REPORT TO THE ADVISORY BOARD ON RADIATION AND WORKER HEALTH

National Institute of Occupational Safety and Health

Audit of Case PIID* from Hanford

Contract No. 200-2004-03805
Task Order No. 4

SCA-TR-TASK4-CNPIID*

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Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program</td><td>Document No.
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1.0 RELEVANT BACKGROUND INFORMATION

This report presents an independent audit of a Dose Reconstruction (DR) Report performed by the National Institute of Occupational Safety and Health (NIOSH) for an energy employee who has worked as an PIID* at the Hanford Site from PIID* to the present. On PIID*, the energy employee was diagnosed with Hodgkin's disease.

Throughout the **PIID*** of consideration, the claimant had been monitored for external exposure on a monthly basis by TLD. For internal assessment, claimant was given a baseline and yearly whole-body counts. NIOSH's dose reconstruction included a total of 54 exposure data entries to be used for determining the probability of causation. These dose data entries are reproduced herein as Appendix A. Throughout this report, reference will be made to select portions of Appendix A; for example, exposure entries #51 through #54 correspond to occupational medical exposure.

Summarized in Table 1 below are dose estimates derived by NIOSH's that correspond to data contained in Appendix A. Using the dose estimate derived by NIOSH, the probability of causation (POC) was determined by the Department of Labor (DOL) to be 4.77% at the 99% confidence interval, and on this basis, the claim was denied.

Table 1. Summary of NIOSH-Derived External/Internal Dose Estimates

	Appendix A Exposure Entry No.	**Dose (rem)**
External Dose:		
▪ Photon Dosimeter Dose	NC*	—
▪ Missed Photon Dose	31 – 40	0.840
▪ Neutron Dosimeter Dose	NC*	—
▪ Missed Neutron Dose	NC*	—
▪ Occupational Medical:	51 – 54	0.021
▪ Onsite Ambient	41 – 50	0.295
Internal Dose (Hypothetical):	1 – 30	9.762
Total:		10.918

*NC – Not considered.

1.1 AUDIT OBJECTIVES

SC&A's audit was performed with the following objectives:

- To determine if assigned doses are consistent with monitoring records provided by the DOE and the information contained in the CATI report
- To determine if the dose reconstruction process complied with applicable procedures that include generic procedures developed by NIOSH and ORAUT, as well as data/procedures that are site-specific to Hanford

- In instances when procedure(s) provide more than one option or require subjective decisions, determine if the process is scientifically defensible and/or claimant favorable.

In pursuit of these objectives, a two-step process is followed in this audit. The first step of this audit is to independently duplicate and, therefore, validate doses derived by NIOSH. This step of the audit process is not only contractually mandated under Task 4, but provides NIOSH and the Advisory Board with a high level of assurance that the SC&A reviewer understands which procedures, models, site-specific data, and assumptions NIOSH used to perform its dose reconstruction. The second step of the audit evaluates whether the methods employed by NIOSH are consistent with applicable procedures, scientifically defensible, and claimant favorable.

Lastly, in compliance with the Privacy Act, this report makes no reference to the claimant's name, SSN, address, or any personal data that might reveal the identity of the claimant.

1.2 SUMMARY OF AUDIT FINDINGS

An overview of SC&A's audit findings for Case PIID* is provided in Table 2 in the form of a checklist. This checklist evaluates the data collection process, information obtained from the CATI interview, and all methods used in the dose reconstruction. When deficiencies are identified by the audit, such deficiencies are further characterized with regard to their impact(s) by means of the following definitions: (1) **low** means that the deficiency has only a marginal impact on dose; (2) **medium** means that the deficiency substantially impacts the dose, but is unlikely to impact the compensability of the case; and (3) **high** means that the deficiency substantially impacts the dose and may also impact the compensability of the case. A full description of deficiencies identified in the checklist is provided in the text of the audit that follows.

