
DRAFT

OCAS-PER-018, SUBTASK 4

**REVIEW OF FIVE ADVISORY BOARD SELECTED CASES
REWORKED FOR THE EVALUATION OF LOS ALAMOS
NATIONAL LABORATORY, OCCUPATIONAL EXTERNAL
DOSE TECHNICAL BASIS DOCUMENT REVISIONS**

**Contract No. 211-2014-58081
Revision 0**

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Task Manager: _____ U. Hans Behling, PhD, MPH	Supersedes: N/A
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Record of Revisions

Revision Number	Effective Date	Description of Revision
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ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation and Worker Health
BRS	Board Review System
CATI	Computer-Assisted Telephone Interview
CF	correction factor
CMB	Chemistry-Metallurgy Baker Division (Building)
DCAS	Division of Compensation Analysis and Support
DCF	dose conversion factor
DOE	(U.S.) Department of Energy
DOL	(U.S.) Department of Labor
DR	Dose Reconstruction
EE	Energy Employee
GM	geometric mean
GSD	geometric standard deviation
ICD	International Classification of Diseases
ICRP	International Commission on Radiological Protection
IREP	Interactive RadioEpidemiological Program
keV	kiloelectronvolt, 1,000 electronvolts
LAMPF	Los Alamos Meson Physics Facility
LANSCE	Los Alamos Neutron Science Center
LANL	Los Alamos National Laboratory
[redacted]	
LOD	limit of detection
MeV	megaelectronvolt, 1 million electronvolts
NIOSH	National Institute for Occupational Safety and Health
η/p	neutron-to-photon (ratio)
[redacted]	
OCAS	Office of Compensation Analysis and Support
PER	Program Evaluation Report
PEP	Program Evaluation Plan
POC	probability of causation
PRSC	Procedures Review Subcommittee

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rem roentgen equivalent man
SC&A S. Cohen and Associates (SC&A, Inc.)
SEC Special Exposure Cohort
[redacted]
TA technical area
TBD technical basis document

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1.0 RELEVANT BACKGROUND INFORMATION

The process for evaluating potential impacts of programmatic changes on previously completed dose reconstructions (DRs) has been proceduralized in OCAS-PR-008, *Preparation of Program Evaluation Reports and Program Evaluation Plans*, Revision 2, dated December 6, 2006. This procedure describes the format and methodology to be employed by NIOSH in preparing a Program Evaluation Report (PER) and a Program Evaluation Plan (PEP).

A PER provides a critical evaluation of the effect(s) that a given issue/programmatic change may have on previously completed DRs. A PER includes a qualitative and, in some cases, quantitative assessment of potential impacts. Most important in this assessment is the potential impact(s) on the probability of causation (POC) of previously completed DRs with POCs of <50%.

1.1 A BRIEF TIMELINE OF EVENTS LEADING TO SUBTASK 4 OF SC&A'S REVIEW OF OCAS-PER-018

- On May 10, 2005, NIOSH issued Revision 00 of the technical basis document (TBD) titled, *Los Alamos National Laboratory – Occupational External Dose* (ORAUT-TKBS-0010-6, Rev. 00). SC&A assessed Revision 00 of ORAUT-TKBS-0010-6 as part of an overall review of the Los Alamos National Laboratory (LANL) Site Profile in a draft report issued on August 28, 2008 (SCA-TR-TASK1-0011).
- On May 30, 2007, NIOSH issued Revision 01 for the *Los Alamos National Laboratory – Occupational External Dose* (ORAUT-TKBS-0010-6, Rev. 01). In the *Publication Record* for this document, NIOSH provided the following information regarding the genesis for Revision 01:

[Rev. 01 of ORAUT-TKBS-0010-6] *incorporates formal **internal and NIOSH review comments**. This revision results in an increase in assigned dose and a PER is required due to the addition of **median photon adjustment values in Tables 6-22, and A-8**; otherwise, the maximum values were replaced with lower 95th percentiles, and therefore would lower doses. An exception to the lower 95th percentile values is the value for **Other Operations**, which is higher than the previously **reported maximum value of annual geometric means**. This change will result in a higher dose. Changes in **Table A-7** will increase skin/shallow dose for LAMPF/LANSCE workers. . . . [Emphasis added.]*

The primary modification made in Revision 01 of ORAUT-TKBS-0010-6 is a change in the neutron dose estimate for individuals who were potentially exposed to neutrons but were not monitored. Both this revision and the earlier version apply a neutron-to-photon (η/p) ratio to the worker's monitored photon dose to determine potential neutron dose. Both revisions provide a median and an upper bound ratio and allow the upper bound ratio to be used as a maximizing assumption. However, the revision to the ratios caused the median values to increase and all but one of the upper bound values decreased. This

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revision also added a category of work locations. The estimates of dose for unmonitored workers may increase or decrease. Because this change only applies to workers who were not monitored for exposure to neutrons, it will not affect dose estimates for individuals with personal neutron monitoring data.

Another modification made in Revision 01 is the change in the energy distribution for photon radiation at the Los Alamos Meson Physics Facility at the Los Alamos Neutron Science Center (LAMPF/LANSCE) in technical area (TA) 53. This change affected the assignment of non-penetrating dose to electrons or photons less than 30 keV. It also affected the assignment of penetrating dose to medium energy photons (30 keV to 250 keV) or high energy photons (greater than 250 keV). In summary, these changes could affect not only the assigned dose but the probability of causation results for those claims which had a DR performed using ORAUT-TKBS-0010-6, Revision 00.

- In response to changes incorporated in Revision 01 of ORAUT-TKBS-0010-6, NIOSH issued OCAS-PER-018 on July 31, 2007. In OCAS-PER-018, NIOSH established an **upper-bound estimate of 300 claims** that may be impacted. This bounding number merely reflects all LANL DRs/claims that were completed under Revision 00 of ORAUT-TKBS-0010-6 with a POC of less than 50%. NIOSH stated its intention to screen these 300 claims against the following criteria:
 - Determine if the LAMPF energy distribution defined in Revision 00 was used in the original dose estimate
 - Determine whether the original dose estimate included an assigned neutron dose that was based on Revision 00 η/p ratio; and secondly determine if the revised neutron-to-photon ratio is higher than the original
- During an Advisory Board meeting on May 20, 2010, SC&A was tasked by the Board to conduct a review of OCAS-PER-018, *Los Alamos National Laboratory TBD Revision*. In conducting a PER review, SC&A is committed to perform the following subtasks, each of which is discussed in this report:

Subtask 1: Assess NIOSH's evaluation/characterization of the "issue" and its potential impacts on 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.

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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 DRs is too large and, for reasons of practicality, NIOSH's re-evaluation is confined to a subset of DRs. 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. Based on PER-specific criteria, the number of DRs selected for audit for a given PER will vary. Selection of the DRs and the total number of DR audits will be made by the Procedures Review Subcommittee (PRSC) with recommendations by NIOSH and SC&A.

Subtask 5: Prepare a written report that contains the results of the Subtask 4 DR audit, along with our review conclusions.

- In October of 2010, SC&A submitted its draft review of OCAS-PER-018 (SCA-TR-PR2010-0018). Our draft review covered Subtasks 1, 2, and 3 and identified a total of five (5) findings. These 5 findings by SC&A's review of OCAS-PER-018 were entered into the Board Review System (BRS) on October 20, 2010.
- On March 22, 2011, the PRSC discussed SC&A's findings pertaining to OCAS-PER-018 (ABRWH 2011, pp. 216–246). In brief, NIOSH stated that SC&A's findings “. . . actually pertain to things that are in the new Site Profile” [ORAUT-TKBS-0010-6, Revision 02].

In response to NIOSH's comment(s), PRSC Chairperson, Wanda Munn, promised to draft an email that transferred the resolution of SC&A's findings for OCAS-PER-018 to the Los Alamos National Laboratory Work Group (ABRWH 2011, pp. 255–256).

- On February 13, 2014, the PRSC tasked NIOSH to identify five DRs that met the OCAS-PER-018 criteria for a revised DR, and forward said DRs to SC&A for audit and completion of Subtask 4.

1.2 SUBSEQUENT EVENTS THAT IMPACTED SELECTION OF SUBTASK 4 DRs FOR AUDIT BY SC&A

Designation of Two Classes of Employees to the Special Exposure Cohort (SEC). Revision 01 of ORAUT-TKBS-0016-6 was issued on May 30, 2007, which prompted the need for OCAS-PER-018. However, since that time, four SEC petitions (Petitions #51, #61, #109, and #170) were filed in behalf of LANL employees, which qualified for evaluation. In summary, these petitions resulted in the designation of the following two classes of employees to the SEC.

