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OCAS-PER-012, SUBTASK 4:

REVIEW OF NINE ADVISORY BOARD SELECTED CASES REWORKED FOR THE EVALUATION OF HIGHLY INSOLUBLE PLUTONIUM COMPOUNDS

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OCAS-PER-012, SUBTASK 4: REVIEW OF NINE ADVISORY BOARD CASES REWORKED FOR THE EVALUATION OF HIGHLY INSOLUBLE PLUTONIUM COMPOUNDS	Page 2 of 46
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

Advisory Board or Board	Advisory Board on Radiation and Worker Health
Bq	Becquerel
CADW	Chronic Annual Dose Workbook
d	day
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
dpm	disintegrations per minute
DR	Dose Reconstruction
EE	Energy Employee
E&I	Electric and Instrumentation
ERR	Excess Relative Risk
FG	fuel-grade
g	gram
GI	gastro-intestinal
GSD	geometric standard deviation
ICD	International Classification of Diseases
ICRP	International Commission on Radiological Protection
IMBA	Integrated Modules for Bioassay Analysis
IREP	Interactive RadioEpidemiological Program
LLI	lower large intestine
LN_{ET}	extrathoracic lymph nodes
LN_{TH}	thoracic lymph nodes
LOD	limit of detection
MDA	minimum detectable activity
MPBB	Maximum Permissible Body Burden
nCi	nanocurie
NIOSH	National Institute for Occupational Safety and Health
NTS	Nevada Test Site
OCAS	Office of Compensation Analysis and Support [now the Division of Compensation and Analysis Support (DCAS)]
ORAUT	Oak Ridge Associated Universities Team

PA	Public Address
pCi	picocuries
PER	Program Evaluation Report
POC	Probability of Causation
rem	Roentgen equivalent man
RFP	Rocky Flats Plant
SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort
SRS	Savannah River Site
TBD	Technical Basis Document
TIB	Technical Information Bulletin
TTR	Tonopah Test Range
ULI	upper large intestine
WBC	Whole-Body Count
WG	weapons-grade
y	year

1.0 RELEVANT BACKGROUND INFORMATION

During an Advisory Board meeting on October 22, 2009, SC&A was tasked by the Advisory Board on Radiation and Worker Health (Advisory Board or Board) to conduct a review of OCAS-PER-012, *Evaluation of Highly Insoluble Plutonium Compounds.* OCAS-PER-012 was initiated after the National Institute for Occupational Safety and Health (NIOSH) acknowledged the existence of highly insoluble plutonium at numerous Department of Energy (DOE) sites, which prompted an investigation into the potential impacts on organ doses to exposed workers. As a result of this investigation, NIOSH issued ORAUT-OTIB-0049, Rev. 00, *Estimating Doses for Plutonium Strongly Retained in the Lung*. This document provided guidance for reassessing organ doses for highly insoluble plutonium designated as Type Super S that have been shown to be retained in the lung longer than predicted by the International Commission on Radiological Protection (ICRP) Task Group Lung Model for Type S. Thereafter, OCAS-PER-012 was issued to determine which previously completed claims required re-evaluation for the affect of ORAUT-OTIB-0049.

On March 18, 2010, SC&A submitted to the Procedures Subcommittee our review of NIOSH's program evaluation report (PER) OCAS-PER-012 (SCA-TR-PR2010-0012, Rev. 0). In conducting a PER review, SC&A is committed to perform five subtasks, as specified below:

Subtask 1: Assess NIOSH's evaluation/characterization of the "issue" and its potential impacts on dose reconstruction (DR). Our assessment intends to ensure that the "issue" was fully understood and characterized in the PER.

Subtask 2: Assess NIOSH's specific methods for corrective action. In instances where the PER involves a technical issue that is supported by document(s) (e.g., white papers, technical information bulletins, procedures) that have not yet been subjected to a formal SC&A review, Subtask 2 will include a review of the scientific basis and/or sources of information to ensure the credibility of the corrective action and its consistency with current/consensus science. Conversely, if such technical documentation has been formalized and previously subjected to a review by SC&A, Subtask 2 will simply provide a brief summary/conclusion of this review process.

Subtask 3: Evaluate the PER's stated approach for identifying the universe of potentially affected DRs, and assess the criteria by which a subset of potentially affected DRs was selected for re-evaluation. The second step may have important implications in instances where the universe of previously denied DRs is very large and, for reasons of practicality, NIOSH's re-evaluation is confined to a subset of DRs that, based on their scientific judgment, have the potential to be significantly affected by the PER. In behalf of Subtask 3, SC&A will also evaluate the timeliness for the completion of the PER.

Subtask 4: Conduct audits of DRs affected by the PER under review. The number of DRs selected for audit for a given PER will vary, based on important elements such as (1) the number of target organs/tissues that may be impacted by a PER, (2) The method/data that were employed in the original DR, and (3) the time period, work location, and job

function(s) that characterize the DR of a claim. (It is assumed that the selection of the DRs and the total number of DR audits per PER will be made by the Advisory Board.)

Subtask 5: Prepare a comprehensive written report that contains the results of the above-stated subtasks, along with our review conclusions.

This report fulfills the requirement defined in Subtask 4, "Conduct audits of DRs affected by the PER under review." To determine the total population of claims that had the potential of being "affected" by ORAUT-OTIB-0049, NIOSH employed a set of criteria identified in Section 3.0 of OCAS-PER-012. Here, the word "affected" refers to all claims/DRs that (1) had been completed on or before February 6, 2007 (i.e., the date of issue for OTIB-0049), (2) involved facilities with potential exposure to Type SS plutonium, and (3) resulted in a probability of causation (POC) of less than 50%. Based on these criteria, NIOSH identified a total of 4,865 potential cases.

Using two screening criteria identified in OCAS-PER-012, the number of potentially affected claims was reduced to 1,757. The first screening criterion that was applied to the 4,865 potential claims is defined by a threshold POC value of 45%. With the exception of the lung and thoracic lymph nodes (LN_{TH}), the application of ORAUT-OTIB-0049 under the most conservative assumption (i.e., when the organ dose/POC was exclusively based on the internal exposure to Type SS plutonium) can be increased by a factor of 4. Thus, for the revised POC of 45% as a screening criterion, any of the 4,865 claims with POCs less than 16.97% (with the exception of lung and thoracic lymph node cancers noted above) can be eliminated from further consideration, as shown in Equation 1 below:

$$POC = \frac{ERR}{1 + ERR} \; x \; 100 \qquad \text{Eq. 1}$$

For a revised POC to reach 45%, the Excess Relative Risk (ERR) must equal 0.81818, or 4 times the original ERR value of 0.20454, which corresponds to the original POC of 16.97%.

A second screening criterion applied to the 4,865 total claims identified those claims for which either no plutonium dose (independent of solubility class) was assigned, or a plutonium intake was based on air monitoring data, but did **not** involve the lung or LN_{TH} as target organs.

When combined, the two screening criteria eliminated 3,108 cases from further consideration. Therefore, it was necessary for NIOSH to perform a dose re-evaluation for 1,757 claims from among the initial 4,865 total cases.

In our review of OCAS-PER-012, SC&A concluded that the selection and screening criteria of claims described in Section 3.0 of OCAS-PER-012 are scientifically sound, inclusive of all potential variables affecting the original DR, and maximally conservative. To satisfy Subtask 4, SC&A indicated the need for dose re-evaluation for four groupings of target tissues that include (1) lungs and LN_{TH}, (2) extrathoracic tissues of the respiratory tract, (3) tissues of the gastro-intestinal (GI) tract, and (4) other systemic organs. The need for and the method for the re-evaluation of dose in behalf of these four groupings is further dictated by the monitoring methods/data that were used in the original DR, which may have employed one of four possible

options: (1) air sampling data, (2) urinalysis, (3) in-vivo lung counting, and (4) fecal analysis. Important to note is that for each of the four target organs/tissues, the prescribed method for dose re-evaluation differs. Thus, SC&A recommended that for OCAS-PER-012, a minimum of 10 DRs are needed to assess at least 1 claim for each of the 10 permutations for dose re-evaluation, as shown in Table 1-1 below. However, this number could be reduced if there are no claims among the 1,757 cases of affected DRs that represent 1 or more of the 10 permutations.

Table 1-1. Potential Categories of Dose Reconstructions

Target Organ	Urinalysis	Lung Counts	Fecal Sample	Air Sampling
Lung/LN_{TH}	Yes	Yes	Yes[1]	Yes
Extrathoracic	Yes	No	Yes[2]	No
GI Tract	Yes	No	Yes[2]	No
Systemic Organs	Yes	No	Yes[2]	No

[1] Re-evaluation is required regardless of time interval between exposure and fecal sampling.
[2] Re-evaluation is required only if time intervals are >2 months between end of exposure and fecal sampling.

At the July 15, 2011, DR Subcommittee meeting, NIOSH provided the subcommittee members with a list of 50 cases from all potential categories specified in Table 1-1, with the exception of fecal sample monitoring for target organs extrathoracic and GI tract. From this list, 9 cases were selected for audit representing 8 of the 10 DR categories.