Table 2. Case Review Checklist

CASE PIID*	ASSIGNED DOSE: 10.918 rem	POC: 4.77%

No.	Description of Technical Elements of Review	Audit Response			If No, Potential Significance		
		YES	N/A	NO	LOW[1]	MEDIUM[2]	HIGH[3]
A. REVIEW OF DATA COLLECTION:							
A.1	Did NIOSH receive all requested data for the DOE or AWE site from any relevant data source?	✓					
A.2	Is the data used by NIOSH for the case adequate to make a determination with regard to POC?	✓					
B. REVIEW OF INTERVIEW AND DOCUMENTATION PROVIDED BY CLAIMANT							
B.1	Did NIOSH properly address all work history dates/locations of employment reported by claimant?	✓					
B.2	Did NIOSH properly address all incidents/occurrences reported by claimant?	✓					
B.3	Did NIOSH properly address monitoring/ personal protection/work practices reported by claimant?	✓					
B.4	Is the interview information consistent with data used for dose estimate?	✓					
C. REVIEW OF PHOTON DOSES							
C.1	Was the appropriate procedure used for determining:						
C.1.1	- Recorded Photon Dose?		✓				
C.1.2	- Missed Photon Dose?	✓					
C.1.3	- Occupational Medical Dose?	✓					
C.1.4	- Onsite-Ambient Dose?	✓					
C.2	Did the DR properly account for all:						
C.2.1	- Recorded Photon Dose?		✓				
C.2.2	- Missed Photon Dose?	✓					
C.2.3	- Occupational Medical Dose?			✓	✓		
C.2.4	- Onsite-Ambient Dose?	✓					
C.3	Is the recorded/assigned dose properly converted to the organ dose of interest for:						
C.3.1	- Recorded Photon Dose?		✓				
C.3.2	- Missed Photon Dose?	✓					
C.3.3	- Occupational Medical Dose?			✓	✓		
C.3.4	- Onsite-Ambient Dose?	✓					
C.4	Is the organ dose uncertainty properly determined for:						
C.4.1	- Recorded Photon Dose?		✓				
C.4.2	- Missed Photon Dose?	✓					
C.4.3	- Occupational Medical Dose?	✓					
C.4.4	- Onsite-Ambient Dose?	✓					
D. REVIEW OF SHALLOW (i.e., 7 mg/cm^2)/ELECTRON DOSES							
D.1	Was the appropriate procedure used for determining:						
D.1.1	- Recorded Shallow/Electron Dose?		✓				
D.1.2	- Missed Shallow/Electron Dose?		✓				
D.1.3	- Onsite Ambient Dose?		✓				
D.2	Did the DR properly account for all:						
D.2.1	- Recorded Shallow/Electron Dose?		✓				
D.2.2	- Missed Shallow/Electron Dose?		✓				
D.2.3	- Onsite Ambient Dose?		✓				
D.3	Is the recorded/assigned dose properly converted to the organ dose of interest for:						
D.3.1	- Recorded Shallow/Electron Dose?		✓				

[1] **Low** means that the deficiency has only a marginal impact on dose.
[2] **Medium** means that the deficiency substantially impacts the dose, but is unlikely to impact the compensability of the case.
[3] **High** means that the deficiency substantially impacts the dose and may also impact the compensability of the case.