- (1) Effective August 12, 2010: All employees who worked at LANL from March 15, 1943, through December 31, 1975, for a number of workdays aggregating at least 250 workdays;

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- (2) Effective January 6, 2013: All employees who worked at LANL from January 1, 1976, through December 31, 1995, for a number of workdays aggregating at least 250 workdays.

Additional Revisions to ORAUT-TKBS-0016-6. Following the issue date of Revision 01 of ORAUT-TKBS-0016-6 on May 30, 2007 (which prompted PER-018), Revision 02 was issued on November 23, 2009, and Revision 03 was issued on March 21, 2013. Revision 02 introduced significant changes to Revision 01.

1.3 OVERVIEW OF CASES SELECTED FOR SUBTASK 4

On March 12, 2014, SC&A received the following revised DRs for audit in behalf of PER-018 Subtask 4, as summarized in Table 1-1 below.

Table 1-1. Salient Data for DRs Revised Under PER-018 and Selected for Audit

Case ID	Cancer	Date of Initial DR	POC (%)	Date of Revised DR	POC (%)
[Case A]	Prostate ^a	05/16/2006	9.11	05/30/2008	14.03
[Case B]	Prostate ^a	06/15/2006	43.48	01/12/2009	39.04 ^d
[Case C]	Prostate ^a	10/09/2006	41.15	04/21/2010 ^c	35.90 ^d
[Case D]	Prostate ^a	10/11/2005	33.09	03/31/2010 ^c	32.41 ^d
[Case E]	Ovarian ^b	06/22/2006	21.44	11/25/2008	30.57

^a Non-presumptive cancer type.

^b On January 17, 2013, the SEC class was expanded to include the employment period of January 1, 1976–December 31, 1995.

^c Revised DR **post-dates Revision 02** of ORAUT-TKBS-0010-6 (issued on November 23, 2009).

^d Revised DR resulted in lower POC.

Inspection of Table 1-1 identifies the following salient characteristics of revised DRs selected for audit:

- Four of the five cases involve the **non-presumptive** prostate cancer. SC&A understands that this does **not** represent a biased selection of cases, but reflects the reduced pool of cancer claims that do not qualify for SEC status.
- The **original** as well as **revised** DR of the presumptive **ovarian** cancer pre-dates the designation of the expanded employment period, which may now qualify this claimant for SEC status.
- Revised DRs for two of the four prostate cancer claims (Cases [C and D]) post-date Revision 02 of ORAUT-TKBS-0016-6 and may, therefore, have been reworked using methods that differ from guidance cited in Revision 01.

2.0 REVIEW OF OCAS-PER-018 ISSUES FOR CASE [A]

2.1 BACKGROUND INFORMATION FOR CASE [A]

Case [A] represents an Energy Employee (EE) who worked at the LANL from [redacted], through [redacted], and from [redacted], through [redacted]. The EE was employed as a [redacted] and, according to the telephone interview, worked at the [redacted] and at the [redacted]. The EE was monitored on a monthly basis for exposure to external radiation from [redacted] through [redacted] and was assigned a quarterly dosimeter during the second quarter of [redacted]. In [redacted], the EE was diagnosed with prostate cancer (ICD-9 Code 185).

2.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DRs

NIOSH performed the original DR of Case [A] in May 2006. The claim was reworked in May 2008 as a result of (1) changes to the LANL Occupational External Dose TBD (ORAUT-TKBS-0010-6), (2) the issuance of OCAS-PER-018, and (3) potential exposure to plutonium for Type Super S material (OCAS-PER-012).

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated using efficiency measures. In the original DR, NIOSH calculated a total dose of 11.161 rem to the prostate. Based on this assigned dose estimate, the Department of Labor (DOL) determined the POC to be 9.11% and the claim was denied.

Using Revision 01 of ORAUT-TKBS-0010-6 and the most current technical guidance documents, a revised prostate dose of 12.454 rem was calculated in the reworked DR. Table 2-1 provides a comparison of the original and revised external and internal organ dose estimates. It should be noted that the values cited in Table 2-1 were extracted directly from NIOSH's reworked DR. With the exception of external measured/missed photon and neutron doses, 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 Prostate in the Original and Reworked DRs

Dose Categories		Prostate Dose (Rem)					
		Occupational External		Onsite Ambient	Medical X-Ray	Internal	Total
		Measured/ Missed Photons	Measured/ Missed Neutrons				
Prostate [redacted]	Original	0.842	7.080	2.358	0.009	0.873	11.161
	Revised	0.851	8.322	2.358	0.007	0.917	12.454

As shown in Table 2-1, a revised prostate dose of 12.454 rem was calculated. Based on this assigned dose, the DOL calculated a POC of 14.03% and the claim was denied.

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2.3 SC&A'S REVIEW OF OCAS-PER-018 ISSUES RELATED TO CASE [A]

As directed by the PRSC, SC&A's review of Case [A] focused on revisions to the calculation of potential neutron doses, as specified in PER-018. Since the unmonitored neutron dose is based on the EE's monitored and missed photon doses, our evaluation also included NIOSH's assessment of photon dose. Case [A] was included in the pool of claims that required the DR to be reworked, since the original DR was performed using Revision 00 of the LANL Occupational External Dose TBD and the EE was not monitored for, but potentially exposed to, neutrons.

2.3.1 Photon Dose Calculation in Original DR

The **original** DR calculated photon doses for those years when the EE was monitored, i.e., [redacted]–[redacted] and [redacted]. Based on Department of Energy (DOE) records, the only positive monthly photon reading was 0.010 rem, which was recorded in [redacted]. This recorded dose was multiplied by an organ dose conversion factor (DCF) of 1.244, using the bladder as the surrogate organ, and a 1.3 uncertainty factor. This resulted in a measured photon dose of 0.016 rem, which was entered into the Interactive RadioEpidemiological Program (IREP) with a photon energy range of 30–250 keV as a constant value.

Missed photon dose was assessed in the original DR by counting the actual number of zero readings in the EE's DOE records, which resulted in identifying 34 missed photon doses. The number of zero readings was multiplied by one-half the limit of detection (LOD) for the period ($LOD_{1968-1970} = 0.040$ rem; $LOD_{1985} = 0.010$ rem) and applying the bladder DCF of 1.244. This resulted in a total missed photon dose of 0.826 rem. Annual 30–250 keV photon doses were entered into IREP as a geometric mean (GM) of a lognormal distribution with a geometric standard deviation (GSD) of 1.52.

2.3.2 Neutron Dose Calculation in Original DR

The **original** DR assigned unmonitored neutron dose for the period of [redacted]–[redacted]. Neutron doses were calculated using a **η/p ratio of 5.5**, which represents the maximum value for workers in plutonium facilities from Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. Neutron dose from the single measured photon reading was determined by multiplying the 0.010 rem reading by an uncertainty factor of 1.3, a DCF of 1.0, an ICRP 60 factor of 1.91, and the η/p ratio of 5.5, resulting in 0.137 rem. Unmonitored neutron doses based on missed photon doses were calculated by multiplying the missed photon dose for [redacted]–[redacted] by a DCF of 1.0, an ICRP 60 factor of 1.91, and the η/p ratio of 5.5, resulting in 6.943 rem. This resulted in a total neutron dose of 7.080 rem being assigned in the original DR. All annual neutron doses were assumed to be within the energy range of 0.1–2.0 MeV and entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

2.3.3 Photon Dose Calculation in Reworked DR

The **reworked** DR also only assigned photon doses for the years [redacted]–[redacted] and [redacted], when the EE was monitored. Since the single positive dosimeter measurement of 0.010 rem was below the LOD/2 level, it was considered as a missed dose. Using the same

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parameters as the original DR (i.e., applicable LOD/2 values and a bladder DCF of 1.244), a total missed dose of 0.851 rem was calculated. Consistent with the original DR, these missed photons were assumed to be in the energy range of 30–250 keV, and annual doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