It was determined by the Procedures Subcommittee that SC&A's audit of selected DRs should be limited to evaluating those methods and corrective actions introduced in the reworked DRs that relate strictly to issues addressed in OCAS-PER-012. Presented in Section 2.0 through Section 10.0 below is SC&A focused review to determine whether reworked internal doses related to potential exposure to highly insoluble plutonium (Type Super S) were modified in accordance with OCAS-PER-012.

2.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

2.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at the Oak Ridge National Laboratory (X-10) from [redacted], 1963, to [redacted], 1994. During this worker's employment, the EE worked as a [redacted]. According to the telephone interview, the EE worked throughout the site, but primarily in the burial grounds and occasionally in hot cells, such as Building 3517. The EE was monitored for external photon, electron, and neutron exposures during employment. Internal exposure monitoring was also conducted by means of in-vitro urinalysis bioassays and one whole-body count (WBC). The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) in [redacted] 1999. In May 2006, the EE was also diagnosed with [redacted] cancer (ICD Code [redacted]).

2.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #[**redacted**] in April 2005. At that time, the EE had only been diagnosed with [**redacted**] cancer. The claim was reworked in November 2008 after the EE was also diagnosed with [**redacted**] cancer. Therefore, in addition to re-evaluating this case based on potential exposure to plutonium for Type Super S material, the case was also revised to evaluate the additional [**redacted**] cancer and utilized all current methods for DR.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated using claimant-favorable assumptions. External dose to the [**redacted**] was determined by using the dose calculated for the bladder. Internal dose to the [**redacted**] was determined by using the highest dose calculated for any non-metabolic organ. In the original DR, NIOSH calculated a dose of 43.59 rem to the [**redacted**]. Based on this assigned dose estimate, the Department of Labor (DOL) determined the POC to be 28.16% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a [**redacted**] dose of 18.244 rem was calculated in the revised DR. Table 2-1 provides a comparison of the original and revised external and internal organ dose estimates for the [**redacted**]. It should be noted that the values cited in Table 2-1 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 2-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External (photon)	3.994	3.379
External (neutron)	21.081	11.498
Missed photon (external)	0.838	0.620
Missed neutron (external)	3.304	1.570
Onsite Ambient	0.203	0.203
Medical X-ray	0.015	0.015
Internal	14.155	0.958
Total	**43.590**	**18.244**

In addition to the **[redacted]** doses cited in Table 2-1, external and internal doses to the **[redacted]** were also included in the reworked case. The internal dose was based on a comparison of doses calculated for the **[redacted]**, **[redacted]**, and the **[redacted]**. It was determined that the **[redacted]** provided the highest internal doses and was used for the DR. Using the EE's DOE records and claimant-favorable assumptions, a dose of 19.508 rem was assigned to the **[redacted]**. The combined **[redacted]** doses of 37.752 rem resulted in a POC of 34.71%, and the revised claim was denied.

2.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual who was monitored via urinalyses for assessing doses to both a GI tract organ and a systemic organ.

Internal dose monitoring records identified numerous urinalyses for strontium, plutonium, and uranium from 1963 through 1968 with results above the site detection level. However, even though there were positive bioassays, internal doses in the **original** DR ([redacted] cancer) were calculated based on a maximizing hypothetical internal dose using ORAUT-OTIB-0002. This hypothetical model assumes an intake of 28 radionuclides, which includes plutonium-238 and plutonium-239, on the first day of employment and is only used for non-compensable cases. The hypothetical inhalation intake is based on 10% of the Maximum Permissible Body Burden (MPBB). For both Pu-238 and Pu-239, the derived intake value that is used in Integrated Modules for Bioassay Analysis (IMBA) is 80 nCi with solubility Type M.

In the **reworked** DR, NIOSH identified that the EE was monitored for plutonium on three occasions, once in [redacted] and twice in [redacted]. Using these data and the IMBA computer code, NIOSH calculated a fitted chronic intake of plutonium-239. For the period of 1969 through the end of employment, coworker intakes were used to estimate plutonium dose, as

specified in the Technical Information Bulletin (TIB) *Internal Dosimetry Coworker Data for X-10* (ORAUT-OTIB-0034). For both the fitted and coworker periods, solubility class Types M and S were evaluated and compared. It was determined that the Type S plutonium provided the highest dose, which resulted in estimated daily intakes of plutonium for the two periods as shown in Table 2-2. In addition, Type Super S plutonium adjustment factors were applied in accordance with ORAUT-OTIB-0049. A comparison of the Type S dose and Type SS dose is shown in Table 2-3.

Table 2-2. Plutonium Intake Values Calculated for the Fitted and Coworker Periods of Exposure

Radionuclide	Period	Start	End	Intake	Unit/Rate
Plutonium-239	Fitted	[redacted]	[redacted]	352.94	dpm per day
Plutonium-239	Coworker	[redacted]	[redacted]	138.1	dpm per day

Table 2-3. Comparison of Types S and SS Plutonium Doses for the [Redacted] and [Redacted]

Cancer	Period	Start	End	Type S Dose (rem)	Type SS Dose (rem)
[Redacted]	Fitted	[redacted]	[redacted]	0.118	0.452
[Redacted]	Coworker	[redacted]	[redacted]	0.110	0.207
[Redacted] ([redacted])	Fitted	[redacted]	[redacted]	0.174	0.588
[Redacted] ([redacted])	Coworker	[redacted]	[redacted]	0.212	0.453

The total internal dose assigned for potential exposure to plutonium was 0.659 rem to the [redacted] and 1.041 rem to the [redacted]. As identified in Table 2-3, the [redacted] dose was calculated using the [redacted] as a surrogate organ, since it resulted in the higher Type S and Type SS dose. It should also be noted that the significant reduction in total internal dose (see Table 2-1) is the result of using a 28-radionuclide hypothetical intake dose in the original DR versus determining dose based on fitted and missed (coworker) bioassay data in the reworked DR.

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing the fitted and coworker exposure to Type SS material specifically for systemic organs (i.e., [redacted]) using urinalyses as the monitoring method. For the convenience of the reader, this guidance is cited below:

> ***Systemic Organs***
> *Type SS material is absorbed into the blood stream at a slower rate than Type S material, which results in lower levels of material in the systemic organs and in the urine. Assuming that the doses to systemic organs are roughly proportional to the urinary excretion rate, organ doses determined from urine data are the same for Type S and Type SS materials during the period of time that urine data are available. However, for the period of time after the last urinalysis is available, the Type SS model would predict a much slower decrease in urine due to the continuing input to the bloodstream from the material contained in the* [redacted].

Therefore, the predicted integrated urine content (and hence systemic organ dose) must be adjusted after the time of the last urine bioassay measurement.

Unmonitored Individual (Coworker Data)
Because the adjustment is based on intake rather than dose, the factor is applied to the time following the period used to determine the coworker intake rate rather than the worker's exposure period. For example, given a set of site urinalysis data from 1974 through 1980 (7 years), and an individual who worked from Jan. 1, 1975 to Dec. 31, 1979 (5 years), the adjustment would be applied beginning in year 7 (relative to the start of worker exposure).

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the bioassay records, the X-10 coworker dose guidance, all IMBA runs, and Chronic Annual Dose Workbook (CADW) worksheets for Case #[redacted]. It was also determined that NIOSH used the OTIB-0049 Workbook for assessing the coworker portion of the dose. Based on our review, we were able to verify that NIOSH's assumptions were appropriate and data were entered into IMBA and the OTIB-0049 Workbook correctly. We also verified the Interactive RadioEpidemiological Program (IREP) input, which was entered with the appropriate distribution and parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

3.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

3.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at the Nevada Test Site (NTS) for [redacted], and again from [redacted]. During employment, the EE worked as a [redacted]. According to the telephone interview, the EE worked at the Tonopah Test Range (TTR) in the years 1989 through 1993, and was monitored for external photon and electron exposures for a portion of employment. Internal exposure monitoring was also conducted in 1993 by means of one WBC and one fecal sample. The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) in [redacted] 1997. In [redacted] 1998, the EE was also diagnosed with [redacted] cancer (ICD Code [redacted]). At the time of the [redacted] cancer diagnosis, the EE was reported to be a [redacted]).

