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December 30, 2008

Mr. David Staudt
Center for Disease Control and Prevention
Acquisition and Assistance Field Branch
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Re: Contract No. 200-2004-03805, Task Order 1: Draft Report SCA-TR-TASK1-0005, Supplement 1, *Idaho National Laboratory (INL) Site Profile Review Update*

Dear Mr. Staudt:

SC&A is pleased to submit its draft report, *Idaho National Laboratory (INL) Site Profile Review Update*, SCA-TR-TASK1-0005, Supplement 1. The original site profile review, dated January 25, 2006, reviewed the 2004 versions of the six TBDs. Given the amount of time that has passed since that review and the subsequent issuing of revised TBDs in 2007, it was the judgment of the Advisory Board that a supplementary review of the site profile was appropriate before beginning the issues resolution process by the recently formed INL Work Group.

This report has been cleared by DOE, and reviewed and cleared for Privacy Act information, and is now cleared for unrestricted distribution.

Should you have any questions, please contact me at 732-530-0104.

Sincerely,

John Mauro, PhD, CHP
Project Manager

cc: P. Ziemer, Board Chairperson
Advisory Board Members
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L. Elliott, NIOSH
J. Neton, NIOSH
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Draft Report

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

ADVISORY BOARD ON RADIATION AND WORKER HEALTH

Idaho National Laboratory (INL) Site Profile Review Update

Contract No. 200-2004-03805
SCA-TR-TASK1-0005, Supplement 1

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December 2008

S. Cohen & Associates: **Technical Support for the Advisory Board on Radiation and Worker Health Review of NIOSH Dose Reconstruction Program**	Document No. SCA-TR-TASK-0005-S1 Effective Date: Draft – December 10, 2008 Revision No: 0 – Draft
Idaho National Laboratory (INL) **Site Profile Review Update**	Page 2 of 28
Task Manager: _____ Date: _____ Stephen L. Ostrow, PhD	Supersedes: N/A
Project Manager: _____ Date: _____ John Mauro, PhD, CHP	

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1.0 INTRODUCTION

At the request of the Advisory Board on Radiation and Worker Health, SC&A performed a brief, supplemental review of the latest revisions of the six Idaho National Laboratory (INL) Technical Basis Documents (TBDs), which were issued in 2007 (ORAUT 2007a-f); the TBDs, when taken together, are often referred to as the Site Profile. SC&A had reviewed earlier revisions of the TBDs (ORAUT 2004a-f), issued in 2004, and other documents and presented its findings in its Site Profile Review Report (SC&A 2006). It is not the intent of this update report to re-review the site profile in depth or to do a detailed comparison of the two site profiles. This update report will refer to the previously reviewed site profile as the "2004 Site Profile" and the latest site profile as the "2007 Site Profile." SC&A 2006 is Rev. 1 of the originally-issued report of September 23, 2005 (SC&A 2005); the revision included the additions of Attachment 3, "Summaries of Site Expert Reviews," and Attachment 5, "Issues Resolution Matrix for Findings and Key Observations," but made only minor changes to the remainder of the report.

It is intended that this update report will serve as a reference document for use by the recently formed Board Work Group on the Idaho National Laboratory. Since a significant amount of time has passed since the SC&A Site Profile Review Report, the approach to dose reconstruction has evolved, new information about the site may have come to light, and NIOSH may have incorporated material generated in response to SC&A's comments to the 2004 Site Profile. The 35 issues identified in the SC&A report are summarized in the Issue Resolution Matrix found in Attachment 5 to SC&A 2006.

In performing its current review, SC&A read the 2007 Site Profile TBDs in light of the comments appearing in its Site Profile Review Report to assess whether the revised TBDs appeared to respond to the comments therein. SC&A also reviewed Technical Information Bulletins (TIBs) that were issued subsequent to the 2004 Site Profile to ascertain whether they would have a significant impact on the SC&A comments. Finally, SC&A conducted a search for any relevant material that might have been placed on the O-drive since the end of 2005; no such material was found, however.

For convenience in considering SC&A's comments (old and new), this report attaches a revised Issues Resolution Matrix that has two new columns: one noting if a particular comment was added, removed, expanded, reduced, upgraded, or unchanged from the original matrix, and the other providing any related comments. Section 2.0 of this report examines the publication records (i.e., revision logs) of the TBDs to note the changes that NIOSH thought important from one revision to the next, and Section 3.0 discusses the revisions made to the SC&A comments, which appear in the attached matrix.

2.0 REVISIONS TO THE ORIGINALLY REVIEWED SITE PROFILE

A starting point in assessing the status of the 2007 Site Profile is to compare it to the one originally reviewed in SC&A 2006, the 2004 Site Profile. Since it is not the purpose of this report to do a detailed assessment and comparison of the site profiles, the following sections will focus on what NIOSH has noted as the changes in each TBD from one revision to the next, as recorded in the Publication Records ("revision logs"). It should be noted that even seemingly minor revisions, such as in the description of a process or location, or in a table, might have an effect on assigned doses, but not necessarily also have an impact on the issues that SC&A identified in its review of the 2004 Site Profile.

2.1 INTRODUCTION

This section compares the originally reviewed ORAUT 2004a (Rev. 0) to the current ORAUT 2007a (Rev. 2). Table 2-1 reproduces the Publication Record of ORAUT 2007a.

Table 2-1. Publication Record

Effective Date	Revision Number	Description
5/7/2004	0	New document for the INEEL Introduction. Incorporates responses to OCAS comments. First approved issue. Initiated by Norman D. Rohrig.
12/13/2006	1	Approved revision as a result of biennial review. Revised language in the Purpose section as required by NIOSH. Attribution and Annotation section added. Constitutes a total rewrite of document. Incorporates internal, NIOSH, and DOL formal review comments. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Norman D. Rohrig.
4/26/2007	2	Approved Revision 02 revised to change document owner and to better identify references in the text. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Jo Ann M. Jenkins.