2.3.4 Neutron Dose Calculation in Reworked DR

In the **reworked** DR, NIOSH also assigned unmonitored neutron doses for the years **[redacted]**–**[redacted]** based on a η/p ratio. In order to maximize the neutron dose, the **η/p ratio of 6.4** was used from Table 6-22 of ORAUT-TKBS-0010-6, Revision 01, which represents the 95th percentile value associated with ‘Other Operations.’ Unmonitored neutron doses were calculated in the revised DR by multiplying the missed photon doses by a DCF of 1.0, an ICRP 60 factor of 1.91, and the η/p ratio of 6.4, resulting in a total neutron dose of 8.322 rem. All neutron doses were assumed to be within the energy range of 0.1–2.0 MeV, and annual doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

2.3.5 SC&A’s Conclusions Regarding Assignment of Photon and Neutron Doses

In evaluating this case, SC&A reviewed pertinent records contained in the EE’s file. We also assessed whether the original and revised DRs followed guidance for assessing under-reported or unmonitored and missed neutron doses, as specified in Revisions 00 and 01 of the LANL Occupational External Dose TBD, respectively. Our review confirmed that both the original and reworked DRs calculated photon and neutron doses appropriately and consistent with the TBD guidance. It was noted that the two DRs differed in their selection of the neutron source for determining the appropriate η/p ratio (i.e., the original DR used the ‘Plutonium facility’ and the reworked DR selected ‘Other Operations’). However, these neutron sources represent the highest η/p ratio value cited in Table 6-22 of Revisions 00 and 01 of the LANL TBD; therefore, this difference was considered acceptable based on NIOSH’s use of an overestimating/maximizing approach in both DRs. Lastly, we verified that the photon and neutron doses were entered into IREP with the appropriate exposure parameters and dose distributions. SC&A has no findings with NIOSH’s methodology for reassessing Case **[A]** based on OCAS-PER-018.

3.0 REVIEW OF OCAS-PER-018 ISSUES FOR CASE [E]

3.1 BACKGROUND INFORMATION FOR CASE [E]

Case [E] represents an EE who worked at LANL from [redacted], through [redacted], according to the original DR. In the 2008 revision to the DR, three post-[redacted] employment periods were added by the DOL, which included (1) [redacted], through [redacted], (2) [redacted], through [redacted], and (3) [redacted], through [redacted]. According to the DOL records and the Computer-Assisted Telephone Interview (CATI) reports, the EE was employed as [redacted] and [redacted] and worked throughout the site. The EE was monitored for external and internal exposure to radiation during the pre-[redacted] employment period. In [redacted], the EE was diagnosed with ovarian cancer (ICD-9 Code 183.0).

3.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DRs

NIOSH performed the original DR of Case [E] in June 2006. The claim was reworked in November 2008 as the result of (1) the addition of three employment periods, (2) changes to the LANL Occupational External Dose TBD (ORAUT-TKBS-0010-6) resulting in the issuance of OCAS-PER-018, and (3) potential exposure to plutonium for Type Super S material (OCAS-PER-012). During the rework, the case was also re-evaluated using the most current procedures/methods for DR.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was **overestimated** using efficiency measures. In the original DR, NIOSH calculated a total dose of 16.876 rem to the ovary. Based on this assigned dose estimate, the DOL determined the POC to be 21.44% and the claim was denied.

In the reworked DR, a dose of 21.229 rem to the ovary was calculated. Table 3-1 provides a comparison of the original and revised external and internal organ dose estimates. It should be noted that the values cited in Table 3-1 were extracted directly from NIOSH's reworked DR. With the exception of external measured/missed photon and neutron doses, 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 Ovary in the Original and Reworked DRs

Dose Categories		Ovary Dose (Rem)					
		Occupational External		Onsite Ambient	Medical X-Ray	Internal	Total
		Measured/ Missed Photons	Measured/ Missed Neutrons				
Ovary [redacted]	Original	1.645	10.279	0.000	0.003	4.949	16.876
	Revised	2.517	14.589	2.476	0.004	1.643	21.229

Using the revised ovary dose of 21.229 rem, the DOL calculated a POC of 30.57% and the claim was denied. (As was noted in Section 1.3 above, this claim should qualify under the SEC class

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established on January 17, 2013, which covered all workers employed during the period of January 1, 1976–December 31, 1995.)

3.3 SC&A’S REVIEW OF OCAS-PER-018 ISSUES RELATED TO CASE [E]

As directed by the PRSC, SC&A’s review of Case [E] focused on revisions to the calculation of potential neutron doses, as specified in PER-018. Since the unmonitored neutron dose is based on the EE’s monitored and missed photon doses, our evaluation also included NIOSH’s assessment of photon dose. Case [E] was included in the pool of claims that required the DR to be reworked, since the original DR was performed using Revision 00 of the LANL Occupational External Dose TBD, and the EE was monitored for exposure to neutrons, but a portion of the assigned neutron dose was based on a η/p ratio.

3.3.1 Photon Dose Calculation in Original DR

The EE was monitored for external exposure on a monthly exchange basis during the entire employment period (i.e., [redacted]–[redacted]) identified in the **original** DR. Based on DOE records, positive monthly photon readings were recorded in [redacted], [redacted], and [redacted]–[redacted]. These recorded doses were multiplied by (1) a claimant-favorable organ DCF of 1.0, (2) a 1.3 uncertainty factor for years [redacted]–[redacted] and 1.14 uncertainty factor during years [redacted]–[redacted], and (3) a photon dose correction factor of 2 for [redacted]–[redacted]. This resulted in a total measured photon dose of 0.255 rem. Annual doses were entered into IREP as a constant value and treated as photons within the energy range of 30–250 keV.

Missed photon dose was assessed in the original DR by counting the actual number of zero readings in the EE’s DOE records, which resulted in identifying 128 missed photon doses. The number of zero readings was multiplied by one-half the LOD for the period ($LOD_{1975-1979} = 0.040$ rem; $LOD_{1980-1986} = 0.010$ rem). This resulted in a total missed photon dose of 1.390 rem. Annual photon doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

3.3.2 Neutron Dose Calculation in Original DR

According to DOE records, the EE was monitored for exposure to neutrons during the [redacted] through [redacted] employment period. All monitoring results were reported as zero, except for one month in [redacted], which showed a recorded neutron dose of 0.080 rem, and one monthly reading in [redacted], where a neutron dose of 0.020 rem was recorded. In accordance with the LANL TBD, measured neutron doses prior to [redacted] were likely underestimated. Therefore, the **original** DR assigned neutron doses for the period of [redacted]–[redacted] using a η/p ratio. In order to maximize the neutron dose, NIOSH selected a **η/p ratio of 5.5** for plutonium facilities from Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. For years [redacted] and after, the DR considered the measured neutron doses to be reasonable estimates once a DCF of 1.0 and ICRP 60 CF of 1.91 were applied. The combined neutron dose based on the η/p ratio and measured neutron readings was 1.407 rem. Annual

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neutron doses were entered into IREP with an energy range of 100 keV to 2.0 MeV and as a constant dose distribution.

For [redacted]–[redacted], missed neutron doses were calculated using missed photon doses and the 5.5 η/p ratio. Missed neutron doses between [redacted] and [redacted] were assessed by counting the actual number of zero readings shown in the DOE records for each year and multiplying this number by LOD/2 (i.e., 0.010 rem/2), a DCF of 1.0, and the ICRP 60 correction factor of 1.91. This resulted in a total missed neutron dose of 8.872 rem being assigned in the original DR. Annual missed neutron doses were assumed to be within the energy range of 0.1–2.0 MeV and entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

3.3.3 Photon Dose Calculation in Reworked DR

The revised DR also calculated photon dose using DOE dosimetry records for [redacted] through [redacted]. However, the guidance current at the time the reworked DR was performed required that measured dose reported as less than $\frac{1}{2}$ LOD be treated as a zero and assessed as missed dose. Therefore, measured dose was only assigned for [redacted] and [redacted]–[redacted]. Doses were calculated assuming 100% 30–250 keV photons, a DCF of 1.0, and an uncertainty factor of 1.3 for [redacted] and 1.14 for [redacted]–[redacted]. This resulted in a total recorded dose of 0.177 rem.

The reworked DR also included three **unmonitored** employment periods (i.e., [redacted]–[redacted], [redacted]–[redacted], [redacted]–[redacted]) that were added by the DOL. Based on the EE’s job description of [redacted]/[redacted] and the lack of external and internal monitoring records, NIOSH chose to assign onsite ambient dose for all three additional employment periods. Onsite ambient doses were calculated based on the LANL Occupational Environmental Dose TBD (ORAUT-TKBS-0010-4, Revision 00) and resulted in a total dose of 2.476 rem, which was entered into IREP as a constant dose distribution with photon energies of 30–250 keV.