3.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #[**redacted**] in April 2005. The claim was reworked in September 2009. In addition to re-evaluating this case based on potential exposure to plutonium for Type Super S material, the case was also revised utilizing all current methods for DR, which included a revision to the NTS Technical Basis Document (TBD) and a TTR site profile that was not available during the initial DR.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated using efficiency measures and claimant-favorable assumptions. External dose to the [**redacted**] was determined by using the dose calculated for the bladder. Internal dose to the [**redacted**] was determined by using the highest dose calculated for any non-metabolic organ. In the original DR, NIOSH calculated a dose of 1.302 rem to the [**redacted**] and 4.444 rem to the [**redacted**]. Based on this assigned dose estimate, the DOL determined the POC to be 4.45% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a [**redacted**] dose of 0.384 rem and [**redacted**] dose of 2.340 was calculated in the revised DR. Table 3-1 provides a comparison the original and revised external and internal organ dose estimates for both organs of interest. It should be noted that the values cited in Table 3-1 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 3-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories		**External** (includes dosimeter, missed, and unmonitored)	**Onsite Ambient**	**Medical X-Ray**	**Internal**	**Total**
[redacted] 1997	**Previous**	0.496	0.692	0.002	0.112	1.302
	Revised	0.200	0.170	0.001	0.012	**0.384**
[redacted] 1998	**Previous**	0.452	0.692	0.562	2.737	4.444
	Revised	0.197	0.170	0.391	1.582	**2.340**

The combined **[redacted]** and **[redacted]** dose of 2.724 rem resulted in a POC of 1.50% and the revised claim was denied.

3.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at NTS, which is a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%. The DR Subcommittee selected this case because it represented an individual who was monitored via fecal sampling for assessing doses to both the [redacted] and a systemic organ.

Internal dose monitoring records identified that the EE had two bioassay measurements throughout employment. One WBC was performed in September 1993 and one fecal sample was collected in November 1993, which coincide with the end of the EE's work assignment at the TTR. The fecal sample was analyzed for Pu-239 and gamma, and the results were reported as 'non detected.' No internal dose was assigned from these bioassays, indicating that the results were insignificant. Therefore, in the original DR, internal dose was assigned based on environmental airborne radionuclide concentrations, as specified in the NTS TBD. This resulted in the assignment of a total internal dose of 0.112 rem and 2.737 rem to the [redacted] and [redacted], respectively.

In the **reworked** DR, NIOSH accounted for the 'non detect' Pu-239 result from the fecal sample by calculating a missed dose using one-half the fecal detection limit of 0.004 pCi/g. This was adjusted to a standard fecal excretion rate of 135 g per day, which resulted in an assumed measurement rate of 0.27 pCi/day. Using IMBA, intake values for the [redacted] and [redacted] were calculated as shown in Table 3-2. Doses were calculated for both absorption Types M and S, with Type S resulting in the highest dose to the [redacted] and Type M resulting in the highest dose to the [redacted]. This resulted in a missed bioassay dose of 0.155 rem to the [redacted] and 0.001 rem to the [redacted].

In addition, the rework assigned environmental intakes for employment at the NTS and TTR based on the NTS TBD (ORAUT-TKBS-0008-4), as shown in Table 3-2. To account for Type Super S plutonium, both the missed bioassay doses and the environmental doses were multiplied

by ORAUT-OTIB-0049 Attachment D [Redacted] Dose Adjustment Factors. The adjustments to dose were made using the OTIB-0049 workbook.

Table 3-2. Assumptions Used Calculating Internal Exposure to Plutonium

Radionuclide	Source	Intake	Distribution applied
Plutonium-239 ([redacted])	fecal	5.77×10^{-1} pCi/day	triangular
Plutonium-239 ([redacted])	fecal	6.39×10^{-1} pCi/day	triangular
Plutonium-238	TTR Environmental	2×10^{-4} Bq/year	Lognormal GSD of 2
Plutonium-239/-240	TTR Environmental	1×10^{-4} Bq/year	Lognormal GSD of 2
Plutonium-238	NTS Environmental	3.47×10^{-1} Bq/year	Constant
Plutonium-239/-240	NTS Environmental	3.81×10^{-1} Bq/year	Constant

Based on these assumptions, NIOSH calculated a total missed plutonium dose of 0.959 rem to the [redacted] and 0.001 rem to the [redacted].

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for the 2 target organs (i.e., [redacted] and systemic organ) using fecal bioassay as the monitoring method. According to Section 4.1.4 of OTIB-0049, fecal samples collected less than 2 months after the end of a chronic intake should be evaluated using air monitoring data. For the convenience of the reader, this guidance is cited below:

> [Redacted] ***Dose***
> *In cases where the intake is derived from air monitoring, the intake is based on direct measurements. For Type SS material, the annual dose to the* [redacted] *(including the* [redacted]*) will be underestimated if one assumes a Type S model because of the longer retention time. Therefore, annual* [redacted] *doses calculated with the Type S model are multiplied by dose adjustment factors. These factors are given in Attachment D for each year from 1 to 65 for 46 different intake scenarios. The scenarios are based on the period of intake, specifically acute and chronic intake periods from 1 to 65 years in 1-year intervals. Because the dose adjustment factors decrease as the chronic exposure period increases, for chronic intakes for partial years, dose reconstructors should truncate the partial year and use the dose adjustment factor table for the full year; for instance, if the intake period is 4.5 years, use the dose adjustment factors for a 4-year chronic intake.*
>
> ***Systemic Organs***
> *For a given intake, the dose to the systemic organs from a Type Super S material will be less than that from Types M or S because the material will be retained in the* [redacted] *longer; the material will be transported to the systemic organs more slowly. Therefore, the assumption that the dose from Type Super S is equal to that from Type S is favorable to the claimant.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the EE's bioassay records, all IMBA runs, and the CADW worksheets for Case #[redacted]. Based on our review, we were able to verify that NIOSH's assumptions were appropriate, and data were entered into IMBA and the OTIB-0049 workbook correctly. We also verified the IREP input, which was entered with the appropriate distribution and parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049 and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

4.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

4.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at the Pantex Plant from [redacted], to the present. According to the telephone interview, the EE worked as a [redacted] throughout employment and worked throughout the site. The EE was monitored for external photon and neutron exposures starting in May 1989 and through the date of cancer diagnosis. Internal exposure monitoring was **not** conducted. The EE was diagnosed with [redacted] ([redacted]) (ICD Code [redacted]) in [redacted].

4.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #[redacted] in November 2003. The claim was reworked in November 2007. This DR was reworked after it was determined that the internal and external dosimetry target organs used for several forms of [redacted] should be changed, as specified in OCAS-PER-009. During this revision, the case was also evaluated for exposure to plutonium for Type Super S material.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated using efficiency measures and claimant-favorable assumptions. External dose to the **[redacted]** system was determined by using the dose calculated for the thyroid. Internal dose was determined by using the **[redacted]**. In the original DR, NIOSH calculated a dose of 12.607 rem to the **[redacted]** system. Based on this assigned dose estimate, the DOL determined the POC to be 1.97% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a total dose of 5.944 rem was calculated in the revised DR. Table 4-1 provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]** system. It should be noted that the values cited in Table 4-1 were extracted from NIOSH's original and reworked DRs. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 4-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned to the [Redacted] System in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External (photon)	2.520	1.507
External (neutron)	–	3.864
Medical X-ray	0.581	–
Internal	8.966	0.573
Total	12.067	5.944

The revised dose of 5.944 rem resulted in a POC of 0.43% and the claim was denied.

4.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%. This case was selected by the DR Subcommittee because it represented an individual whose doses were calculated for the [redacted] (including [redacted]).

Internal dose records contained no bioassay monitoring results. In the **original** DR, internal doses were calculated based on a maximizing hypothetical internal dose using ORAUT-OTIB-0002. This hypothetical model assumes an intake of 28 radionuclides on the first day of employment, which includes plutonium-238 and plutonium-239, and is only used for non-compensable cases.

Since the EE did not participate in the bioassay monitoring program, the **reworked** DR assigned internal doses based on Table 5-19 of the Pantex Occupational Internal Dose TBD (ORAUT-TKBS-0013-5), which assumes default intakes based on occupation and job description. Considering the EE's job function of [redacted], the EE was assumed to be a category 2 worker. In accordance with the Pantex TBD, a plutonium-239 intake of 29 pCi/y, Type S absorption, was used as input to the IMBA computer code, which resulted in a dose to the [redacted] system of 0.026 rem. In addition, Type Super S plutonium adjustment factors were applied in accordance with ORAUT-OTIB-0049, which resulted in a total Pu-239 dose of 0.070 rem.

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for a target organ associated with the [redacted]. For the convenience of the reader, this guidance is cited below:

> [Redacted] ***Dose***
> *In cases where the intake is derived from air monitoring, the intake is based on direct measurements. For Type SS material, the annual dose to the* [redacted] *(including* [redacted]*) will be underestimated if one assumes a Type S model because of the longer retention time. Therefore, annual* [redacted] *doses calculated with the Type S model are multiplied by dose adjustment factors. These factors are given in Attachment D for each year from 1 to 65 for 46 different intake scenarios. The scenarios are based on the period of intake, specifically acute and chronic intake periods from 1 to 65 years in 1-year intervals. Because the dose adjustment factors decrease as the chronic exposure period increases, for chronic intakes for partial years, dose reconstructors should truncate the partial year and use the dose adjustment factor table for the full year; for instance, if the intake period is 4.5 years, use the dose adjustment factors for a 4-year chronic intake.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A examined the IMBA run and CADW worksheet for Case #[redacted]. It was determined that NIOSH used the OTIB-0049 workbook for assessing the Type SS dose. Based on our review, we were able to verify that NIOSH's assumptions were appropriate and data were entered into IMBA and the OTIB-0049 workbook correctly. We also verified the IREP input, which was entered with the appropriate distribution and parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated dose.