Source: ORAUT 2007a

2.2 SITE DESCRIPTION

This section compares the originally reviewed ORAUT 2004b (Rev. 1) to the current ORAUT 2007b (Rev. 3). Table 2-2 reproduces the Publication Record of ORAUT 2007b.

Table 2-2. Publication Record

Effective Date	Revision Number	Description
11/7/2003	0	New technical basis document for the Idaho National Engineering and Environmental Laboratory — Site Description. First approved issue. Initiated by Norman D. Rohrig.
7/28/2004	1	Corrects date of operation in Section 2.4.11 and adds OGC required paragraphs. Approved issue of Revision 01. Initiated by Norman D. Rohrig.

Table 2-2. Publication Record

Effective Date	Revision Number	Description
7/29/2005	2	Adds additional descriptive material on ICPP in response to union outreach comments. Incorporates formal internal and NIOSH review comments. Approved issue of Revision 02. Retraining is not required. Initiated by Norman D. Rohrig.
8/17/2007	3	Approved Revision 03 initiated to add Attributes and Annotations section. Added references. Incorporates formal internal and NIOSH review comments. Training required: As determined by the Task Manager. Initiated by Jo Ann M. Jenkins.

Source: ORAUT 2007b

2.3 OCCUPATIONAL MEDICAL DOSE

This section compares the originally reviewed ORAUT 2004c (Rev. 0) to the current ORAUT 2007c (Rev. 1). Table 2-3 reproduces the Publication Record of ORAUT 2007c (including the signature block for Rev. 0, PC-1, which appears in the original document).

Table 2-3. Publication Record

Effective Date	Revision Number	Description
1/15/2004	0	New Technical Basis Document for the Idaho National Engineering and Environmental Laboratory — Occupational Medical Dose. First approved issue. Initiated by Norman D. Rohrig.
5/28/2004	0 PC-1	Adds spleen to organ table on page 10. Eliminates date overlap in table on page 11. Initiated by Norman Rohrig. Approval: Signature on File 5/27/2004 Norman D. Rohrig, Document Owner Signature on File 5/27/2004 Task 3 Manager, Judson Kenoyer, Task 3 Manager Signature on File 5/27/2004 Richard E. Toohey, Project Director Signature on File 5/27/2004 James W. Neton, OCAS Health Science Administrator
1/31/2007	1	Approved Revision 01 as a result of biennial review. Revised language in the Purpose section as required by NIOSH. Attributions and Annotations section added. Changed treatment of eye and brain dose. As a result of internal formal review, add Table 3-3. Incorporates NIOSH formal review comments. This revision results in an increase in assigned dose and a PER is required. Constitutes a total rewrite of document. Initiated by Norman D. Rohrig.

Source: ORAUT 2007c

2.4 OCCUPATIONAL ENVIRONMENTAL DOSE

This section compares the originally reviewed ORAUT 2004d (Rev. 0) to the current ORAUT 2007d (Rev. 1). Table 2-4 reproduces the Publication Record of ORAUT 2007d.

Table 2-4. Publication Record

Effective Date	Revision Number	Description
3/30/04	0	New Technical Basis Document for the Idaho National Engineering and Environmental Laboratory — Occupational Environmental Dose. First approved issue. Initiated by Norman D. Rohrig.
8/17/07	1	Approved Revision 01 initiated to add additional information on how TLD results were chosen. Added Purpose, Scope, and Acronyms sections. Added references and SRDB numbers. Changed Idaho National Engineering and Environmental Laboratory to Idaho National Laboratory. Incorporates formal internal and NIOSH review comments. Adds Attributions and Annotations section. Incorporates formal internal and NIOSH review of the Attributions and Annotations section. Constitutes a total rewrite of the document. Training Required: As determined by the Task Manager. Initiated by Jo Ann M. Jenkins.

Source: ORAUT 2007d

2.5 OCCUPATIONAL INTERNAL DOSE

This section compares the originally reviewed ORAUT 2004e (Rev. 0, PC-1) to the current ORAUT 2007e (Rev. 2). Table 2-5 reproduces the Publication Record of ORAUT 2007e.

Table 2-5. Publication Record

Effective Date	Revision Number	Description
8/11/2004	0	New Technical Basis Document for the Idaho National Engineering and Environmental Laboratory — Occupational Internal Dose. First approved issue. Initiated by Norman D. Rohrig.
10/12/2004	0, PC-1	Approved page change revision. Deletes references to rigorous radiation program on page 39. Initiated by Norman Rohrig. Approval: Signature on File 9/30/2004 Norman D. Rohrig, Document Owner Signature on File 10/1/2004 Judson Kenoyer, Task 3 Manager Signature on File 10/1/2004 Richard E. Toohey, Project Director Signature on File 10/12/2004 James W. Neton, Associate Director for Science

Table 2-5. Publication Record

Effective Date	Revision Number	Description
1/13/2006	1	Approved issue of Revision 01. Revised to change table number format, responds to new information from Workers Outreach Effort and revises MDA tables. Incorporates 1-year decay time for Al fuel in Tables 5-18 and 5-24. Combined "INTEC & Unknown" and "Other Area" categories in Table 5-24 for 1971-80 into "All but ANL-W." Training required: As determined by the Task Manager. Initiated by Norman D. Rohrig.
6/5/2006	1, PC-1	Page change revision to correct error on page 24 in Table 5-12 in Section 5.5 on sample volume in 1980s. Approved issue of Rev. 01 PC-1. No sections were deleted. Incorporates NIOSH formal review comments. This revision results in a reduction in assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Norman D. Rohrig. Approval: Signature on File 5/23/2006 John M. Byrne, Document Owner Signature on File 5/23/2006 John M. Byrne, Task 3 Manager Signature on File 5/22/2006 Edward F. Maher, Task 5 Manager Signature on File 5/24/2006 Kate Kimpan, Project Director Signature on File 6/5/2006 James W. Neton, Associate Director for Science
7/30/2007	2	Revision initiated to add Purpose, Scope, and Attributions and Annotations sections. Added references. Updated the formatting and made editorial changes. Corrected error in Fecal MDA for Th-230 and Np-237 in Table 5-13. Constitutes a total rewrite of the document. Incorporates formal internal and NIOSH review comments. Training required: As determined by the Task Manager. Initiated by Jo Ann M. Jenkins.