3.3.4 Neutron Dose Calculation in Reworked DR

In the reworked DR, NIOSH assigned neutron doses for the period of [redacted]–[redacted] using the measured photon dose to estimate neutron dose (i.e., η/p ratio). In order to maximize the neutron dose, NIOSH used the 95th percentile **η/p ratio of 6.4** listed for ‘Other Operations’ from Table 6-22 of ORAUT-TKBS-0010-6, Revision 01. For years after [redacted], the measured neutron doses reported in the DOE records were assumed to be reasonable estimates, and assigned neutron doses were calculated by applying a DCF of 1.0 and an ICRP 60 CF of 1.91. The NIOSH-calculated combined neutron dose based on the η/p ratio and measured neutron readings was 0.677 rem. Annual neutron doses were entered into IREP with an energy range of 100 keV to 2.0 MeV and as a constant dose distribution.

For [redacted]–[redacted], missed photon doses were used to estimate the missed neutron doses based on the η/p ratio of 6.4 from Table 6-22 of ORAUT-TKBS-0010-6, Revision 01. After [redacted], missed neutron doses were assessed by counting the actual number of zero readings shown in the DOE records for each year and multiplying this number by the LOD/2 (i.e.,

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0.010 rem/2), a DCF of 1.0, and the ICRP 60 correction factor of 1.91. This resulted in a total missed neutron dose of 13.912 rem being assigned in the reworked DR. All annual missed neutron doses were assumed to be within the energy range of 0.1–2.0 MeV. Missed neutron doses based on a η/p ratio were entered into IREP as a GM of a lognormal distribution with a GSD of 2.55, and missed neutron doses calculated based on the number of reported zero readings were entered as a GM with a GSD of 1.52.

3.3.5 SC&A’s Conclusions Regarding Assignment of Photon and Neutron Doses

In evaluating this case, SC&A reviewed pertinent records contained in the EE’s file and compared NIOSH’s methodology for assessing unmonitored neutron doses to guidance specified in Revisions 00 and 01 of the LANL Occupational External Dose TBD. Our review confirmed that the reworked DR calculated neutron doses consistent with TBD revisions, which prompted the issuance of OCAS-PER-018. It was noted that the original and reworked DRs differed in their selection of the neutron source for determining the appropriate η/p ratio (i.e., the original DR used the ‘Plutonium facility’ and the reworked DR selected ‘Other Operations’). However, these neutron sources are associated with the highest η/p ratio value cited in Table 6-22 of Revisions 00 and 01 of the LANL Occupational External Dose TBD; therefore, this difference was considered acceptable based on NIOSH’s use of an overestimating/maximizing DR approach. In addition, NIOSH did not apply the neutron uncertainty factor of 8% to the measured neutron doses after [redacted] as specified in the original and revised TBDs. However, the use of a claimant-favorable DCF value of 1.0 more than compensated for the 8% neutron uncertainty factor.

Our review of the photon and neutron doses assigned in the original and reworked DRs, however, did identify several calculational errors, as described in Observation #1 and Finding #6. (Please note that since Subtasks 1–3 identified 5 findings, the first Subtask 4 finding will begin with number 6.)

Observation #1. According to guidance in the LANL Occupational External Dose TBD (ORAUT-TKBS-0010-6, Revision 00), the photon dose calculated for [redacted] in the **original** DR should have included a dosimeter correction factor (CF) of 1.3 rather than the 1.14 CF used by NIOSH. This was corrected in the **revised** DR.

Finding #6. Based on LANL occupational radiation exposure records provided by DOE, a measured neutron dose of 0.080 rem was reported in [redacted]. However, neither the original DR nor the revised DR assigned a measured neutron dose for [redacted]. Although this error resulted in an underestimate of neutron doses, it would have minimal impact on the POC in behalf of this case. However, this error does identify a concern regarding NIOSH’s quality assurance.

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4.0 REVIEW OF OCAS-PER-018 ISSUES FOR CASE [B]

4.1 BACKGROUND INFORMATION FOR CASE [B]

Case [B] represents an EE who worked at LANL from [redacted], through [redacted], and again from [redacted], through [redacted], according to the original DR. In the 2009 revision to the DR, an employment period of [redacted], through [redacted], was added by the DOL. In addition to the EE's employment at LANL, the EE also worked [redacted] from [redacted], through [redacted], and visited the [redacted] and [redacted] as an [redacted] employee in [redacted]. (It should be noted that, for purposes of this review, SC&A will only evaluate a portion of the EE's external radiation exposure associated with work at LANL, as specified in OCAS-PER-018.)

The EE worked as [redacted] [redacted] during employment at LANL. Based on information provided in the CATI, the EE reported working at the [redacted] and [redacted]. According to DOE records provided for employment at LANL, the EE was monitored on a monthly basis for exposure to external radiation from [redacted]–[redacted] and [redacted]–[redacted]. (It should be noted that the DOE dosimetry records are inconsistent with the covered employment periods identified by the DOL in the original DR (i.e., [redacted]–[redacted] and [redacted]–[redacted]) and in the reworked DR (i.e., [redacted]–[redacted], [redacted]–[redacted], and [redacted]–[redacted]). However, NIOSH did include all doses reported by the DOE in both DRs.) In [redacted], the EE was diagnosed with prostate cancer (ICD-9 Code 185).

4.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DRs

NIOSH performed the original DR of Case [B] in June 2006. The claim was reworked in January 2009 as the result of (1) the addition of an employment period from [redacted]–[redacted], (2) changes to the LANL Occupational External Dose TBD (ORAUT-TKBS-0010-6, Revision 01) resulting in the issuance of OCAS-PER-018, (3) changes to doses for Construction Trades Workers (OCAS-PER-014), and (4) potential exposure to plutonium for Type Super S material (OCAS-PER-012).

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was **overestimated** using efficiency measures. In the original DR, NIOSH calculated a total dose from all employment locations of 85.579 rem to the prostate. Based on this assigned dose estimate, the DOL determined the POC to be 43.48% and the claim was denied.

Using the Revision 01 of ORAUT-TKBS-0010-6 and the most current technical guidance documents, a prostate dose of 66.616 rem was calculated in the reworked DR. Table 4-1 provides a comparison of the original and revised external and internal organ dose estimates. It should be noted that the values cited in Table 4-1 were extracted directly from NIOSH's reworked DR. With the exception of assigned external measured/missed photon and neutron doses for the EE's LANL employment, 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 for the Prostate in the Original and Reworked DRs

Dose Categories	Prostate Doses (Rem)			
	Original DR – All Sites ([redacted], LANL, [redacted], [redacted])	Original DR – LANL Only	Revised DR – All Sites ([redacted], LANL, [redacted], [redacted])	Revised DR – LANL Only
Occupational External:				
- Measured/Missed Photons	17.794	6.652	7.457	3.539
- Measured/Missed Neutrons	28.775	28.755	43.045	7.820
Onsite Ambient	1.123	–	1.000	–
Medical X-Ray	0.105	–	0.301	–
Internal	37.782	–	14.813	–
Total	85.579	–	66.616	–

Using the revised prostate dose of 66.616 rem, the DOL calculated a POC of 39.04% and the claim was denied.

4.3 SC&A’S REVIEW OF OCAS-PER-018 ISSUES RELATED TO CASE [B]

As directed by the PRSC, SC&A’s review of Case [B] focused on revisions to the calculation of potential neutron doses, as specified in PER-018. Since neutron doses for a portion of the worker’s employment are based on the EE’s monitored and missed photon doses, our evaluation also reviewed NIOSH’s estimate of photon dose. Case [B] was included in the pool of claims that required the DR to be reworked, since the original DR was performed using Revision 00 of the LANL Occupational External Dose TBD, and the EE was monitored for exposure to neutrons, but a portion of the assigned neutron dose was based on a η/p ratio.

4.3.1 Photon Dose Calculation in Original DR

The **original** DR calculated photon doses for those years when the EE was monitored at LANL (i.e., [redacted]–[redacted] and [redacted]–[redacted]), even though the second covered employment period was cited as [redacted]–[redacted]. NIOSH stated that positive recorded photon doses were multiplied by an organ DCF of 1.244, using the bladder as the surrogate organ, and an uncertainty factor of 1.3 prior to [redacted] and 1.14 after [redacted]. An additional dosimeter CF of 2 was applied to recorded readings between [redacted] and [redacted] in accordance with the ORAUT-TKBS-0010-6, Revision 00. Since the EE indicated in the CATI that he sometimes worked with gloveboxes while at LANL, a photon CF of 2.19 was applied as specified in *Technical Information Bulletin: Special External Dose Reconstruction Considerations for Glovebox Workers* (OCAS-TIB-010, Revision 02). This resulted in a measured photon dose of 4.101 rem, which was entered into IREP with a photon energy range of 30–250 keV and as a GM of a lognormal distribution with a GSD of 1.340.