5.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

5.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #006747 represents an energy employee (EE) who worked at the Savannah River Site (SRS) during [redacted] discrete employment periods that extended from [redacted], to [redacted], which are detailed below in Table 5-1. During this worker's employment, the EE's job function was a [redacted]. According to the telephone interview, the EE worked throughout the site in any areas requiring [redacted] pouring, including Areas 321M, 105, 100K, 100L, 200F, and 200H.

Table 5-1. Employment Periods

Start	End
[Redacted], 1951	[Redacted], 1955
[Redacted], 1965	[Redacted], 1965
[Redacted], 1967	[Redacted], 1968
[Redacted], 1968	[Redacted], 1969
[Redacted], 1969	[Redacted], 1970
[Redacted], 1970	[Redacted], 1971
[Redacted], 1971	[Redacted], 1976

The EE was monitored for external photon, electron, and neutron exposures during employment. Internal exposure monitoring was also conducted by means of in-vitro urinalysis bioassays. The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) in [redacted] 1975. At the time of diagnosis, it was reported that the EE [redacted] per day.

5.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #**[redacted]** in January 2006. The claim was reworked in December 2008 to re-evaluate this case based on potential exposure to plutonium for Type Super S material. Both the original and revised DRs stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. In the original DR, NIOSH calculated a dose of 69.000 rem to the **[redacted]**. Based on this assigned dose estimate, the DOL determined the POC to be 25.67% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a **[redacted]** dose of 340.801 rem was recalculated in the revised DR. Table 5-2 provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**. It should be noted that the values cited in Table 5-2 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 5-2. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/Missed	11.039	7.508
Unmonitored	7.190	5.328
Ambient External	1.314	1.183
Medical X-ray	3.546	3.501
Internal	45.911	323.282
Total	**69.000**	**340.801**

Using the EE's DOE records and claimant-favorable assumptions, a **[redacted]** dose of 340.801 rem resulted in a POC of 40.83% and on this basis, the revised claim was denied.

5.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual who was monitored via urinalyses for assessing doses to the [redacted].

Internal dose monitoring records identified several urinalyses for tritium, plutonium, and fission products from 1968 through 1971, with results below their reporting levels. Even though there were no positive bioassays, the **original** DR made the claimant-favorable assumption that the EE was exposed to Type S weapons-grade (WG) plutonium from the time the EE returned to work in [redacted] until the date of cancer diagnosis. The intake of WG plutonium was determined using the reporting level limit of detection divided by 2 (LOD/2) specific to the each bioassay as found in the EE's records. Using these data and the IMBA computer code, NIOSH calculated a missed chronic intake of plutonium-239. Once the plutonium alpha intake rate was determined, the plutonium-238, plutonium-239, plutonium-241, and americium-241 intake rates were calculated assuming the 10-year aged 12% (plutonium-240) plutonium mix ratios presented in the SRS TBD. Additionally, the original DR assigned environmental Pu-238 dose to the EE using the maximum 50th percentile site-wide annual intakes.

In the **reworked** DR, NIOSH identified that the EE was monitored for plutonium on five occasions between 1968 and 1971. To account for doses associated with the negative urinalyses reported, NIOSH limited their missed dose assignment to a chronic intake beginning [redacted], through [redacted]. NIOSH began their dose calculation using the same assumptions and methodology as the original DR. Plutonium intake values for assessing missed dose and environmental dose (discussed below) are presented in Table 5-3. To account for Type Super S plutonium, the original annual doses were multiplied by ORAUT-OTIB-0049 Attachment D [Redacted] Dose Adjustment Factors, assuming a chronic 3-year intake. In addition, a urinalysis adjustment factor of 4 was applied to the annual dose calculations in accordance with ORAUT-

OTIB-0049 recommendations. Both adjustments to dose were made in the OTIB-0049 workbook. This resulted in a total missed plutonium dose of 320.941 rem.

In addition, the reworked DR made adjustments to the assigned environmental dose assigned to the EE. NIOSH established the years that the EE was and was not employed at SRS, then used the SRS TBD Table C-17 to determine the 50th percentile maximum environmental intakes of Pu-238 during each period. Each of the intake periods were then adjusted using the ORAUT-OTIB-0049 Attachment D [Redacted] Dose Adjustment Factors and the results were summed annually. No environmental dose was assigned to 1952 and 1953, because the SRS site profile indicated that the risk of plutonium exposure did not begin until 1954. This resulted in the environmental Type Super S plutonium dose of 0.907 rem.

Table 5-3. Plutonium Intake Values

Radionuclide	Dose Type	Start	End	Intake	Unit/Rate
Pu-238	Missed	[Redacted]	[Redacted]	32.98	dpm per day
Pu-239	Missed	[Redacted]	[Redacted]	166.59	dpm per day
Pu-241	Missed	[Redacted]	[Redacted]	3987.2	dpm per day
Am-241	Missed	[Redacted]	[Redacted]	81.21	dpm per day
Pu-238	Environmental	[Redacted]	[Redacted][a]	24.6	Bq per yr
Pu-238	Environmental	[Redacted]	[Redacted][b]	0.0419	Bq per yr
Pu-238	Environmental	[Redacted]	[Redacted]	4.82	Bq per yr

[a] [Redacted]–[Redacted] are excluded, because the EE had no employment periods during the time interval.
[b] [Redacted] is excluded from environmental dose, because the EE had no employment periods during the year.

Based on these intake values, the total internal dose assigned for potential exposure to plutonium was 321.848 rem to the [redacted].

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for the target organ (i.e., [redacted]) using urinalyses as the monitoring method. For the convenience of the reader, this guidance is cited below:

> [Redacted]
> *To calculate Type SS* [redacted] *doses from urinary excretion measurements, the annual dose to the* [redacted] *for the years of interest is first calculated from urinary excretion data using the standard Type S model. The urinary excretion data can consist of measured results and/or results less than the reporting level. The annual* [redacted] *doses calculated with the Type S model are then multiplied by the dose adjustment factors in Attachment D. This adjustment accounts for the longer retention of Type SS material in the* [redacted]*, but it does not address the lower urinary excretion rate expected from Type SS material.*
>
> *To account for the lower excretion rate expected from Type SS material, the approach adopted here is to apply a single bounding correction factor of 4 (which*

is derived in Attachment C) to adjust the intake of Type S material upward to an intake of Type SS material. This "intake adjustment" increases the thoracic doses determined from urinalysis with the Type S model by a factor of 4 and is applied in addition to the Attachment D adjustment factors that account for increased retention in the [redacted].

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the bioassay records, all IMBA runs, and the CADW worksheets for Case #[redacted]. SC&A was able to verify that NIOSH's assumptions were appropriate and claimant favorable and data were entered into IMBA and the OTIB-0049 workbook correctly. SC&A also verified the IREP input, which indicated that the doses were entered with the appropriate distribution and uncertainty parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

It should be noted that under the SRS Special Exposure Cohort (SEC), granted March 3, 2012, this case would qualify for SEC status and thus be eligible for compensation.

6.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

6.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at the SRS during 2 discrete employment periods: [redacted], through [redacted], and [redacted], through [redacted]. The EE's job function during the first employment period was [redacted] and [redacted] during the second employment period. According to the telephone interview, the EE worked throughout the site, including area T-1 while a [redacted], and the F and H areas, the canyons, tank farm, burial grounds and reactors 100P, 100L, and 100K while a [redacted].

The EE was monitored for external photon and electron exposures during employment. Internal exposure monitoring was also conducted by means of in-vitro urinalysis bioassays. The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) on [redacted], 1996. At the time of diagnosis, it was reported that the EE was a former [redacted].

6.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #**[redacted]** in December 2005. The claim was reworked in October 2008 to re-evaluate this case based on potential exposure to plutonium for Type Super S material; both the original and revised DRs stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. In the original DR, NIOSH calculated a dose of 32.378 rem to the **[redacted]**. Based on this assigned dose estimate, the DOL determined the POC to be 44.36% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a **[redacted]** dose of 36.319 rem was recalculated in the revised DR. Table 6-1 provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**. It should be noted that the values cited in Table 6-1 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/ correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 6-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured	0.480	0.468
External Missed	0.263	0.338
Ambient External	0.697	0.697
Medical X-ray	2.669	2.669
Internal	28.270	32.148
Total	**32.378**	**36.319**

Using the EE's DOE records and claimant-favorable assumptions, a **[redacted]** dose of 36.319 rem resulted in a POC of 44.86% and on this basis, the revised claim was denied.

6.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual with a [redacted] cancer who was not monitored for plutonium exposure, but was assigned a potential incidental dose based on the SRS air monitoring program.