Source: ORAUT 2007e

2.6 OCCUPATIONAL EXTERNAL DOSIMETRY

This section compares the originally reviewed ORAUT 2004f (Rev. 0) to the current ORAUT 2007f (Rev. 2). Table 2-1 reproduces the Publication Record of ORAUT 2007f.

Table 2-6. Publication Record

Effective Date	Revision Number	Description
4/6/2004	0	New technical basis document for the Idaho National Engineering and Environmental Laboratory (INEEL) — Occupational External Dosimetry. First approved issue. Initiated by Norman D. Rohrig.
11/7/2006	1	Document revised as a result of biennial review. Approved Revision 01. Incorporates formal internal review comments. Revision constitutes a total rewrite of document. Adds Section 6.5.1 to incorporate comments from the Worker Outreach meeting with the PACE Local 8-0652 on April 28, 2004. Incorporates

Table 2-6. Publication Record

Effective Date	Revision Number	Description
		formal NIOSH review comments. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Norman D. Rohrig.
6/18/2007	2	Approved Revision 2 initiated to incorporate Attribution and Annotation section. A minor change was made to Sections 6.3.4.5 and 6.5.4.2, which will reduce the dose for a very few individuals. Incorporates formal internal and NIOSH review comments. Constitutes a total rewrite of the document. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Jo Ann M. Jenkins.

Source: ORAUT 2007f

3.0 SC&A ISSUES ASSESSMENT

SC&A examined the 2007 Site Profile TBDs and compared them to the corresponding 2004 TBDs, which were the subject of the original SC&A assessment report, SC&A 2006. Issues[1] identified by SC&A (divided into findings and observations, as illustrated in Figure 3-1) are summarized in Attachment 1 to this report: "Issue Resolution Matrix for Findings and Key Observations." The matrix was derived from the Attachment 5, Table A-5 matrix in SC&A 2006 by adding a column indicating SC&A's new assessment of each issue and a column containing comments for some issues. The original matrix contained 35 issues, divided into 18 observations and 11 distinct findings (several of the 17 issues categorized as findings were combined to produce 11 distinct findings). The new matrix corrected one issue (No. 2), expanded four issues (Nos. 25, 26, 29, 35), and added three new issues (Nos. 36, 37, 38) for a total of 38 issues. In addition, one of the original observations (No. 26) was upgraded to a finding (No. 12).

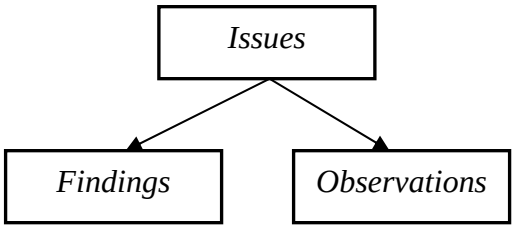

Figure 3-1. Issues Divided into Findings and Observations

Table 3-1 summarizes the number and division of issues in the matrices in SC&A 2006 and this report.

Table 3-1. Issue Resolution Matrix Summary

	SCA 2006	This Report
Issues	35	38
Distinct Findings	11	13
Observations	18	19

Revisions to the original matrix of SC&A 2006 will be discussed in turn.

3.1 ISSUE 25: DISCREPANCIES BETWEEN PIC AND FILM READING

This issue was expanded from SC&A 2006 by adding the following to the matrix description: "Many difficulties in comparing PIC readings and film results make agreement within a factor of two the best that can be expected."

Attempting to compare PIC and film readings is fraught with difficulties. SC&A 2006 focuses on the beta-to-photon ratio issue. This is a concern, but only one of several. Perhaps of greater importance in many situations are the large energy-dependent response differences between the two classes of dosimeter. Unfortunately, we do not have detailed information regarding the

[1] Note that the matrices use the terms "issue" and "comment" interchangeably.

types of PIC used and their wall characteristics; the PICs are described in very general terms in several contemporaneous documents available on the NIOSH O-drive document collection. Generally, early PICs had a wall that was opaque to x-rays below about 40–80 keV, where there is also a large over-response for uncorrected film emulsions. Thus, depending on the situation, the film-to-PIC reading ratio varies greatly with photon energy over the range of just a few tens of keV.

It should be noted that, even under current conditions, a film dosimetry system and older style PIC device could both be working within DOELAP (Department of Energy Laboratory Accreditation Program) or NVLAP (National Voluntary Laboratory Accreditation Program) requirements, while readings from the two could still differ by a factor of two even at energies where the PIC is responsive. When energy cutoff and human error factors are considered as well, large variations in comparing the readings from the two different measurement methods are to be expected. Somewhat mitigating the difference in readings, however, is that since many of the sources of error and disparity are independent, they will sum in quadrature, reducing their overall impact. Thus, the value of comparing the two dosimetry methods is limited, even if variations of a factor of two are accepted and even if averaged over an entire year. Some of the factors that would lead to disagreement between the two dosimeter readings are summarized in the following:

Technical Factors

- Cut off for low x-ray energies due to PIC construction.
- Widely differing energy response of film and PICs to x-rays and low energy gammas.
- Widely differing responses as a function of beta energy.
- Added variable of the film algorithm. This has a number of impacts including mischaracterization of beta radiation as x-ray radiation in early film badge systems, under-reporting deep dose for some photon energies, and, overall wide swings in energy response. These disparities are due to an only partially successful effort to smooth out the factor of 30 over response of film emulsion to x-ray energies compared with high energy gammas.
- Calibration systems may be different.
- Zeroing, reading, and rounding errors. (PICs have no control or background subtraction, are usually read after being worn for short periods, and are difficult to read precisely).
- Mechanical errors (PICs).
- Temperature and humidity effects (Film).
- Processing variables (Film).
- Angular response differences between the two devices. This can be a large problem with x-ray energies when exposure from the side of the film holder can bypass the filters and cause a large over response.