Missed photon dose was assessed in the original DR by counting the actual number of zero readings in the EE’s DOE records, which resulted in identifying 187 missed photon doses. The number of zero readings was multiplied by (1) one-half the LOD for the period ($LOD_{prior1980} =$

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0.040 rem; $LOD_{after1979} = 0.010$ rem), (2) the bladder DCF of 1.244, and (3) the 2.19 glovebox CF. This resulted in a total missed photon dose of 5.356 rem. Annual 30–250 keV photon doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.69.

4.3.2 Neutron Dose Calculation in Original DR

The **original** DR assigned measured neutron doses prior to [redacted] using η/p ratio method, as specified in the TBD. A η/p ratio of 2.4 (maximum value from ‘Other Operations’) was selected from Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. Neutron doses measured in [redacted] and after were considered to represent a reasonable estimate after applying an uncertainty factor of 1.08, as well as an ICRP 60 factor 1.91, DCF of 1.0, and glovebox CF of 2.19. This resulted in a total measured neutron dose of 11.597 rem. Measured neutron doses were entered into IREP with an energy range of 0.1–2.0 MeV as a GM of a lognormal distribution with a GSD of 1.34.

Missed neutron doses prior to [redacted] were calculated by multiplying the missed photon dose by the η/p ratio of 2.4, a DCF of 1.0, an ICRP 60 factor of 1.91, and a glovebox CF of 2.19. In [redacted] and after, the actual number of zero neutron readings reported in the DOE records was multiplied by (1) one-half the LOD value of 0.010, (2) a DCF of 1.0, (3) an ICRP 60 CF of 1.91 and (4) the 2.19 glovebox CF. This resulted in a total missed neutron dose of 17.158 rem. Missed annual neutron doses were assumed to be within the energy range of 0.1–2.0 MeV and entered into IREP as a GM of a lognormal distribution with a GSD of 1.69.

4.3.3 Photon Dose Calculation in Reworked DR

The **reworked** DR also assigned photon doses for all years in which records indicated that the EE was monitored for external exposure at LANL (i.e., [redacted]–[redacted]; [redacted]–[redacted]). Based on current guidance, positive dosimeter measurements that were below the $LOD/2$ value were considered missed dose. The measured photon doses equal to or greater than $LOD/2$ values were calculated by applying a bladder DCF value of 1.244 and an uncertainty factor of 1.3 (prior to 1980) or 1.14 (1980 and after). This resulted in the assignment of a total measured photon dose of 0.919 rem, which was entered into IREP with an energy range of 30–250 keV and as a constant dose distribution.

Missed photon doses were calculated by counting the actual number of zero and $<LOD/2$ badge readings. A total number of 194 missed dosimeter cycles was determined. Missed photon dose was estimated by multiplying the number of missed badge exchange cycles by the applicable $LOD/2$ values and a bladder DCF of 1.244. A total missed photon dose of 2.620 rem was calculated. Annual missed photons were assumed to be in the energy range of 30–250 keV, and doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

4.3.4 Neutron Dose Calculation in Reworked DR

In the **reworked** DR, NIOSH assigned neutron doses for the years prior to [redacted] based on a η/p ratio. The neutron dose was calculated using the median ‘Other Operations’ η/p ratio of 1.6 from Table 6-22 of ORAUT-TKBS-0010-6, Revision 01, which represents the median value associated with ‘Other Operations,’ and applying the 1.91 ICRP 60 CF and an organ DCF of 1.0.

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This resulted in a neutron dose of 1.708 rem, which was entered into IREP with an energy range of 0.1–2 MeV and as a GM of a lognormal distribution with a GSD of 2.323. For the years [redacted] and after, positive measured neutron doses were calculated using the reported value and multiplying by an uncertainty factor of 1.08, an ICRP 60 CF of 1.91, and a DCF of 1.0. The only measured positive post-1978 dose was a 0.020 rem value that was reported in 1979. Applying the stated CFs resulted in a dose of 0.041 rem, which was entered into IREP as a constant dose distribution.

Missed neutron doses were calculated in the revised DR by multiplying the missed photon doses prior to [redacted] by a DCF of 1.0, an ICRP 60 factor of 1.91, and the η/p ratio of 1.6. Post-[redacted], missed neutron doses were estimated based on the actual number of zero and <LOD/2 values reported in the EE’s records, and were estimated by multiplying the number of missed badge exchange cycles by the applicable LOD/2 values, an ICRP 60 CF of 1.91, and a DCF of 1.0. This resulted in a total missed neutron dose of 6.071 rem. All missed neutron doses were assumed to be within an energy range of 0.1–2.0 MeV, and annual doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

4.3.5 SC&A’s Conclusions Regarding Assignment of Photon and Neutron Doses

In evaluating this case, SC&A reviewed pertinent records contained in the EE’s file. We also assessed whether the original and revised DRs followed guidance for assessing monitored or unmonitored and missed neutron doses, as specified in Revisions 00 and 01 of the LANL Occupational External Dose TBD, respectively. For this case, our review confirmed that both the original and reworked DRs calculated photon and neutron doses appropriately and consistent with the TBD guidance. The significant reduction in neutron dose assigned in the revised DR was due to the use of a **median** rather than maximum η/p ratio for ‘Other Operations.’ In addition, the reworked DR did not apply a glovebox CF. Considering the EE’s job function and primary work locations, SC&A concurs that the selection of a median η/p ratio is reasonable. SC&A has no findings with NIOSH’s methodology for reassessing Case [B] based on OCAS-PER-018.

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5.0 REVIEW OF OCAS-PER-018 ISSUES FOR CASE [D]

5.1 BACKGROUND INFORMATION FOR CASE [D]

Case [D] represents an EE who worked at the [redacted] from [redacted], through [redacted], and at LANL for 5 intermittent periods between [redacted], and [redacted]. It should be noted that for purposes of this review, SC&A will only evaluate the photon and neutron portions of the EE's external radiation exposure associated with work at LANL, as specified in OCAS-PER-018.

During the EE's employment at LANL, the EE worked as a [redacted] and [redacted]. Based on information provided by the EE in the telephone interview, the EE worked at various LANL buildings and locations. According to DOE records provided for employment at LANL, the EE was periodically monitored for exposure to external radiation from [redacted]–[redacted], [redacted], [redacted], [redacted], and [redacted]. The EE was also intermittently monitored for neutron exposure during [redacted]–[redacted], [redacted], [redacted], and [redacted]. In [redacted], the EE was diagnosed with prostate cancer (ICD-9 Code 185).

5.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DRs

NIOSH performed the original DR of Case [D] in October 2005. The claim was reworked in May 2010 as a result of changes to the LANL Occupational External Dose TBD, which were incorporated in ORAUT-TKBS-0010-6, Revision 01 and resulted in the issuance of OCAS-PER-018, as well as consideration of potential exposure to plutonium for Type Super S material (OCAS-PER-012). It should be noted that at the time of this rework (May 2010), Revision 02 of ORAUT-TKBS-0010-6 had already been issued. Revision 2 of this TBD retained the η/p ratios introduced in Revision 01; however, it included changes due to the addition of a class of employees to the SEC.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated based on claimant-favorable assumptions. In the original DR, NIOSH calculated a total dose from both the LANL and [redacted] employment locations of 65.563 rem to the prostate. Based on this assigned dose estimate, the DOL determined the POC to be 39.92% and the claim was denied.

Using Revision 02 of ORAUT-TKBS-0010-6 and the most current technical guidance documents, a prostate dose of 35.422 rem was calculated in the reworked DR. Table 5-1 provides a comparison of the original and revised external and internal organ dose estimates. It should be noted that the values cited in Table 5-1 were extracted directly from NIOSH's reworked DR. With the exception of assigned external measured/missed photon and neutron doses for the EE's LANL employment, 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 5-1. Comparison of NIOSH-Derived External/Internal Dose Estimates Assigned for the Prostate in the Original and Reworked DRs

Dose Categories	Prostate Doses (Rem)			
	Original DR – LANL and [redacted]	Original DR – LANL Only	Revised DR – LANL and [redacted]	Revised DR – LANL Only
Occupational External:				
- Measured/Missed Photons	12.497	4.106	8.845	4.111
- Measured/Missed Neutrons	29.009	29.009	10.481	10.481
Onsite Ambient	5.140	–	6.111	–
Medical X-Ray	0.942	–	0.702	–
Internal	17.974	–	9.285	–
Total	65.563	–	35.424	–

Using the revised prostate dose of 35.424 rem, the DOL calculated a POC of 32.41% and the claim was denied.