CASE PIID*	ASSIGNED DOSE: 10.918 rem	POC: 4.77%

No.	Description of Technical Elements of Review	Audit Response			If No, Potential Significance		
		YES	N/A	NO	LOW[1]	MEDIUM[2]	HIGH[3]
D.3.2	- Missed Shallow/Electron Dose?		✓				
D.3.3	- Onsite Ambient Dose?		✓				
D.4	Is the organ dose uncertainty properly determined for:						
D.4.1	- Recorded Shallow/Electron Dose?		✓				
D.4.2	- Missed Shallow/Electron Dose?		✓				
D.4.3	- Onsite Ambient Dose?		✓				
E. REVIEW OF NEUTRON DOSES							
E.1	Was the appropriate procedure used for determining:						
E.1.1	- Recorded Neutron Dose?		✓				
E.1.2	- Assigned Neutron Dose?		✓				
E.1.3	- Missed Neutron Dose?		✓				
E.2	Did the DR properly account for all:						
E.2.1	- Recorded Neutron Dose?		✓				
E.2.2	- Assigned Neutron Dose?		✓				
E.2.3	- Missed Neutron Dose?		✓				
E.3	Is the recorded/assigned dose properly converted to the organ dose of interest for:						
E.3.1	- Recorded Neutron Dose?		✓				
E.3.2	- Assigned Neutron Dose?		✓				
E.3.3	- Missed Neutron Dose?		✓				
E.4	Is the organ dose uncertainty properly determined for:						
E.4.1	- Recorded Neutron Dose?		✓				
E.4.2	- Assigned Neutron Dose?		✓				
E.4.3	- Missed Neutron Dose?		✓				
F. REVIEW OF INTERNAL DOSE: BASED ON HYPOTHETICAL MODEL							
F.1	Is the use of the selected hypothetical internal dose model appropriate, based on the likely POC value?	✓					
F.2	Is the use of a hypothetical internal dose model appropriate/conservative, based on claimant's available bioassay data,?	✓					
F.3	Was the hypothetical dose value correctly derived?	✓					
G. REVIEW OF INTERNAL DOSE: BASED ON BIOASSAY/IMBA							
G.1	Was the appropriate procedure (or section of procedure) used for determining likely (>50%), unlikely (<50%), or undetermined POC and compensability?		✓				
G.2	Are bioassay data sufficiently adequate for internal dose reconstruction?		✓				
G.3	Are assumptions pertaining to dates of uptake reasonable/conservative?		✓				
G.4	Are critical parameters (e.g., solubility class, particle size, etc.) used for IMBA organ dose estimates appropriate?		✓				
G.5	Are assigned uncertainties (measurement errors) for bioassay data (used as input to IMBA) appropriate?		✓				
H. Total Number of Deficiencies and Their Combined Potential Significance				2	✓		

[1] **Low** means that the deficiency has only a marginal impact on dose.
[2] **Medium** means that the deficiency substantially impacts the dose, but is unlikely to impact the compensability of the case.
[3] **High** means that the deficiency substantially impacts the dose and may also impact the compensability of the case.

2.0 AUDIT OF EXTERNAL DOSES

2.1 PHOTON DOSE

2.1.1 Recorded Photon Dose

Based on assigned duties that had the potential for external exposure, the claimant was monitored on a monthly change-out schedule for the full PIID* period under consideration. External dose records submitted by the DOE provide a complete record of the claimant's external exposure. A review of DOE records shows that the claimant had no monthly dosimeter readings that were positive. Thus, external photon exposures were limited to missed photon dose estimates (see Exhibit 1).

2.1.2 Missed Photon Doses

Of relevance to this case are exposures recorded as deep dose ($H_P(10)$). The claimant's Dose Reconstruction report states that:

> *. . . For the purpose of estimating probability of causation, all photon doses, except on-site ambient are assumed to be* ***acute*** *as this maximizes probability of causation . . .* [Emphasis added.]

And,

> *For the purposes of this dose reconstruction, the distribution of . . . exposure geometry and radiation energies was selected to maximize dose. To ensure that the estimated dose has been maximized, an organ dose conversion factor of 1 has been applied. To maximize the probability of causation, a photon energy range of 100% 30–250 keV was applied.*

A review of the claimant's external photon dosimeter data shows that for the entire PIID* monitoring period, there were no positive dosimeter readings. Correspondingly, estimates of external deep-dose photon exposure were based on missed dose assumed for monthly dosimeters' minimum detectable limits (MDLs), as provided in Table 6-30 of ORAUT-TKBS-0006-2. Table 6-30 identifies the following MDLs.

Period Of Use	MDL (mrem)	Maximum Annual Missed Dose (mrem)
PIID*	20	120
PIID*	10	60

Missed doses for the claimant's PIID* period for monitoring were calculated at 840 mrem ((4 yrs x 120 mrem/yr) + (6 yrs x 60 mrem/yr) = 840 mrem).

The selected method for estimating missed photon doses was based on the LOD/2, which defines a central value along with an uncertainty that assumes a lognormal distribution with a geometric

standard deviation of 1.52. The generic geometric standard deviation was derived by the following formula:

$$GSD = \frac{95^{th}\ percentile^{(1/1.6558)}}{50^{th}\ percentile}$$
$$= \frac{LOD\ tissue}{LOD/2}$$
$$= 2^{1/1.6558}$$
$$= 1.52$$

This generic approach is recommended by OCAS-IG-001, ORAUT-PROC-0006, and ORAUT-TKBS-0006-6. Thus, for missed photon exposure, the DR Report followed procedural recommendations and assigned the correct missed doses.