Human Factors

- Were both dosimeters worn in close proximity to each other?; i.e., were they in an identical radiation field to begin with?
- Were both dosimeters worn for the entire period in question?
- Was there a bias introduced in reading one's own PIC?
- Were errors made in reading, transcribing, and matching PIC doses with the relevant film dosimeter?

3.2 ISSUE 26: MINIMUM DETECTION LIMIT

This issue was expanded from SC&A 2006 and upgraded from an observation to a finding by adding the following to the matrix description:

> The selection of 10 mrem as the MDL [minimum detection limit] for high energy gamma is questionable. Even for modern densitometers and film, it is a challenge to achieve this level, as a single density "click" can correspond to greater than 10 mrem for high-energy gamma radiation; this is not a problem, however, for intermediate and low-energy x-rays. Rather, one click of the densitometry system may correspond to 15 or 20 mrem for 660 keV or 1.2 MeV gammas, for example. If the claim is made that 10 mrem is a valid choice for the MDL, then supporting materials should be provided, such as film dose-to-density curves and densitometer calibration data. Other sites (e.g., Savannah River Site - SRS) have adopted 40 mrem as the high-energy gamma MDL for early film.

3.3 ISSUE 29: FAILURE TO PROPERLY ADDRESS NEUTRON EXPOSURES

This issue was expanded from SC&A 2006 by adding the following to the matrix description:

> The method presented in the TBD of determining who needs to be assigned a missed neutron dose is circular: Section 6.5.4 states: *"If no neutron dose was assigned to the worker or coworkers for several months, the dose reconstructor should assume that the person was not exposed to neutrons."* Clearly this does not allow for individual workers having temporary or varying assignments. Also, if the program failed to correctly identify that they should have been monitored, the record will show no assigned neutron dose.
>
> In addition, the TBD makes the assumption that high Z materials, such as iron and lead, were never used (e.g., for shield penetrations) in place of hydrogenous materials, such as water and concrete. However, no attempt is made to validate or qualify this assumption.
>
> ORAUT-OTIB-0051, *Effect of Threshold Energy and Angular Response of NTA Film on Missed Neutron Dose at the Oak Ridge Y-12 Facility*, was issued after the 2004 Site Profile and has a bearing on neutron dosimetry issues; hence, it should be considered in this TBD.

ORAUT-OTIB-0051 (ORAUT 2006, May 15, 2006) was issued subsequent to the SC&A review (SC&A 2006), but is not referred to in the latest version of the INL external dose TBD (ORAUT 2007f), which has an effective date of June 18, 2007. This TIB specifically investigates the NTA film neutron energy threshold issue. Based on this TIB, dependant on energy and angle, a factor of up to 2.9 is recommended to adjust for underreported intermediate energy neutron dose at Y12. This is significantly higher than the factors of 1.25 and 2 contained in the current INL TBD. NIOSH should consider which, if any, of the issues considered for Y12 are applicable to the INL facilities; perhaps an even larger multiplication factor is warranted in some areas. Any review will need to consider the site-specific ORAUT-OTIB-0009 (ORAUT 2004g) that reanalyzed the Bonner sphere work conducted by Hankins at INL.

Despite the fact that application of ORAUT-OTIB-0051 would increase the correction factors for NTA under response, it may still underestimate the true problem; NTA counting for tracks at the lower energy cutoff is difficult and subject to error. The TIB discusses these issues, but may not give sufficient consideration to real-world counting conditions; it is not clear how data gathered during careful tests under ideal conditions should be applied to day-to-day dosimetry operations that took place 50 years ago. Significant human factors are involved in counting NTA film, especially when near the limits of energy and dose detection. A review of this issue is recommended.

In Table 6.12 of the TBD (ORAUT 2007f), a 500 keV threshold is mentioned for NTA film neutron detection. Elsewhere in the document, a 500-800 keV value is used. Other sources use an 800–1,000 keV value. Original site reference material (Sommers undated) notes that the minimum detectable energy is 800 keV. The value chosen is important, as a significant component of the neutron spectrum can be below the detection threshold, depending on the location, method of neutron generation, and the degree of thermalization that has occurred in intervening materials. Clear guidance is needed to enable dose reconstructors to correctly interpret and assess missed dose. ORAUT-OTIB-0051, and a possible supplement specifically for INL, could be used to clear up the confusion with regard to energy threshold.

Whatever multiplying factors are adopted, correction for NTA under response should not be spread uniformly among the various IREP neutron energy groups, as shown in Table 6-14 of the TBD (ORAUT 2007f). Instead, all under reported dose should be assigned to the IREP groups corresponding to energies lower than 800 keV. Current procedure calls for multiplying the reported dose by the modifying factor and then assigning the results to all energy groups. This will assign too much of the dose to higher energies and too little to lower energies.

3.4 ISSUE 35: MULTIPLYING FACTORS FOR MISSED NEUTRON DOSE

This issue was expanded from SC&A 2006 by adding the following to the matrix description: "See ORAUT-OTIB-0051 and Issue No. 29."

Section 3.3 contains a discussion relevant to this issue.

