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**ADVISORY BOARD ON  
RADIATION AND WORKER HEALTH**

*National Institute for Occupational Safety and Health*

**SC&A'S EVALUATION OF ORAUT-OTIB-0088, REVISION 00,  
"EXTERNAL DOSE RECONSTRUCTION"**

**Contract No. 211-2014-58081  
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**SC&A, INC.:**

***Technical Support for the Advisory Board on Radiation and Worker Health Review of NIOSH Dose Reconstruction Program***

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## ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation and Worker Health
DOE	U.S. Department of Energy
DR	dose reconstruction
GSD	geometric standard deviation
keV	kiloelectron volt
LOD	limit of detection
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical information bulletin

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## 1.0 INTRODUCTION AND BACKGROUND

As a result of the Subcommittee for Procedure Reviews meeting of October 31, 2018, SC&A was tasked with a technical review of ORAUT-OTIB-0088, Revision 00, *External Dose Reconstruction*, issued September 25, 2018 (NIOSH 2018, referred to as “OTIB-0088”). OTIB-0088 was initiated to convert ORAUT-PROC-0006, Revision 01, *External Dose Reconstruction*, issued June 5, 2006 (NIOSH 2006a), to a technical information bulletin. It included information about assignment of onsite ambient dose to facilitate cancellation of ORAUT-PROC-0060, Revision 01, *Occupational Onsite Ambient Dose Reconstruction for DOE Sites*, issued June 28, 2006 (NIOSH 2006b).

This report presents SC&A’s evaluation of the technical approach, methods used, and documentation in OTIB-0088 to replace ORAUT-PROC-0006 and facilitate cancellation of ORAUT-PROC-0060.

## 2.0 OVERVIEW OF ORAUT-OTIB-0088

The following is a brief outline of OTIB-0088.

- **General Approach** – OTIB-0088 methodology is based primarily on information in OCAS-IG-001, Revision 3, *External Dose Reconstruction Implementation Guideline*, issued November 21, 2007 (NIOSH 2007).
- **Initial Evaluation of a Claim** - Figure 2-1, page 7, of OTIB-0088 provides a condensed, overall view of the method recommended for sorting and processing a claim as an overestimate, best estimate, or underestimate.
- **Hierarchy of Data** – Table 2-1, page 8, of OTIB-0088 summarizes the order of importance of data sources used for dose reconstruction (DR).
- **Level of Worker Monitoring** – OTIB-0088, pages 8–10, recommends DR methods to be used for three levels of worker monitoring:
  1. Worker was monitored adequately.
  2. Worker was not monitored.
  3. Worker monitored inadequately.
- **Types of External Radiation** – OTIB-0088, Section 2.2, pages 11– 15, summarizes the types of potential radiation exposures and recommended energy intervals.
  - **Photons** – The total photon dose consists of measured, missed, occupational medical x-rays, and environmental dose. Photons can be <30 kiloelectron volts (keV), 30–250 keV, or >250 keV in energy. Photon dose is assigned as an acute exposure.
  - **Neutrons** – The total neutron dose consists of measured and missed dose. Early neutron dosimetry is not always available or reliable; therefore, neutron-to-photon ratios must sometimes be used. Table 2-2, page 14, of OTIB-0088 provides the

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recommended neutron energy intervals and weighting factors. Neutron dose is assigned as a chronic exposure.

- **Betas** – The total beta dose consists of measured, missed, and skin contamination dose and is assigned as >15 keV electrons. Electron dose is assigned as an acute exposure.
- **Attachment A** – This attachment of OTIB-0088 provides an overview, with example calculations, of the recommended methods to use to assess the potential number of missed zeros using:
  - Overestimate approach
  - Underestimate approach
  - Best-estimate approach
- **Attachment B** – This attachment of OTIB-0088 provides a general outline of the sources of onsite ambient dose. It recommends assigning ambient external dose as a chronic exposure of 30–250 keV photons. The attachment offers some guidance concerning best-estimate methods for ambient dose assignment. It does not provide any site-specific information or data tables concerning ambient external dose, as these data are contained in site-specific technical basis documents.

### 3.0 SC&A'S EVALUATION OF ORAUT-OTIB-0088

The following sections summarize SC&A's evaluation of the technical approach, methods used, and documentation in OTIB-0088.