2.2 MISSED NEUTRON DOSES

In reviewing the DOE dosimetry records for this case, there is the potential that the DR Report may have underestimated the missed neutron doses. The Radiological Exposure Individual Dosimeter History Report for Case PIID* (see Exhibit 1) identifies the annual neutron dose as zero for the entire PIID* employment period of concern. This implies that the claimant was monitored for neutrons. However, the DR Report failed to account for any missed neutron doses. It should be noted that the claimant's work location included the Hanford PIID*. Moreover, Exhibit 1 shows positive ring dosimeter results, which suggests that the energy employee may have been exposed to Pu and, therefore, to neutrons.

As stated in the Hanford Technical Basis Document, ORAUT-TKBS-0006-6, missed neutron doses should be calculated based on MDLs of the dosimeters in use at the time. Table 6-31 of ORAUT-TKBS-0006-6 identifies the MDL and maximum annual missed dose for the periods of concern as follows:

Period Of Use	MDL (mrem)	Maximum Annual Missed Neutron Dose (mrem)	Total Missed Neutron Dose (mrem)
PIID*	50	300	1,500
PIID*	15	100	500
			2,000

Using this procedural guidance, the missed neutron dose for the claimant's PIID* monitoring period should have been 2,000 mrem ((5 years)(300 mrem) + (5 years)(100 mrem) = 2,000 mrem).

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Exhibit 1

Deletions made to the following table – please see hard copy labeled "#7-Hanford"

2.3 OCCUPATIONAL MEDICAL EXPOSURE

A total dose of 0.021 rem (21 mrem) was assigned to lymphatic tissue from external occupational medical exposure for the PIID* period, with the following explanations given in the claimant's Dose Reconstruction report:

> *The **external** dose to the lymphatic tissue was determined by using the dose calculated for the remainder organ. There is **no** existing model that calculates external dose to the lymphatic tissue.* [Emphasis added.]

and,

> *Occupational Medical Dose*
> *In addition to the estimated dose received from site operations, the dose received from diagnostic X-ray procedures that were required as a condition of employment was also included in the overall dose to the lymphatic tissue. Based on information in the External Dose Reconstruction procedure[6] and **an assumed annual X-ray procedure each year of employment** up to the date of cancer diagnosis, a total X-ray dose of 0.021 rem was assigned. This X-ray dose is considered claimant favorable as it likely exceeds the true X-ray dose to the lymphatic tissue.* [Emphasis added.]

and,

> *The actual doses to the lymphatic tissue from **occupational medical X-ray** procedures are likely to be smaller than were calculated based on the maximizing assumptions used in this dose reconstruction.* [Emphasis added.]

No additional information was provided, and the above-cited Reference 6 is given as ORAUT-PROC-0006, "External Dose Reconstruction," Revision 00, June 27, 2003 in the report's Reference List.

2.3.1 Reviewer's Comments

As stated above, the assigned organ dose of 21 mrem was described in the text of the DR Report as representing a total of 10 medical x-rays. This value is in error, as explained below.

- Outdated Reference. Reference #6 in the DR Report identifies ORAUT-PROC-0006, Rev. 00, June 27, 2003. Rev. 00, June 27, 2003, does **not** contain the cited "Attachment E." Attachment E was not added to ORAUT-PROC-0006 until November 2003, along with a subsequent revision in December. Reference #6 in the DR Report should, therefore, have identified ORAUT-PROC-0006 with an effective date of December 11, 2003, and a Revision No. 00 PC-2.

- Table 2 of Attachment E of ORAUT-PROC-0006 contains organ doses for PA chest x-ray exams by year. Organ doses are categorized into three groupings and by year. Although organ doses are considered "high," the dose reconstructor may further maximize the dose by multiplying the organ dose by 1.3 and enter the dose as a constant.

  Lymphoid tissue in the chest cavity **should** have been defined as a Group 2 tissue instead of Group 3. For the PIID* period between PIID* and PIID*, the occupational medical x-ray dose of 161 mrem should have been entered as follows:

Year	Organ Dose (mrem)
PIID*	constant 18
PIID*	constant 18
PIID*	constant 18
PIID*	constant 18
PIID*	constant 18
PIID*	constant 18
PIID*	constant 18
PIID*	constant 15
PIID*	constant 10
PIID*	constant 10
Total	161

In summary, the assigned dose of 21 mrem is not claimant favorable and clearly conflicts with statements contained in the DR Report; secondly, the dose reconstructor failed to assign the proper Group 2 dose, as defined in ORAUT-PROC-0006.

