the period August 1991 through June 1993, NIOSH has determined that the lack of CEP *in vitro* data has not affected NIOSH's ability to perform sufficiently accurate internal dose reconstructions for monitored or unmonitored workers.

- NIOSH compared remediation period bioassay data to the operational period data (through 1988) that were used to develop NIOSH's internal coworker intake rates. NIOSH sees no indication that the coworker intake rates assigned for the end of the Area IV operation period (circa 1988) do not bound the potential remediation period exposures for unmonitored workers.

- NIOSH examined operations throughout the remediation period (1989–present) to evaluate the exposure conditions before, during, and after the CEP period of concern. NIOSH finds that work remained consistent through the remediation period, and has found no major radiological project that occurred in the CEP period 1991–1993, that would not have had workplace and/or personnel monitoring performed outside the CEP-related period.

- During the August 1991 through June 1993 period with disqualified CEP bioassay results, the site was performing routine *in vivo* whole-body scans with a different contractor. The site reported that the whole-body scans showed no measurable exposures. In response to concerns with CEP data, the SSFL site also initiated confirmatory resamples analyzed by a new contractor, and reported that these follow-up *in vitro* results confirmed no measurable internal exposures.

- NIOSH has determined that it is feasible to reconstruct personnel internal exposures with sufficient accuracy for employees at Area IV of the SSFL for the period from August 1, 1991 through June 30, 1993.

- Principal sources of external radiation for members of the proposed class included exposures to potentially high amounts of surface contamination, or exposure to activated building materials present during remediation activities, and waste reduction and handling operations.

- NIOSH has access to photon, beta, and neutron external dosimetry results, as well as other supporting data for the entire period under evaluation (available for all years of site operation). To assess potential external dose to unmonitored employees, NIOSH developed a coworker dose distribution model (ORAUT-OTIB-0077).

- In its previous SEC evaluations, NIOSH has found, and DHHS has concurred, that it has access to sufficient employee monitoring and workplace monitoring data to bound potential external exposures for employees at Area IV of the SSFL for January 1, 1955 through December 31, 1958,

January 1, 1959 through December 31, 1964, and January 1, 1965 through December 31, 1988. This current evaluation has found no evidence to the contrary for the period from August 1, 1991 through June 30, 1993.

- NIOSH has determined that it is feasible to reconstruct personnel external exposures with sufficient accuracy for employees at Area IV of the SSFL for the period from August 1, 1991 through June 30, 1993.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is sufficient information to either: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred under plausible circumstances by any member of the class; or (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the evaluated class.

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SEC Petition Evaluation Report for SEC-00235

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Monica Harrison-Maples, Oak Ridge Associated Universities. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing radiation doses for all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory in Ventura County, California, from August 1, 1991 through June 30, 1993. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH. This report also does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

This evaluation was conducted in accordance with the requirements of EEOICPA, 42 C.F.R. pt. 83, and the guidance contained in the Division of Compensation Analysis and Support's (DCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, DCAS-PR-004.[1]

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (DHHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.[2]

42 C.F.R. § 83.13(c)(1) states: *Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose.*

Under 42 C.F.R. § 83.13(c)(3), if it is feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires

[1] DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).

[2] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available on the NIOSH Radiation Dose Reconstruction Program webpage.

NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those employees who were employed for at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for one or more other SEC classes.

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioner(s) and the Advisory Board on Radiation and Worker Health (Advisory Board). The Advisory Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Advisory Board considers appropriate, in order to make recommendations to the Secretary of DHHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Advisory Board, the Director of NIOSH will propose a decision on behalf of DHHS. The Secretary of DHHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Advisory Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of DHHS.[3]

3.0 SEC-00235, Area IV of the SSFL Class Definitions

The following subsections address the evolution of the class definition for SEC-00235, Area IV of the SSFL. When a petition is submitted, the requested-class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of the petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

NIOSH previously evaluated three other petitions for Area IV of the SSFL. In NIOSH's *Petition Evaluation Report, Petition SEC-00093* (NIOSH, 2009), NIOSH determined that it could not estimate radiation doses with sufficient accuracy for the period from January 1, 1955 through December 31, 1958, for employees at Area IV of the SSFL. NIOSH's decision was primarily based on a lack of internal monitoring data for potentially exposed individuals from January 1, 1955 through December 31, 1958. NIOSH also determined that it could reconstruct external dose, including occupational medical dose, for the period from January 1, 1955 through December 31, 1958. In June 2009, the Department of Health and Human Services (DHHS) issued a letter designating the January 1, 1955 through December 31, 1958, period for inclusion in the SEC (DHHS, 2009).

[3] See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available on the NIOSH Radiation Dose Reconstruction Program webpage.

In NIOSH's *Petition Evaluation Report, Petition SEC-00156* (NIOSH, 2010), NIOSH determined that it could not reconstruct radiation doses with sufficient accuracy for the period from January 1, 1959 through December 31, 1964, for employees at Area IV of the SSFL. NIOSH's decision was primarily based on incomplete bioassay, air monitoring, or process and radiological source data from January 1, 1959 through December 31, 1964. NIOSH also determined that it could reconstruct external dose, including occupational medical dose, for the period from January 1, 1959 through December 31, 1964. In April 2010, DHHS issued a letter designating the January 1, 1959 through December 31, 1964, period for inclusion in the SEC (DHHS, 2010).

In NIOSH's *Petition Evaluation Report, Petition SEC-00234* (NIOSH, 2016) NIOSH determined that it could not reconstruct radiation doses with sufficient accuracy for the period from January 1, 1965 through December 31, 1988, for employees at Area IV of the SSFL. NIOSH's decision was primarily based on insufficient internal dosimetry data or air monitoring data available to bound intakes of thorium and americium, including their associated progeny, for the period from January 1, 1965 through December 31, 1988. Consistent with prior determinations, NIOSH also determined that it could reconstruct external dose, including occupational medical dose, for the period from January 1, 1965 through December 31, 1988. In January 2017, DHHS issued a letter designating the January 1, 1965 through December 31, 1988, period for inclusion in the SEC (DHHS, 2017).

3.1 Petitioner-Requested Class Definition and Basis

NIOSH received petition SEC-00235 on August 9, 2016, and it qualified on February 1, 2017. The petitioner requested that NIOSH consider the following class: *All employees of North American Aviation, to include corporate successors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory (SSFL) from December 31, 1964 through the present.* The petitioner-requested class included a portion of the class previously evaluated by NIOSH for SEC-00234 (NIOSH, 2016). Therefore, NIOSH's qualification assessment considered only the period that was not already evaluated, that is the period from January 1, 1989 through the present.

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Area IV employees in question. Although NIOSH concluded that there is insufficient documentation to support the petitioner's assertion that radiation exposures and radiation doses were not adequately monitored at Area IV, either through personal monitoring or area monitoring, for the petitioner-requested time period as evaluated (1989 – present), NIOSH qualified a portion of the SEC-00235 petitioner-requested class for evaluation based on the qualifying basis that monitoring records have been lost, falsified, or destroyed.

Based on its research and data capture efforts related to Area IV of the SSFL, NIOSH determined that it has access to bioassay data, external monitoring records, radiological monitoring methods and procedures, environmental monitoring reports, and facility characterization records for Area IV employees during the period requested by the petitioner. However, NIOSH has determined that a portion of the petitioner-requested period warrants further evaluation to determine the impact of NIOSH's rejection of bioassay results provided by the sample analysis vendor Controls for Environmental Pollution (CEP) on the ability to perform sufficiently accurate dose reconstruction.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH was unable to qualify the petitioner-requested class because the available documentation did not support any of the defined bases for qualifying an SEC petition. Many of the petitioner-submitted documents pertained to workers in Area I, II, or III of SSFL, which are not covered by EEOICPA, or pertained to periods already included in the SEC through NIOSH evaluations of SEC-00093, SEC-00156, or SEC-00234. However, NIOSH did note the involvement of CEP during 1991, 1992, and 1993, as a primary bioassay vendor that supported Area IV's dosimetry program. Because NIOSH does not accept CEP as a quality supplier of dosimetry information, the dosimetry information provided by CEP has not been used by NIOSH for dose reconstruction of any claims related to this or other sites. NIOSH considers bioassay results from CEP as lost, falsified or destroyed, in support of the F.2 basis for qualification for evaluation. In a 1994 letter to radiation workers, Rockwell International stated that CEP was used for bioassay analysis between 1991 and 1993. NIOSH examined available documentation and internal dosimetry records for 1991 through 1993, to determine the exact scope of CEP involvement in the Area IV radiation dosimetry program. The radiological records indicated the sample analysis vendor along with other sample information. In analyzing the sample records, NIOSH was able to determine the earliest CEP sample analysis date was in August 1991 and the final was in June 1993. Therefore, NIOSH defined the following class for further evaluation: All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory in Ventura County, California, from August 1, 1991 through June 30, 1993.

3.3 NIOSH Determination about the Proposed Class to be Added to the SEC

NIOSH has obtained internal monitoring data to include urinalysis sample results (uranium, plutonium, gross alpha, mixed fission products, strontium-90), and *in vivo* scan results. The data are included with the scanned radiological exposure files of individual workers across the entire operational history of Area IV through 2000. NIOSH also has external dosimetry results for workers in radiological job assignments. NIOSH has developed both an internal coworker model (ORAUT-OTIB-0080) and an external coworker model (ORAUT-OTIB-0077) to assess doses to unmonitored workers at Area IV. NIOSH has reviewed facility plans, procedures, and activity reports to gain understanding of the scope of the potential exposure scenarios during the period under evaluation. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding Area IV of the SSFL. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment One includes a summary of documents related to Area IV of the SSFL. The

summary specifically includes data capture details and general descriptions of the documents retrieved.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices documented at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored employees, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document. As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Area IV of the SSFL operations or related topics/operations at other sites:

- *Atomics International—Introduction*, ORAUT-TKBS-0038-1, Rev. 01; effective August 30, 2006; SRDB Ref ID: 30080

- *Energy Technology Engineering Center—Site Description*, ORAUT-TKBS-0038-2, Rev. 00; effective February 2, 2006; SRDB Ref ID: 22140

- *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational Medical Dose*, ORAUT-TKBS-0038-3, Rev. 02; effective October 31, 2008; SRDB Ref ID: 53184

- *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational Environmental Dose*, ORAUT-TKBS-0038-4, Rev. 02; effective April 26, 2010; SRDB Ref ID: 80536

- *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational Internal Dose*, ORAUT-TKBS-0038-5; Rev. 01, effective April 26, 2010; SRDB Ref ID: 80541

- *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational External Dose*, ORAUT-TKBS-0038-6; Rev. 02, effective April 26, 2010; SRDB Ref ID: 80538

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

An ORAU Technical Information Bulletin (OTIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIBs and procedures as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 04; effective June 20, 2011; SRDB Ref ID: 98147

- *OTIB: Analysis of Coworker Bioassay Data for Internal Dose Assignment*, ORAUT-OTIB-0019, Rev. 01; effective October 7, 2005; SRDB Ref ID: 19438

- *OTIB: Estimation of Neutron Dose Rates from Alpha-Neutron Reactions in Uranium and Thorium Compounds*, ORAUT-OTIB-0024, Rev. 00; effective April 7, 2005; SRDB Ref ID: 19445

- *OTIB: External Coworker Dosimetry Data for Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)*, ORAUT-OTIB-0077, Rev. 00; effective August 3, 2009; SRDB Ref ID: 72162

- *OTIB: Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site*, ORAUT-OTIB-0079, Rev. 01; effective March 18, 2016; SRDB Ref ID: 152173

- *OTIB: Internal Coworker Dosimetry Data for Area IV of the Santa Susana Field Laboratory and the De Soto Avenue Facility*, ORAUT-OTIB-0080, Rev. 00; effective March 14, 2014; SRDB Ref ID: 131215

- *Procedure: Generating Summary Statistics for Coworker Bioassay Data*, ORAUT-PROC-0095, Rev. 00; effective June 5, 2006; SRDB Ref ID: 73397

- *Procedure: Occupational Onsite Ambient Dose Reconstruction for DOE Sites*, ORAUT-PROC-0060, Rev. 01; effective June 28, 2006; SRDB Ref ID: 29986

4.3 Facility Employees and Experts

There have been numerous interviews conducted with former Area IV employees, including 51 interviews conducted by the Environmental Protection Agency (EPA) as documented in the *Draft Final Former Employee Interview Report, Santa Susana Field Laboratory Site Area IV Radiological Study, Ventura County, California* (HydroGeoLogic, 2012), 107 conducted by DOE and documented in *Santa Susana Field Laboratory Former Worker Interviews* (P2 Solutions, 2011), and 23 separate documented communications with 37 former employees conducted by the EEOICPA program. As always, NIOSH reviewed the applicable Computer Assisted Telephone Interview (CATI) reports contained in NOCTS. Specific to this evaluation, NIOSH also interviewed one former employee (Personal Communication, 2017). NIOSH does not expect that additional interviews will provide new information for the August 1, 1991 through June 30, 1993, SEC-00235 evaluation period.

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH DCAS Claims Tracking System (referred to as NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of April 24, 2017)

Table 4-1: No. of Area IV of the SSFL Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	316
Total number of claims submitted for energy employees who worked during the period under evaluation (August 1, 1991 through June 30, 1993)	29
Total number of claims submitted for energy employees who started their employment during the period under evaluation (August 1, 1991 through June 30, 1993)	6
Number of dose reconstructions completed for energy employees who worked during the period under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	22
Number of claims for which internal dosimetry records were obtained for the time period in the evaluated class definition	5
Number of claims for which external dosimetry records were obtained for the time period in the evaluated class definition	10

NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. In addition to exposure data received in response to requests for individual claimant history data, NIOSH has scans created in 2009 of employee radiological exposure files. The NIOSH scans included radiological exposure files through 2001. A sampling of DOE-supplied claimant data found sample results matching those in the scanned employee radiological exposure files. The claimant data in NOCTS were later reviewed for all bioassay results and whole-body scans in the post-CEP period. One Sr-90 result and five whole-body scans were identified that were not in the scanned bioassay records obtained by NIOSH.

Results used to assess external exposure, including deep, shallow, extremity, eye, and neutron results (indicated as thermal or fast), are found in both the 2009 scanned files and the DOE claimant response files. Internal dosimetry results in both file sets include urine bioassay, fecal bioassay, thyroid scan, chest scan, total body count, and some post-incident wound and nasal swab counting results.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. The SRDB contains 2,520 documents identified as pertaining to Area IV of the SSFL. These documents were evaluated for their relevance to this petition. The documents include historical background on Area IV radiological operations, employee and area monitoring records, radiological control program descriptions and procedures, and former worker interviews.

4.6 Documentation and/or Affidavits Provided by Petitioners

On August 9, 2016, NIOSH received a Form B petition with supporting attachments. On August 19 and August 22, 2016, NIOSH received additional supporting documents. In qualifying and evaluating the petition, NIOSH reviewed the following documents submitted by the petitioner:

- *Special Exposure Cohort Petition—Form B*, with attachments; received August 9, 2016; DSA Ref ID: 127147
- *Two Affidavits*; signed January 11, 2017; DSA Ref ID: 127726
- *Select page from October 1966 Monthly Progress Report*; author not specified; November 8, 1966; DSA Ref ID: 127201
- *Press release on NASA contract to develop SNAP power systems*; Atomics International; May 20, 1963; DSA Ref ID: 127202
- *Transfer of Neutron Source*, correspondence from A. R. Yarrow; August 21, 1963; DSA Ref ID: 127203
- *Plan of Action for RMDF*, correspondence from Jim Harris; December 18, 1975; DSA Ref ID: 127204
- *Transfer of Neutron Source Approval*, correspondence from A. R. Yarrow; May 24, 1963; DSA Ref ID: 127205
- *KEWP Health Physics Log Book*; dated September 18, 1959 through April 9, 1963; DSA Ref ID: 127206
- *Accidental Exposure of Film Badges*, correspondence from R. R. Garcia; May 18, 1965; DSA Ref ID: 127207
- *Duty Cycle SNAP 10A Actuators*, correspondence from I. Rowe; May 28, 1963; DSA Ref ID: 127208
- *Operational Safety Unit Weekly Newsletter for Week Ending June 1, 1968*, correspondence from R. E. Alexander; June 6, 1968; DSA Ref ID: 127209
- *Steam Accumulator Blowdown Evaluation Rig (SABER) Large Scale Steam Valve Test*; author not specified; June 29, 1990; DSA Ref ID: 127210
- *Approval for more than 600 MREM Exposure during S8ER Core Vessel Removal and Disassembly*, correspondence by R. M. Hill; September 27, 1965; DSA Ref ID: 127211
- *Health Physics Log Book*; dated October 28, 1964 through November 18, 1965; DSA Ref ID: 127212
- *Radiation Safety Unit Weekly Newsletter for the Period Ending July 15, 1967*, correspondence from R. E. Alexander; July 25, 1967; DSA Ref ID: 127213

- *History of the Bowl Area*, with descriptions of gasification and propellants for rocket fire tests; author not specified; date not specified; DSA Ref ID: 127214

- *Neuron Radiography of S8DR Fuel Elements in STIR Facility*, correspondence from R. E. Durand; May 4, 1970; DSA Ref ID: 127215

- *Accidental Exposure of Atomics International Film Badges during the Latter Part of November 1962*; author not specified; post-November 1962; DSA Ref ID: 127217

- *Site Description and Historical Operations of the Bowl Area*; author not specified; November 1992; DSA Ref ID: 127219

- *One-Quarter-Ton-Per-Hour Coal Hydropyrolisis Conversion Test Facility*, correspondence from S. F. Iacobellis; September 15, 1978; DSA Ref ID: 127220