3.5 ISSUE 36: MISSED LOW ENERGY BETA DOSE

This is a new issue, and is characterized as finding No. 13. The matrix entry states the following:

> *Section 6.3.2.2 of the TBD* [ORAUT 2007f] *discusses the 100mg/cm^2 plastic dosimeter holder and the fact that betas of less than 360 keV will not penetrate the holder. (It is unclear if this density includes the film wrapper.) However, the TBD does not discuss allowance for or consideration of the possibility of the complete failure to detect these betas.*
>
> *The general, averaging approach to missed beta is questionable. The concern is that beta exposure is always assumed to be due to a mix of energies and thus the dose component from low energies is known and can be corrected. Clearly this is not the case, as is stated in the attribution.*
>
> *A specific concern is the Rare Gas Processing Facility (CPP-604), which harvested Kr-85. This nuclide is a pure beta emitter, with an endpoint energy of 670 keV. The film badges in use at the time were far from ideal for betas and failed to see any below 360 keV. NIOSH should determine if the maximum modifier recommended for betas of 2.8 is sufficient for this environment.*

Table 6.10 (ORAUT 2007f) provides a beta correction factor of 2.8 for multifilter film. However, in the case of exposure to low-energy betas, the factor is inappropriate and an alternate means of deriving low energy beta dose is required. Furthermore, the whole approach to missed beta is questionable. For example, Attribution [13] in the TBD states: *"Rohrig, Norman D. ORAU Team. Health Physicist. June-October 2003. Retrospectively, there is no simple way of knowing the beta emitters that caused employee X's exposure in week Y, so this is a generic approach to the issue."* This was by way of explanation for the following: *"Beta-emitting nuclides varied from location to location and time to time at INL, so a correction factor common for all facilities was estimated"* (ORAUT 2007f, 30). The concern with this averaging approach is that beta exposure is always assumed to be due to a mix of energies, and thus the dose component from low energies is known and can be corrected. Clearly this is not the case, as is stated in the attribution.

A specific concern is the Rare Gas Processing Facility (CPP-604), discussed on p. 30 of the TBD, which harvested Kr-85. This nuclide is a pure beta emitter with an endpoint energy of 670 keV. There would be opportunity for worker exposure to Kr-85 betas during processing, any accidental releases, or deliberate venting. As this work was performed in the 1950s, we know that the film badges in use at the time were far from ideal for betas and failed to see any below 360 keV. NIOSH should determine if the maximum modifier recommended for betas of 2.8 is sufficient for this environment.

3.6 ISSUE 37: ERROR IN REFERENCE

Issue 37, which is characterized as an observation, is quite minor and states: "The second paragraph of page 41 of the External Dose TBD (ORAUT 2007f) references Table 6-16 for IREP groups; it should refer to Table 6-14 instead."

3.7 ISSUE 38: SHALLOW DOSE

Issue 38, which is characterized as an observation, states: "NIOSH should consider making use of ORAUT-OTIB-0017, *Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose* (ORAUT 2005), where appropriate. Additionally, contrary to the OTIB's claim (p. 15) that the assumption of undergarment and pants thicknesses of 2 mm each is claimant favorable, SC&A believes that measured thicknesses are about half that and, hence, the OTIB assumptions are not claimant favorable."

In the course of reviewing the 2007 NIOSH Site Profile, SC&A examined ORAUT-OTIB-0017 (ORAUT 2005) as well. This OTIB, which SC&A reviewed in SC&A 2007, is not referenced by the External Dose TBD (ORAUT 2007f), but may be germane nonetheless. OTIB-0017 states the following:

> *For modeling purposes it is assumed that male workers wore pants or shorts and one layer of undergarments. Pants were assumed to have a thickness of 2 mm and a density of 0.7 g/cm^3 while the layer of undergarment was also assumed to have a thickness of 2 mm and a density of 0.7 g/cm^3. These estimates are considered to be claimant favorable.*

SC&A conducted some experimental research and determined that the thickness of men's undergarments are less than 1 mm thick and jeans about 1 mm thick. Women's clothing is expected to be even thinner. Hence, the OTIB assumptions do not appear to be claimant favorable for assignment of shallow beta doses.

3.8 CONCLUSION

Overall, the original SC&A review of the 2004 Site Profile is still current and valid, as none of the findings of SC&A 2006 appear to have been addressed in the revised TBDs of the 2007 Site Profile. In addition, following its current review of the two Site Profiles and other documents, SC&A modified or added a number of findings and observations, as summarized in the Issue Resolution Matrix. Other documents surveyed included the ORAUT-OTIBs (about 25) that have been issued or revised subsequent to the 2004 Site Profile; SC&A did not note any relevance to the site profile, with the possible exception of ORAUT-OTIB-0017 (see Issue 38). SC&A also looked at the one INL Program Evaluation Report, OCAS-PER-017 (OCAS 2007), pertaining to the INL site, and found that it did not impact the site profile.

4.0 REFERENCES

OCAS 2007. *Evaluation of Incomplete Internal Dosimetry Records from Idaho, Argonne East and Argonne-West National Laboratories*, OCAS-PER-017, Rev. 0, September 11, 2007.

ORAUT 2004a. *Technical Basis Document for the Idaho National Engineering and Environmental Laboratory (INEEL) – Introduction*, ORAUT-TKBS-0007-1, Rev. 0, Oak Ridge Associated Universities Team, Cincinnati, Ohio. May 7, 2004.

ORAUT 2004b. *Technical Basis Document for the Idaho National Engineering and Environmental Laboratory (INEEL) – Site Description*, ORAUT-TKBS-0007-2, Rev. 1, Oak Ridge Associated Universities Team, Cincinnati, Ohio. July 28, 2004.

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ATTACHMENT 1: ISSUES RESOLUTION MATRIX FOR FINDINGS AND KEY OBSERVATIONS

Issue Resolution Matrix for INL Findings and Key Observations (11/26/08) (Revised Attachment 5, Table A-5 of SC&A 2006)

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
1	ORAUT-TKBS-0007-4	5	**Issue 1:** (5.1.1.1) Routine Airborne Releases - Source terms provided require improvement for use in determining the worker intake from airborne releases at different INL facilities. The data NIOSH uses do not take into account the deficiencies in the environmental monitoring equipment and their locations, and, in addition, NIOSH does not assess the uncertainties associated with the meteorological dispersion model used for the INL site. Most importantly, the source terms do not account for worker inhalation of resuspended contaminated soils and materials around the INL facilities.	45	Unchanged	
2	ORAUT-TKBS-0007-4	6	**Issue 2:** (5.1.1.2) Episodic Airborne Release - The airborne releases associated with several of the Initial Engine Tests of the Aircraft Nuclear Propulsion (ANP) Program were likely to have been underestimated by factors ranging from **2 to 16**. Also, NIOSH did not evaluate the uncertainties associated with the deficiencies in air monitoring equipment.	55	Upgraded	The original matrix shows 2–7, while SC&A 2006 shows 2–16 (p. 56).
3	ORAUT-TKBS-0007-4	7	**Issue 3:** (5.1.1.3) Direct Gamma Exposures – The fence-line TLD measurements are not adequate for reconstructing direct gamma doses to personnel working outdoors at and around a specific INL facility inside the fence-line boundary, because they do not take into account the most bounding scenarios.	57	Unchanged	

[1] Page numbers refer to SC&A 2006.
[2] Compared to SC&A 2006, Attachment 5, Table A-5.