2.4 ONSITE AMBIENT DOSE

Ambient onsite external exposures that may result from plume immersion, stack releases, environmental surface contamination, and other sources are generally only included for **un**monitored workers or for monitored workers with missing dosimetry data.

Although the claimant was continuously monitored, which should have recorded any elevated ambient levels of external radiation (EALER), onsite ambient doses were, nevertheless, assigned.

For the assignment of ambient onsite dose, the DR Report made use of historical onsite dose rate measurements, as summarized in Table 4.3.1-1 of ORAUT-TKBS-0006-4. To maximize claimant favorability, the onsite location with the highest average annual dose was selected without regard to claimant's actual work location(s). Additional claimant-favorable assumptions included a correction factor of 1.3 that represented an increase of the number of annual work hours from 2,000 hours to 2,600 hours and an organ dose conversion factor of 1.

For the PIID* period of employment, the following maximum average annual onsite ambient doses were identified in Table 4.3.1-1 of ORAUT-TKBS-0006-4 for a 2,000 hr/yr and 2,600 hr/yr.

Year	Max. Avg. Annual Dose for 2,000 hr (mrem)	Dose Adjusted to 2,600 hr/yr
PIID*	27	35
PIID*	24	31
PIID*	23	30
PIID*	28	36
PIID*	20	26
PIID*	20	26
PIID*	20	26
PIID*	21	27
PIID*	22	29
PIID*	22	29
	Total	295

These claimant-favorable maximum estimates of annual onsite ambient doses were in fact assigned as annual organ doses, as shown in Appendix A, exposure entries #41-#50.

3.0 INTERNAL DOSE

Records indicate that the claimant was monitored for internal dose by means of whole-body counting. In addition to a baseline whole-body count (WBC) at time of initial employment in PIID*, claimant was subject to periodic whole-body counting for the years PIID* through PIID* None of the in vivo measurements resulted in radionuclide body burdens above minimum detectable activity (MDA).

A simple QA check that suggests proper operation of the whole-body counting systems is the recorded level of the naturally occurring isotope potassium-40 (K-40). The WBCs showed levels of K-40 that were consistent over time and commensurate with the claimant's sex, age, and body weight.

To account for any potential undetected dose, an internal dose was assigned based on hypothetical intake, as defined in ORAUT-OTIB-0002, *Technical Information Bulletin – Maximum Internal Dose Estimates for Certain DOE Complex Claims*, Rev. 01.

The purpose of procedure ORAUT-OTIB-0002 is to provide a method that employs worst-case assumptions in order to expedite the processing of claims in instances with little or no reported internal dose to the tissue/organ under evaluation. On the basis of conservative/claimant-favorable parameter assumptions, this procedure models internal organ doses for a single acute inhalation uptake at time of hire for 12 radionuclides for sites without a reactor, and 28 radionuclides for sites with a reactor. For calculating organ doses, each of the radionuclides is characterized for radiation type (i.e., alpha, electron >15 keV, or photon >250 keV). For this case, maximum internal organ doses were derived for 28 radionuclides.

As a benefit to the dose reconstructor and to facilitate data entry into the IREP computer code, NIOSH has developed an Excel® workbook entitled Maximum Internal Dose Calculation Workbook.xls.

As part of this review, the maximum internal dose to the lymphatic tissue was recalculated by means of the Excel® workbook. It should be noted that Table 3.1.1-4 of ORAUT-OTIB-0002 does not list lymphatic tissues among the 15 organs; however, in Section 4.0 Applications and Limitations of the TIB, the following conditional application is stated: ". . . The target organ must be listed in Table 3.1.1-4 or must be an organ whose dose is based on the highest non-modeled organ dose."

Among the 15 organs modeled in ORAUT-OTIB-0002, the colon yields the highest dose and was, therefore, used as the surrogate tissue for estimating maximum internal dose to the lymphatic tissue. Exhibit 2 summarizes the maximum estimated internal dose to the lymphatics for 28 radionuclides. Our estimated dose of 9.762 rem matches the dose cited in Attachment 1 of the DR Report (see exposure entries #1 through #30 of Appendix A).