- *Presentation: Advanced Single Stage Gasifier Development Program*; Pratt & Whitney Rocketdyne; October 12, 2005; DSA Ref ID: 127222

- *Single sheet showing dosimetry distribution points*; author not specified; April 1, 2014; DSA Ref ID: 127223

- *Advancement of Flash Hydrogasification: Task VIII Performance Testing*; A. Y. Falk, M. D. Schuman, and D. R. Kahn; June 1986; DSA Ref ID: 127224

- *DOE Authority for Release of Certain Facilities at SSFL*, correspondence from R. T. Lancet; January 11, 1990; DSA Ref ID: 127225

- *List of buildings and their status*; author not identified; August 9, 1995; DSA Ref ID: 127226

- *ETEC Co-generation Equipment*, correspondence from R. W. Buckles; January 14, 1986; DSA Ref ID: 127227

- *Hydrogen Fluoride Chemical Laser Technology*, correspondence from J. G. Byrne; June 30, 1976; DSA Ref ID: 127228

- *ETEC Environmental Protection Implementation Plan Pursuant to DOE Order DOE 5400.1*; Rockwell International Corporation; Revision C, November 9, 1992–November 9, 1993; DSA Ref ID: 127230

- *Quarterly Report (July through September 1959) of Activity Released to the Atmosphere*; G. Borg; November 20, 1959; DSA Ref ID: 127231

- *Photograph of two drums under a desk that are labeled as radioactive material contaminated waste*; date not specified; DSA Ref ID: 127232

- *Energy Systems Group brochure*; Rockwell International; date not specified; DSA Ref ID: 127234

- *Contract Solicitation/Modification for DOE-Boeing*, official form extending contract for ETEC remediation; December 15, 1998; DSA Ref ID: 127237

- *The Pied Piper—A Historical Overview of the U.S. Space Power Reactor Program*; George P. Dix and Susan S. Voss; date not specified; DSA Ref ID: 127239

- *Presentation: RFI Data Gap Work Plan for Boeing RFI Subarea 1A North B-1, IEL, AILF, and Unaffiliated Areas*, originally presented at a Santa Susana Field Laboratory technical meeting; June 7, 2013; DSA Ref ID: 127240

- *Commendation Regarding Uranium Fire at Canoga Facility, May 17, 1967*; J. E. Stewart, Jr.; May 19, 1967; DSA Ref ID: 127241

- *The Gasification of Various Coals in Molten Salts*; S. J. Yosim and K. M. Barclay; date not specified; DSA Ref ID: 127243

- *Preliminary Services for SNAP8 Flight Prototype Test Facility, Building 056 Santa Susana, California*; Bechtel Corporation; August 1964; DSA Ref ID: 127244

- *Radiation Survey of the Downey Facility*; approved by P. Rutherford and S. Reeder; release date of May 7, 2001; DSA Ref ID: 127245

- *Health Physics Log Book for Building 12*; dated October 12, 1962 through July 27, 1966; DSA Ref ID: 127246

- *Airborne Radioactive Contamination in SRE High Bay During Reactor Operations*, correspondence from R. K. Owen; July 17, 1959; DSA Ref ID: 127247

- *Atomics International and Energy Technology Engineering Center*, correspondence documenting DEEOIC finding that any employee of NAA at AEC where operations were conducted was potentially eligible under the Act; September 7, 2005; DSA Ref ID: 127248

- *Memo with License R-19 authorizing operation of L-47 reactor at Canoga*; H. L Price; issued August 1957; DSA Ref ID: 127249

- *Memo with License R-40 authorizing operation of L-77 reactor at Canoga*; H. L Price; issued May 17, 1958; DSA Ref ID: 127250

- *Confirmation of 1958 Termination of License R-19*; E. R. Price; June 30, 1958; DSA Ref ID: 127251

- *Amendment to R-40 License*; H. L. Price; issued June 28, 1960; DSA Ref ID: 127252

- *Rockwell International Site Visit*, correspondence from Ross A. Scarano; January 29, 1996; DSA Ref ID: 127253

- *Photograph of a reactor at Canoga Park*; date not specified; DSA Ref ID: 127254

- *Photograph of SNAP building complex, with a key specifying building names*; date not specified; DSA Ref ID: 127255

- *2006 Site Description: Santa Susana Field Laboratory (SSFL) Proposed Corrections to Technical Basis Documents 1 and 2, ORAUT-TKBS-0038-1/ORAUT-TKBS-0038-2*; CORE Advocacy for Nuclear & Aerospace Workers; presented to NIOSH on August 9, 2016; DSA Ref ID: 127256

- *2016 SSFL Site Description Bibliography*; CORE Advocacy for Nuclear & Aerospace Workers; presented to NIOSH on August 9, 2016; DSA Ref ID: 127257

- *EEOICPA Bulletin No. 10-10 on Designation of SEC Class for Area IV of SSFL from January 1, 1959 through December 31, 1964*; Department of Labor; May 5, 2010; DSA Ref ID: 127389

- *Response to the SEC-00235 Consult Call Letter*; CORE Advocacy for Nuclear & Aerospace Workers; December 21, 2016; DSA Ref ID: 127639

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at Area IV of the SSFL from August 1, 1991 through June 30, 1993, and the information available to NIOSH to characterize particular processes and radioactive source materials. For the purposes of completeness, there will be some discussion regarding radiological operations outside of the evaluated period (August 1991 through June 1993). From available sources NIOSH has gathered programmatic and operational site history information regarding the identity and quantities of radionuclides of concern, information describing remediation-period processes through which radiation exposures may have occurred, and descriptions of the physical environment in which exposures may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Plant and Process Descriptions Impacting the Remediation Period

The SSFL is located in the Simi Hills of Ventura County, California, approximately 30 miles northwest of downtown Los Angeles, California. It was initially established by North American Aviation in 1947 to meet the country's needs for a field test laboratory for large rocket engines. The SSFL is divided into four areas, based on ownership and operations. DOE operations were conducted in facilities within Area IV. Area IV is the 290-acre westernmost administrative and operational portion, established at the SSFL in 1953 as a nuclear research and development facility, including 272 numbered structures. As the site was a test site, facilities were often remediated as necessary and demolished once their mission was achieved.

5.1.1 Operational Period Process Descriptions

Area IV's nuclear-related operations consisted of two functional areas: (1) nuclear reactor development and testing and (2) nuclear support operations. Radiological work was conducted from 1953 until nuclear operations and most nuclear support functions ended in 1980 (limited radiological operations supporting decontamination and decommissioning continued through 1998). A total of 135 million Ci of radioactivity was generated in the nuclear reactor fuel from about 7,200 MWd of total reactor operation. The purpose of the reactor program was nuclear development and research, and as the various reactor missions were achieved, the reactors were shut-down, the fuel was removed and shipped offsite. Often the reactor components were disassembled and transported from the reactor

vault for study in hot cells. The following descriptions of individual reactor programs detail the disposition of each reactor.

Nuclear Reactor Development and Testing

The Sodium Reactor Experiment (SRE) reactor operations (Building 4143) were terminated in February 1964, and the irradiated fuel from SRE Cores I and II was stored at the Radioactive Materials Disposal Facility (part of the Radioactive Materials Handling Facility) after its removal from the reactor (1959 for Core I and 1964 for Core II) (Rockwell, 1975). Almost 90% of the total Area IV radioactivity was generated by the SRE. The facility containing the SRE was "stored in place" until decontamination and decommissioning began in 1974 and was completed in 1983 (NIOSH, 2009).

The Kinetics Experiment Water Boiler (KEWB) reactor (Building 4073) was last operated in 1966. The fuel was drained and the system rinsed in 1968. The fuel was removed from the fuel storage tank and shipped to a recovery plant during fiscal year (FY) 1969. Radiological surveillance of the facility was performed until dismantling was initiated in January 1975. The facility had both contaminated and activated structures, including the reactor core vessel, the graphite reflector, the recombiner and gas-handling system, the fuel storage tank, and the contaminated underground lines and tanks (Rockwell, 1975). The decontamination and decommissioning (D&D) work was performed by the Atomics International Remote Technology Unit No. 731- 540, which consisted of SSFL employees trained to work with radioactive materials. Continuous consulting support was provided by a former KEWB operator. Health, Safety and Radiation Services (HSRS), Industrial Engineering, and the Maintenance department provided assistance as required. A demolition contractor was hired to break up the concrete, dig out the tanks, and backfill and grade the excavation (Ureda, Feb1976, PDF p. 12). As of February 1976, all of the facility equipment was removed from the site. The report, *KEWB Facilities Decontamination and Disposition Final Report* (Ureda, Feb1976) provides more detail regarding the D&D procedures.

The research Reactor L-85 (Building 4093) was moved to Area IV from the Downey facility in 1956 and operated until February 29, 1980. The reactor was operated to provide a neutron source for subcritical experiments, neutron radiography, and training. In March 1980, Rockwell International applied to the Nuclear Regulatory Commission (NRC) for authorization to dismantle the facility, dispose of the component parts, and terminate the facility license #R-118. The fuel solution was transferred to the Idaho Nuclear Engineering Laboratory in September 1982. In March 1986, Rockwell submitted a radiation survey report (RI 86) of the decommissioned facility, indicating the facility satisfied the NRC guidelines for release from licensing restrictions (Murphy, 1986).

Building 4010, which housed the SNAP 2 Experimental Reactor (SER) and later the SNAP 8 Experimental Reactor (S8ER), was originally constructed in 1959. Following the SNAP 2 test in 1960, the SER and associated test equipment were removed from the building. In 1961, facility and equipment improvements and modifications were made that enabled the safe operation of the facility during testing with S8ER. Following the SNAP 8 test in 1965, the reactor and all associated equipment were removed from the facility. The nuclear portion of Building 4010 was inactive between the time of S8ER removal in FY 1966 and the SNAP close-out period in FY 1973. The SNAP close-out program removed and salvaged or buried all equipment that was not required for general occupancy or service to the building in approved disposal sites. The remaining components were surface cleaned (Stelle, 1976; Rockwell, 1975).

The Systems for Nuclear Auxiliary Power (SNAP) Environmental Test Facility (Building 4024), contained two reactors, the SNAP-2 Development Reactor (S2DR) and the SNAP-10 Flight Simulation Reactor (S10FS3), which were operated in two different vaults. Criticality tests were also conducted in this facility. The nuclear portion of Building 4024 has been inactive since the removal of the S10FS3 reactor in 1965, except for intermittent periods during which SNAP Transient Test (SNAPTRAN) support reactor experiments were performed in one of the test vaults. The reactor vaults were made radioactive by neutron activation during the reactor tests. During the SNAP close-out period in FY 1973, all control consoles and reactor instrumentation were removed from the facility. Also, at that time, the SNAPTRAN machine and other contaminated items were removed from the test vaults, and the vaults were decontaminated. According to the 2003 *Environmental Assessment for Cleanup and Closure of the Energy Technology Engineering Center* (DOE, 2003, PDF p. 24) the reactors and associated equipment have all been removed and disposed of as radioactive waste.

The Shield Test Irradiation Reactor (STIR) was used primarily to conduct basic shielding experiments. It was housed in Building 4028, which was inactive following the partial dismantling of the reactor, including its defueling in June 1973 (Rockwell, 1975). When the fuel was shipped to a reprocessing plant, the control consoles and reactor instrumentation were removed and the pool water was drained. A number of activated and contaminated structures remained at the facility until the facility was fully dismantled in 1976. The actual dismantling of STIR began on September 24, 1975, and was completed March 26, 1976. The work was performed by the Atomics International Remote Technology Unit, which included SSFL employees trained to handle radioactive materials (Ureda, Aug1976). Contaminated and irradiated components and structures associated with the reactor, water cooling system, thermal column, test carriage, and facility exhaust system were removed, packaged, and shipped to Beatty, Nevada, for disposal by land burial. As required, floor and wall openings resulting from the D&D operations were filled and covered with concrete to restore the facility to a safe condition.

The Systems for Nuclear Auxiliary Power Ground Prototype Test Facility (Building 4059) was built in 1962–1963 for development testing of space nuclear auxiliary power reactors. It has one reactor vault in the basement (another vault in the basement did not house a reactor). Testing of the SNAP-8 Development Reactor (S8DR) was conducted in 1968–1969. The reactor vault was made radioactive by neutron activation during the reactor tests. At the end of the test operations, the reactor core and control system were removed, sent to an onsite examination facility for inspection, and then shipped offsite for disposal. To make a portion of the facility available for other use, decontamination was conducted according to DOE Order 5400.5 surface contamination requirements (leaving a residual dose of less than one millirem per year). In 1999, the above-grade portion of the building and the underground, non-activated portions of the basement were decontaminated and surveyed for release for unrestricted use. Building 4459 (a storage building) is within the fence line boundary of Building 4059.

As described above and indicated in Table 5-1 below, by 1980, the operational nuclear reactors and critical test assemblies had all ended operations. The reactors, having expended their fuel or having been decommissioned, would have had their spent fuel removed. The spent fuel contained fission products and transuranic materials. A more detailed history of the individual nuclear reactor development and testing facilities is available in *Energy Technology Engineering Center—Site Description* (ORAUT-TKBS-0038-2).

Nuclear Support Operations

Nuclear support operations included work associated with the following:

- Reactor fuel manufacturing;
- Reactor fuel storage;
- Disassembly and examination of reactors and used reactor fuel assemblies;
- Radioactive source fabrication, use, and storage;
- Preparation for radioactive material disposal;
- Research on reprocessing used reactor fuel;
- Particle accelerator operations;
- Research using radioisotopes;
- Corrosion testing;
- Mechanical component development; and
- Sodium disposal.

The four major nuclear support operations facilities were the Radiological Materials Handling Facility, the Fuel Storage Facility, the Hot Laboratory, and the Nuclear Materials Development Facility (NMDF) (Sapere, 2005).

The Radiological Materials Handling Facility complex consists of nine different buildings that are used for the following purposes: (a) decontamination and packaging (Building 4021), (b) operations and storage vaults (Building 4022), (c) offices (Building 4034), (d) health physics services (Building 4044), (e) enclosed storage (Buildings 4075, 4621, and 4665), (f) covered storage (Building 4688), and (g) security (Building 4658). A rainwater runoff basin (referred to as Building 4614) is also included within the approximately 12,000-square-meter (3-acre) Radiological Materials Handling Facility. The Radiological Materials Handling Facility has been in continuous operation as a storage and handling facility for radioactive materials and waste since the late 1950s. It is a Resource Conservation and Recovery Act (RCRA)-permitted facility. The facility is radiologically contaminated from past operations, including storing both new fuel and irradiated fuel (DOE, 2003).

The Fuel Storage Facility was located in Building 4064 and was constructed in 1958. The building was a vault, built to provide secure storage for non-irradiated fissionable fuel material (enriched uranium and plutonium) used to make reactor fuel. Closed containers of radioactive waste were also stored outside on a concrete pad within the locked and fenced facility perimeter. Following removal of all fissionable material in the mid-1980s, miscellaneous equipment and containers of radioactive waste (principally soil) were stored inside the building. By 1993, the building was emptied of all contents. Decontamination and demolition activities for Building 4064 were completed in 1997 (Sapere, 2005, PDF p. 28).

The Hot Laboratory, later known as the Rockwell International Hot Laboratory or RIHL (Building 4020) operated from 1959 to 1988. The Hot Laboratory was used to examine fuel and/or components from the SRE, SER, S2DR, S8DR, and S10FS-3 reactors operated at Area IV, and to examine used reactor fuel from nuclear reactors outside Area IV. Reactor fuel elements were shipped into the Hot Laboratory, disassembled, or separated from their cladding material. The separated materials were then shipped offsite for disposal. All contaminated items were removed from the test vault. 4020 was demolished in 1996, but final decontamination and demolition activities of the Building 4020 site were completed in 1999 (Sapere, 2005, PDF p. 28).

The NMDF (Building 4055) was constructed in 1967 and operated until 1979. It was built specifically for development work involving plutonium and supported several research programs. The decontamination and demolition activities were completed by 1987 and the building was released for use without restrictions (Sapere, 2005, PDF p. 28).