The **original** DR estimated an internal dose based on environmental dose for all years of employment using guidance from ORAUT-TKBS-0003. Additionally, during the EE's employment as a [redacted], internal dose was assigned based on SRS air sampling programs assuming that plutonium was the most restrictive radionuclide to [redacted] dose.

In the **reworked** DR, NIOSH identified that the employment periods likely had different risks of exposure because the job functions had different requirements. During the time that the EE worked as a [redacted] ([redacted]), NIOSH assumed the EE had a potential for environmental levels of radionuclide intake. ORAUT-TKBS-0003, Table C-17, was used to assign the 50th percentile maximum SRS site-wide environmental plutonium dose. To account for Type SS plutonium, this dose was then multiplied by the OTIB-0049 Attachment D [Redacted] Dose Adjustment factors, assuming 2 years of intake. No environmental dose was assigned to [redacted] and [redacted], because the SRS site profile indicated that the risk of plutonium exposure did not begin until [redacted]. This resulted in a total environmental plutonium dose of 1.340 rem to the [redacted].

During the second employment period ([redacted]–[redacted]) while employed as a [redacted], NIOSH assumed that the EE had a potential to be exposed to greater than environmental levels on occasion. Dose was assigned during the [redacted] time period based on maximizing air monitoring programs. This dose was calculated in two ways. First, an intake was calculated using the default limiting alpha air concentration in the TIB *Internal Dose Overestimates for Facilities with Air Sampling Programs*, Table 4-1 (ORAUT-OTIB-0018). An adjustment was also made to account for potential ingestion. Both values were used as input to the OTIB-0018 Annual Dose Summary Workbook to calculate total dose to the [redacted]. This resulted in a total alpha intake from inhalation and ingestion of 12.943 rem.

In the second method, internal doses were overestimated by assigning 100% of the intake to the single radionuclide that produces the largest dose per unit intake to the [redacted], which was Type S Pu-239, in accordance with ORAUT-OTIB-0018. To account for Type Super S plutonium, this intake was then adjusted using the OTIB-0049 workbook by assuming an intake of 6 years and applying the Attachment D [Redacted] Dose Adjustment Factor. This resulted in a total Type SS plutonium dose of 9.191 rem.

Annual doses from the two methodologies were compared, and the larger annual dose for each year was used for calculating the POC. This resulted in the combined plutonium dose of 15.994 rem for the second employment period. No environmental dose was assigned, because the air monitoring method already accounts for potential environmental levels of radionuclides.

Based on these intake values, the total internal dose assigned for potential exposure to plutonium was 17.334 rem to the [redacted] from both employment periods.

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for the target organ (i.e., [redacted]) using air monitoring as the monitoring method. For the convenience of the reader, this guidance is cited below:

> [Redacted] ***Dose***
> *In cases where the intake is derived from air monitoring, the intake is based on direct measurements. For Type SS material, the annual dose to the* [redacted] *(including* [redacted]*) will be underestimated if one assumes a Type S model because of the longer retention time. Therefore, annual* [redacted] *doses calculated with the Type S model are multiplied by dose adjustment factors. These factors are given in Attachment D for each year from 1 to 65 for 46 different intake scenarios. The scenarios are based on the period of intake, specifically acute and chronic intake periods from 1 to 65 years in 1-year intervals. Because the dose adjustment factors decrease as the chronic exposure period increases, for chronic intakes for partial years, dose reconstructors should truncate the partial year and use the dose adjustment factor table for the full year; for instance, if the intake period is 4.5 years, use the dose adjustment factors for a 4-year chronic intake.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the CADW and OTIB-0049 worksheets for Case #[redacted]. SC&A was able to verify that NIOSH's assumptions were appropriate and claimant favorable and data were entered into all workbooks correctly. SC&A also verified the IREP input, which indicated that the doses were entered with the appropriate distribution and uncertainty parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

7.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

7.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #003036 represents an energy employee (EE) who worked at the SRS from [redacted], through at least [redacted], when the revised DR was completed. During this worker's employment, the EE's job function was in [redacted] in the F and H areas.

The EE was monitored for external photon, electron, and neutron exposures during employment. Internal exposure monitoring was also conducted by means of in-vitro urinalysis bioassays. The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) in [redacted] 1999.

7.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #**[redacted]** in July 2004. The claim was reworked in June 2008 to re-evaluate this case based on potential exposure to plutonium for Type Super S material; both the original and revised DRs stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. In the original DR, NIOSH calculated a dose of 18.440 rem to the **[redacted]**. Based on this assigned dose estimate, the DOL determined the POC to be 27.86% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a **[redacted]** dose of 15.036 rem was recalculated in the revised DR. Table 7-1 provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**. It should be noted that the values cited in Table 7-1 were extracted from the original and reworked DRs. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 7-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured	8.939	9.068
External Missed	5.766	8.304
Ambient External	1.064	0.109
Medical X-ray	0.146	0.070
Internal	2.525	1.580
Total	18.440	15.036

Using the EE's DOE records and claimant-favorable assumptions, a **[redacted]** dose of 15.036 rem resulted in a POC of 21.05%, and on this basis, the revised claim was denied.

7.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was presented to the DR Subcommittee as representing an individual who was monitored via fecal sampling for assessing doses to the [redacted] (systemic tissue). However, as discussed in more detail below, the internal dose was assigned using a hypothetical intake.

Internal dose monitoring records identified several urinalyses for tritium, plutonium, and fission products done throughout employment. Several positive fecal plutonium samples were analyzed in the 1990s and a positive WBC done in 1981. In the **original** DR, citing efficiency measures, NIOSH used guidance from ORAUT-OTIB-0001 to assign plutonium dose to the [redacted] of the EE. Therefore, a hypothetical intake was assumed that NIOSH states "provides a greater dose than that would result from a detailed reconstruction." SC&A contends that the use of OTIB-0001 in this instance was inappropriate, because the claimant does not meet the assumptions necessary for its applications. Specifically, the EE has multiple positive bioassays, which prohibit the use with OTIB-0001 guidance.

In the **reworked** DR, NIOSH identified that the EE was monitored for plutonium and had several positive bioassays. SC&A's review of DOE records showed the EE was routinely monitored for plutonium exposure between 1981 and 2002. Additionally, the EE received fecal bioassays, which are indicative of increased exposure potential. Four of these assays were positive for plutonium-239 and/or plutonium-238. SC&A identified one routine urinalysis done in [redacted] that was positive for plutonium; this positive bioassay was not listed in the DR report. The EE was also monitored occasionally by WBC and chest counts; one chest count detected Am-241 levels equal to the minimum detectable activity (MDA). In an attempt to calculate a fitted and missed internal dose based on bioassay samples, NIOSH used IMBA to model this chest count assuming an acute intake occurred on the EE's first day of 1981, which corresponds to the start year of bioassay monitoring in the EE's records. Type S Pu was found to best-fit the EE's other bioassay records. No Type SS plutonium adjustment was necessary for fitted dose based on OTIB-0049 guidance. This intake is summarized in Table 7-2.

Table 7-2. Summary of Intake

Radionuclide	Intake (dpm)	Dose (rem)
Pu-238	4,660	>0.001
Pu-239	23,600	0.002
Pu-241	564,000	0.001
Am-241	11,500	0.001

NIOSH also assumed that the EE likely received dose that was not captured by monitoring records. NIOSH modeled potential intake of the LOD/2 of plutonium and americium. NIOSH

found that Type M Pu-239 resulted in the largest missed dose in modeling. NIOSH adjusted this missed dose to account for a 10-year aged 12% plutonium mixture. No Type SS adjustment was necessary, because Type M dose was assigned. Using this methodology, NIOSH calculated a total missed plutonium dose of 0.002 rem to the EE.

Based on these intake values, the total internal dose for potential exposure to plutonium was estimated at 0.006 rem to the [redacted]. However, after expending an extensive effort to calculate internal dose based on the EE's actual bioassay samples, NIOSH chose to use a hypothetical acute intake method (ORAUT-OTIB-0001) for calculating and assigning internal dose, which resulted in an internal dose of 1.546 rem. The total internal dose of 1.580 rem shown in Table 7-2 also includes 0.979 rem estimated from exposure to tritium. Although NIOSH considered the potential for exposure to Type Super S plutonium, no additional dose was added, as justified in the DR report and cited below:

> *Because workers at facilities with plutonium that were potentially exposed to insoluble plutonium compounds (i.e., compounds that have a Type S* [redacted] *absorption type) may have also been exposed to plutonium compounds with a* [redacted] *retention exceeding that of Type S material, potential exposures to those plutonium compounds need to be evaluated in accordance with the recommendations in the Technical Information Bulletin: Estimating Doses for Plutonium Strongly Retained in the Lung. … However, since the assigned internal doses used in this assessment were based on an overestimate of the soluble types of nuclides, no additional dose was added to account for a highly insoluble form of plutonium.*

In evaluating this case, SC&A questions the assignment of internal dose based on the SRS hypothetical intake model. Although this model results in a claimant-favorable dose, it is an inappropriate methodology, since the EE had positive bioassay samples. SC&A also identified this issue with regard to using the OTIB-0001 model in the original DR.