3.1 COMMENTS PERTAINING TO THE APPLICABILITY OF ORAUT-OTIB-0002 FOR LYMPHOID TISSUE THAT MAY BE ASSOCIATED WITH THE LUNG

In general, the use of ORATU-OTIB-0002 for estimating maximum internal doses for certain DOE complex claims must be regarded as highly conservative and favorable to the claimant. An exception, however, may involve a case in which the target tissue involves specific tissues/lymph nodes of the lymphatic system on the basis of anatomical location, as explained below.

Dose estimates derived by procedure ORAUT-OTIB-0002 represent non-metabolic organ doses, which may reasonably serve as surrogate values for most lymphatic tissues except those associated with the lungs. Materials deposited into the lung are cleared by three main routes that include (1) absorption into blood, (2) ciliary-mucus transport into the gastrointestinal tract, and (3) endocytotic uptake by either phagocytosis or pinocytosis. Pinocytosis is followed by transfer to the lymphatic system and lymph nodes associated with the lung. As noted in ICRP Publication 66 (page 154):

> *Macrophages that have phagocytised particulate matter may enter lymphatics and are then transported into lymph nodes, where they can stay for* ***long periods*** *of time. . .* [Emphasis added.]

The potential for high doses to lymph nodes associated with the lung is also acknowledged in OCAS-IG-002 (page 11):

> *. . .* ***insoluble*** *compounds often cause the lymph nodes associated with the lungs to receive high doses, often the* ***highest*** *dose of* ***any organ****. Because lymph nodes in the lung are considered to retain radioactive material almost indefinitely, the material is not transferred throughout the lymphatic system. This means that lymphatic cancers* ***not*** *associated with lymph nodes of the lungs . . .* [should be assigned] *. . . the highest exposed organ that is* ***not*** *described by the ICRP metabolic models . . . as the appropriate dose.* [Emphasis added.]

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Exhibit #2. Maximum Internal Dose for Case PIID* Based on Methodology Defined in Procedure No. ORAUT-OTIB-0002

Enter first exposure year in cell H3, for IREP input format		PIID*	PIID*	Copy internal dose data from the first year through the year of cancer diagnosis		
Exposure Year	**Exposure Rate**	**Radiation Type**	**Dose Distribution Type**	**Parameter 1**	**Parameter 2**	**Parameter 3**
PIID*	chronic	alpha	Constant	7.69E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	4.46E+00	0	0
PIID*	chronic	photons E>250keV	Constant	1.52E+00	0	0
PIID*	chronic	alpha	Constant	2.65E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	1.93E-01	0	0
PIID*	chronic	photons E>250keV	Constant	1.52E-01	0	0
PIID*	chronic	alpha	Constant	2.59E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	9.13E-02	0	0
PIID*	chronic	photons E>250keV	Constant	4.16E-02	0	0
PIID*	chronic	alpha	Constant	2.53E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	6.53E-02	0	0
PIID*	chronic	photons E>250keV	Constant	1.57E-02	0	0
PIID*	chronic	alpha	Constant	2.49E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	5.20E-02	0	0
PIID*	chronic	photons E>250keV	Constant	8.10E-03	0	0
PIID*	chronic	alpha	Constant	2.45E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	4.28E-02	0	0
PIID*	chronic	photons E>250keV	Constant	4.96E-03	0	0
PIID*	chronic	alpha	Constant	2.43E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	3.57E-02	0	0
PIID*	chronic	photons E>250keV	Constant	3.32E-03	0	0
PIID*	chronic	alpha	Constant	2.40E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	2.98E-02	0	0
PIID*	chronic	photons E>250keV	Constant	2.29E-03	0	0
PIID*	chronic	alpha	Constant	2.38E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	2.50E-02	0	0
PIID*	chronic	photons E>250keV	Constant	1.64E-03	0	0
PIID*	chronic	alpha	Constant	2.37E-01	0	0
PIID*	chronic	electrons E>15keV	Constant	2.11E-02	0	0
PIID*	chronic	photons E>250keV	Constant	1.20E-03	0	0
			TOTAL INTERNAL ORGAN DOSE* =	**9.76218**		

* It should be noted that ORAUT-OTIB-0002 does not identify lymphatic tissue among the 15 organs for which a maximum internal dose is calculated. For this reason, the above-cited internal organ doses were derived for the colon, which is considered an appropriate surrogate organ for lymphatic tissue.