Table 5-1: Summary of Area IV Programs

Functional Area	Program Name	Building Number	Program Operational Period	End of D&D and/or Release	Status
Reactor Development and Testing	KEWB (Water Boiler Reactor)	4073	1956–1966	DOE released: 1976	Demolition: 1975
Reactor Development and Testing	AE-6/L-85 (Water Boiler Reactor)	4093	1958–1980	NRC released: March 1987	Demolition: 1995
Reactor Development and Testing	Sodium Reactor Experiment (SRE)	4143	1957–1964	1974–1983	Storage: 1983–1999; Demolition: 1999
Reactor Development and Testing	Organic Moderated Reactor (OMR)	4009	1958–1967	Original D&D: 1967; DHS released: 1999	Non-nuclear R&D
Reactor Development and Testing	Sodium Graphite Reactor (SGR)	4009	1958–1967	Original D&D: 1967; DHS released: 1999	Non-nuclear R&D
Reactor Development and Testing	Advanced Epithermal Thorium Reactor (AETR)	4100	1960–1974	D&D: 1974; NRC released: 1980	Counting and Instrument Calibration Lab
Reactor Development and Testing	Shield Test Reactor (STR) (renamed STIR)	4028	1961–1964	Modified to STIR: 1967; Radiation operations terminated: 1984; Cleanout and Decontamination began: 1988; DHS released: Dec 1995	Demolition began:1989; Demolition completed: 1998
Reactor Development and Testing	Shield Test and Irradiation Reactor (STIR)	4028	1964–1972	Decommissioned and removed: 1976	Demolition began: 1989; Demolition completed: 1998
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP Experimental Reactor (SER)	4010	Sept 1959–Dec 1960	Original D&D: 1978; DOE released: Dec 1982	Demolition: 1978

Functional Area	Program Name	Building Number	Program Operational Period	End of D&D and/or Release	Status
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP 8 Experimental Reactor (S8ER)	4010	May 1963–Apr 1965	Original D&D: 1978; DOE released: Dec 1982	Demolition: 1978
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP 2 Development Reactor (S2DR)	4024	Apr 1961–Dec 1962	D&D (all areas except power test vaults released): Sept 1978	Power test vaults in surveillance & maintenance mode
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP 10 Flight Simulation Reactor (S10FS3)	4024	Jan 1965–Mar 1966	D&D (all areas except power test vaults released): Sept 1978	Power test vaults in surveillance & maintenance mode
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP 8 Development Reactor (S8DR)	4059	1968–1969	D&D: 1978–1989	Demolition (above ground and activated cells): 2004
Systems for Nuclear Auxiliary Power (SNAP) Program	First SNAP Critical Test Facility	4373	1957–1963	DHS released: 1995	Demolition: 1999
Systems for Nuclear Auxiliary Power (SNAP) Program	Second SNAP Critical Test Facility	4012	1961–1967	DOE and DHS released: 1997	Initial demolition: 1986; Final demolition: 2003
Systems for Nuclear Auxiliary Power (SNAP) Program	Heavy Metal Reflected Fast Spectrum Reactor (HMRFSR)	4012	1970–1972	DOE and DHS released: 1997	Initial demolition: 1986; Final demolition: 2003
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP Flight System Critical Facility (FS-1, FS-4, and FS-5 reactors)	4019	1964–1965	DOE released: 2005	Building inactive
Systems for Nuclear Auxiliary Power (SNAP) Program	SNAP Transient Test Facility	4024	Throughout 1971	D&D (all areas except power test vaults released): Sept 1978	Power test vaults in surveillance & maintenance mode
Nuclear Support Operations	Hot Laboratory (RIHL)	4020	1957–1988	DOE released: 2005	Demolition: 1996
Nuclear Support Operations	Engineering Test Building (includes the Hot Cave)	4003	1957–1973	DOE released: 2005	Demolition: 1999
Nuclear Support Operations	Fuel Storage Facility	4064	1958–1993	DOE released: 2005	1997-Demolition
Nuclear Support Operations	Radioactive Measurement Facility	4029	1959–1974	DHS released: 1995; DOE released: 1997	Non-radiation material storage

Functional Area	Program Name	Building Number	Program Operational Period	End of D&D and/or Release	Status
Nuclear Support Operations	Radioactive Materials Disposal Facility (RMDF/RMHF)	4021, 4022, 4034, 4044, 4075, 4621, 4665, 4688, 4658	1959–Present	Active	Building active
Nuclear Support Operations	Nuclear Materials Development Facility	4055	1967–1979	D&D began: 1979; NRC released: 1987	Non-radiation research
Nuclear Support Operations	Van de Graaff Accelerator Facility	4030	1960–1964	Accelerator removed: 1966; DOE released: 1997; DHS released: 1999	Demolition: 1999
Nuclear Support Operations	Liquid Metals Component Test Building	4023	1962–1986	DOE released: 1997; DHS released: 1998	Demolition: 1999
Nuclear Support Operations	Uranium Carbide Fuel Manufacturing Pilot Plant	4005	1964–1967	DHS released: 1995	Demolition: 1996
Nuclear Support Operations	Radiation Instrument Calibration Laboratory	4011	1984–1996	DHS released: 1998	Non-radiation equipment storage
Nuclear Support Operations	Fast Critical Experiment Laboratory	4100	1961–1974	NRC released: Oct 1980	Counting and Instrument Calibration Laboratory

Source: Information for this table was compiled from *Historical Site Assessment of Area IV Santa Susana Field Laboratory Ventura County, California* (Sapere, 2005).

5.1.2 Remediation Period Process Descriptions

During the years under evaluation, 1991–1993, Rockwell International was the contractor performing environmental restoration, including decontamination and demolition of former radiological facilities. During that time, the only radiological support facilities that were operational were the Fuel Storage Facility, the Radiological Materials Handling Facility, and the Radiation Instrument Calibration Laboratory. Operations at the Radiological Materials Handling Facility currently include waste characterization, limited treatment, packaging, and temporary storage of radioactive and mixed waste materials, which are shipped offsite to appropriate approved disposal facilities.

For the period evaluated by NIOSH, the Area IV workforce size was on the order of hundreds of employees in any year. In 1991, there were approximately 150 employees assigned to Area IV, and less than 1,000 throughout the SSFL complex (Personal Communication, 2017).

5.2 Radiological Exposure Sources during the Remediation Period

The following subsections provide an overview of the internal and external exposure sources for the Area IV class under evaluation.

There were both reactor facilities and research testing at facilities within Area IV during the radiological operations period through 1988, including the actual reactors, critical test facilities, nuclear fuel preparation, and post-irradiation examination facilities. Nuclear reactor operations generate fission products, transuranics, and activation products, all of which are left in the spent fuel material after the reactor is shut down. The cladding and structural materials become activated during exposure to the neutron radiation generated by the reactor. The fuel examination and manufacturing facilities, reactors, and critical test facilities handled fissionable fuels, mostly compounds of uranium including carbides, as well as limited quantities of plutonium and thorium. Pilot-scale separations of irradiated fuel were performed. Fuel decladding (in a hot cell) was performed, with quantities of fission products being released into the cell environment.

Though none of these operations were ongoing during the 1991–1993 period being evaluated, both residual contamination and exposure to activation-product radiation are potential sources of radiological exposure during the remaining post-1988 D&D activities. The primary potential sources of internally deposited radioactivity for Area IV employees during the evaluation period were inhalation and ingestion of uranium, plutonium, and mixed fission product residual activity becoming airborne as a result of D&D and waste-handling operations.

5.2.1 Internal Radiological Exposure Sources during the Remediation Period

This section addresses potential exposures to radionuclides at Area IV of the SSFL during remediation. During the remediation period, beginning in 1988, through the evaluated period of 1991–1993, the primary sources of covered exposure to Area IV workers included inhalation or ingestion of residues from the nuclear-reactor-generated fission products; transuranics and activation products; uranium compounds; and limited quantities of plutonium and thorium during D&D activities. During the evaluated period from August 1991 through June 1993, the activities with the likely highest airborne concentrations (Personal Communication, 2017) included:

- Building 4059, demolition of SNAP-8 Development Reactor;
- Building 4020, decontamination of the Hot Laboratory; and
- Waste handling operations in the Radioactive Materials Handling Facility.

5.2.1.1 D&D, August 1991–June 1993

Decommissioning generally involved four steps: (1) radiological survey to locate and quantify contamination, (2) decontamination using appropriate techniques (i.e., washing, excavating, scabbling etc.), (3) size reduction (i.e., cutting or sawing into smaller components, disassembly) when practical, and (4) packaging for disposal and removal. The principal sources of internal radiation doses for Area IV workers from August 1991 through June 1993, were airborne alpha and beta-gamma particulate materials. Alpha-emitting radionuclides associated with the fissionable material and transuranics contamination from reactor fuel include plutonium-238, plutonium-239, uranium-234, uranium-235, uranium-238, thorium-228, thorium-230, thorium-232, and americium-241. Previous reactor

operations produced beta-gamma-emitting mixed fission products and activation products including cobalt-60, strontium-90, cesium-137, and tritium.

Workers were potentially exposed to dust, generated during heavy decontamination work like scabbling, sawing, or grit blasting, which might dislodge or send particles contaminated by radionuclides airborne which could then be inhaled by workers and deposited in the respiratory tract. Disassembly and demolition actions would also be likely to generate respirable particulates. Dust generally settles and is subject to resuspension in the air, to be inhaled, when disturbed during normal work activities or to be ingested by transfer from contaminated surfaces via hand to mouth. During the period from August 1991 through June 1993, the D&D activities with the highest known airborne concentrations included Building 4059, where the below-grade vault in which the S8DR reactor had been tested was being demolished. This work included breaking up and removing reactor-activated concrete and building materials. The decontamination of the Hot Laboratory in Building 4020 was also identified as an airborne contamination job. The hot cells in Building 4020 were highly contaminated. Supplied air respirators were required for workers doing these jobs (Personal Communication, 2017).

5.2.1.2 Ongoing Radiological Support Operations, August 1991–June 1993

During the period from August 1991 through June 1993, only the Fuel Storage Facility (Building 4064), the Radioactive Materials Handling Facility, and the Radiation Instrument Calibration Laboratory (Building 4011) were operational and actively involved with radiological materials. Of these three, the Radioactive Materials Handling Facility would have been the only facility where workers might have been routinely exposed to unencapsulated radiological materials in the course of their work. Operations at the Radiological Materials Handling Facility currently include waste characterization, limited treatment, packaging, and temporary storage of radioactive and mixed-waste materials, which are shipped offsite to the appropriate approved disposal facilities. The Radioactive Materials Handling Facility is one of the three areas where airborne potential would have been the highest onsite during the 1991–1993 timeframe (Personal Communication, 2017). The workers at the Radioactive Materials Handling Facility would have the potential for the same mechanisms of inhalation and ingestion of radionuclides.

The Radioactive Materials Disposal Facility, which is part of the Radioactive Materials Handling Facility, was designed to be a central area for decontamination and radioactive waste management activities. Building 4021 is the decontamination and packaging building and contains a liquid-waste evaporator unit, decontamination equipment, air cleaning unit, and tanks (Rockwell, 1984, PDF p. 28). In the course of decontamination actions and packaging materials for disposal, workers at Building 4021 had the potential to be exposed to airborne contamination or aerosolized radiological materials, including any of the isotopes found onsite.

5.2.2 External Radiological Exposure Sources during the Remediation Period

The primary potential sources of external dose for Area IV employees during the remediation period include exposure to sometimes high amounts of surface contamination present or exposure to activated building materials during decontamination and demolition activities. A review of periodic As Low as Reasonably Achievable (ALARA) program reports for the 1991–1993 period indicate that the D&D activities with the highest known airborne concentrations were the activities with the highest potential for external exposure as well (Quarterly Reviews, 1991–1993, PDF pp. 43-81). As with internal exposures discussed above, during the August 1991 through June 1993 period, the bounding

external exposures were associated with work in: Building 4059 SNAP reactor demolition; decontamination of the Hot Laboratory in Building 4020; and the waste reduction and packaging activities in the Radioactive Materials Handling Facility. The hot cells in Building 4020 are where the fuel decladding work had been conducted, and the cells were likely contaminated with fission products.

5.2.2.1 D&D, August 1991–June 1993

During the remediation period, Area IV workers performed decontamination, decommissioning, demolition, and waste-handling work involving building materials and utility systems activated in the past by reactor operation. Another possible external exposure pathway during heavy decontamination or demolition actions is immersion in airborne contamination. External exposures to photon radiation would have resulted from the proximity to activation products. The beta and photon emissions of the radionuclides of major external exposure concern can be found in most standard health physics reference documents. Exposure to these emissions was possible during contact with contaminated surfaces, proximity to activated structural materials in the course of remediation or demolition, and handling the decontamination waste materials.

With the termination of nuclear operations, neutron source term materials were packaged and transported for disposal off site.

5.2.2.2 Ongoing Radiological Support Operations, August 1991–June 1993

As described in Section 5.2.1.2, from August 1991 through June 1993, the Fuel Storage Facility (Building 4064), the Radioactive Materials Handling Facility, and the Radiation Instrument Calibration Laboratory (Building 4011) were actively involved with radiological materials. NIOSH has information on the beta and photon energies associated with work in these buildings through 1993 (ORAUT-TKBS-0038-6, PDF p. 12). The Fuel Storage Building was used for plutonium storage from 1958 to 1993, and thus is a potential source of neutron radiation via spontaneous fission and alpha-neutron reactions. Following removal of fissionable material in the mid-1980s, miscellaneous equipment and containers of radioactive waste (principally soil) were stored inside the building. However, these facilities are assumed to be a negligible contributor to neutron doses due to the limited quantities of fuel present at any one time (ORAU-TKBS-0038-6, PDF pp. 10-11).

6.0 Summary of Available Monitoring Data for the Class Evaluated by NIOSH

The following subsections provide an overview of the state of the available internal and external monitoring data for the Area IV of the SSFL class under evaluation.

6.1 Available Internal Monitoring Data

NIOSH has access to workplace air, surface, and environmental monitoring data for Area IV buildings. The SSFL Area IV health physics program records include air samples for alpha (in limited cases) and beta-emitters.

Details regarding the various analyses used and the associated minimum detectable activities are presented in *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen*

Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational Internal Dose (ORAU-TKBS-0038-5).

6.1.1 *In Vitro* Monitoring

NIOSH has radiation dosimetry records for workers assigned to areas of high surface contamination or airborne contamination, including results of special samples that may have been triggered by general workplace air and breathing-zone air samples exceeding prescribed thresholds. The bioassay records in the individual radiological exposure files generally consist of:

- Individual personnel McBee Key-sort cards, which were used to track the type, frequency, and week of sample collection (the card summarized individual results);
- Bioassay data sheets, which were two-page forms that contained all the information on analyses conducted by the onsite laboratory;
- Individual analysis result sheets, which contained all the information on analyses conducted by offsite laboratories. This form might show the calculated result (even if it was below the limit of detection), the sensitivity of the analysis, and the uncertainty;
- Wound monitoring reports; and
- Individual, hand-drawn or computer-generated plots of bioassay data, apparently done as follow-up to high results.

6.1.2 *In Vivo* Monitoring

Helgeson Scientific Services was contracted by Rocketdyne to provide onsite *in vivo* evaluations of workers every six months. Suspected intakes would have triggered follow-up bioassay sampling or if the *in vivo* vendor was scheduled to be available, a whole-body or other count would be performed. Under the routine bioassay program, an *in vivo* analysis typically would be scheduled once every six months for workers with duties in high-contamination areas or airborne-radiation areas. In addition to whole-body count results, NIOSH has a limited number of other *in vivo* results, such as lung, thyroid, and wound counts. The *in vivo* reports provided by Helgeson Scientific identify the scans as organ-specific or total-body, and include a table of minimum sensitivities for the counter, calibration information, and descriptions of the counting equipment in terms of the detector and electronics (Helgeson, 1993).

6.1.3 Air Monitoring

The site used continuous air monitoring to identify and designate areas of airborne contamination, as well as the results of routine surveys to designate high contamination areas. NIOSH has examples of job-specific, breathing-zone air sample results and continuous air monitor results for various buildings in 1990 (Quarterly Review, Q4-1990), in 1991 (Quarterly Reviews, 1991–1993) and in 1998 (Survey Reports, Jan–Dec1998).

The 1993 *Rocketdyne Radiological Controls Manual* indicates that workers in an Airborne Radioactivity Area, defined as having 10% DAC or greater, or in areas where they were likely to

receive intakes resulting in 100 millirem committed effective dose equivalent, were to participate in the bioassay program (Barnes, 1993, PDF p. 74). It also states that bioassay analyses were to be performed when: face or nasal contamination was indicated; "airborne monitoring" indicated uptakes of 100 millirem or greater; or when "[a]n intake is suspected for any reason" (Barnes, 1993, PDF p. 74). By the late 1980s, the criterion was "personnel whose work assignments potentially expose them to radioactive aerosols" (Tuttle, 1989, PDF p. 12). A former Area IV worker indicated that anyone working in a high contamination area or airborne radioactivity area was included in the routine bioassay program (Personal Communication, 2017). The number of individuals participating in the routine bioassay program would be on the order of several dozen people, most of whom would be on a regular frequency. Short-term contract workers were on an assay regimen designed to accommodate the length of their contract. Quarterly evaluations alternating between *in vivo* and *in vitro* analyses were performed (Barnes, 1998, PDF p. 8). The official trigger points for special samples were general workplace air and breathing-zone air (BZA) samples that exceeded a threshold of 4 DAC-h in a day or in a specific event, 10 DAC-h in a calendar quarter, or 20 DAC-h in a calendar year. The interviewee indicated that in practice, the program was managed conservatively and a follow-up sample would be requested any time detectable activity was determined from a BZA sample (Personal Communication, 2017). The results of these analyses were maintained by the site and have been provided to NIOSH. NIOSH has reviewed an example case where airborne activity exceeded 10% DAC and found that nasal smears were taken and special bioassay samples were collected. This report also included air sample results showing several continuous air monitors in and near the work area, including the associated results (McGinnis, 1991).

6.1.4 Site Response to Disqualification of CEP *In Vitro* Data

In response to DOE concerns with CEP falsification of Sandia National Laboratory bioassay processing, Rockwell International examined their SSFL bioassay data and initiated qualifications of replacement laboratories (Rutherford, 1994). In December 1994 letters to SSFL monitored employees (Rockwell, 1994), Rockwell International stated the following:

- The CEP-related bioassay were all routine and/or baseline samples and none were the result of incidents;
- During the period when samples were analyzed by CEP (1991–1993), air sample data were routinely taken in work areas to confirm that airborne activity remained below regulatory limits;
- During that same time, the same workers underwent whole-body scans (WBS) performed by a different contractor (Helgeson), instituted as a separate and independent measure of internal exposure;
- The whole-body scans showed no measurable exposures; and
- Follow-on samples analyzed by the new contractor, Teledyne-Brown Engineering, confirmed no measurable internal exposure.

Rockwell concluded their letter with, "In summary, although CEP bioassay results have been questioned, independent Helgeson WBS, Teledyne bioassays, and air sampling have confirmed that Rocketdyne workers have experienced no measurable internal exposure."