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
4	ORAUT-TKBS-0007-5	8	**Issue 4:** (5.1.2.1) Completeness and Quality of INL Internal Dosimetry Programs - The identification and determination of missed internal dose for workers are heavily influenced by the assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker internal doses.	73	Unchanged	
5	ORAUT-TKBS-0007-5	9	**Issue 5:** (5.1.2.2) High-Risk Jobs (Internal Exposure) - NIOSH did not evaluate comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker internal exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant's file are not complete.	77	Unchanged	
6	ORAUT-TKBS-0007-5	O [3]	**Issue 6:** (5.1.2.3) Calibration of Internal Dosimetry Analytical and Monitoring Equipment - The TBD does not provide any information on the calibration procedures, sensitivities, and standards of the internal dosimetry analytical equipment and monitoring instrumentation. The 1991 DOE Tiger Team findings show the deficiencies in these areas. NIOSH should evaluate the uncertainties and impacts on the internal dose assessment results associated with the deficient calibration programs at INL.	78	Unchanged	

[3] "O" denotes an observation (rather than a finding).

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
7	ORAUT-TKBS-0007-5	O	**Issue 7:** (5.1.2.4) Changes of Internal Dose Limits - Inconsistent work practices were prevalent in the early years of the INL operation and may have led to significant missed dose to workers. NIOSH should evaluate the impacts of these dose limit changes over the operating history of INL to see whether there were missed doses in the early years when the radiation protection policy was less protective and inconsistently implemented.	78	Unchanged	
8	ORAUT-TKBS-0007-5	10	**Issue 8:** (5.1.2.5) High-Fired Plutonium and Uranium Intakes - The TBD did not evaluate the hazard associated with high-fired plutonium and uranium at the INTEC (ICPP) and RWMC facilities. High-fired Pu-238, Pu-239, and uranium are not easily dissolvable, nor do they readily break into very small particles. They also emit some gamma rays and neutrons. Similar to the treatment of recycled uranium, NIOSH should evaluate the lung dose for intake of high-fired uranium and plutonium oxide particulates (alveolar deposition).	78	Unchanged	
9	ORAUT-TKBS-0007-5	O	**Issue 9:** (5.1.2.6) Skin and Facial Contamination - This TBD does not consider incidents with workers having skin contamination, facial contamination, and positive nasal swipes in the INL facilities. These kinds of problems would be compounded by the deficiencies in air sampling systems and ineffective respiratory protection programs. Guidance should be provided to a dose reconstructor to account for the missed dose due to the unaccounted uptake.	79	Unchanged	
10	ORAUT-TKBS-0007-5	O	**Issue 10:** (5.1.2.7) Breathing Rates - The TBD assumption appears less claimant favorable than the ICRP or NCRP assumptions.	79	Unchanged	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
11	ORAUT-TKBS-0007-5	11	**Issue 11:** (5.1.2.8) Non-Occupational Worker Elimination of DU Background - The derivation of the background value of 0.16 µg/L used for subtraction from each urinalysis result of uranium prior to assessment of occupational internal dose for SMC radiation workers is not technically sound. The baseline background (population) intake value was determined by a study of urine samples submitted by non-radiation workers at the SMC facility. A better approach would be to use the urine excretion samples by non-INL people in the Idaho Falls area. NIOSH should consider this subtraction from urinalysis results as a missed internal dose.	79	Unchanged	
12	ORAUT-TKBS-0007-5	O	**Issue 12:** (5.1.2.9) Unmonitored Workers - The potential missed doses for unmonitored workers would be from inhaling resuspended contaminated soils and ingesting contaminated materials while eating in a contaminated, previously considered uncontaminated, area (such as office and cafeteria). NIOSH should evaluate these potential missed doses.	80	Unchanged	
13	ORAUT-TKBS-0007-4/5/6	O	**Issue 13:** (5.1.2.10) Naval Reactor Facility Workers - As the internal dose TBD indicates, "some workers' internal dose could have resulted from their support work at the NRF." NIOSH should evaluate the potential missed dose at the NRF for these workers.	80	Unchanged	
14	ORAUT-TKBS-0007-5	O	**Issue 14:** (5.1.2.11) Plutonium Monitoring - The TBD does not provide any historical information on the plutonium analysis methods used at INL. It is entirely possible that selective plutonium monitoring on workers was used at INL until 1980, but without this information, the dose reconstructors would not be able to assign missed internal dose due to plutonium intakes in the time period before 1980. NIOSH should provide information on plutonium monitoring.	80	Unchanged	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
15	ORAUT-TKBS-0007-4/5/6	1	**Issue 15:** (5.1.3) SL-1 Accident Dose Reconstructions - The TBDs do not evaluate the potential missed internal and external doses or the associated uncertainties for the over 1,000 rescue and cleanup workers involved with the SL-1 accident that occurred in January 1961. There was a high potential for significant exposures, because the equipment used and the radiological control policies in place in that era were not as advanced and protective as those in current use. The TBDs should develop adjustment factors related to stay time, dose field estimates, internal dose results, external dose readings, and contamination level estimates.	80	Unchanged	
16	ORAUT-TKBS-0007-6	8	**Issue 16:** (5.1.4.1.1) Completeness and Quality of INL Beta/Gamma Dosimetry and Record Keeping Programs - The identification and determination of missed external dose for workers are heavily influenced by this assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker external doses.	96	Unchanged	
17	ORAUT-TKBS-0007-6	4	**Issue 17:** (5.1.4.1.2) Penetrating and Non-Penetrating Doses - NIOSH should re-evaluate the missed gamma dose, due to the deficiencies in the procedures and algorithms.	96	Unchanged	
18	ORAUT-TKBS-0007-6	O	**Issue 18:** (5.1.4.1.3) Correction For Beta Doses – NIOSH should develop a method to consistently account for uncertainties in dosimetry readings. Claimant-favorable correction factors should be developed for beta dose reconstruction.	97		