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In brief, while the use of a non-metabolic organ dose as a surrogate for lymphatic cancers may be applied to lymphatic tissues/lymph nodes not associated with the lung, such a non-metabolic surrogate organ dose would significantly underestimate the dose to lymphatic tissue and lymph nodes that are associated with the lungs. It should further be noted that for lymphatic tissues that are associated with the lung, claimant-favorable dose estimates should be based on an assumption of radionuclide insolubility (i.e., Type S).

As a final note, a substantial number of ICD-9 codes describe cancers of the lymph system without identifying their anatomical/physiological relationship to the lung.

Relevant to the review of this case is the indeterminacy as to whether or not this lymphatic cancer is associated with the lung. In response to this concern, NIOSH confirmed that for Case PIID*, the lymphoid tissue was **not** associated with the lung, and the assigned hypothetical dose is, therefore, correct.

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4.0 CATI REPORT AND RADIOLOGICAL INCIDENTS

The CATI report was reviewed for consistency with DOE-submitted records and the NIOSH DR Report. The CATI report identifies that the energy employee was monitored for internal exposure by means of urinalysis. However, neither the DOE records nor the DR Report makes mention of such monitoring data. The absence of documented radiological incidents and NIOSH's assignment of a hypothetical internal dose adequately addresses any potential exposures that can reasonably be attributed to this discrepancy.

For this case, there were no formal records involving radiological incidents submitted by the DOE. In the report that summarizes the telephone interview with the claimant, the response was negative. It can therefore be concluded that there were no radiological incidents that could significantly add to the claimant's exposure.

5.0 SUMMARY CONCLUSIONS

Official records submitted by the DOE indicate that claimant was provided radiological monitoring for the relevant PIID* employment period. External monitoring consisted of monthly TLDs, and internal monitoring consisted of a baseline and yearly whole-body counts. Neither TLDs nor WBC data revealed exposures above their detection limits. For the PIID* period, official records show only two medical chest x-rays that are regarded as occupational medical exposures.

In support of reconstructing an organ dose from external sources, 840 mrem was assigned as missed photon dose in behalf of 120 zero dosimeter readings, 295 mrem was assigned to onsite ambient dose, and 21 mrem was assigned for occupational medical exposure. The external photon dose and onsite ambient dose estimates are consistent with stated assumptions in the DR Report and/or official records, and comply with the claimant-favorable/process-efficient methods prescribed for cases with a low probability of compensability.

In order to account for potential undetected internal organ doses, the dose reconstruction employed a hypothetical model defined in ORAUT-OTIB-0002 and assigned an organ dose of 9.762 rem. On the assumption that the lymphatic tissue is not associated with the lung, this hypothetical model and the assigned organ dose of 9.762 rem must be regarded as highly claimant favorable.

Since the hypothetical internal organ dose of 9.762 rem represents nearly 90% of the total assigned dose of 10.918 rem, it is reasonable to conclude that the actual organ dose was considerably smaller.

The DR Report assumptions that are not considered claimant favorable include (1) neglecting to assign any missed neutron dose, which, based on procedural guidance, would have resulted in an additional external dose of 2,000 mrem, and (2) the assignment of an occupational medical dose of 21 mrem for 10 x-ray exams.

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ORAUT-OTIB-0006. 2003. "Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures," Rev. 02. Oak Ridge Associated Universities Team. Cincinnati, Ohio.

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APPENDIX A: IREP INPUT

The following information was obtained from the NIOSH Dose Reconstruction Report. This information was used as the input file for IREP.