With regard to NIOSH not adding any additional dose for potential exposure to highly insoluble plutonium, we consider this approach reasonable, since the hypothetical intake model results in a highly conservative dose. It should also be noted that if the assigned dose had been based on the chest count data, no Type Super S adjustment would have been made, in accordance with ORAUT-OTIB-0049 guidance.

8.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

8.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at the SRS from [redacted], through [redacted]. During this worker's employment, the EE's job function was a [redacted] and a [redacted] in the Electric and Instrumentation (E&I) Department.

The EE was monitored for external photon and electron exposures during employment. Internal exposure monitoring was also conducted by means of in-vitro urinalysis bioassays. The EE was diagnosed with [redacted] carcinoma at the [redacted] (ICD Code [redacted]), cancer of the [redacted] (ICD-9 Code [redacted]) and cancer of the [redacted] (ICD-9 Code [redacted]) during [redacted] 1981.

8.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #[**redacted**] in January 2005. The claim was reworked in April 2009 to re-evaluate this case based on potential exposure to plutonium for Type Super S material. The original DR stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. As discussed in more detail below, the rework required only a partial DR, since the revised internal dose estimate for only one of the cancers was sufficient to result in a POC greater than 50%. In the original DR, NIOSH calculated a dose of 8.318 rem to the **[redacted]** and **[redacted]**. Additionally, a dose of 85.284 rem to the **[redacted]** was calculated. Based on this assigned dose estimate, the DOL determined the POC to be 44.89% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a dose of 260.653 rem was recalculated for the [redacted] in the revised DR. This represents only a partial DR to the [redacted] and no dose was assigned to the [redacted] or [redacted]. NIOSH states:

> *Only the dose to the* [redacted] *was necessary to complete this revised dose reconstruction. Per the provisions in 42 CFR § 82.10(k)(1), it was determined that the partially reconstructed dose was of sufficient magnitude to consider the dose reconstruction complete. That is, the partially reconstructed dose produced a probability of causation of 50% or greater. To expedite this claim, only a partial dose has been included in this dose reconstruction. The dose reported is a partial estimate of* [the EE's] *total occupational radiation dose.*

Table 8-1 provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**. It should be noted that the values cited in Table 8-1 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report. Dose to the **[redacted]** and **[redacted]**

are not included in this table, because no dose was assigned to either organ as part of the revised DR.

Table 8-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/ Missed	4.609	0
Ambient External	1.022	0
Medical X-ray	7.082	0
Internal	72.569	260.653
Total	85.282	260.653

Using the EE's DOE records and minimizing assumptions, an **[redacted]** dose of 260.653 rem resulted in a POC of 68.41%, and on this basis, the revised claim was **granted**.

8.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual who was monitored via urinalyses for assessing doses to the extra-thoracic region.

Internal dose monitoring records identified a single urinalysis for tritium and another for plutonium. Both samples were below the reporting level. Even though there were no positive bioassays, the **original** DR made the claimant-favorable assumption that the EE was exposed to 10-year aged 12% Pu-240 material Type S chronically over the entire employment period. The plutonium intake was determined using the reporting level LOD/2 specific to the plutonium bioassay found in the EE's records. Dose to each organ was modeled in IMBA assuming 100% Pu-239. Dose was then adjusted to account for 10-year aged 12% Pu-240 material and annual doses were calculated in the CADW. This resulted in a dose of 0.217 rem to both [redacted] and to the [redacted], and 72.569 rem to the [redacted].

In the **reworked** DR, NIOSH identified that the intake range established in the original DR was too broad. The revised DR assumed plutonium exposure only from January 1, 1954, through the date of the urinalysis, April 19, 1967. No plutonium intake was assumed during 1951–1953 because the SRS site profile indicated that risk of plutonium exposure did not begin until 1954. The IMBA program was used to calculate intake rates for both Types M and S plutonium materials based on half the last urinalysis measurement's MDA (0.1 dpm/1.5 liters) for plutonium, assuming 100% Pu-239. Type S gave a significantly higher dose to the [redacted] region. NIOSH elected to use minimizing assumptions and assumed an intake rate of 1 dpm/d to the isotopes associated with fresh fuel grade plutonium. To account for insoluble plutonium, NIOSH multiplied each annual dose by 4, which is consistent with the OTIB-0049 guidance for

an extra-thoracic cancer that was monitored by urinalysis. Plutonium intake values for assessing missed dose are presented in Table 8-2.

Table 8-2. Plutonium Intake Values

Radionuclide	Dose Type	Start	End	Intake	Unit/Rate
Pu-238	Missed	1/1/1954	4/19/1967	1	dpm per day
Pu-239	Missed	1/1/1954	4/19/1967	1	dpm per day
Pu-241	Missed	1/1/1954	4/19/1967	1	dpm per day
Am-241	Missed	1/1/1954	4/19/1967	1	dpm per day

Based on these intake values, the total internal dose assigned for potential exposure to plutonium was 260.653 rem to the [redacted].

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for the target organ (i.e., [redacted]) using urinalyses as the monitoring method. The [redacted] are part of the extra-thoracic region discussed in ORAUT-OTIB-0049. For the convenience of the reader, this guidance is cited below:

> ***Extra-thoracic***
> *Extra-thoracic doses should be calculated from urine bioassay data using the Type S model and then multiplied by a factor of 4 to account for the lower excretion rate of Type SS material compared to Type S material.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the bioassay records, all IMBA runs, and the CADW worksheets for Case #[redacted]. SC&A was able to verify that NIOSH's assumptions were appropriate, and data were entered into IMBA and the OTIB-0049 workbook correctly. SC&A also verified the IREP input, which indicated that the doses were entered with the appropriate distribution and uncertainty parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

9.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

9.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #013347 represents an energy employee (EE) who worked at the Rocky Flats Plant (RFP) during [redacted], through [redacted]. During this worker's employment, the EE's job function was as a [redacted]. According to the telephone interview, the EE worked on the site's [redacted] and [redacted].

The EE was monitored for external photon, electron, and neutron exposures during employment. Internal exposure monitoring was also conducted by means of chest counting. The EE was diagnosed with [redacted] cancer (ICD-9 Code [redacted]) in [redacted] 1990, [redacted] cancer (ICD-9 Code [redacted]) in [redacted] 1991, and [redacted] carcinoma ([redacted] cancer) on the [redacted] (ICD-9 Code [redacted]) in [redacted] 2000. At the time of the [redacted] cancer diagnosis, it was reported that the EE [redacted] per day.

9.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #**[redacted]** in March 2005. The claim was reworked in October 2007 to re-evaluate this case based on potential exposure to plutonium for Type Super S material; both the original and revised DRs stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. In the original DR, NIOSH calculated a dose of 23.152 rem to the **[redacted]**, 20.368 rem to the **[redacted]**, and 24.302 rem to the **[redacted]**. Based on this assigned dose estimate, the DOL determined the POC to be 28.14% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a **[redacted]** dose of 6.297 rem, a **[redacted]** dose of 2.057 rem, and a dose to the **[redacted]** to be 4.633 rem were recalculated in the revised DR. Tables 9-1 through 9-3 below provide a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**, **[redacted]**, and **[redacted]**, respectively. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 9-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/Missed/Coworker	18.856	1.851
Ambient External	0.437	0
Medical X-ray	0.356	0.356
Internal	3.476	4.090
Total	23.125	6.297

Table 9-2. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/Missed/Coworker	19.888	2.047
Ambient External	0.474	0
Medical X-ray	0.002	0.002
Internal	0.004	0.008
Total	20.368	2.057

Table 9-3. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/Missed/Coworker	22.345	4.250
Ambient External	0.634	0
Medical X-ray	1.310	0.356
Internal	0.013	0.027
Total	24.302	4.633

Using the EE's DOE records and claimant-favorable assumptions, a **[redacted]** dose of 6.297 rem, a **[redacted]** dose of 2.057 rem, and a dose to the **[redacted]** to be 4.633 rem resulted in a POC of 1.83% and on this basis, the revised claim was denied.

9.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #[REDACTED]

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual with in-vivo monitoring for assessing doses to the [redacted].

Internal dose monitoring records identified several urinalyses for uranium, plutonium, and americium products from 1981 through 1995, with results below their reporting levels. The **original** DR made the claimant-favorable assumption that the EE was exposed to plutonium during the entire time of employment. The intake of WG plutonium was determined using the reporting level LOD/2 specific to each bioassay found in the EE's records. Using these data and the IMBA computer code, NIOSH calculated a missed chronic intake of plutonium-239. Once the plutonium alpha intake rate was determined, the plutonium-238, plutonium-239, plutonium-241, and americium-241 intake rates were calculated assuming the fresh WG plutonium mixture ratio presented in the RFP TBD.