5.3 SC&A’S REVIEW OF OCAS-PER-018 ISSUES RELATED TO CASE [D]

As directed by the PRSC, SC&A’s review of Case [D] focused on revisions to the calculation of exposure to neutrons, as specified in OCAS-PER-018. Since neutron doses for a portion of the worker’s employment are based on the EE’s monitored and missed photon doses, our evaluation also reviewed NIOSH’s estimate of photon dose. Case [D] was included in the pool of claims that required the DR to be reworked, since the original DR was performed using Revision 00 of the LANL Occupational External Dose TBD, and the EE was monitored for exposure to neutrons, but a portion of the assigned neutron dose was based on a η/p ratio.

5.3.1 Photon Dose Calculation in Original DR

The **original** DR calculated photon doses for those years when the EE was monitored at LANL, (i.e., [redacted]–[redacted], [redacted], [redacted], [redacted], and [redacted]). Positive recorded doses were multiplied by an organ DCF of 1.244, using the bladder as the surrogate organ, and an uncertainty factor of 1.3 prior to [redacted] and 1.14 after [redacted]. This resulted in a total measured photon dose of 1.601 rem during the EE’s employment at LANL. All photons were assumed to be an energy range of 100% 30–250 keV and were entered into IREP as a constant dose distribution.

Missed photon dose was assessed in the original DR by counting the actual number of zero readings in the EE’s LANL occupational radiation exposure records, which resulted in identifying 113 missed photon doses. The number of zero readings was multiplied by (1) one-half the limit of detection (LOD) for the period (LOD_{prior1980} = 0.040 rem; LOD_{after1979} = 0.010 rem) and the bladder DCF of 1.244. This resulted in a total missed photon dose of 2.505 rem. Annual photon doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

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5.3.2 Neutron Dose Calculation in Original DR

The **original** DR assigned measured neutron doses prior to [redacted] using the η/p ratio method. A η/p ratio of 5.5, representing the maximum value for ‘Plutonium facilities,’ was selected from Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. There were no recorded positive photon or neutron doses reported after 1978 in the EE’s LANL dosimetry records. Therefore, under-reported neutron doses were calculated using measured photon doses and applying a η/p ratio of 5.5, an ICRP 60 CF of 1.91, and an organ DCF of 1.0. This resulted in a total measured neutron dose of 13.520 rem. Measured neutron doses were entered into IREP with an energy range of 0.1–2.0 MeV as a constant value.

Missed neutron doses prior to [redacted] were calculated by multiplying the missed photon dose by the η/p ratio of 5.5, a DCF of 1.0, and an ICRP 60 factor of 1.91. In [redacted] and after, the actual number of zero neutron readings reported in the LANL records was multiplied by one-half the LOD value of 0.010, a DCF of 1.0, and an ICRP 60 CF of 1.91. This resulted in a total missed neutron dose of 15.489 rem. Missed annual neutron doses were assumed to be within the energy range of 0.1–2.0 MeV and entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

5.3.3 Photon Dose Calculation in Reworked DR

The **reworked** DR also assigned photon doses for all years in which records indicated that the EE was monitored for external exposure at LANL. In the revised DR, guidance regarding the treatment of positive dosimeter measurements that were below the LOD/2 value had changed. These <LOD/2 values were now considered missed dose. Therefore, measured photon doses equal to or greater than LOD/2 values were calculated by applying a bladder DCF value of 1.244, and an uncertainty factor of 1.3 (prior to [redacted]) or 1.14 ([redacted] and after). This resulted in the assignment of a total measured photon dose of 1.585 rem, which was entered into IREP with an energy range of 30–250 keV and as a constant dose distribution.

Missed photon doses were calculated by counting the actual number of zero and <LOD/2 badge readings. A total number of 114 missed dosimeter cycles was determined. Missed photon dose was estimated by multiplying the number of missed badge exchange cycles by the applicable LOD/2 values and a bladder DCF of 1.244. A total missed photon dose of 2.526 rem was calculated. Annual missed photons were assumed to be in the energy range of 30–250 keV, and doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

5.3.4 Neutron Dose Calculation in Reworked DR

In the **reworked** DR, NIOSH assigned neutron doses for the years prior to [redacted] based on a η/p ratio. The neutron dose was calculated using the η/p ratio of 1.6 from Table 6-22 of ORAUT-TKBS-0010, Revision 02, which represents the median value for ‘Other Operations,’ and applying the 1.91 ICRP 60 CF and an organ DCF of 1.0. This resulted in a neutron dose of 2.875 rem, which was entered into IREP with an energy range of 0.1–2 MeV and as a GM of a lognormal distribution with a varying GSD that accounts for a combined dosimeter uncertainty and missed dose uncertainty. There were no positive neutron doses reported after [redacted].

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For years prior to [redacted], the revised DR calculated missed neutron doses by multiplying the missed photon doses by a DCF of 1.0, an ICRP 60 factor of 1.91, and the η/p ratio of 1.6. Post-[redacted], missed neutron doses were estimated based on the actual number of zero and <LOD/2 values reported in the EE's records and were estimated by multiplying the number of missed badge exchange cycles by the applicable LOD/2 values, an ICRP 60 CF of 1.91, organ DCF of 1.0, and an uncertainty factor 1.08. This resulted in a total missed neutron dose of 7.453 rem. All missed neutron doses were assumed to be within an energy range of 0.1–2.0 MeV, and annual doses were entered into IREP as a GM of a lognormal distribution with a varying GSD that accounts for a combined dosimeter uncertainty and missed dose uncertainty.

5.3.5 SC&A's Conclusions Regarding Assignment of Photon and Neutron Doses

In evaluating this case, SC&A reviewed pertinent records contained in the EE's file. We also assessed whether the original and revised DRs followed guidance for assessing monitored or unmonitored and missed neutron doses, as specified in Revisions 00 and 02 of the LANL Occupational External Dose TBD, respectively. For this case, our review confirmed that both the original and reworked DRs calculated photon and neutron doses appropriately and consistent with the TBD guidance. It was noted that the original and reworked DRs differed in their selection of the neutron source for determining the appropriate η/p ratio (i.e., the original DR used the 'Plutonium facility' and the reworked DR selected the ratio for 'Other Operations'). Another factor that significantly reduced the assigned neutron dose in the revised DR was the use the **median** η/p ratio for 'Other Operations,' while the original DR selected the highest η/p ratio listed in Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. Considering the EE's job function and primary work locations, SC&A concurs that the selection of a median η/p ratio associated with 'Other Operations' is reasonable. SC&A has no findings with NIOSH's methodology for reassessing Case [D] based on OCAS-PER-018.

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6.0 REVIEW OF OCAS-PER-018 ISSUES FOR CASE [C]

6.1 BACKGROUND INFORMATION FOR CASE [C]

Case [C] represents an EE who worked at LANL from [redacted], through [redacted]. Based on information provided by the EE in the telephone interview, his job title was [redacted], and he worked primarily at TA-[redacted] and TA-[redacted]. According to DOE records provided for employment at LANL, the EE was monitored for exposure to external radiation for all years of employment except in [redacted], [redacted], and [redacted]. While employed at LANL, the EE made periodic visits to [redacted] between [redacted] and [redacted], where the EE was also monitored for external radiation. (It should be noted that SC&A's review will only assess the photon and neutron doses assigned in behalf of work at LANL, as discussed in OCAS-PER-0018.) In [redacted], the EE was diagnosed with prostate cancer (ICD-9 Code 185).

6.2 COMPARISON OF NIOSH'S ORIGINAL AND REWORKED DRs

NIOSH performed the original DR of Case [C] in October 2006. The claim was reworked in April 2010 as the result of changes to the LANL Occupational External Dose TBD, which were incorporated in ORAUT-TKBS-0010-6, Revision 01, and resulted in the issuance of OCAS-PER-018. It should be noted that at the time of this rework (April 2010), Revision 02 of ORAUT-TKBS-0010-6 had already been issued. Revision 2 of this TBD retained the η/p ratios introduced in Revision 01, but added a class of employees to the SEC.