Additional evidence of site follow-up to the CEP concerns is found in a Health Physics Activity Report from August 30, 1993 (Activity Reports, Jan–Dec1993, PDF pp. 55-58), which states, "The CEP contract expired on 7/31/93. Strontium-90 analysis will be performed on those samples that indicated trace MFP under the expired contract. Further analyses are on hold until quotes are reviewed and a new purchase order is written. The semi-annual whole body gamma scan for radiation workers who work with unencapsulated radioactivity is scheduled for September 29th and 30th, 1993 at the SSFL site."

The site's efforts to contract new bioassay vendor laboratories are illustrated in additional Health Physics Activity Reports (Activity Reports, Jan–Dec1993, PDF p. 53), "The IT Radiochemistry Service Agreement will be extended to November 30, 1993 to provide service coverage until a new service agreement can be signed. A data package was submitted to contracts documenting our dissatisfaction with CEP's performance over the past two years, and stating that CEP should be eliminated from the current list of suppliers who responded to the Request for Proposal." The site's stated dissatisfaction with CEP data referred to both urine samples sent to CEP for analysis as well as environmental surface and groundwater sample analyses (Rutherford, 1993).

6.2 Available External Monitoring Data

Work associated with facility decontamination, packaging, storing and transporting radiological waste materials, operating the Radioactive Materials Disposal Facility, analytical laboratory work functions, and industrial radiography all have a potential to result in exposure to ionizing radiation. Area IV required external radiation monitoring for workers with a potential for external exposure. Landauer provided external dosimetry services, on a quarterly exchange frequency, supplying a multi-element dosimeter to measure and account for photon and beta exposures. Radiological workers and engineers entering radiological areas would have been included in the external dosimetry program.

NIOSH has access to photon and beta external dosimetry results, as well as other supporting data and information on Area IV site operations during the period of evaluation. Activity reports documenting workplace radiation levels, environmental TLD results, and workplace contamination summaries are available to supplement dosimetry information. SSFL's policy was to assign external dosimetry based on job assignments that required potential exposure to radioactive materials (ORAUT-TKBS-0038-6). Details regarding the various analyses used and the associated minimum detectable activities are presented in *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational External Dose* (ORAU-TKBS-0038-6).

Through the course of ongoing dose reconstruction efforts and investigations associated with both SEC-00093 and SEC-00156, NIOSH determined that although external monitoring data are available for most employees at Area IV, some employees could have received external radiation exposures that went unmonitored. To assess potential external dose to unmonitored employees, NIOSH developed a coworker dose distribution model (ORAUT-OTIB-0077).

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the class of employees under evaluation in this report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to estimate the maximum radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class, or to estimate the radiation doses to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. This approach is discussed in NIOSH's SEC Petition Evaluation Internal Procedures which are available on the NIOSH Radiation Dose Reconstruction Program webpage. The next four major subsections of this evaluation report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00235 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Area IV of the SSFL Data

This subsection answers questions that need to be asked before performing a feasibility evaluation. Data Pedigree addresses the background, history, and origin of the data. It requires looking at site methodologies that may have changed over time; primary versus secondary data sources and whether they match; and whether data are internally consistent. All these issues form the bedrock of the researcher's confidence and later conclusions about the data's quality, credibility, reliability, representativeness, and sufficiency for determining the feasibility of dose reconstruction. The feasibility evaluation presupposes that data pedigree issues have been settled.

Upon request, the facility provides original hardcopy records, including internal and external dosimetry records for individual claimants; these records are used by NIOSH to support dose reconstruction.

7.1.1 Internal Monitoring Data Pedigree Review

The availability of a significant quantity of health physics records, held by the Area IV site, was detailed in a November 2007 telephone interview with [Job Title Redacted]. The extent of these

records was corroborated during a subsequent data capture trip to the site. In 2008, Area IV provided spreadsheets of bioassay data. There were separate spreadsheets for each of the vendor laboratories, extracted from tables within a database created for the mortality study and comprehensive dose reconstruction methodology study at Rocketdyne/Atomics International (Boice, 2004; Boice, 2006). Upon investigation, it was determined that not all data from the site was included in the spreadsheets (Lang, 1960; Atomics International, 1960), so the site went back to the original data sheets and entered missing or unclear information. After several such iterations of attempting to use the originally-provided data associated with the mortality and DR methodology studies, urinalysis bioassay data were obtained directly by NIOSH from SSFL in the form of electronic scans of hardcopy bioassay data records. These records contain data from SSFL internal records and records from the analytical laboratories that performed the urinalyses. SSFL received urinalysis results data from their vendor laboratories and transcribed that data onto internal forms, which SSFL referred to as "8X11" and "McBee cards." These data, digital copies of the original data, were used to perform the NIOSH coworker analysis for Area IV of the SSFL. For additional detail, see *Internal Coworker Dosimetry Data for Area IV of the Santa Susana Field Laboratory and the De Soto Avenue Facility* (ORAUT-OTIB-0080, PDF pp. 8–10).

7.1.2 External Monitoring Data Pedigree Review

Atomics International started using commercial vendors for its dosimetry needs in the early 1960s and continued that practice throughout the evaluated period. Original, individual external dosimetry records are available for all workers whose job entailed a potential for radiation exposure and thus were monitored over the period evaluated in this report. The exchange frequencies for employees at the site were based on the potential to exceed the administrative exposure limits (ORAUT-TKBS-0038-6). Having the original personnel records and the associated radiological program information for Area IV of SSFL eliminates the need for a further consistency check of the external data for the period from 1991 through 1993.

The data, including external exposure data for Area IV, was put into a database and used to develop the external coworker dosimetry model, ORAUT-OTIB-0077. The SSFL dosimetry database contains data for penetrating dose, which is a combination of gamma and fast neutron dose. Because it was difficult to separate statistically significant neutron dose from the penetrating dose, and because shallow dose data are not available, the neutron dose component (which represented less than 5% of the total data points available) was left embedded with gamma dose, resulting in penetrating dose values that are biased high. Exposure information was compiled from the following sources: Rocketdyne radiation safety folders, NRC-REIRS, DOE-REMS, Landauer dosimetry, individual facilities, the U.S. Army, and the U.S. Air Force. These data include results from workers who had duties at the Canoga, De Soto, and Downey sites.

7.2 Evaluation of Bounding Internal Radiation Doses at Area IV of the SSFL

The principal source of internal radiation doses for members of the class under evaluation were airborne radiological particulates generated during D&D activities, and waste reduction/handling. The three onsite projects of highest potential for airborne activity during the period from 1991 through 1993 were: (1) the D&D of Building 4059 (the SNAP Reactor Development Facility); (2) the D&D of Building 4020 (which housed the Hot Laboratory); and (3) operation of the Radiological Material Handling Facility (Personal Communication, 2017). The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding Internal Doses during the Remediation Period

The D&D program at Area IV during the remediation period (from 1989 onward), which includes the August 1991 through June 1993 evaluated period, was a mature program. Projects were of limited duration and access, and were performed under significant planning and control to minimize worker exposure (Activity Reports, Jan–Dec1991; Activity Report, W43-1991; Quarterly Reviews, 1991–1993; Activity Reports, Jan–Dec1992; Activity Reports, Jan–Dec1993; Personal Communication, 2017). The onsite activities during the DOE remediation period involved environmental monitoring and facility caretaking. As depicted in Figure 7-1: History of Area IV Building Operation and Remediation, D&D was an ongoing occurrence at Area IV. As a research and testing facility, buildings and spaces were decontaminated and demolished as missions were completed. The end of each horizontal bar represents the point in time when the building was cleared for unrestricted use by the responsible licensing or regulatory agency. With the exception of three buildings, all buildings had been cleared for unrestricted use during the 1950–2010 timeframe shown in Figure 7-1. As evident, the process of releasing facilities, including the D&D activities, occurred equally across the DOE remediation period; both before and after the period from August 1991 through June 1993.

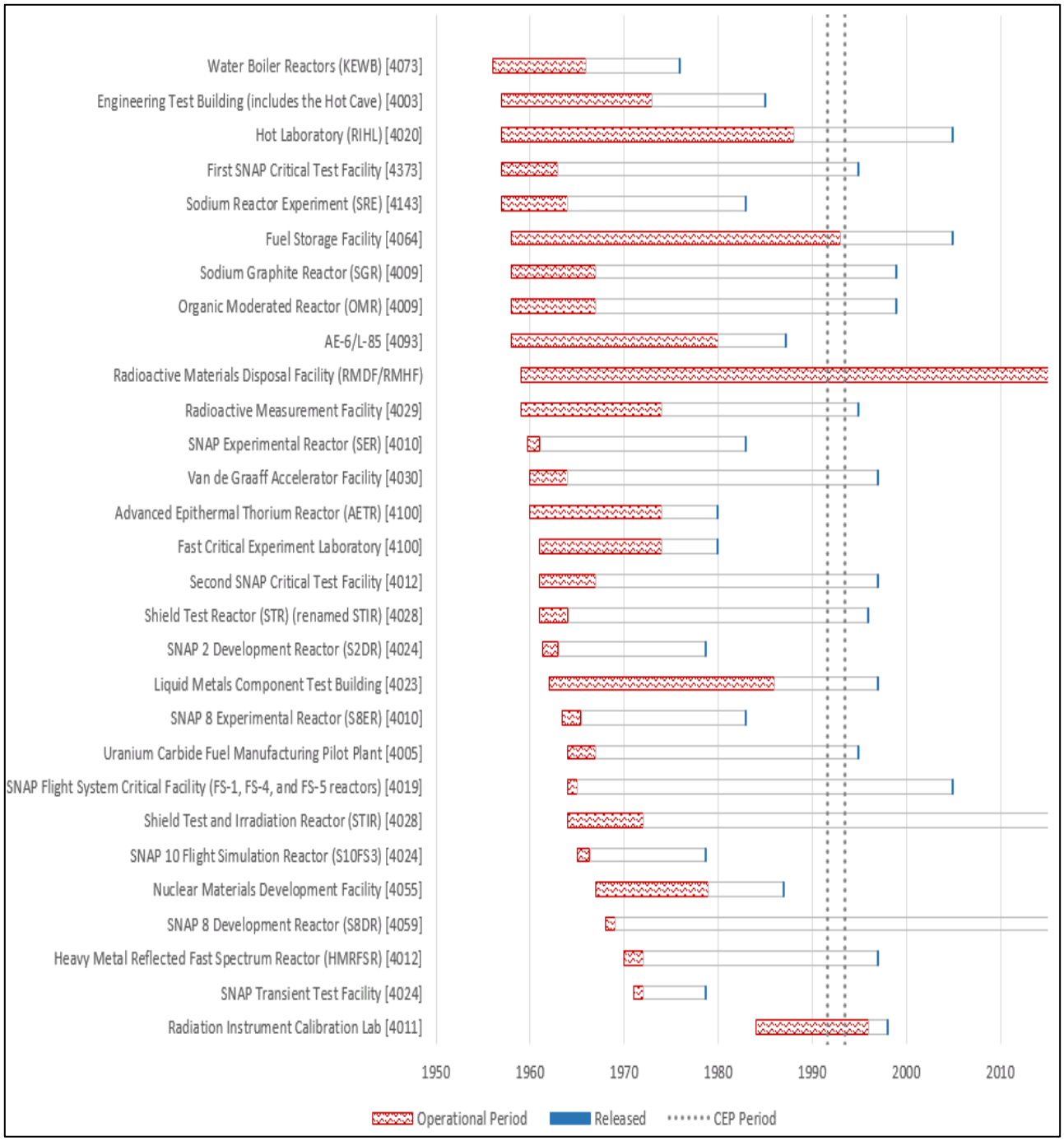

Figure 7-1: History of Area IV Building Operation and Remediation

NIOSH reviewed the available documentation describing work processes and projects to evaluate the exposure conditions before, during, and after the evaluated period and assess the representativeness of the available data. NIOSH's review indicates that work remained consistent as to procedures, personnel protection equipment, and exposure risks. The facilities being decommissioned were of similar radiation hazard, with the hot cells being the most highly contaminated. No record was found of any project or process onsite that was likely to generate higher radiation or intake exposure during the evaluated years than those listed in Section 7.2, the D&D of buildings 4059 and 4020, and operation of the Radiological Materials Handling Facility. This was confirmed during the interview

conducted on April 18, 2017 (Personal Communication, 2017). The bioassay data presented in the following sections include the results for the Area IV workers involved in these higher exposure efforts.

Workers at Area IV whose job assignments entailed a high potential for internal exposure were monitored for intakes of radiological material through bioassay. The internal monitoring procedures included collecting urine samples at regular intervals. Sampling was typically performed on a quarterly basis, but the frequency was increased if elevated exposure conditions were suspected, as in the case of high area air sampling results. Follow-up bioassay samples were taken if elevated internal exposure was indicated. Commercial vendors were routinely used for the analysis of the *in vitro* bioassay samples and the results were retained in each worker's radiological exposure file. The *in vitro* program primarily consisted of urine samples analyzed for uranium, plutonium, and mixed fission products, and were collected for different individuals, selected at the discretion of the responsible health physicist (Inspection, 1986).

The majority of the urinalysis results were reported as non-detectable and shown as "<" values. A smaller number of the non-detectable results were reported in the files as a value of zero. The quantities of zero values found in the data are tabulated below. Zero-value results are not presented in the plots below.

Table 7-1: Urine Analytical Results Prior to CEP Period

Analyte	Date Range	Number of Results Reported as Positive	Number of Results Reported as <MDA	Number of Results Reported as Zero	Total Number of Results
Uranium	1980–1988	25 (3%)	586 (61%)	351 (36%)	962
Plutonium	1969–1986	48 (7%)	386 (53%)	298 (41%)	732
Mixed Fission Products	1965–1991	1,685 (29%)	2,909 (51%)	1,129 (20%)	5,723
Gross Alpha	1968–1987	38 (5%)	483 (66%)	213 (29%)	734

Table 7-2: Urine Analytical Results After CEP Period

Analyte	Date Range	Number of Results Reported as Positive	Number of Results Reported as <MDA	Number of Results Reported as Zero	Total Number of Results
Uranium	Post June 1993	2 (7%)	22 (76%)	5 (17%)	29
Plutonium	Post June 1993	0 (0%)	43 (38%)	70 (62%)	113
Strontium-90	Post June 1993	7 (11%)	10 (15%)	48 (74%)	65
Gross Alpha	Post June 1993	2 (6%)	8 (22%)	26 (72%)	36

Some workers at Area IV were not monitored for potential intakes to radioactive material, because their job assignment was not likely, in the assessment of the facility health physicist, to have the potential for intake of significant radiological materials. If the job assignment was not in a high-contamination area or an airborne radioactivity area, the workers were generally unmonitored for internal exposure (Personal Communication, 2017). The NIOSH coworker study, initiated to address potentially unmonitored workers at Area IV, utilized the urinalysis results of monitored workers obtained directly from SSFL in 2009 to assign internal dose to address potential intakes of radioactive

material. The data and how they were processed are described in ORAUT-OTIB-0080. Analyte results were documented in the monitored-employee radiological exposure files obtained from the site, including the results of various analysis methods for uranium, plutonium, and mixed fission products (MFP). The statistical analysis of the data was performed according to ORAUT-OTIB-0019, *Analysis of Coworker Bioassay Data for Internal Dose Assignment*, its implementing procedure, ORAUT-PROC-0095, *Generating Summary Statistics for Coworker Bioassay Data*, and the statistical methods in ORAUT-RPRT-0053, *Analysis of Stratified Coworker Datasets*. The results were entered into the Integrated Modules for Bioassay Analysis (IMBA) computer program to obtain intake rates for the assignment of dose distributions.

ORAUT-OTIB-0080 describes the processes for selecting the results, organizing and providing a statistical analysis of the data, and for creating coworker estimates for the three radionuclide groups: uranium, plutonium, and MFP. In each group, where sufficient data were available within each year, coworker estimates were created. Also for each group, estimates were calculated for different date ranges with years grouped together based on similarity of each year's overall bioassay result average. For uranium, the last year range was 1980 through 1988. For plutonium, it was 1969 through 1986, and for mixed fission products there was one time period, 1965 through 1991. In addition to analyzing for specific radionuclides, the site routinely screened urinalyses samples through gross-alpha and gross-beta (minus K-40) counting. If positive results were found, dose assessments were performed based on default radionuclide mixtures or specific exposure scenario information. Although the gross-alpha results were not included in the development of the coworker model, the results, both before and following the CEP period, are presented here for completeness, in Section 7.2.1.4. Graphical representations of the most recent groups of data are in the nuclide-specific subsections below. As is visible in the graphs, there is no marked difference between the activity results within the data for the latest coworker groupings (in time) and the remediation era results through 2000. Though there are no available urinalysis data for the August 1991 through June 1993 period, due to the invalidation of the CEP-analyzed sample results, it is clear that the data available from before 1991, and following 1993, are of a similar or reduced value to that in the coworker data for all three coworker-study analytes: uranium, plutonium, and MFP.

The monitoring information in the employee radiological exposure files described above also included Whole Body Count (WBC) scan information and results. A graph of the number of WBCs is shown in Figure 7-5. The counting was primarily done by the commercial vendor Helgeson, and the results provided were entered in the worker's radiological exposure files. It is notable that in the 1994 letter to Area IV workers potentially affected by the CEP bioassay issue, Rockwell International stated the scans done during the time of the CEP contract were "instituted as a separate, independent measure of internal exposure." This letter also stated that there was "no measurable internal exposure" to the Rocketdyne workers (Rockwell, 1994). This statement is supported in the results, which consisted predominantly of non-detectable WBC results.