CLAIMANT CANCER DIAGNOSIS							
	Primary Cancer #1	Primary Cancer #2	Primary Cancer #3	Secondary Cancer #1	Secondary Cancer #2	Secondary Cancer #3	
Cancer Type	Hodgkin's Disease	N/A	N/A	N/A	N/A	N/A	
Date of Diagnosis	PIID*	N/A	N/A	N/A	N/A	N/A	
EXPOSURE INFORMATION							
Number of exposures							
54							
Exposure #	Exposure Year	Exposure Rate	Radiation Type	Dose Distribution Type	Parameter 1	Parameter 2	Parameter 3
1	PIID*	chronic	alpha	Constant	0.769	0.000	0.000
2	PIID*	chronic	alpha	Constant	0.265	0.000	0.000
3	PIID*	chronic	alpha	Constant	0.259	0.000	0.000
4	PIID*	chronic	alpha	Constant	0.253	0.000	0.000
5	PIID*	chronic	alpha	Constant	0.249	0.000	0.000
6	PIID*	chronic	alpha	Constant	0.245	0.000	0.000
7	PIID*	chronic	alpha	Constant	0.243	0.000	0.000
8	PIID*	chronic	alpha	Constant	0.240	0.000	0.000
9	PIID*	chronic	alpha	Constant	0.238	0.000	0.000
10	PIID*	chronic	alpha	Constant	0.237	0.000	0.000
11	PIID*	chronic	photons E>250keV	Constant	1.519	0.000	0.000
12	PIID*	chronic	photons E>250keV	Constant	0.152	0.000	0.000
13	PIID*	chronic	photons E>250keV	Constant	0.042	0.000	0.000
14	PIID*	chronic	photons E>250keV	Constant	0.016	0.000	0.000
15	PIID*	chronic	photons E>250keV	Constant	0.008	0.000	0.000
16	PIID*	chronic	photons E>250keV	Constant	0.005	0.000	0.000
17	PIID*	chronic	photons E>250keV	Constant	0.003	0.000	0.000
18	PIID*	chronic	photons E>250keV	Constant	0.002	0.000	0.000
19	PIID*	chronic	photons E>250keV	Constant	0.002	0.000	0.000
20	PIID*	chronic	photons E>250keV	Constant	0.001	0.000	0.000
21	PIID*	chronic	electrons E>15keV	Constant	4.458	0.000	0.000
22	PIID*	chronic	electrons E>15keV	Constant	0.193	0.000	0.000
23	PIID*	chronic	electrons E>15keV	Constant	0.091	0.000	0.000
24	PIID*	chronic	electrons E>15keV	Constant	0.065	0.000	0.000
25	PIID*	chronic	electrons E>15keV	Constant	0.052	0.000	0.000
26	PIID*	chronic	electrons E>15keV	Constant	0.043	0.000	0.000
27	PIID*	chronic	electrons E>15keV	Constant	0.036	0.000	0.000
28	PIID*	chronic	electrons E>15keV	Constant	0.030	0.000	0.000
29	PIID*	chronic	electrons E>15keV	Constant	0.025	0.000	0.000

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30	PIID*	chronic	electrons E>15keV	Constant	0.021	0.000	0.000
31	PIID*	acute	photons E=30-250keV	Lognormal	0.120	1.520	0.000
32	PIID*	acute	photons E=30-250keV	Lognormal	0.120	1.520	0.000
33	PIID*	acute	photons E=30-250keV	Lognormal	0.120	1.520	0.000
34	PIID*	acute	photons E=30-250keV	Lognormal	0.120	1.520	0.000
35	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
36	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
37	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
38	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
39	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
40	PIID*	acute	photons E=30-250keV	Lognormal	0.060	1.520	0.000
41	PIID*	chronic	photons E=30-250keV	Constant	0.035	0.000	0.000
42	PIID*	chronic	photons E=30-250keV	Constant	0.031	0.000	0.000
43	PIID*	chronic	photons E=30-250keV	Constant	0.030	0.000	0.000
44	PIID*	chronic	photons E=30-250keV	Constant	0.036	0.000	0.000
45	PIID*	chronic	photons E=30-250keV	Constant	0.026	0.000	0.000
46	PIID*	chronic	photons E=30-250keV	Constant	0.026	0.000	0.000
47	PIID*	chronic	photons E=30-250keV	Constant	0.026	0.000	0.000
48	PIID*	chronic	photons E=30-250keV	Constant	0.027	0.000	0.000
49	PIID*	chronic	photons E=30-250keV	Constant	0.029	0.000	0.000
50	PIID*	chronic	photons E=30-250keV	Constant	0.029	0.000	0.000
51	PIID*	acute	photons E=30-250keV	Constant	0.005	0.000	0.000
52	PIID*	acute	photons E=30-250keV	Constant	0.005	0.000	0.000
53	PIID*	acute	photons E=30-250keV	Constant	0.005	0.000	0.000
54	PIID*	acute	photons E=30-250keV	Constant	0.005	0.000	0.000