In the **reworked** DR, NIOSH identified that the EE was monitored in vivo on 6 occasions between 1981 and 1995, and provided 6 urine samples that were assessed for plutonium

during the same time period. All measurement results showed activities less than MDAs. To account for doses associated with the negative monitoring results, NIOSH limited their missed dose assignment to a chronic intake beginning May 26, 1981, through June 30, 1995. For this DR, each cancer was addressed independently to maximize dose. It was determined that, for the plutonium dose to the [redacted] and [redacted], the urine bioassay for solubility Type M was more claimant favorable. For the [redacted], missed plutonium dose was determined based on MDA levels of Am-241, as identified in the EE's termination chest count. NIOSH compared solubility Types S and M while assessing dose based on the chest count, with Type S resulting in a more claimant-favorable dose.

NIOSH modeled missed dose from the urinalysis and missed dose from the chest count separately. To adequately address the modeling for each cancer, they are discussed separately below.

[Redacted]
NIOSH modeled missed dose in IMBA using half the MDA values of Am-241, using an intake rate of 0.097 dpm/d from the last negative chest count. Assuming a WG plutonium mixture as suggested in the RFP TBD, this resulted in a missed intake of Type S Pu-239 of 20.21 dpm/d. This intake was used as input to IMBA, resulting in a dose of 4.090 rem to the [redacted]. To account for Type SS plutonium, this dose was then multiplied by the OTIB-0049 Attachment D [Redacted] Dose Adjustment Factors, assuming 14 years of intake, and divided by the chest count adjustment factor of 4.7. Both adjustments to dose were made in the OTIB-0049 workbook and were performed in accordance with the recommendations of OTIB-0049. This resulted in a Type SS dose of 2.478 rem. Since Type S plutonium resulted in a larger dose to the [redacted], this dose was assigned in order to be claimant favorable.

[Redacted]
To assign internal dose to the [redacted], NIOSH calculated Type M dose using the LOD/2 from the last urinalysis. NIOSH assumed the EE was chronically exposed to plutonium during the entire period of employment. NIOSH assigned dose based on the Type M urinalysis LOD/2 results. This resulted in a total dose of 0.005 rem to the [redacted] using the [redacted] as a surrogate organ. Since Type M dose was assigned, no adjustment for Type SS plutonium was warranted.

Although it is beyond the scope of this review, SC&A takes exception with NIOSH's selection of the [redacted] as a surrogate organ to the [redacted]. The [redacted] is an organ already modeled in IMBA and thus does not require the use of a surrogate. In addition, all instances of using the [redacted] in modeling dose to the [redacted] yield a higher dose than using the [redacted] (i.e., 0.011 rem vs. 0.005 rem). This is obviously a small difference and would not have an impact on the POC of this case; however, it is difficult for SC&A to understand NIOSH's rationale for this organ selection.

[Redacted]
To assign dose to the [redacted], NIOSH assumed that Type M yields the most claimant-favorable dose to the EE. NIOSH modeled this dose using half of the LOD of the final

urinalysis. This resulted in an intake of 36.581 dpm/d Pu-239. NIOSH then adjusted to account for a mixture of WG plutonium that the EE was likely exposed to. This resulted in a total plutonium dose to the [redacted] of 0.011 rem. Since Type M dose was assigned, no adjustment for Type SS plutonium dose was necessary.

Based on these intake values, the total internal dose assigned for potential exposure to plutonium was a [redacted] dose of 4.090 rem, a [redacted] dose of 0.005 rem, and a dose to the [redacted] of 0.011 rem.

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for each target organ (i.e., [redacted], [redacted] and [redacted]) using the most limiting monitoring method. For the convenience of the reader, this guidance is cited below:

> [Redacted] [Chest Count]
> *To calculate Type SS* [redacted] *doses from chest count measurements, the dose to the* [redacted] *is first calculated assuming that Type S material was inhaled. This dose is then adjusted upward with the factors given in Appendix D. However, the application of the adjustment factor will result in an implied Type SS* [redacted] *content that is inconsistent with the original chest count. To make the observed and predicted chest counts agree, the Type SS* [redacted] *dose must be adjusted downward by applying the adjustment factor for the year of the chest count used to determine the intake. …*
>
> ***Systemic Organ*** [Monitored Individual Urinalysis]
> …[T]*he annual doses to systemic organs should be determined from urine data using the Type S assumption. Annual doses received during the period for which urine data are available should not be adjusted. Annual doses received after the year of the last urine sample used in the determination should be multiplied by a factor of 4.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the bioassay records, all IMBA runs, and the Pu/Am Intake Calculation Workbook for Case #[redacted]. SC&A was able to verify that NIOSH's assumptions were appropriate, with the exception of their organ selection for calculating internal dose to the [redacted], and data were entered into IMBA and the OTIB-0049 workbook correctly. SC&A also verified the IREP input, which indicated that the doses were entered with the appropriate distribution and uncertainty parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

10.0 REVIEW OF OCAS-PER-012 ISSUES FOR CASE #[REDACTED]

10.1 BACKGROUND INFORMATION FOR CASE #[REDACTED]

Case #[redacted] represents an energy employee (EE) who worked at Hanford in Richland, Washington, during [redacted] discrete employment periods, as detailed in Table 10-1, which extended from [redacted], to [redacted]. Monitoring records identified during the original DR indicate that the EE may have also had employment periods during 1951 and 1952, though DOL could not confirm employment during this time; thus, no dose was assigned to these years in the revised DR. During this worker's employment, the EE's was a [redacted]. Records indicate that the employee [redacted] primarily in the 200 East/West and 100 D Areas.

Table 10-1. Employment Periods

Start	End
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]
[Redacted]	[Redacted]

The EE was monitored for external exposures during employment. Internal exposure monitoring was not conducted. The EE was diagnosed with [redacted] cancer (ICD Code [redacted]) in [redacted] 1961.

10.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DOSE RECONSTRUCTIONS

NIOSH performed the original DR of Case #[**redacted**] in January 2006. The claim was reworked in December 2008 to re-evaluate this case based on potential exposure to plutonium for Type Super S material; both the original and revised DRs stated that the EE's radiation dose was overestimated using claimant-favorable assumptions. In the original DR, NIOSH calculated a dose of 7.671 rem to the **[redacted]**. Based on this assigned dose estimate, the DOL determined the POC to be 37.39% and the claim was denied.

Using the most current technical guidance documents and considering Type Super S plutonium, a **[redacted]** dose of 3.000 rem was recalculated in the revised DR. Table 10-2 below provides a comparison of the original and revised external and internal organ dose estimates for the **[redacted]**. It should be noted that the values cited in Table 10-2 were extracted directly from NIOSH's reworked DR. With the exception of internal doses from plutonium, SC&A has not assessed the accuracy/correctness of these doses, since performing such an assessment is beyond the scope of this Subtask 4 report.

Table 10-2. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the [Redacted] in the Original and Reworked Dose Reconstructions

Dose Categories	Previous Dose (rem)	Revised Dose (rem)
External Measured/Missed/Unmonitored	5.158	0.311
Ambient External	0.966	0.328
Medical X-ray	1.114	0.798
Internal	0.433	1.563
Total	7.671	3.000

Using the EE's DOE records and claimant-favorable assumptions, a **[redacted]** dose of 3.000 rem resulted in a POC of 35.33%, and on this basis, the revised claim was denied.

10.3 SC&A'S REVIEW OF OCAS-PER-012 ISSUES RELATED TO CASE #016131

As directed by the Procedures Subcommittee, SC&A's review of Case #[redacted] strictly focused on internal doses calculated in behalf of exposure to plutonium. Case #[redacted] was included in the pool of claims that required the DR to be reworked for evaluation of potential exposure to Type Super S plutonium, since it met the OCAS-PER-012 criteria of (1) original DR was performed prior to February 6, 2007, (2) the EE worked at a site with the potential for a highly insoluble form of plutonium, and (3) the POC was less than 50%, but greater than 16.97%. This case was selected by the DR Subcommittee because it represented an individual who was not monitored for intake, but was assigned dose to a systemic organ using coworker urine bioassay data.

The EE was not monitored for internal exposure to plutonium. Because there were no bioassays, the **original** DR assigned only environmental internal dose to the [redacted]. NIOSH assumes all environmental plutonium was Pu-239. Using guidance from ORAUT-TKBS-0006-4 and the CADW, NIOSH calculated a full year of environmental dose to each partial year of employment. This resulted in a dose of less than 0.001 rem to the [redacted]; therefore, no plutonium dose was assigned in the original DR.

As a result of the SEC Class for Hanford (issued December 8, 2006), no internal plutonium dose could be reconstructed for the 1944 employment period. In the **reworked** DR, DR made the claimant-favorable assumption that the EE was exposed to fuel-grade (FG) plutonium (12% Pu) aged 10 years during the remaining [redacted] employment periods, based on the 50th percentile coworker models for Hanford. The intake of FG plutonium was determined using the Type S and Type M coworker plutonium intake values from ORAUT-TKBS-0006-5, Tables C-9 and C-10. Using the "Hanford Pu and RU Mix Intake Rate Calculator 1.10," NIOSH accounted for the radionuclide composition of FG Pu aged 10 years. Then, using the CADW, a dose beginning 1958 through 1959 was calculated for a Type S and Type M mixture of FG Pu aged 10 years. Both Type S and Type M mixtures resulted in a total dose of less than 0.001 rem to the [redacted]. The potential for Type Super S plutonium exposure was also evaluated using guidance from OTIB-0049. Type Super S Plutonium was also found to contribute less than 0.001 rem to the [redacted].