7.2.1.1 Uranium

Uranium data are presented as fluorometric (mass) and radiometric (activity) results. Samples analyzed fluorometrically were also analyzed radiometrically. Only the data that were reported in activity units with a site designation as "UR" were examined by NIOSH for the coworker analysis. The site used both zeros and "less-than" values to indicate non-detectable results. As indicated in Table 7-1, but not shown in Figure 7-2, are 351 results as zero between January 1, 1980 and December 31, 1988, and 5 results as zero after the CEP period. The zeros formed 36% of the results

in the coworker period and 17% of the results after the CEP period. As described in ORAUT-OTIB-0080, sufficient bioassay data were available to perform a statistical analysis for 1965 through 1988. Although uranium bioassay data are available through 1993, there were insufficient data to perform the desired statistical analysis after 1988.

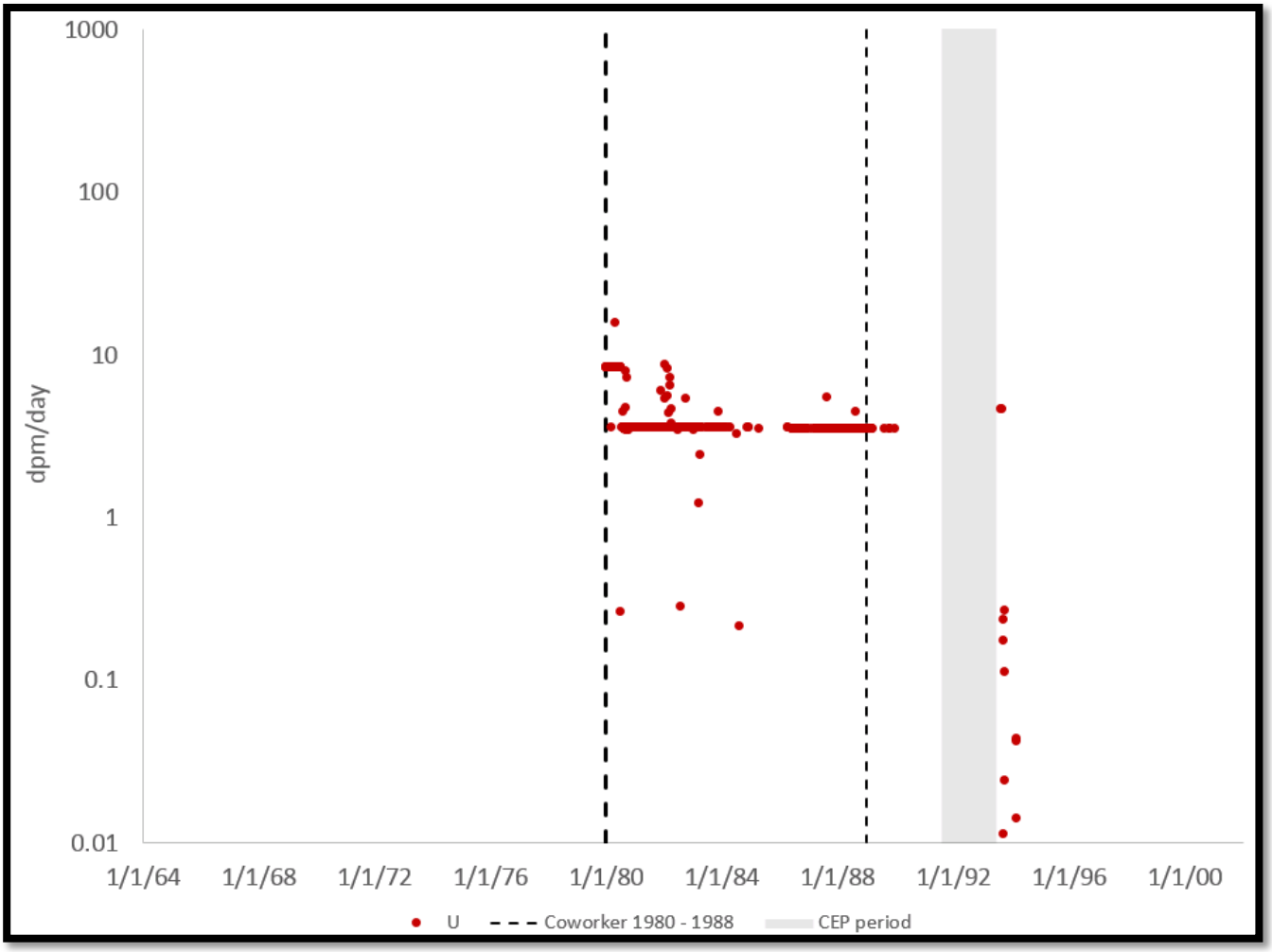

Figure 7-2: Non-Zero Uranium Urinalysis

7.2.1.2 Plutonium

Two analytical techniques were used for plutonium bioassay—autoradiography (labeled "PUA") and gas-flow proportional counting (labeled "PUB"). The two techniques were distinguished beginning in 1974. Previous results were only indicated as "PU," which is presumed to be indicative of autoradiography based on the earlier use of this procedure. It is assumed the "A" and "B" designations were added with the introduction of the gas-flow proportional counting procedure. Analysis type designations that were used for this study were "PUA" (autoradiography), "PU," and "Pu" (unknown analytical technique, presumed to be autoradiography). No results were identified with an analysis type of "PUB." As with uranium, the site used both zeros and "less-than" values to indicate non-detectable results for plutonium analysis. Not shown in Figure 7-3 below, are 298 results as zero between January 1, 1969 and December 31, 1986, and 70 results as zero for the period after the CEP period. The zeros formed 41% of the results in the coworker period and 62% of the results

after the CEP period. As described in ORAUT-OTIB-0080, sufficient bioassay data were available to perform a statistical analysis for 1965 through 1986. Although plutonium bioassay data are available through 1994, there were insufficient data to perform the desired statistical analysis after 1986.

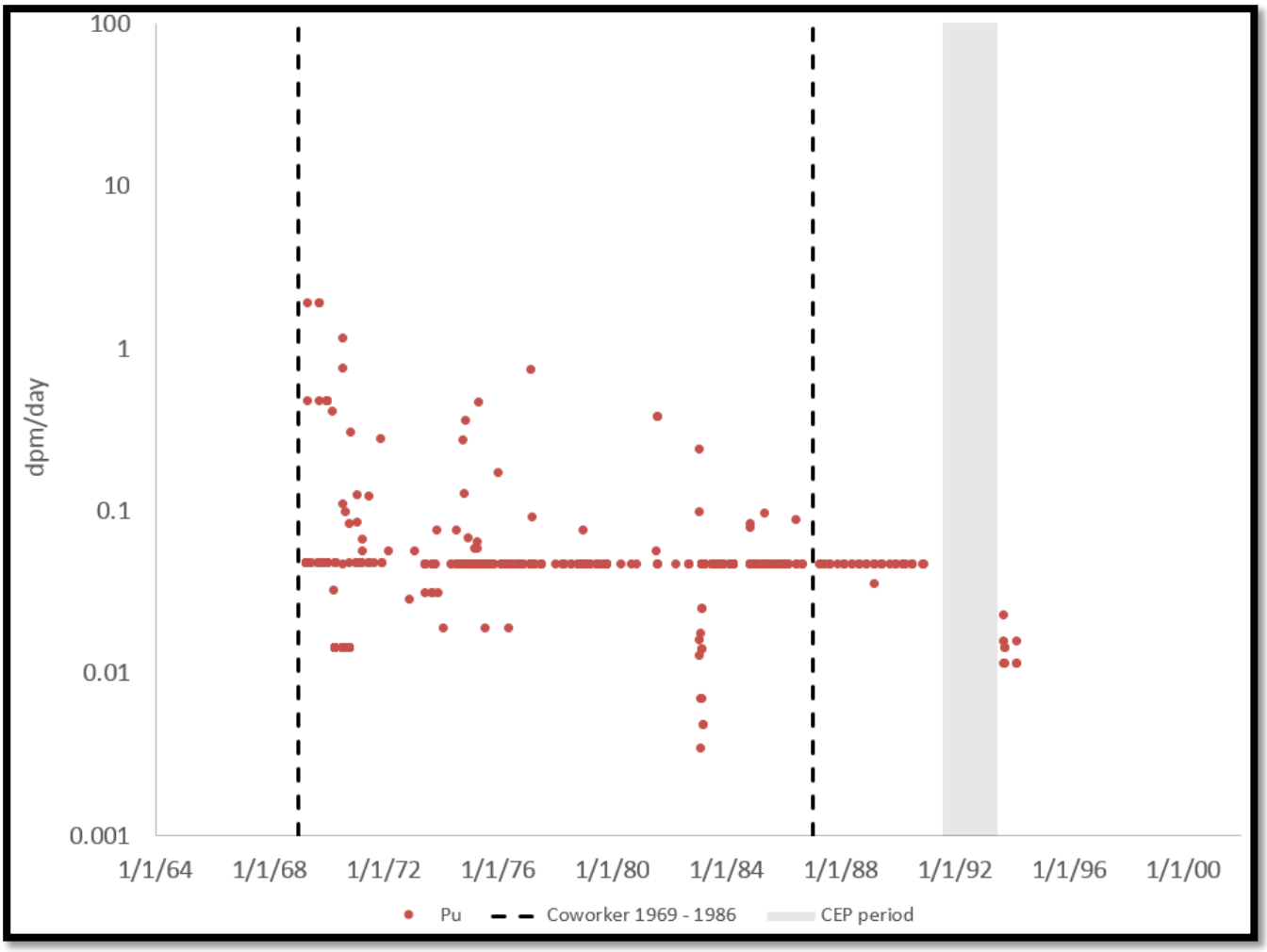

Figure 7-3: Non-Zero Plutonium Urinalysis

7.2.1.3 Fission Products

The analysis type designations that were used were “MFP” (mixed fission product, chemical separation of alkaline earths and rare earths including strontium) if the method type was “B” for beta counting (which excludes gamma-counting data), “MFPB,” and “MFP(B),” and “FP” if the method type was “3A” (mixed fission products less cesium and volatiles, assumed to indicate strontium).

The site used both zeros and “less-than” values to indicate non-detectable results. Not shown in Figure 7-4 are 1,129 results as zero between January 1, 1965 and December 31, 1991, and 10 results as zero for the period after the CEP period. The zeros formed 20% of the results in the coworker period and 15% of the results after the CEP period. As described in ORAUT-OTIB-0080, sufficient bioassay data were available to perform a statistical analysis for 1965 through 1991. Although fission product bioassay data are available through 1993, there were insufficient data to perform the desired

statistical analysis after 1991. The fission product data from beyond the coworker analysis, including those found in the claimant data, are included below in Figure 7-4.

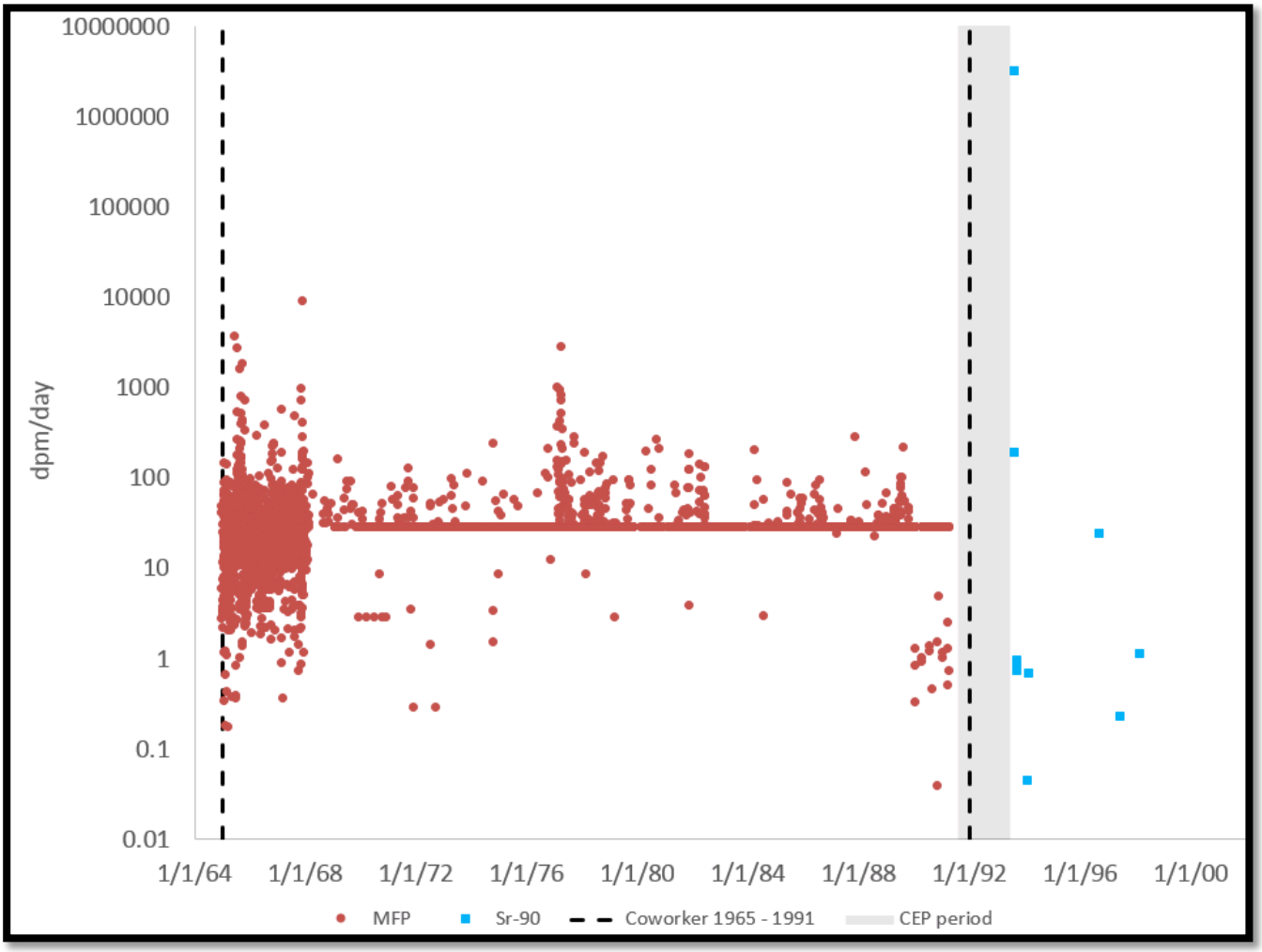

Figure 7-4: Non-Zero MFP Urinalysis

7.2.1.4 Gross Alpha

In addition to analyzing bioassay samples for uranium and plutonium, Area IV performed gross-alpha sample analysis. The original NIOSH effort to develop a coworker model for the site involved using the gross-alpha data to extend each of the uranium and plutonium coworker periods, but even with these results, there were not enough to meet the one-person-one-sample requirements of a coworker estimate. The coworker evaluations for uranium and plutonium end in 1988 and 1986, respectively, due to the limited number of available data points after those years. Although the gross-alpha results were not included in developing the coworker intake models found in ORAUT-OTIB-0080, they are plotted and presented here for completeness.

Not shown in Figure 7-5 are 213 zero (non-detectable) results prior to the CEP period and 26 zero results for the period after the CEP period. The zeros formed 29% of the results before 1991, and 72% of the results after the CEP period.

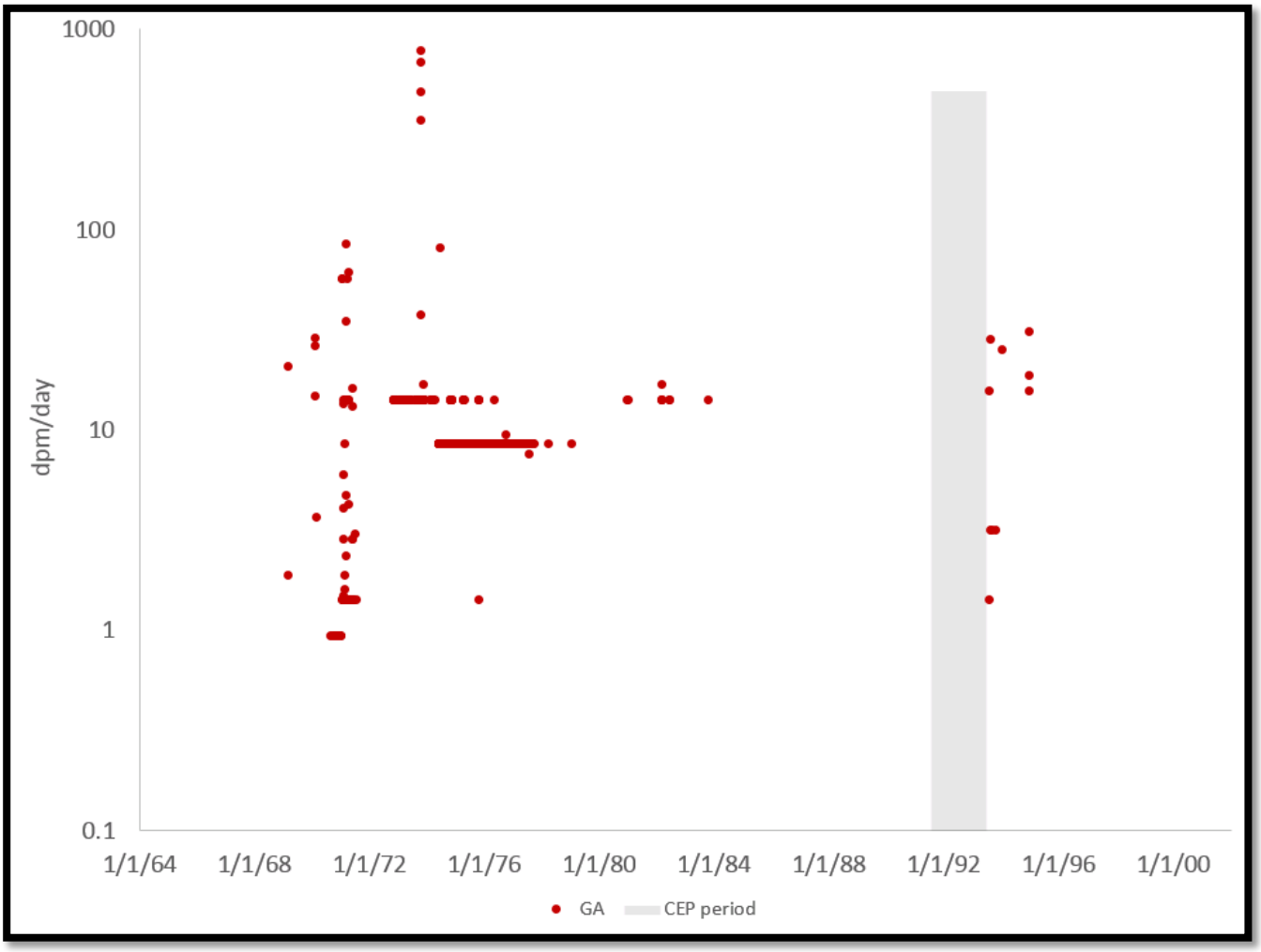

Figure 7-5: Non-Zero Gross Alpha Urinalysis

7.2.1.5 Whole-Body Count Scans

The whole-body count scans for Area IV workers were performed by Helgeson, using mobile scanner facilities brought onsite by the contractor. Organ-specific scans were limited, and are not included in the chart.