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
19	ORAUT-TKBS-0007-6	O	**Issue 19:** (5.1.4.1.4) Angular Dependence Correction Factor for Gamma Dose - NIOSH should provide angular dependence (anatomic geometry) correction factors for external gamma doses, particularly for low-photon energies, where the angular dependence of the sensitivity of the dosimeter is most pronounced. These correction factors are used to account for, for example, the bias introduced by a dosimeter worn at the neck level and the higher doses received by tissues/organs below the waist.	99	Unchanged	
20	ORAUT-TKBS-0007-6	O	**Issue 20:** (5.1.4.1.5) Restating Beta Dose As Gamma Dose - It is not claimant favorable to state that the entire dose measured in the open window is due to the beta dose.	99	Unchanged	
21	ORAUT-TKBS-0007-6	O	**Issue 21:** (5.1.4.1.6) Photon Spectrum Split – NIOSH should provide guidance assigning dose values for the 30 keV<E<250 keV and E>250 keV regions.	99	Unchanged	
22	ORAUT-TKBS-0007-6	O	**Issue 22:** (5.1.4.1.7) Immersion Dose - The dose recorded on a dosimeter due to a semi-infinite cloud irradiation would be approximately half of the actual dose received. NIOSH should, therefore, consider a weighting factor of 2 for immersion dose.	100	Unchanged	
23	ORAUT-TKBS-0007-6	9	**Issue 23:** (5.1.4.1.8) High-Risk Jobs (Beta/Gamma Exposure) - Site experts interviewed by SC&A classified INL as an “acute dose” site, with a significant number of facilities, operations, experiments, and occurrences providing the possibility of personnel receiving dangerous levels of radiation. NIOSH did not evaluate comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker external exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant’s file are not complete.	100	Unchanged	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
24	ORAUT-TKBS-0007-6	O	**Issue 24:** (5.1.4.1.9) Extremity Dose - NISOH should evaluate the potential for missed extremity dose for workers working in facilities where highly contaminated equipment, piping, instruments, valves, and systems resulted in exposures in confined spaces to hands.	100	Unchanged	
25	ORAUT-TKBS-0007-6	O	**Issue 25:** (5.1.4.1.10) Discrepancies between PIC and Film Reading – NIOSH should compare PIC versus film badge data (i.e., shallow and deep), and ensure that all the dose has been captured by the film badge. It is important to note that some PICs were worn for only the length of the job, so the discrepancy between readings of the two-dosimeter systems cannot be explained by drifting. **Expanded:** Many difficulties in comparing PIC readings and film results make agreement within a factor of two the best that can be expected.	100	Expanded	
26	ORAUT-TKBS-0007-6	**12**	**Issue 26:** (5.1.4.1.11) Minimum Detection Limit – NIOSH should re-evaluate the approach in determining the MDL of the dosimetry system by taking into account the system uncertainties. **Expanded:** The selection of 10 mrem as the MDL [minimum detection limit] for high energy gamma is questionable. Even for modern densitometers and film, it is a challenge to achieve this level, as a single density "click" can correspond to greater than 10 mrem for high-energy gamma radiation; this is not a problem, however, for intermediate and low-energy x-rays. Rather, one click of the densitometry system may correspond to 15 or 20 mrem for 660 keV or 1.2 MeV gammas, for example. If the claim is made that 10 mrem is a valid choice for the MDL, then supporting materials should be provided, such as film dose-to-density curves and densitometer calibration data. Other sites (e.g., Savannah River Site - SRS) have adopted 40 mrem as the high-energy gamma MDL for early film.	101	Expanded/upgraded	This issue was expanded and upgraded from an observation to a finding.