In addition, the reworked DR made adjustments to account for environmental dose to the EE. NIOSH first established the years that the EE was and was not employed at Hanford, then used

the Hanford TBD, Table 4-7, to determine the 50th percentile maximum environmental intakes of Pu-239 during 1944 and 1958–1959. No environmental dose was assigned for 1951 and 1952, because the DOL could not confirm the EE's employment. A total environmental plutonium dose of less than 0.001 rem to the [redacted] was calculated.

Based on these intake values, the total internal dose assigned for potential exposure to plutonium was less than 0.001 rem to the [redacted].

In evaluating this case, SC&A reviewed the guidance provided in ORAUT-OTIB-0049 for assessing exposure to Type SS material specifically for the target organ (i.e., [redacted]) using urinalyses as the monitoring method of the coworker model. For the convenience of the reader, this guidance is cited below:

> ***Systemic Organs***
> *Type SS material is absorbed into the blood stream at a slower rate than Type S material, which results in lower levels of material in the systemic organs and in the urine. Assuming that the doses to systemic organs are roughly proportional to the urinary excretion rate, organ doses determined from urine data are the same for Type S and Type SS materials during the period of time that urine data are available. However, for the period of time after the last urinalysis is available, the Type SS model would predict a much slower decrease in urine due to the continuing input to the bloodstream from the material contained in the* [redacted]. *Therefore, the predicted integrated urine content (and hence, systemic organ dose) must be adjusted after the time of the last urine bioassay measurement.*

Along with reviewing the ORAUT-OTIB-0049 guidance, SC&A analyzed the CADW and OTIB-0049 workbook for Case #[redacted]. SC&A was able to verify that NIOSH's assumptions were appropriate and claimant favorable, and data were entered into CADW and the OTIB-0049 workbook correctly. SC&A also verified the IREP input, which indicated that the doses were entered with the appropriate distribution and uncertainty parameters. SC&A found that the rework was done in accordance with guidance provided in ORAUT-OTIB-0049, and has no findings with NIOSH's methodology for assessing the EE's exposure to highly insoluble plutonium and the resulting estimated doses.

11.0 SUMMARY CONCLUSIONS

Under SC&A's *A Protocol to Review NIOSH's Program Evaluation Reports (PERs)* (SCA-TR-PR2009-0002, Rev. 1), Subtask 4 requires the audit of DR cases reworked as a result of the PER under review. In March 2010, SC&A submitted our review of NIOSH's PER, *Evaluation of Highly Insoluble Plutonium Compounds* (OCAS-PER-012), to the Procedures Subcommittee. In that review, SC&A indicated that, based on guidance in ORAUT-OTIB-0049, *Estimating Doses for Plutonium Strongly Retained in the Lung*, which prompted the issuance of OCAS-PER-012, the prescribed method for dose re-evaluation differs (1) for each of four target organs/tissues (i.e., lung/LN_{TH}, extrathoracic, GI tract, system organs) and (2) based on monitoring methods (i.e., urinalysis, lung count, fecal sample, air sampling) that were used in the original DR. Therefore, in order to satisfy Subtask 4, SC&A recommended selection of 1 case from each of 10 potential permutations addressed in PER-012.

In July 2011, the DR Subcommittee selected 9 cases for audit representing 8 of the 10 DR categories. Only 8 categories of reworked DRs were selected, since there were no cases available where fecal sample monitoring was performed for target organs extrathoracic and GI tract. Table 11-1 provides a listing of the OTIB-0049 criteria that were applied to each of the nine cases, identified in the table by case number. It should be noted that some DRs are listed in two categories, because the EE was diagnosed with more than one cancer.

Table 11-1. ORAUT-OTIB-0049 Dose Re-evaluation Criteria Used for the Nine Audited Dose Reconstructions

Target Organ	Urinalysis	Lung Counts	Fecal Sample	Air Sampling
Lung/LN_{TH}	6,747	13,347	2,614	2,767; 2,994
Extrathoracic	3,871	NA	No DR Available	NA
GI Tract	1938	NA	No DR Available	NA
Systemic Organs	1938; 3036; 16131	NA	2614	NA

For each of the nine cases, SC&A provided an overview of the case and a brief comparison of external and internal doses assigned in the original and revised DRs. Based on directives from the Procedure Subcommittee, SC&A's audit of these cases focused strictly on those elements of the DR that were affected by the issuance of ORAUT-OTIB-0049 and OCAS-PER-012. Therefore, our audit only evaluated whether the internal doses associated with potential exposure to Type Super S plutonium were performed accurately and in accordance with guidance in ORAUT-OTIB-0049. For each case, we reviewed applicable IMBA files and workbooks employed for calculating the plutonium dose. In addition, we verified that all data were entered into IREP correctly.

As discussed in Sections 2.0 through 10.0 above, SC&A concurs with the approach and assumptions used by NIOSH in calculating internal doses associated with potential exposure to highly insoluble plutonium for all nine cases. We also found that NIOSH re-evaluated each of these DRs using methodology consistent with the guidance in ORAUT-OTIB-0049. SC&A believes that the development of the OTIB-0049 workbook, which assists the dose reconstructor in entering appropriate data and then calculates fitted and missed organ doses, makes

comparisons of these data, and generates the IREP input, has been very instrumental in the successful implementation of OCAS-PER-012.

12.0 REFERENCES

42 CFR 82. *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol. 67, No. 85/Thursday, May 2, 2002, p. 22314.

OCAS-PER-009, Rev. 0, *Target Organs for Lymphoma*, Office of Compensation Analysis and Support, Program Evaluation Plan, Cincinnati, Ohio, March 8, 2007.

OCAS-PER-012, Rev. 0, *Evaluation of Highly Insoluble Plutonium Compounds*, Office of Compensation Analysis and Support, Program Evaluation Plan, Cincinnati, Ohio, August 7, 2007.

ORAUT-OTIB-0001, Rev. 00, *Maximum Internal Dose Estimates for Savannah River Site (SRS) Claims*, Oak Ridge Associated Universities, Cincinnati, Ohio, July 15, 2003.

ORAUT-OTIB-0002, Rev. 01 PC-2, *Technical Information Bulletin – Maximum Internal Dose Estimates for Certain DOE Complex Claims*, Oak Ridge Associated Universities, Cincinnati, Ohio, May 7, 2004.

ORAUT-OTIB-0018, Rev. 01, *Technical Information Bulletin: Internal Dose Overestimates for Facilities with Air Sampling Programs*, Oak Ridge Associated Universities, Cincinnati, Ohio, August 9, 2005.

ORAUT-OTIB-0034, Rev. 00, *Technical Information Bulletin: Internal Dosimetry Coworker Data for X-10*, Oak Ridge Associated Universities, Cincinnati, Ohio, December 13, 2005.

ORAUT-OTIB-0049, Rev. 00, *Estimating Doses for Plutonium Strongly Retained in the Lung*, Oak Ridge Associated Universities, Cincinnati, Ohio, February 6, 2007.

ORAUT-TKBS-0003, Rev. 03, *Savannah River Site*, Oak Ridge Associated Universities, Cincinnati, Ohio, April 5, 2005.

ORAUT-TKBS-0006-4, Rev. 02, *Hanford Site – Occupational Environmental Dose*, Oak Ridge Associated Universities, Cincinnati, Ohio, June 5, 2007.

ORAUT-TKBS-0006-5, Rev. 02, *Hanford Site – Occupational Internal Dose*, Oak Ridge Associated Universities, Cincinnati, Ohio, June 22, 2007.

ORAUT-TKBS-0008-4, Rev. 01, *Nevada Test Site – Occupational Environmental Dose*, Oak Ridge Associated Universities, Cincinnati, Ohio, May 27, 2008.

ORAUT-TKBS-0011-5, Rev. 02, *Rocky Flats Plant – Occupational Internal Dose*, Oak Ridge Associated Universities, Cincinnati, Ohio, August 17, 2007.

ORAUT-TKBS-0013-5, Rev. 01, *Pantex Plant – Occupational Internal Dose*, Oak Ridge Associated Universities, Cincinnati, Ohio, June 22, 2007.

SCA-TR-PR2009-0002, Rev. 1, *A Protocol to Review NIOSH's Program Evaluation Reports (PERs)*, SC&A, Inc., Vienna, Virginia, December 1, 2009.

SCA-TR-PR2010-00012, Rev. 0, *A Review of NIOSH's Program Evaluation Report OCAS-PER-012, "Evaluation of Highly Insoluble Plutonium Compounds"* SC&A, Inc., Vienna, Virginia, March 18, 2010.