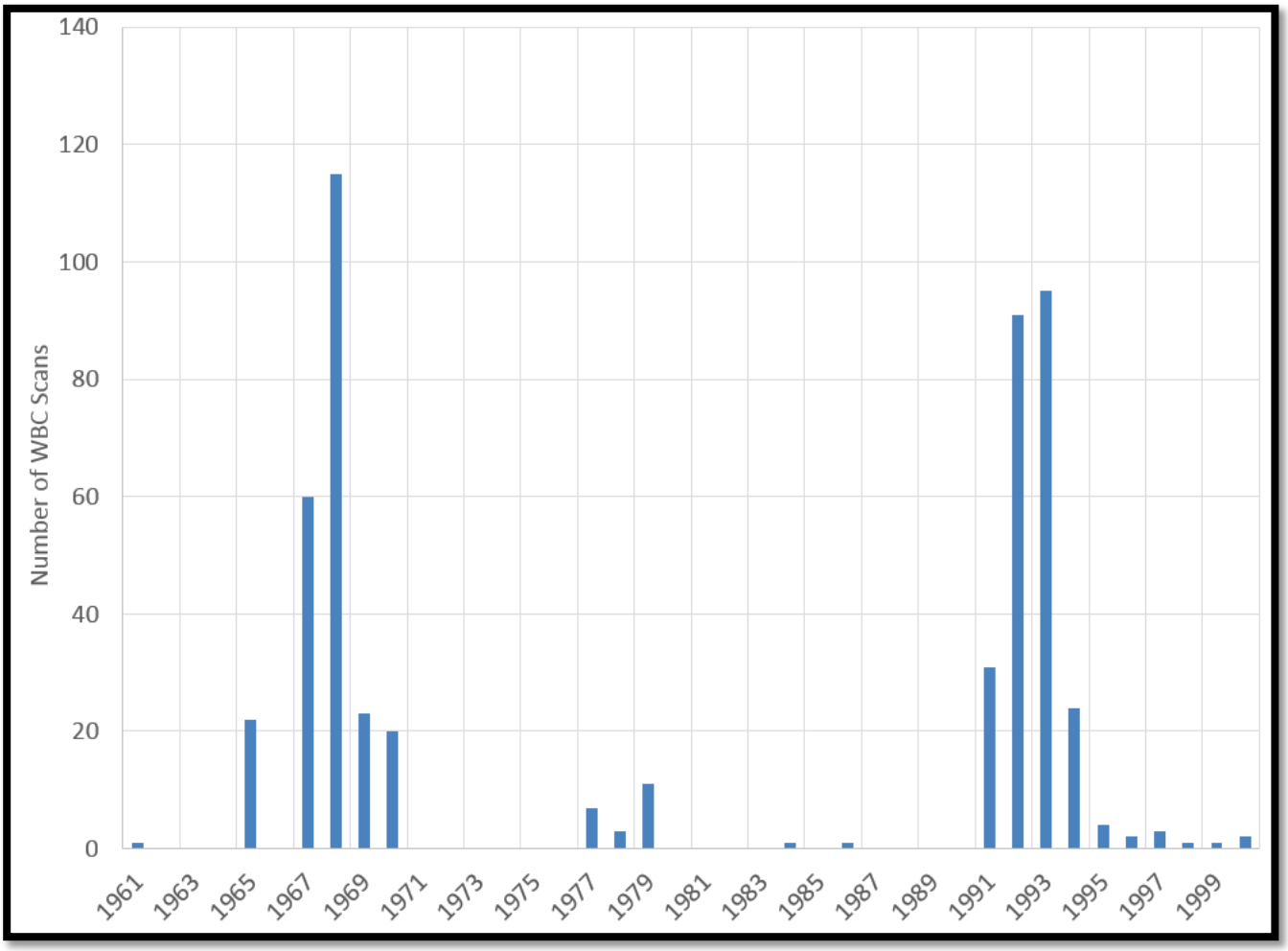

Figure 7-6: Whole-Body Count Scans

7.2.2 Methods for Bounding Internal Dose during the Remediation Period

As presented above, workers at Area IV whose job assignments entailed working with unencapsulated radioactivity, or in high-contamination or airborne-radioactivity areas, were monitored for intakes of radiological material through bioassay. The routine internal monitoring procedures included collecting urine samples and performing semi-annual *in vivo* whole-body scans. *In vitro* sampling was typically performed on a quarterly or semi-annual basis, and primarily consisted of urine samples analyzed for uranium, plutonium, and mixed fission products. As presented graphically above in Section 7.2.1, NIOSH has obtained bioassay monitoring data for Area IV workers involved with unencapsulated radioactivity. In response to requests for individual claimant history data, NIOSH continues to receive internal dosimetry monitoring data for claimants included in the site bioassay monitoring program.

Some workers at Area IV were not monitored for potential intakes to radioactive material, because their job assignment was not likely, in the assessment of the facility health physicist, to have the potential for intake of significant radiological materials. If the job assignment was not in a high-contamination area or an airborne-radioactivity area, the workers were generally unmonitored for internal exposure (Personal Communication, 2017). The NIOSH coworker study, initiated to address

potentially unmonitored workers at Area IV, utilized the urinalysis results of monitored workers through 2000. Based on operational period bioassay data, *Internal Coworker Dosimetry Data for Area IV of the Santa Susana Field Laboratory and the De Soto Avenue Facility,* ORAUT-OTIB-0080, assigns intakes for uranium, plutonium, and mixed fission products through the years 1988, 1986, and 1991, respectively. For unmonitored workers during the site remediation period, intakes are assigned based on the operationally derived coworker data, assuming that intake potential in the remediation period is bounded by that of the operational period through 1988. As is visible in the graphs of Sections 7.2.1.1 through 7.2.1.4, there is no marked difference between the activity results within the data for the latest coworker groupings and the remediation era results through 2000. Though there are no available urinalysis data for the August 1991 through June 1993 period, due to the invalidation of the CEP-analyzed sample results, NIOSH has determined that the data available from before 1991, and following 1993, are of a similar or reduced value to that in the operational-era coworker data for all three coworker-study analytes: uranium, plutonium, and MFP.

7.2.3 Internal Dose Reconstruction Feasibility Conclusion

As presented in Section 7.2, the principal source of internal radiation doses for members of the class under evaluation was airborne radiological particulates generated during D&D activities, and waste reduction/handling. The three onsite projects of highest potential for airborne activity during the period from 1991 through 1993 were: (1) the D&D of Building 4059 (the SNAP Reactor Development Facility); (2) the D&D of Building 4020 (which housed the Hot Laboratory); and (3) operation of the Radiological Material Handling Facility. The remediation period bioassay data presented in the plots in sections 7.2.1.1 through 7.2.1.4 include the data for the workers involved with these three limiting exposures during the period 1991 through 1993.

Although NIOSH has disqualified Area IV *in vitro* data analyzed by CEP during the period August 1991 through June 1993, NIOSH has determined that the lack of CEP *in vitro* data has not affected NIOSH's ability to perform sufficiently accurate internal dose reconstructions for monitored or unmonitored workers. The NIOSH determination is based on the following:

- NIOSH has compared remediation period bioassay data to the operational period data (through 1988) used to develop the intake rates of ORAUT-OTIB-0080. NIOSH sees no indication that the ORAUT-OTIB-0080 intake rates assigned for the end of the Area IV operation period (circa 1988) do not bound the potential remediation period exposures for unmonitored workers.

- NIOSH examined the D&D and waste handling operations throughout the remediation period (1989-present) to evaluate the exposure conditions before, during, and after the CEP period being evaluated in this report. NIOSH's review indicates that work remained consistent as to procedures, personnel protection equipment, and exposure risks. NIOSH has found no major radiological project that occurred in the CEP period 1991–1993, that would not have had workplace and/or personnel monitoring performed outside the CEP-related period.

- During the August 1991 through June 1993 period with disqualified CEP bioassay results, the site was performing routine *in vivo* whole-body scans with a different contractor (Helgeson). The site reported that the whole-body scans showed no measurable exposures.

- In response to the DOE concerns with CEP data, the SSFL site initiated confirmatory resamples analyzed by the new contractor, Teledyne-Brown Engineering. The site reported that these follow-up *in vitro* results confirmed no measurable internal exposures.

- The site's investigation was summarized in December 1993 as, "… although CEP bioassay results have been questioned, independent Helgeson WBS, Teledyne bioassays, and air sampling have confirmed that Rocketdyne workers have experienced no measurable internal exposure."

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes: all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory in Ventura County, California, from August 1, 1991 through June 30, 1993.

7.3 Evaluation of Bounding External Radiation Doses at Area IV of the SSFL

The principal source of external radiation doses for members of the evaluated class was exposure to sometimes high amounts of surface contamination present or exposure to activated building materials during D&D activities.

The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external radiation dose reconstruction.

7.3.1 Evaluation of Bounding External Doses during the Remediation Period

Area IV began using commercial vendors for external dosimetry in the 1960s and continued that practice throughout its operations. Landauer was the site vendor for external radiation dosimetry services for individuals involved in the facility remediation during the period under evaluation. The following subsections summarize the extent and limitations of information available for reconstructing the process-related external doses of members of the class under evaluation.

7.3.1.1 Employee Dosimetry Data

NIOSH has access to photon, beta, and neutron external dosimetry results, as well as other supporting data for the entire period evaluated in this report (available for all years of site operation). The policy at SSFL was to assign the applicable dosimetry to anyone with the potential for photon, beta, or neutron exposure. Dosimetry was assigned based on job assignments that required exposure to radioactive materials (ORAUT-TKBS-0038-6). Summaries of the available external monitoring data can be found in the previous NIOSH evaluation report, *SEC Petition Evaluation Report for Petition SEC-00093, Santa Susana Field Laboratory-Area IV* (NIOSH, 2009). Details regarding the various analyses used, and the associated minimum detectable activities, are presented in ORAUT-TKBS-0038-6.

The NIOSH external dosimetry database for Area IV of the SSFL contains dosimetry data for penetrating dose, including gamma and fast neutron dose. Because it was difficult to separate statistically significant neutron dose from the penetrating dose, and because shallow dose data are not available in the database described above in Section 7.1.2, the neutron dose component (which represented less than 5% of the total data points available) was left embedded with gamma dose, resulting in penetrating dose values that are favorable to claimants. An analysis of average neutron

dose revealed that the average value for any individual year was bounded by the 95th percentile values for penetrating dose given in ORAUT-OTIB-0077, covering the period from 1948 to 1999.

7.3.1.2 Area Monitoring Data

As presented in ORAUT-TKBS-0038-4, *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational Environmental Dose*, ambient external radiation dose information for Area IV of the SSFL is available for the period 1975 through 1999. During the later years (1974–1989) of the active nuclear programs at SSFL, the ambient radiation monitoring program used complex bulb dosimeters (CaF2:Mn). During the period under evaluation, through 1995, lithium-fluoride chips were used. ORAUT-TKBS-0038-4 presents annual ambient Area IV dose rates for assignment for the years under evaluation, 1991 through 1993.

7.3.1.3 Alternative Data Sources for Bounding External Dose

Through the course of ongoing dose reconstruction efforts and investigations associated with both SEC-00093 and SEC-00156, NIOSH determined that although external monitoring data are available for most employees at Area IV, some employees could have received external radiation exposures that went unmonitored. To assess potential external dose to unmonitored employees, NIOSH developed a coworker dose distribution model (ORAUT-OTIB-0077). This current evaluation dealing with the disqualification of internal bioassay data has identified no concerns with the external coworker dose distribution models of ORAUT-OTIB-0077.

7.3.2 Evaluation of Bounding Ambient Environmental External Dose

ORAUT-TKBS-0038-4 presents ambient external radiation dose information for Area IV of the SSFL for the period 1975 through 1999. During the period under evaluation, lithium-fluoride chips were used. The baseline dose during this period is based on the minimum dosimeter sensitivity of 10 mrem/quarter or 40 mrem/year. This minimum sensitivity baseline results in a higher annual dose than subtraction of offsite background dose from onsite environmental dosimeter results. ORAUT-TKBS-0038-4 presents annual ambient Area IV dose rates for assignment for the years under evaluation, 1991 through 1993. This current evaluation dealing with the disqualification of internal bioassay data has identified no concerns with the assignment of ambient environmental external doses.

7.3.3 Occupational X-Ray Examinations

In its previous SEC class designation for SEC-00234, for the period through December 31, 1988 (DHHS, 2017), HHS states:

> *NIOSH finds that it is feasible to reconstruct occupational medical dose for Area IV workers using information and methods in Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures (ORAUT-OTIB-0006) and the Area IV site profile documents.*

This current evaluation has found no evidence to the contrary for the remediation period post 1988, or specifically for the period under evaluation, August 1, 1991 through June 30, 1993. NIOSH has determined that it is feasible to reconstruct occupational medical dose for Area IV workers for the period from August 1, 1991 through June 30, 1993, using information and methods in *Dose*

Reconstruction from Occupationally Related Diagnostic X-Ray Procedures (ORAUT-OTIB-0006) and the Area IV site profile documents (ORAUT-TKBS-0038-1,-2, -3, -4, -5, -6)

7.3.4 Methods for Bounding External Dose

NIOSH has an established protocol for assessing external exposure when performing dose reconstructions. These external dose assignment protocols address photon dose, beta dose, neutron dose, and medical X-ray dose.

7.3.4.1 Methods for Bounding Remediation Period External Dose

NIOSH has access to photon, beta, and neutron external dosimetry results, as well as other supporting data for the entire period evaluated in this report (available for all years of site operation). The policy at SSFL was to assign the applicable dosimetry to anyone with the potential for photon, beta, or neutron exposure. Standard external dose reconstruction practices can be employed by using the actual individual dosimeter results and by assigning missed dose to each non-positive dosimeter cycle per guidance in ORAUT-TKBS-0038-6, *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International)—Occupational External Dose.*

The records provided by DOE typically include adequate information to define the date, type, and count of X-ray examinations that were administered to each employee as a condition of employment. Assumptions regarding radiographic exposure frequency, based on site policies and procedures, are used only for screening or when specific claimant records are not available. In accordance with ORAUT-OTIB-0006 and ORAUT-PROC-0061, NIOSH has sufficient data and information to support bounding the medical X-ray dose.

7.3.4.2 Methods for Bounding Ambient Environmental External Doses

As described in Sections 7.3.1.2 and 7.3.2, NIOSH has access to workplace and environmental monitoring data for Area IV during the remediation period, including August 1991 through June 1993.

External onsite ambient doses are determined as specified in ORAUT-PROC-0060, *Occupational Onsite Ambient Dose Reconstruction for DOE Sites* and ORAUT-TKBS-0038-4, *Area IV of the Santa Susana Field Laboratory, the Canoga Avenue Facility (Vanowen Building), the Downey Facility, and the De Soto Avenue Facility (sometimes referred to as Energy Technology Engineering Center [ETEC] or Atomics International) – Occupational Environmental Dose*.

7.3.5 External Dose Reconstruction Feasibility Conclusion

In its previous SEC-00093 and SEC-00156 class designations, NIOSH has found that it has access to sufficient employee monitoring and workplace monitoring data to bound potential external exposures for employees at Area IV of the SSFL for January 1, 1955 through December 31, 1958, and January 1, 1959 through December 31, 1964. This current evaluation has found no evidence to the contrary for the period from August 1, 1991 through June 30, 1993. NIOSH has established that it has access to sufficient information to either: (1) estimate the maximum external radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible

circumstances by any member of the class; or (2) estimate the external radiation doses to members of the class more precisely than a maximum dose estimate.

NIOSH has determined that it is feasible to reconstruct occupational medical dose for Area IV workers for the period from August 1, 1991 through June 30, 1993, using information and methods in *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures* (ORAUT-OTIB-0006) and the Area IV site profile documents (ORAUT-TKBS-0038-1, -2, -3, -4, -5, -6).

7.4 Evaluation of Petition Basis for SEC-00235

The following subsections evaluate the assertions (consolidated by major theme) made on behalf of petition SEC-00235 for Area IV of the SSFL.

7.4.1 General Covered Employment Status

Issue: The petitioner asserted that the location of job performance at SSFL cannot be reliably or accurately determined for all DOE contracted employees. Therefore, NIOSH cannot rule out Area IV employment among employees of North American Aviation, its divisions, its corporate successors, or its subcontractors.