NIOSH indicated in both the original and revised DRs that the EE's radiation dose was overestimated based on claimant-favorable assumptions. In the original DR, NIOSH calculated a total dose from radiation exposures at both LANL and NTS of 77.450 rem to the prostate. Based on this assigned dose estimate, the DOL determined the POC to be 41.15% and the claim was denied.

Using Revision 02 of ORAUT-TKBS-0010-6 and the most current technical guidance documents, a prostate dose of 39.501 rem was calculated in the reworked DR. Table 6-1 provides a comparison of the original and revised external and internal organ dose estimates. It should be noted that the values cited in Table 6-1 were extracted directly from NIOSH's reworked DR. With the exception of assigned external measured/missed photon and neutron doses for the EE's LANL employment, 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 Prostate in the Original and Reworked DRs

Dose Categories	Prostate Doses (Rem)			
	Original DR – LANL and [redacted]	Original DR – LANL Only	Revised DR – LANL and [redacted]	Revised DR – LANL Only
Occupational External:				
- Measured/Missed Photons	14.318	13.286	10.562	9.359
- Measured/Missed Neutrons	50.656	47.552	27.265	23.414
Onsite Ambient	0.573	–	0.133	–
Medical X-Ray	1.222	–	1.163	–
Internal	10.681	–	0.379	–
Total	77.450	–	39.501	–

Using the revised prostate dose of 39.501 rem, the DOL calculated a POC of 35.90% and the claim was denied.

6.3 SC&A’S REVIEW OF OCAS-PER-018 ISSUES RELATED TO CASE [C]

As directed by the PRSC, SC&A’s review of Case [C] focused on revisions to the calculation of exposure to neutrons, as specified in OCAS-PER-018. Since neutron doses for a portion of the worker’s employment are based on the EE’s monitored and missed photon doses, our evaluation also reviewed NIOSH’s estimate of photon dose. Case [C] was included in the pool of claims that required the DR to be reworked, since the original DR was performed using Revision 00 of the LANL Occupational External Dose TBD and the EE was monitored for exposure to neutrons, but a portion of the assigned neutron dose was based on a η/p ratio.

6.3.1 Photon Dose Calculation in Original DR

The **original** DR calculated photon doses for those years when the EE was monitored at LANL, (i.e., [redacted]–[redacted], [redacted]–[redacted]). Any measured badge readings reported at a value of <LOD/2 were treated as missed dose. Positive recorded doses at or greater than LOD/2 were multiplied by an organ DCF of 1.244, using the bladder as the surrogate organ, and an uncertainty factor of 1.3 prior to [redacted] and 1.14 after [redacted]. This resulted in a total measured photon dose of 5.494 rem during the EE’s employment at LANL. All photons were assumed to be an energy range of 100% 30–250 keV and were entered into IREP as a constant dose distribution.

Missed photon dose was assessed in the original DR by counting the actual number of zero and <LOD/2 readings in the EE’s LANL occupational radiation exposure records, which resulted in the identification of 332 missed photon doses. The number of missed photon doses was multiplied by one-half the LOD for the period ($LOD_{prior1980} = 0.040$ rem; $LOD_{after1979} = 0.010$ rem) and the bladder DCF of 1.244. This resulted in a total missed photon dose of 7.792 rem. Annual photon doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

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6.3.2 Neutron Dose Calculation in Original DR

The **original** DR assigned measured neutron doses prior to [redacted] using the η/p ratio method in accordance with the LANL TBD. NIOSH selected a η/p ratio of 2.4, representing the maximum value for ‘Other Operations’ from Table 6-22 of ORAUT-TKBS-0010-6, Revision 00. LANL dosimetry records showed no recorded positive neutron doses after [redacted]. Therefore, all measured but under-reported neutron doses were calculated using recorded photon doses and applying a η/p ratio of 2.4, an ICRP 60 CF of 1.91, and an organ DCF of 1.0. This resulted in a total measured neutron dose of 20.142 rem. Measured neutron doses were entered into IREP with an energy range of 0.1–2.0 MeV as a constant value.

Missed neutron doses prior to [redacted] were calculated by multiplying the missed photon dose by the η/p ratio of 2.4, a DCF of 1.0, and an ICRP 60 factor of 1.91. For [redacted] and after, the actual number of zero neutron readings reported in the LANL records was multiplied by (1) one-half the LOD value of 0.010, (2) a DCF of 1.0, and (3) an ICRP 60 CF of 1.91. This resulted in a total missed neutron dose of 27.410 rem. Missed annual neutron doses were assumed to be within the energy range of 0.1–2.0 MeV and entered into IREP as a GM of a lognormal distribution with a GSD of 1.52.

6.3.3 Photon Dose Calculation in Reworked DR

The **reworked** DR also assigned photon doses for all years in which records indicated that the EE was monitored for external exposure at LANL. The revised DR states “. . . the dose conversion factors were applied to the reported and missed doses as a triangular distribution using numerical methods” and references *Technical Information Bulletin: Monte Carlo Methods for Dose Uncertainty Calculations* (ORAUT-OTIB-0012). The mode of the organ DCF was identified as 1.244, which is associated with the surrogate organ of the bladder. This resulted in the assignment of a total measured photon dose of 3.643 rem, which was entered into IREP with an energy range of 30–250 keV and as a mean of a normal dose distribution with a standard deviation ranging from 27% to 65%.

Missed photon doses were calculated by counting the actual number of zero and <LOD/2 badge readings. A total number of 316 missed dosimeter cycles was determined. Missed photon dose was estimated by multiplying the number of missed badge exchange cycles by the applicable LOD/2 values and the triangular distribution of the organ DCF, as specified in ORAUT-OTIB-0012. A total missed photon dose of 5.716 rem was calculated. Annual missed photons were assumed to be in the energy range of 30–250 keV, and doses were entered into IREP as a GM of a lognormal distribution with a GSD of 1.62.

6.3.4 Neutron Dose Calculation in Reworked DR

In the **reworked** DR, NIOSH assigned neutron doses for the years prior to [redacted] based on a η/p ratio. The DR report states that “. . . the neutron-to-photon ratio used was the lognormally-distributed ratio listed for the ‘Other Operations’ in the Technical Basis Document for the Los Alamos National Laboratory (ORAUT-TKBS-0010-6, Rev. 02).” SC&A therefore assumed that the neutron dose was calculated using the **η/p ratio of 1.6** from Table 6-22 of ORAUT-TKBS-

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0010, Revision 02, which represents the **median** value for ‘Other Operations,’ and applying the 1.91 ICRP 60 CF and an organ DCF of 0.796 (representing the neutron deep dose equivalent for the bladder). This resulted in a neutron dose of 10.389 rem, which was entered into IREP with an energy range of 0.1–2 MeV and as a GM of a lognormal distribution with varying GSD values. There were no positive neutron doses reported after 1978.

According to the revised DR report, missed neutron doses for years prior to [redacted] were calculated by multiplying the missed photon doses by a DCF of 0.796, an ICRP 60 factor of 1.91, and the η/p ratio of 1.6. Post-[redacted], missed neutron doses were estimated based on the actual number of zero and <LOD/2 values reported in the EE’s records, and were calculated by multiplying the number of missed badge exchange cycles by the applicable LOD/2 values, an ICRP 60 CF of 1.91 and organ DCF of 0.796. This resulted in a total missed neutron dose of 13.025 rem. All missed neutron doses were assumed to be within an energy range of 0.1–2.0 MeV, and annual doses were entered into IREP as a GM of a lognormal distribution with varying GSD values.

6.3.5 SC&A’s Conclusions Regarding Assignment of Photon and Neutron Doses

In evaluating this case, SC&A reviewed pertinent records contained in the EE’s file. We also assessed whether the original and revised DRs followed guidance for assessing monitored or unmonitored and missed neutron doses, as specified in Revisions 00 and 02 of the LANL Occupational External Dose TBDs, respectively. For this case, our review identified the following inconsistencies with the TBD guidance.

Finding #7: Dosimeter Uncertainty Factors Not Applied to Photon Exposure in Revised DR

The **revised** DR did not apply the recommended film badge uncertainty factor of 30% to measured photons prior to 1980 and the Model 7776 dosimeter uncertainty factor of 14% after 1979, as cited in Table A-4 of ORAUT-TKBS-0010-6, Revision 02. This error will also underestimate the assigned neutron doses prior to [redacted], since they are based on a η/p ratio.