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
27	ORAUT-TKBS-0007-6	3	**Issue 27:** (5.1.4.1.12) Minimum Reporting Level (Beta/Gamma) - NIOSH does not provide adequate information supporting the use of chosen detection threshold levels to represent the MRL values for gamma film badges and TLDs. The use of MRL/2 as the missed external dose for dose reconstruction per OCAS-IG-001 is not claimant favorable for claims where the probability of causation value is close to 50%. In addition, NIOSH should re-evaluate the MRL values used and provide more supportable default values.	103	Unchanged	
28	ORAUT-TKBS-0007-6	3	**Issue 28:** (5.1.4.2.1) Minimum Reporting Level (Neutron) - NIOSH's approach for determining the MRL values for NTA emulsion film is not thorough or supported. For example, NIOSH uses 10 neutron readings in one data sheet from March 1958 to determine the MRL values for the period between 1951 and 1957, and 6 neutron readings to represent all neutron measurements between 1959 and 1976. Furthermore, the use of MRL/2 as the missed external dose for dose reconstruction per OCAS-IG-001 is not claimant favorable for claims where the probability of causation value is close to 50%. In addition, NIOSH's MRL values of 14 mrem and 20 mrem appear low and are inconsistent with generic values given for NTA dosimeters, as well as values cited by other DOE facilities with similar neutron source terms and detectors. NIOSH should re-evaluate the MRL values used and provide more supportable default values.	108	Unchanged	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
29	ORAUT-TKBS-0007-6	2	**Issue 29:** (5.1.4.2.2) Failure to Properly Address Neutron Exposures - INL had a total of 52 reactors, most of which were experimental/ prototype in design, which typically operated with high-power densities and with minimum shielding and neutron moderation. It is unjustified to presume that there are no missed neutron doses. In addition, there are deficiencies associated with neutron calibrations. Due to the use of the PoBe source for neutron calibration, dosimeters would significantly under-measure neutron doses from sources with lower-energy spectra. NIOSH should re-evaluate the entire approach in the TBD to account for potential missed neutron doses. **Expanded:** The method presented in the TBD of determining who needs to be assigned a missed neutron dose is circular: Section 6.5.4 states: *"If no neutron dose was assigned to the worker or coworkers for several months, the dose reconstructor should assume that the person was not exposed to neutrons."* Clearly this does not allow for individual workers having temporary or varying assignments. Also, if the program failed to correctly identify that they should have been monitored, the record will show no assigned neutron dose. In addition, the TBD makes the assumption that high Z materials, such as iron and lead, were never used (e.g., for shield penetrations) in place of hydrogenous materials, such as water and concrete. However, no attempt is made to validate or qualify this assumption. ORAUT-OTIB-0051, *Effect of Threshold Energy and Angular Response of NTA Film on Missed Neutron Dose at the Oak Ridge Y-12 Facility*, was issued after the 2004 Site Profile and has a bearing on neutron dosimetry issues; hence, it should be considered in this TBD.	109	Expanded	
30	ORAUT-TKBS-0007-6	2	**Issue 30:** (5.1.4.2.3) Neutron Calibration Deficiencies - Due to the use of the PoBe source for neutron calibration, dosimeters would significantly under-measure neutron doses from sources with lower energy spectra. NIOSH should re-evaluate the approach in the TBD to account for potential missed neutron doses.	110	Unchanged	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
31	ORAUT-TKBS-0007-6	8	**Issue 31:** (5.1.4.2.4) Completeness and Quality of INL Neutron Dosimetry and Record Keeping Programs - The identification and determination of missed neutron dose for workers are heavily influenced by this assumption of confidence, but SC&A found this premise to be unsupported after examining several critical DOE-HQ Tiger Team and DNFSB site audit reports. In addition, many site experts interviewed by SC&A indicated that there were significant deficiencies and inconsistencies in radiation work practices throughout the operating history of the INL facilities. These observations jeopardize the validity of the TBD approaches in reconstructing missed worker neutron doses.	110	Unchanged	
32	ORAUT-TKBS-0007-6	O	**Issue 32:** (5.1.4.2.5) Uncertainty Estimation for Neutron Doses – NIOSH should explain how the FNCFs were obtained and provide instruction to dose reconstructors on how to apply them.	110	Unchanged	
33	ORAUT-TKBS-0007-6	O	**Issue 33:** (5.1.4.2.6) Neutron Organ Dose – NIOSH should provide neutron spectrum information and guidance for organ dose reconstruction for workers at ZPPR and TREAT.	110	Unchanged	
34	ORAUT-TKBS-0007-6	9	**Issue 34:** (5.1.4.2.7) High-Risk Jobs (Neutron Exposure) - NIOSH did not evaluate comprehensively the facility and field data to identify and separate out the high-risk or high-dose jobs for worker neutron exposures. This information is essential for dose reconstructors to fill in the data gap when dose records in a claimant's file are not complete.	111	Unchanged	
35	ORAUT-TKBS-0007-6	O	**Issue 35:** (5.1.4.2.8) Multiplying Factors for Missed Neutron Dose – NIOSH should provide data to support the two multiplying factors (1.25 and 2) and the fixed missed neutron dose default value of 50 mrem. **Expanded:** See ORAUT-OTIB-0051 and Issue No. 29.	111	Expanded	

Comment Number	TBD Number	Finding Number	Issue Number and Description	SC&A Page No.[1]	Added, Removed, Expanded, Reduced, Upgraded or Unchanged? [2]	Comments
36	ORAUT-TKBS-0007-6	13	**Issue 36:** (6.3.2.2) Missed Low Energy Beta Dose - Section 6.3.2.2 of the TBD discusses the 100mg/cm^2 plastic dosimeter holder and the fact that betas of less than 360 keV will not penetrate the holder. (It is unclear if this density includes the film wrapper.) However, the TBD does not discuss allowance for or consideration of the possibility of the complete failure to detect these betas. The general, averaging approach to missed beta is questionable. The concern is that beta exposure is always assumed to be due to a mix of energies and thus the dose component from low energies is known and can be corrected. Clearly this is not the case, as is stated in the attribution. A specific concern is the Rare Gas Processing Facility (CPP-604), which harvested Kr-85. This nuclide is a pure beta emitter, with an endpoint energy of 670 keV. The film badges in use at the time were far from ideal for betas and failed to see any below 360 keV. NIOSH should determine if the maximum modifier recommended for betas of 2.8 is sufficient for this environment.	NA	Added	
37	ORAUT-TKBS-0007-6	O	**Issue 37:** (6.5.4) Error in Reference - The second paragraph of page 41 of the External Dose TBD (ORAUT 2007f) references Table 6-16 for IREP groups; it should refer to Table 6-14 instead.	NA	Added	
38	ORAUT-TKBS-0007-6	O	**Issue 38:** Shallow Dose - NIOSH should consider making use of ORAUT-OTIB-0017, *Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose*, where appropriate. Additionally, contrary to the OTIB's claim (p. 15) that the assumption of undergarment and pants thicknesses of 2 mm each is claimant favorable, SC&A believes that measured thicknesses are about half that and, hence, the OTIB assumptions are not claimant favorable.	NA	Added	SC&A already reviewed ORAUT-OTIB--0017 in SC&A 2007 (*Review of NIOSH/ORAUT Procedures and Methods Used for Dose Reconstruction (Supplement 1)*, SCA-TR-TASK3-0001, Rev. 1, August 3, 2007).