Response: NIOSH does not determine eligibility for covered employment. Additionally, worker eligibility by worksite or location at a covered facility is not an SEC determining basis. Petitions are qualified for evaluation for inclusion into the SEC based on circumstances related to an entire class of employees that prevent accurate reconstruction of potential radiation exposure for that class of workers.

7.4.2 Area IV of the SSFL Site Profile Concerns

Issue: The petitioner asserted that the 2006 Site Profile is lacking information pertinent to additional radiological facilities within Area IV and outside Area IV.

Response: Site profile documents are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. Much of the information provided as additions to the 2006 site profile is informational but does not directly support more accurate dose reconstruction. Information on broad scope incidents likely to be relevant to dose reconstruction across the site population is generally included in the site profile, although smaller-scale incidents are not included in the site profile. When the EEOICPA program makes a request for an individual's dosimetry records for the purposes of dose reconstruction, the request includes any incident reports involving that individual. Such incident reports become part of the file and the specifics of the incident are considered in reconstructing the radiation dose. NIOSH routinely evaluates the need to update the site profile and will include information provided in this petition package, relevant to performing dose reconstructions, during the next update cycle.

7.4.3 Radiological Incidents

Issue: Boeing's Incident database contains numerous incident reports wherein workers that were either not assigned to a radiological location, or not equipped with appropriate radiation protection, were involved in an exposure incident. In some cases, the workers were unauthorized subcontractor employees that had unfettered access to radiological locations and radioactive materials.

Response: NIOSH reviewed the Incident database and did not find evidence of routine radiological processes at non-radiological facilities. Nor did the incident summaries indicate that "unauthorized subcontractor employees" had "unfettered access to radiological locations and radioactive materials." When any employee was involved in a reported exposure incident, the Health and Safety personnel investigated the extent of the incident and likely exposures involved. The investigation was documented and used to assign dose that resulted from the incident to the individual.

The Building 4066 incident from October 1966, was provided as an example of "a non-radiological location being used for radioactive processes; a non-nuclear and un-monitored worker associated with the location and potentially present in proximity to radiological materials; and workers from this location having access to restricted nuclear areas like the Hot Laboratory (Building 4020)." The example does not include radiological processes, but rather a failure of procedure, allowing an internally contaminated piece of equipment to be brought for maintenance without proper assessment and radiological controls. In this example, the worker was inappropriately exposed to radiological material; however, the exposure was investigated and sufficient information is available to allow some understanding of potential dose received from the incident, and does not preclude dose reconstruction of the exposure. Finally, as part of the response to the incident, the worker was sent to Building 4020 to shower. The Health and Safety staff would not have allowed the worker to be exposed to radiological processes or additional radiological materials in traveling to decontamination facilities within Building 4020. The access allowed for decontamination is not the same as uncontrolled access to a radiological facility.

NIOSH reviewed the incident summary listing and located a total of 56 incidents (once instances of natural radon deposition, procedural violation with no potential for exposure, and incidents at non-Area IV locations were screened out) for assessment during the period being evaluated. The Area IV facilities in the incident summary listing are all known radiological facilities, with the exception of a loading dock where a carbon-14 source was improperly controlled. These radiological facilities include buildings containing reactors, critical test facilities, the Hot Laboratory, the Radioactive Materials Handling Facility, the Fuel Storage Facility, the Calibration Laboratory, and the Uranium Carbide Fuel Manufacturing Pilot Plant.

7.4.4 Employment Records

Issue: An incident from 1966 is described as an example of the contractor withholding "complete and authentic worker records based on the worker being 'unmonitored' and presumably not a designated radiation worker." The petitioner further asserted that exposure locations of monitored workers cannot be determined because of the loss of the translation key for the building codes used on the visitor logs. Included in commentary from Boeing to the Advisory Board (Boeing, 2014) includes discussion of employment records for 8,400 employees that contained radiation records that were "blank."

Response: The administrative policies of Rocketdyne created these 8,400 empty radiation records. The site policy, until the late 1970s, was to prepare a radiation exposure record folder with employee identification information for every new employee in anticipation of job conditions that would require a worker to be monitored for radiation exposure. This created 14,200 worker radiation dose folders (Lang, 1960; Atomics International, 1960, PDF p. 4), of which 5,800 were for radiation monitored workers. The remaining 8,400 so-called "blank" records were unmonitored non-radiation workers. These records do not indicate unmonitored radiation exposure.

7.4.5 Lack of Monitoring

Issue: The petitioner's intention was to support the F.1 basis; that radiation exposures and radiation doses potentially incurred by members of the proposed class that relate to this petition, were not monitored, either through personal monitoring or through area monitoring. The petition indicated multiple attached documents were provided in support of the F.1 basis.

Response: NIOSH reviewed all of the documentation provided for indications supporting the F.1 basis, but found insufficient evidence of a lack of monitoring for Area IV workers. NIOSH has access to personal monitoring data, work area and breathing zone air monitoring data, contamination and radiation survey reports, and bioassay result data for Area IV workers, including examples throughout the period evaluated, August 1991 through June 1993. NIOSH has copies of facility procedures that indicate the Health and Safety program at the site was quite thorough. Program procedures required monitoring of radiation exposures and radiation doses. Incident reports for unplanned exposures to radiological materials document follow-up measures, such as bioassay sampling and scans.

7.5 Summary of Feasibility Findings for Petition SEC-00235

This report evaluates the feasibility for completing dose reconstructions for employees at Area IV of the SSFL from August 1, 1991 through June 30, 1993. NIOSH found that the available monitoring records, process descriptions, and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-1 summarizes the results of the feasibility findings at Area IV of the SSFL for each exposure source during the period from August 1, 1991 through June 30, 1993.

Table 7-3: Summary of Feasibility Findings for SEC-00235

August 1, 1991 through June 30, 1993

Source of Exposure	Reconstruction-Feasible (Yes or No)
Internal[1]	**Y**
Uranium	Y
Plutonium	Y
Mixed Fission Products	Y
External	**Y**
Gamma	Y
Beta	Y
Neutron	Y
Occupational Medical X-ray	Y

[1] Internal includes an evaluation of urinalysis (*in vitro*) and WBC scan (*in vivo*) data.

As of April 24, 2017, a total of 29 claims have been submitted to NIOSH for individuals who worked at Area IV of the SSFL during the period under evaluation in this report. Dose reconstructions have been completed for 22 individuals (~76%).

8.0 Evaluation of Health Endangerment for Petition SEC-00235

The health endangerment determination for the class of employees covered by this evaluation report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. Section 83.13 requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those employees who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has reviewed internal and external radiological monitoring data, facility plans, procedures, and activity reports to gain understanding of the scope of the potential exposure scenarios during the period under evaluation. NIOSH's evaluation determined that it is feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Therefore, a health endangerment determination is not required.

9.0 Class Conclusion for Petition SEC-00235

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient-accuracy. This class includes all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Area IV of the Santa Susana Field Laboratory in Ventura County, California, from August 1, 1991 through June 30, 1993.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the SRDB, for information relevant to SEC-00235. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

These actions are based on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing radiation dose for the class under evaluation.

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Attachment One: Data Capture Synopsis

Table A1-1: Summary of Holdings in the SRDB for Area IV of the SSFL

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Primary Site/Company Name: Area IV of the Santa Susana Field Laboratory (SSFL) DOE 1955-1988, DOE remediation 1988-present Other Site Names: Nuclear Development Field Laboratory (NDFL) Liquid Metal Engineering Center (LMEC) Energy Technology Engineering Center (ETEC) Physical Size of the Site: SSFL is a total of 2,850 acres with Area IV being 290 acres. Approximately 104 buildings are located in Area IV based on a 2005 aerial photo, of which 27 were radiological facilities. Site Population: In 1973 at its height, ETEC employed 450 people. Between 1950 and 1993, 4,563 Rocketdyne/AI employees were monitored for external radiation exposure and 2,297 were monitored for internal radiation exposure (Note: the 2,297 is primarily a subset of the 4,563). In 1991 there were about 150 employees at ETEC and less than 1,000 throughout the SSFL Complex.	Environmental surveys (1952-1955), basis for routine urine sampling of workers exposed to Pu-239, activity released to atmosphere, AE-6 reactor operations neutron and gamma exposure (1959-1960), air sample data, airflow measurements in ventilation systems, ALARA report (1991), authorization for test operation of Organically Moderated Reactor Experiment (OMRE), annual radiation exposure reports (1965, 1967, 1970, and 1971), annual review of radiological controls (1977, 1979), approval for critical loading and low power tests in the OMRE, area film badge readings with gamma and neutron data (1959), health physics procedures, bioassay data (1958-1961), control film adjustments for film badges, trip report, disposal of excess property, dosimeter exposure records (1952-1954), effluent monitoring reports (1976-1989), environmental sampling (1954-1970), excretion of strontium-90 following accidental inhalation, exhaust stack data, fast test reactors information (1958), film badge calibration data (1955-1956), first experimental data bioassay logbook (1958), neutron data, dose rates (1963), health and safety manual, incident reports, lapel sample data (1975-1976), license information and renewals, list of operations and rooms for SSFL and Vanowen (1959), location badge results (1952-1954), location of air sample stations, medical program description, neutron/gamma radiation survey, nuclear safety and operations at SSFL, plutonium contamination levels, radiation safety plan, source inventory, radiological characterization, radiological surveys, reactor and fuel element data, reactor operations monthly reports (1969), Sodium Reactor Experiment (SRE) related information, stack characterization, tritium production and release to groundwater at SSFL, U-235 lung measurements (1982), uranium fire incident (1967), urinalysis results (1959-1963), and a wound monitoring procedure. NOTE: Documented communication with [Name Redacted] (former employee) was conducted April 2017 and is being reviewed for classification. There is a placeholder for this in the SRDB.	04/18/2017	733
State Contacted: California Department of Public Health	Amendments and inspection reports associated with licenses 0015-19, 0273-59, 0015-70, 0015, 0015-59 and SNM-21, confirmation radiological surveys for Buildings T363, T019, T013, T012, T059, T626, T038, T023, T030, and 009, encapsulation of the 1000 ci Po-Be neutron source, exposures received by Atomics International personnel at the University of Washington cyclotron (1975), radiological procedures, post-remediation ambient gamma radiological survey of the former Sodium Disposal Facility, reviews of the Rocketdyne Radiation Worker Health Study, survey of contaminated fume hood and HEPA filter system, and a verification survey of the De Soto Mass Spectroscopy Laboratory.	12/28/2009	56

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Albany Research Center	Atomic Energy Commission (AEC) hot cells and related facilities information.	03/21/2013	1
Ames Laboratory	Decommissioning the Ames Laboratory Research Reactor (ALRR).	07/21/2015	1
Argonne National Laboratory East (ANL-E)	Health and safety plan for technical support to the ANL-E Area 317 project (1993).	09/22/2005	1
Atomics International	Questions on external dosimetry and background doses (2005-2006).	05/15/2007	2
Cincinnati Library	History of the United States Atomic Energy Commission Volume III, beta-gamma delayed coincidence method for U-238 activation analysis, computing absolute thermal neutron flux from measurements made with indium foils, disposal of OMRE high boiler fractions by burning, evaluation of fallout data, neutron-flux distribution, and thorium-uranium fuel elements for the SRE.	09/30/2009	12
Claimant Provided	Collection of technical data records on Systems for Nuclear Auxiliary Power (SNAP) and the implosion of plexiglass bubble on welding in Building 001.	06/03/2009	2
Department of Labor - Paragon	Surplus Facilities Management Program (SFMP) year-end review and contract DE-ACO1-88NE46125 monthly progress report (1989).	12/30/2008	2
DOE Carlsbad	Annual groundwater monitoring report SSFL (1992-1999), Atomics International Skywriter newsletter, environmental monitoring report (1990-1992), fission product and fissile content of SRE fuel, flux mapping study for SNAP 10a and 2, measurement of the 10-B(N, He) and 6-Li(N, He) reaction rates in Zero Power Physics Reactor (ZPPR) r-13c, contract AT(04-3)-701 information, monthly decontamination report (1975-1976), radiological safety responsibilities, reactor safety survey report Kinetic Experiments on Water Boilers (KEWB), removal of primary sodium components from the sodium service vaults, flight test experience, snapshot vehicle dosimeters, weekly progress reports (1958), threshold helium generation reaction rate measurements in Fast Flux Test Facility (FFTF), and the transfer of excess 3.02 per cent U-235 uc from Hallam Nuclear Power Facility (HNPF) to Advanced Sodium Cooled Reactor (ASCR).	08/16/2010	47
DOE Environmental Management Consolidated Business Center (EMCBC) - Cincinnati	10 CFR 835 implementation radiological protection plan, airborne hazard evaluation, ALARA and surveillance quarterly reports (1991-1993), ALARA program plan, annual and weekly activity reports for Radiation Protection and Health Physics services (1991-1994), annual site environmental report, Area IV radiological characterization survey final report, bioassay analysis results for Controls for Environmental Pollution (CEP) under investigation information, bioassay data, DOE Laboratory Accreditation Program (DOELAP) for radiobioassay, environmental TLD results adjusted, external dose data by building roster (1991), external dosimetry program technical basis document, final NESHAPS report (1993), scheduling of radiation worker in-vivo (whole body) counts, internal dosimetry program review, internal dosimetry technical basis document and procedure, job exposure and air breathing zone monitoring, personal air sampling data worksheets, controlled work permits (1990), license SNM-21 information, quarterly review of the Radioactive Materials Disposal Facility (RMDF), radcon manual compliance assessment, radiation dosimetry and radiation exposure control procedures, radiological incident reports, radiological occurrence reports, SNM inventory reports, status of 10 CFR 835 implementation, termination reports, occupational radiation exposure reports (1952-1989), trip reports, U.S. DOE contract facility effluent report, and an X-radiography barrier posting violation.	04/13/2017	173

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
DOE Environmental Management Consolidated Business Center (EMCBC) - Oakland	Decommissioning safety analysis reports, environmental monitoring reports, groundwater management, monitoring program for industrial wastewater, onsite radiological contingency plan under special nuclear material license SNM-21, posting radiologically controlled areas, radiation incident reports, radiological surveys, reports detailing activities on the groundwater program, and unusual shipment occurrence.	12/18/2009	19
DOE Germantown	Area IV (ETEC) SSFL De Soto Avenue Facility Canoga Avenue Facility/Vanowen Building Downey Facility (Boeing Company) search procedures and Building 059 phase 1 pipe chase room remediation.	03/07/2011	4
DOE Legacy Management - Grand Junction Office	Memorandum for decontamination and decommissioning of the surplus facilities at the SSFL, radiological survey reports for the SRE and Hot Cave (Building 003), radiological investigation reports, decontamination and disposition final reports, depleted uranium for Argonne National Laboratory (1951), recommendations concerning the sewer system, interim post remedial action survey report for KEWB, interim post remedial action survey reports, radiation exposure data for personnel records file, site maps and photographs, special aerospace medicine report, a groundwater bi-monthly report, request for uranyl nitrate hexahydrate reagent grade, and depleted metal orders.	06/17/2011	47
DOE Legacy Management - Grand Junction Office / SC&A	Request for uranyl nitrate hexahydrate reagent grade and depleted metal orders.	03/02/2009	4
DOE Legacy Management - Morgantown	Department of Energy Ohio Field Office recycled uranium report, resurvey program, Fernald enriched uranium production orders (1957-1960), and the National Emission Standards For Hazardous Air Pollutants proposed standards for radionuclides.	12/01/2011	9
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	History of the operation of the Feed Materials Production Center by NLO, Inc., temporary stoppage of shipments of low-level nuclear waste to commercial burial grounds, DOE's annual radionuclide air emission report (1985), and a semi-annual index of nuclear energy unusual occurrence reports (1983).	02/07/2007	7
DOE Oak Ridge Operations Office - Records Holding Task Group (RHTG)	Resumption of activities (1954) and monthly status and progress reports (1952).	06/27/2012	3
DOE Office of Scientific and Technical Information (OSTI)	Absolute thermal neutron determination, neutron leakage from the 30 megawatt Sodium Graphite Reactor (SGR), quarterly technical progress report (1965), report on survey of irradiation facilities, thermal neutron flux in a lattice cell, and waste management site maps and facilities listing.	11/23/2016	12