Finding #8: Dosimeter Uncertainty Factor Not Applied to Neutron Exposure in Original and Revised DRs

Both the original and reworked DRs did not apply the recommended Model 7776 Dosimeter uncertainty factor of 8% to measured neutrons after [redacted], as specified in Revision 00 and Revision 02 of ORAUT-TKBS-0010-6.

Finding #9: SC&A Questions the Selection of a Median Neutron-to-Photon Ratio for Estimating Under-Reported Neutron Doses

In the years between [redacted] and [redacted] when the EE was monitored for neutrons, the records indicate that the neutron doses were significantly higher than the photon dose. For example, in [redacted], the recorded photon dose was 0.060 rem and the recorded neutron dose was 0.750 rem. Based on this comparison and considering that the TBD states that neutron doses prior to [redacted] were likely under-reported, SC&A believes that it would have been more

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appropriate to select the 95th percentile η/p dose ratio of 6.4 for ‘Other Operations’ in the revised DR.

SC&A’s Subtask 4 evaluation also attempted to reproduce the recorded/missed photon and neutron doses. Since the revised DR used a Monte Carlo method described in ORAUT-OTIB-0012 for estimating photon doses, SC&A’s manually calculated doses were not identical to NIOSH’s doses, but were reasonably close. For neutron doses assigned in the **revised DR**, SC&A was not able to reasonably match NIOSH’s assigned values, as described in the finding below.

Finding #10. SC&A was Unable to Manually Calculate Measured Neutron Doses Based on a Neutron-to-Photon Ratio for Years [redacted], [redacted], [redacted], and [redacted] that are Reasonably Close Estimates of NIOSH’s Assigned Dose in the Revised DR

SC&A could not calculate a neutron dose using the η/p ratio method described in the revised DR that is reasonably close to the NIOSH’s assigned values for select years. An example for [redacted] is provided below:

$$0.040 \text{ rem (recorded photon dose)} \times 1.6 (\eta/p \text{ ratio}) \times 1.91 (\text{ICRP CF}) \times 0.796 (\text{DCF}) = 0.097 \text{ rem}$$

SC&A’s manually calculated value of 0.097 rem must be compared to the NIOSH-assigned value of 0.433 rem for [redacted]. Although NIOSH’s value is claimant favorable in comparison to the SC&A derived value, SC&A is unclear as to the reason for this discrepancy. As stated in Finding #9 above, the recorded neutron dose for [redacted] was significantly higher than the recorded photon dose. If NIOSH has applied some CF to account for the higher reported neutron dose, it was not discussed in the DR report. Therefore, SC&A needs a clarification of NIOSH’s calculational methods in behalf of this claim.

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7.0 SUMMARY CONCLUSIONS

Under SC&A's *A Protocol to Review NIOSH's Program Evaluation Reports (PERs)*, SCA-TR-PR2009-0002, Revision 1 (SC&A 2009), Subtask 4 requires the audit of DR cases reworked as a result of the PER under review. SC&A's review of OCAS-PER-018 "LANL TBD Revision," identified five findings, which were transferred to the LANL Work Group for resolution. Thereafter, the PRSC selected five cases and tasked SC&A with reviewing these reworked claims.

This report satisfies the Subtask 4 requirement. Since the TBD revisions associated with OCAS-PER-018 included changes to η/p ratios, SC&A's review of the five cases evaluated both the NIOSH-derived photon and neutron doses. For each case, SC&A reviewed all case records, the CATI reports, applicable technical guidance documents, and applicable workbooks employed for assessing photon and neutron doses. We manually calculated all photon and neutron doses and compared those values to NIOSH-derived doses. Lastly, we verified that all data were correctly entered into IREP. This review resulted in the identification of one observation and five findings.

For three of the cases reviewed (i.e., Cases [A, B, and D]) and discussed in Sections 2, 4, and 5, respectively, SC&A concurs with the approach used for assessing photon and neutron doses based on the revised η/p ratios. SC&A was able to manually derive doses that matched or were reasonably close to those assigned by NIOSH. We also found that exposure parameters and dose distribution data for these cases were correctly entered into IREP.

As discussed in Section 3, SC&A had one observation and one finding associated with Case [E]. The observation identified that an incorrect photon dose uncertainty factor was applied to the [redacted] recorded dose in the original DR; and the finding (Finding #6) identified that the [redacted] measured neutron dose of 0.080 rem was not included in either the original or revised DRs.

Under Section 6, SC&A had four findings associated with Case [C]. Finding #7 identifies NIOSH's failure to apply the TBD-specified uncertainty factors to measured photon doses. In both the original and reworked DRs, NIOSH also failed to apply the TBD-specified uncertainty factor of 8% to monitored neutron doses reported after [redacted] (Finding #8). Additionally, SC&A questions NIOSH's selection of a median rather than 95th percentile η/p dose ratio for 'Other Operations,' in the revised DR based on the EE's recorded neutron and photon doses in the early years of employment at LANL (Finding #9). Lastly, SC&A was unable to manually calculate a neutron dose that is reasonably close to the doses assigned by NIOSH for years [redacted], [redacted], [redacted] and [redacted] (Finding #10). Therefore, SC&A is requesting clarification on the calculational methods used by NIOSH.

With the exception of Finding #9, all other findings will have only a modest impact on the total dose and POCs for these cases. However, they do raise concerns about quality assurance. With regard to Findings #8 and #10, SC&A is also questioning if the issues identified may reflect an error in the LANL Calculation Workbook.

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REFERENCES

ABRWH 2011. Transcript from Subcommittee on Procedures Meeting held March 22, 2011. Available on the internet at website: <http://www.cdc.gov/niosh/ocas/pubm2011.html#mar22>.

ICRP (International Commission on Radiological Protection) 1990. *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60, Annals of the ICRP, Vol. 21, Pergamon Press, Oxford, England.

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

OCAS-PER-014. *Construction Trade Workers*, Rev. 00, NIOSH's Office of Compensation Analysis and Support, Cincinnati, Ohio. November 28, 2007.

OCAS-PER-018. *Los Alamos National Laboratory TBD Revision*, Rev. 00, NIOSH's Office of Compensation Analysis and Support, Cincinnati, Ohio. July 31, 2007.

OCAS-PR-008. *Preparation of Program Evaluation Reports and Program Evaluation Plans*, Rev. 2, NIOSH's Office of Compensation Analysis and Support, Cincinnati, Ohio. December 6, 2006.

OCAS-TIB-010. *Technical Information Bulletin: Special External Dose Reconstruction Considerations for Glovebox Workers*, Rev. 02, NIOSH's Office of Compensation Analysis and Support, Cincinnati, Ohio. December 30, 2005.

ORAUT-OTIB-0012. *Technical Information Bulletin: Monte Carlo Methods for Dose Uncertainty Calculations*, Rev. 00, Oak Ridge Associated University Team: Cincinnati, Ohio. February 14, 2005.

ORAUT-TKBS-0010-4, Rev. 00. *Los Alamos National Laboratory – Occupational Environmental Dose*, Rev. 00, Oak Ridge Associated University Team: Cincinnati, Ohio. October 8, 2004.

ORAUT-TKBS-0010-6, Rev. 00. *Los Alamos National Laboratory – Occupational External Dose*, Rev. 00, Oak Ridge Associated University Team: Cincinnati, Ohio. May 10, 2005.

ORAUT-TKBS-0010-6, Rev. 01. *Los Alamos National Laboratory – Occupational External Dose*, Rev. 01, Oak Ridge Associated University Team: Cincinnati, Ohio. May 30, 2007.

ORAUT-TKBS-0010-6, Rev. 02. *Los Alamos National Laboratory – Occupational External Dose*, Rev. 02, Oak Ridge Associated University Team: Cincinnati, Ohio. November 23, 2009.

ORAUT-TKBS-0010-6, Rev. 03. *Los Alamos National Laboratory – Occupational External Dose*, Rev. 03, Oak Ridge Associated University Team: Cincinnati, Ohio. March 21, 2013.

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SCA-TR-TASK1-0011. *Los Alamos National Laboratory Site Profile Review*, SC&A, Inc.: Vienna, Virginia. August 28, 2008.

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

SCA-TR-PR2010-0018. *A Review of NIOSH's Program Evaluation Report OCAS-PER-018, "Los Alamos National Laboratory TBD Revision,"* Rev. 0. SC&A, Inc.: Vienna, Virginia. September 28, 2010.