#### 3.1 EVALUATION OF APPROACH USED IN ORAUT-OTIB-0088

SC&A evaluated the approach used in OTIB-0088 to assign external dose and found it reasonable and useful. Figure 2-1 of OTIB-0088 presents a useful guideline for the dose reconstructor that will provide consistency in DR. The use of OCAS-IG-001 methodology provides for continuity in the DR process.

#### 3.2 EVALUATION OF METHODS USED IN ORAUT-OTIB-0088

SC&A evaluated the methods used in OTIB-0088 to assign external dose. SC&A concurs with the National Institute for Occupational Safety and Health's (NIOSH's) methods, equations, and recommendations in OTIB-0088. However, SC&A did have one observation concerning the lack of information in OTIB-0088, if it is used to facilitate cancellation of ORAUT-PROC-0060.

#### **Observation 1. Need to Retain Information Contained in ORAUT-PROC-0060**

Attachments A, B, and C of ORAUT-PROC-0060 are very informative sections of the procedure that provide the dose reconstructor with a quick reference for the assignment of site-specific onsite ambient dose. These attachments also help ensure the DR process is conducted in a consistent manner. The ORAUT-PROC-0060 attachments are:

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- **Attachment A** – External Onsite Ambient Dose Assignment for Monitored Site Employees
- **Attachment B** – Maximizing Dose Summary
- **Attachment C** – Methods for Assigning Site-Specific Best Estimates of External Onsite Ambient Doses

Since OTIB-0088 lacks the valuable information provided in the ORAUT-PROC-0060 attachments, the time to complete DRs would likely increase because the dose reconstructor would need to locate specific information now in the attachments, such as the current site environmental profile, personnel and control badge handling and storage policies, ambient dose levels, etc. In addition, this could result in inconsistencies in DRs among different claims.

SC&A strongly suggests reconsideration of the cancellation of ORAUT-PROC-0060 without an equivalent replacement document.

### 3.3 EVALUATION OF DOCUMENTATION IN ORAUT-OTIB-0088

SC&A evaluated the documentation in OTIB-0088 for assigning external dose and found one item that appears to be in error.

#### Observation 2. Apparent Error in Example Calculations

Attachment A, page 20, states three times throughout the text that the 95th percentile missed dose of a lognormal distribution is the number of zeros multiplied by the limit of detection (LOD). However, on page 21, the example calculation in the fifth bullet uses the value  $LOD/2$  (i.e.,  $0.040/2$ ) for deriving the 95th percentile missed dose, and the resulting geometric standard deviation (GSD):

- *95<sup>th</sup> percentile dose is  $48 \times 0.040/2 = 0.960$  rem*

with a calculated GSD of 1.162.

According to the text on page 20 of OTIB-0088, this should read: “95th percentile dose is  $48 \times 0.040 = 1.920$  rem,” with a calculated GSD of 1.771.

## 4.0 SUMMARY AND CONCLUSIONS

**Approach** – SC&A found the approach to external DR in OTIB-0088 to be reasonable and useful.

**Methods** – SC&A analyzed the methods and recommendations in OTIB-0088 and found them to be correct and applicable. However, SC&A does not find that OTIB-0088 provides adequate information that allows for the cancellation of ORAUT-PROC-0060 and had the following observation, as described in Section 3.2 of this report:

- **Observation 1. Need to Retain Information Contained in ORAUT-PROC-0060**

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**Documentation** – SC&A evaluated NIOSH’s documentation in OTIB-0088 for assigning external dose and found one item that appears to be in error. SC&A had the following observation, which is described in Section 3.3 of this report:

- **Observation 2. Apparent Error in Example Calculations**

## 5.0 REFERENCES

NIOSH 2006a. *External Dose Reconstruction*, ORAUT-PROC-0006, Revision 01, National Institute for Occupational Safety and Health, Cincinnati, OH. June 5, 2006.

NIOSH 2006b. *Occupational Onsite Ambient Dose Reconstruction for DOE Sites*, ORAUT-PROC-0060, Revision 01, National Institute for Occupational Safety and Health, Cincinnati, OH. June 28, 2006.

NIOSH 2007. *External Dose Reconstruction Implementation Guideline*, OCAS-IG-001, Revision 3, National Institute for Occupational Safety and Health, Cincinnati, OH. November 21, 2007.

NIOSH 2018. *External Dose Reconstruction*, ORAUT-OTIB-0088, Revision 00, National Institute for Occupational Safety and Health, Cincinnati, OH. September 25, 2018.