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Energy Technology Engineering Center (ETEC)	Bioassay program information, industrial and radiological accidents in USACE facilities, activity report for radiation protection and health physics services, American Nuclear Insurers audit reports (1978-1990), annual review of radiological controls (1975-1988), thorium oxide material users permit and machining of thorium oxide components (1971), Atomics International environmental monitoring and facility effluent annual report (1975), health physics procedures, bioassay information (1965-1967), dosimetry record descriptions, environmental monitoring report (1972), ETEC occupational medical exposure on activities at Building 038 (Vanowen Building), internal/external dosimetry technical basis documents, Landauer film dosimeter information, monthly progress report on health, safety, and the environment, neutron survey of "SRE Hot Cell" containing a 14 mev neutron generator, report of in-vivo counting for Atomic International Division, Rocketdyne Division environmental monitoring annual report, thorium machining, and updated whole body counting data and errors (1968).	01/21/2011	111
Energy Technology Engineering Center (ETEC) / NRC - Public Document Room	Rocketdyne Division environmental monitoring and facility effluent annual report for De Soto and Santa Susana Field Laboratories (1988).	11/03/2005	1
Federal Records Center (FRC) - Kansas City	Argonne National Laboratory nuclear fuel cycle and waste management field work package and task proposal/agreements (1983, 1984, and 1985).	08/15/2008	1
Federal Records Center (FRC) - San Bruno	Environmental monitoring reports (1984-1989), air emissions annual report (1985), appraisal of Atomics International Radiation Safety Program (1967), groundwater monitoring report (1989), CERCLA assessment, employee safety concerns, ETEC radioactive materials and waste management, radiological surveys, external dosimetry, hazardous materials inventory, health physics quarterly reports, internal dose assessment procedures, investigation of naturally occurring radionuclides, appraisal of Occupational Medical Program Atomics International (1970), exposure during chest X-ray, radiological decontamination, request waiver of DOELAP for personnel dosimetry, Rocketdyne exposures (1984), summaries of fuels and materials development programs (1966), and a facility effluent report (1988).	08/02/2012	58
Federal Records Center (FRC) - San Bruno / Internet - Google	Rocketdyne Division environmental monitoring and facility effluent annual report for De Soto and Santa Susana Field Laboratories (1989).	03/25/2005	1
General Atomics	Fatality at Scrap Recovery Plant in Wood River Junction - SNAP 8-ER and contamination limit information.	08/18/2005	2
Hagley Museum & Library	Relations with independent laboratories.	09/29/2010	1
Hanford	Hanford laboratories operation monthly activities reports (1958), irradiated test fuel at Hanford, and test procedure for flow measurement using pulsed neutron activation technique.	09/18/2014	8
Idaho National Laboratory	Idaho annual exposure records (1952), progress report (1964), radiological surveys and shipment documents, material receipts for the ZPPR (1975-1978), and Rocky Flats solid waste shipments (1954-1970).	04/07/2016	22
Interlibrary Loan	Twenty-fifth semi-annual report of the AEC, Organic Moderator Reactor (OMR) operating history and experience, and environmental levels of radioactivity (1965-1972).	05/16/2016	16
Internet - Defense Technical Information Center (DTIC)	Baseline environmental management report (1995), second international conference uranium hexafluoride handling, and radiological health data Vol. 6 No. 9 (1965).	06/24/2016	3

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	Mortality among radiation workers at Rocketdyne (Atomics International) (1948-1999) and a Rocketdyne worker health study final report.	08/31/2009	3
Internet - DOE Environmental Management Consolidated Business Center (EMCBC)	Material orders and estimates.	04/09/2010	1
Internet - DOE Energy Technology Engineering Center	Environmental monitoring report (1961).	09/03/2009	1
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	Reports of the SSFL advisory panel, potential pathways for release of gaseous radioactivity following fuel damage at the SRE, and monthly Hanford operations reports (1955-1956).	10/31/2008	4
Internet - DOE Health, Safety and Security (HSS)	10 CFR 835 related exemption information.	02/07/2017	4
Internet - DOE Legacy Management Considered Sites	FUSRAP item involving Gilman Hall and a site management guide (2012).	08/01/2012	2
Internet - DOE National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant documents identified.	07/20/2016	0
Internet - DOE Noncompliance Tracking System (NTS)	No relevant documents identified.	04/05/2017	0
Internet - DOE Occurrence Reporting Processing System (ORPS)	No relevant documents identified.	04/05/2017	0
Internet - DOE OpenNet	AEC financial report (1964) and Hanford material balance reports.	09/20/2012	5
Internet - DOE OpenNet / NIOSH	Annual report to Congress of the AEC (1960).	01/11/2008	1
Internet - DOE OSTI	Radial thermal and fast neutron flux distributions in the SRE, radiological implications concerning the use of argon as the core cover, procedures for low-power physics experiments, SRE standard operating procedures, study of sodium fires, Monte Carlo method for computing the basic lattice parameters and the space dependent neutron spectra, analysis of neutron flux in the shielding of the SRE, reactor physics quarterly progress report (1953-1954), and sodium fires and the release characteristics of particulates and fission products.	01/28/2010	18
Internet - DOE OSTI / SC&A	Nuclear experiments on the SRE, preliminary radiation survey of the SRE, and radiological hazards from rupture of the secondary coolant system.	07/31/2009	3
Internet - DOE OSTI Energy Citations	Proceedings of the conference on decontamination and decommissioning, Piqua Nuclear Power Facility surveillance and recovery final report, experimental testing of core component handling for HNPF, environmental monitoring report (1960), annual report Rockwell Hot Laboratory decommissioning, gamma-ray and fast neutron annular streaming evaluation, fast neutron monitoring with film packets, annual report of waste generation (1995), nuclear fission at the HNPF, and the experience from two small quantity Rh-Tru waste sites.	01/26/2013	19

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - DOE OSTI Information Bridge	Swing check valve testing, small-quantity-site transuranic waste disposition alternatives, annual report FY 1998 shipments to and from the Nevada Test Site, annual report of waste generation and pollution prevention progress, annual report Rockwell International Hot Laboratory decommissioning, design and performance of induction pump for the SRE, eddy-current brake for a sodium-cooled reactor, emergency preparedness information, environmental management progress, evaluation of irradiated experimental OMR fuel elements, evaluation of thorium-uranium alloys, fuel burnup studies for Advanced Sodium Graphite Reactor, hydraulic tests of a prototype Hallam fuel element, spent fuel and radioactive waste inventories, projections, and characteristics, irradiation of U-Mo base alloys, managing spent nuclear fuel at the Idaho National Laboratory, neutron flux measurements in the mock-up of the uranium converter reactor, Savannah River Site approved site treatment plan, SRE systems and component experience, summary of radionuclide air emissions, and transuranic contaminated waste from characterization and data volume.	03/29/2013	125
Internet - DOE OSTI Information Bridge/ SC&A	Environmental assessment for off-site transportation of low-level waste, neutron scattering from supporting structures of SNAP 8, and a SNAP technology handbook.	08/31/2009	3
Internet - DOE OSTI SciTech Connect	Preliminary services for SNAP 8 flight prototype test facility Building 056 (1964), SNAP II program characteristics, kinetic behavior of water boiler type reactors (1956), feasibility report for fabrication of SNAP fuel elements, Sandia Corporation bibliography radiation effects, document review to characterize Atomic International fuels shipped to Idaho National Laboratory (1966-1973), DOE decontamination and decommissioning experience, progress reports, program report Hallam fuel decladding, feasibility report for fabrication of SNAP fuel elements, performance of cesium thermionic diodes, nuclear space power systems, SNAP power conversion, history of the AEC sodium components, developmental testing SNAP fuel elements, final evaluation report HNPF (1964), summary review of the kinetics experiments on water boilers (1963), steam generator for the Liquid Metal Fast Breeder Reactor (LMFBR), fission energy program of the DOE (1979), estimated airborne release of plutonium from Atomics International's Nuclear Materials Development Facility as a result of postulated damage from severe wind and earthquake hazard (1981), planning for uranium carbide transient heating experiments, Heavy Water Organic Cooled Reactor (HWOCR) dual channel cross flow studies, summary of industrial accidents, operating manual for the AE-6 Reactor (1960), Special Power Excursion Reactor test program review (1960), environmental laboratory and equipment information (1964), retirement of the SRE (1968), and a fuel summary report (1994).	07/26/2016	199
Internet - Energy Employees Claimant Assistance Project (EECAP)	No relevant documents identified.	07/20/2016	0

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - Google	Chronology of radiation protection, hazards associated with the North American Aviation water boiler neutron source, master work plan/field sampling and analysis plans, airborne radioactive contamination in SRE during reactor operation (1959), ALARA analysis, annual site environmental reports, Area 1 burn pit work plan, Area IV characterization, health and safety plan, request for approval to ship soil, building verification surveys, remedial action certification docket - SRE Complex, calculation of uranium and plutonium inventories in the SRE 1st core loading (1960), final status survey reports, confirmatory radiological surveys, construction of the SRE, distribution of fission product contamination in the SRE, DOE occupational radiation exposures, dose reconstruction for epidemiologic studies, effects of internal radiation exposure on cancer mortality in nuclear workers at Rocketdyne/Atomics International, environmental impact statements, environmental monitoring and facility effluent annual reports (1959, 1960, 1961, 1967-1972, 1985), facilities dismantling plan for SRE, Radioactive Materials Handling Facility building surveys, final gamma radiation scanning reports, final groundwater report, final radiological characterization of soils, MARSSIM final status survey reports, health physics survey reports, historical location of sites Area IV map, historical site assessment of Area IV, NPDES discharge monitoring report, radiological procedures, radiological safety incident reports, residual radioactivity summary, retirement of the SRE, SSFL site description and history, shipment of SRE sodium to Hanford, and a timeline of the Downey property.	07/15/2016	364
Internet - Google / SC&A	From Cleanup to Stewardship Appendix E.	08/27/2009	1
Internet - Health Physics Journal	No relevant documents identified.	07/20/2016	0
Internet - Journal of Occupational and Environmental Hygiene	No relevant documents identified.	07/20/2016	0
Internet - National Academies Press (NAP)	No relevant documents identified.	08/10/2009	0
Internet - National Institute for Occupational Safety and Health (NIOSH)	Report on residual radioactive and beryllium contamination at atomic weapons employer and beryllium facilities and the NIOSH Advisory Board on Radiation and Worker Health 70th meeting (2010).	04/17/2017	16
Internet - National Service Center for Environmental Publications (NEPIS)	Toxicological review of trichloroethylene, site characterization and monitoring, and the hazardous materials spill warning system (1981).	07/14/2016	5
Internet - NRC Agencywide Document Access and Management (ADAMS)	Integrated database for 1991-92 spent fuel and radioactive waste inventories, special nuclear materials license SNM-33, application for byproduct material license, feasibility report DEM-6, fabrication of 164 enriched (10 per cent) fuel pins for the SRE test program, renewed special nuclear materials license SNM-21, environmental restoration wastes, final Hanford solid waste program environmental impact statement, environmental monitoring annual report (1988), protective radiation standards, SSFL routine inspection report, occupational exposure, confirmatory radiological survey of the phase II area, status of the decommissioning program 2008-2011 annual report, and a license application for promethium-147 fuel capsule for cathode heating program.	03/28/2013	53
Internet - Oak Ridge National Laboratory (ORNL) Library	Operations Division monthly reports (1952-1954), and ORNL status and progress reports (1961).	12/18/2012	10

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Internet - US Army Corps of Engineers (USACE)	No relevant documents identified.	07/18/2016	0
Internet - US Transuranium and Uranium Registries	No relevant documents identified.	08/10/2009	0
Kansas City Plant	Daily operations reports (1991).	10/20/2014	1
Los Alamos National Laboratory	Accelerator health physics characterization report of DOE laboratories.	02/28/2012	1
Los Alamos National Laboratory / Los Alamos Historical Document Retrieval and Assessment (LAHDRA)	Quantities and characteristics of the contact-handled low-level mixed waste streams for the DOE Complex.	12/06/2007	1
National Archives and Records Administration (NARA) - Atlanta	Results of the DOE indoor radon study volumes 1 and 2, summary of industrial accidents, and weekly activity reports.	05/21/2008	3
National Institute for Occupational Safety and Health (NIOSH)	Environmental survey preliminary report at SSFL, annual report to Congress of the AEC (1959, 1961, 1963, 1964,1966, 1968 and 1969), worker outreach meeting minutes, burn pit chemical profile, disposal of NASA area soils, soil sampling for radionuclides results and statistical analysis, waste characterization sample location maps, SSFL RCRA Facility investigation report, plot plan - Propulsion Field Laboratory map 1956 boundary, assessment of pond sediments, verification survey of the 17th Street drainage area, incidents or releases of chemical and radiological contamination, reclaim water flow schematic, decontamination plan, product material license 4-4292-1, radiation safety standard analysis, run-off and dilution effects for retention ponds, and site test areas and landfills.	02/26/2015	87
Nevada Test Site	Final environmental impact statement for Nevada Test Site.	10/01/2003	2
NIOSH Support Claims Tracking System (NOCTS)	Sodium Reactor Experiment wash cell incident (1959/redacted).	03/25/2015	1
Nuclear Regulatory Commission - Public Document Room	License SNM-21 renewal request.	11/04/2016	1
ORAU Team	Potential for tritium in water supply at SSFL, documented communications, radiation exposures for DOE and DOE contractor employees (1985-1988), external coworker dosimetry data for Area IV of the SSFL, the Canoga Avenue Facility, and the De Soto Avenue Facility, potable water delivered to SSFL (1962-1965), a spreadsheet created using SSFL unredacted dosimetry database, review of a sample of ETEC archive X-ray films, technical basis document for the Energy Technology Engineering Center, and a summary of an SSFL call with NIOSH, DOE, DOL, and Boeing on interpreting SSFL employment and exposure records.	06/28/2016	36
S. Cohen & Associates (SC&A)	Tiger Team assessment of Energy Technology Engineering Center (1991), Chemical Processing Plant (CPP) production monthly report (1960), and the counting of tritium smears.	06/24/2010	2
Sandia National Laboratory, NM	Health physics log (1971-1972).	03/03/2006	1
Sandia National Laboratory, NM / SC&A	Radiological surveys (1991).	09/15/2010	1
Santa Susana Field Laboratory (SSFL) / NRC - Public Document Room	Rocketdyne Division Annual Site Environmental Report Santa Susana Field Laboratory and De Soto Sites 1994.	09/24/2009	1

Data Capture Information	Data Capture Description	Date Completed	No. Uploaded into SRDB
Santa Susana Field Laboratory (SSFL) / SC&A	Basis for routine urine sampling of workers exposed to Pu-239, Helgeson lung count results, health physics procedures, bioassay MDA (1963), external dosimetry procedures (1965-1987), film badge procedure, fire in Building 021, health and safety facility condition checklist, neutron data, dose rates (1963), and tritium production and release to groundwater at SSFL.	11/18/2009	38
SC&A / NIOSH	Proceedings of the Sodium Reactor Experiment Forum (1958).	06/09/2016	1
SC&A / Pinellas Plant	Annual report on waste generation and minimization (1993).	06/24/2010	1
SC&A / SSFL	Personnel interviews, elimination of unneeded radioactive material, amendment to license 0015-70, environmental, health, and safety self-assessment, specification for metal for ZPPR fuel elements, plutonium and uranium, authorization for use of radioactive materials or radiation producing devices, bioassay information, criticality study for handling plutonium, determination of airborne plutonium radioactivity, determination of total plutonium activity in air and water, based on alpha counting, including corrections for Pu-241 content, discontinuance of routine use of lapel air samplers, dosimeter calibration, errors in UCLA whole body counting data, fabrication of mixed oxide pellets, uranium fuel fabrication bioassays, industrial hygiene program - thoria, description of analytical procedures and accuracy, internal monitoring results (in-vivo lung scanning), worker exposure histories, listing of locations in SSFL Area IV associated with radioactive materials, medical examinations for radiation workers, modification of film badge program, plutonium urinalysis, plutonium wound monitor status, quarterly inspection of for radiation safety (1978), radiation exposure incidents, radiation surveys, radiation machines registered with the state of California, fires in the hot cell, radiological safety at Atomics International, survey of stray radiation, trip reports, monthly progress reports (1966), and inspection of fuels fabrication/storage areas (1967).	06/24/2010	130
SC&A / SSFL / Cincinnati EMCBC	Bioassay of authorization 141 workers.	06/24/2010	1
SC&A / SSFL / Internet - Google	Potential for off-site exposures.	06/24/2010	1
Unknown	Review of criticality accidents (2000), analysis for the decommissioning of the BORAX-V Reactor Facility, database report for Sylvania Corning Nuclear Corp, decommissioning information, investigations and summary reports of thorium, surveys, articles, facility list and database report information, and Westinghouse Nuclear Fuels Division and Westinghouse Atomic Power Development Plant information (1940-2002).	11/14/2006	13
Total	**N/A**	**N/A**	**2,519**

Table A1-2: Database Searches for Area IV of the SSFL

Database/Source	Keywords	No. Hits	No. Selected
Defense Technical Information Center (DTIC) COMPLETED 07/20/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	793	0
DOE Comprehensive Epidemiologic Data Resource (CEDR) COMPLETED 08/10/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	0	0
DOE Hanford Declassified Document Retrieval System (DDRS) COMPLETED 07/08/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	576	1
DOE Legacy Management Considered Sites COMPLETED 07/18/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	25	2
DOE National Nuclear Security Administration (NNSA) - Nevada Site Office COMPLETED 07/20/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	38	0
DOE Noncompliance Tracking System (NTS) COMPLETED 04/05/2017	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	0	0
DOE Occurrence Reporting Processing System (ORPS) COMPLETED 04/05/2017	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	111	0
DOE OpenNet COMPLETED 08/09/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	611	0
DOE OSTI Energy Citations COMPLETED 08/08/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	7,156	0
DOE OSTI Information Bridge COMPLETED 08/06/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	5,763	3
DOE OSTI SciTech Connect COMPLETED 07/18/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	3,105	220
Energy Employees Claimant Assistance Project (EECAP) COMPLETED 07/20/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	14	0
Google COMPLETED 07/11/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	936,430	244
Health Physics Journal COMPLETED 07/20/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	0	0
Journal of Occupational and Environmental Health COMPLETED 07/20/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	0	0
National Academies Press COMPLETED 08/10/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	6,758	0
National Service Center for Environmental Publications (NEPIS) COMPLETED 07/18/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	28	6
NRC ADAMS Reading Room COMPLETED 01/13/2012	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	5,393	43

Database/Source	Keywords	No. Hits	No. Selected
United States Army Corps of Engineers (USACE) COMPLETED 07/18/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	5	0
United States Army Corps of Engineers (USACE) Los Angeles District COMPLETED 07/18/2016	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	6	0
U.S. Transuranium & Uranium Registries COMPLETED 08/10/2009	Database search terms and Internet URL are available in the Excel file called "Area IV of the SSFL Rev 01, (83.13) 04-27-17."	0	0