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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 01, "External Dose Reconstruction"

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Abbreviations and Acronyms

ABRWH	Advisory Board on Radiation and Worker Health
DOE	U.S. Department of Energy
DR	dose reconstruction
ICRP	International Commission on Radiological Protection
keV	kiloelectron volt
NCRP	National Council on Radiation Protection & Measurements
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical information bulletin

1 Introduction and Background

On March 15, 2021, the Advisory Board on Radiation and Worker Health tasked SC&A with a technical review of ORAUT-OTIB-0088, revision 01, "External Dose Reconstruction," issued October 21, 2019 (NIOSH, 2019; "OTIB-0088"). OTIB-0088, revision 01, was initiated to (1) correct an error in attachment A, (2) include a new attachment (C) to provide dates when U.S. Department of Energy (DOE) sites incorporated the recommendations of International Commission on Radiological Protection (ICRP) Publication 60 (ICRP, 1991; "ICRP 60") for neutron weighting factors, and (3) incorporate formal internal and National Institute for Occupational Safety and Health (NIOSH) review comments. Since the time SC&A was tasked with the review of revision 01 of OTIB-0088, NIOSH issued revision 02 on June 11, 2021, "to provide additional guidance regarding the potential need to use ICRP 60 weighting factors with neutron missed dose after the ICRP 60 implementation dates for sites in the DOE complex" (NIOSH, 2021, p. 2). SC&A has not yet been tasked to review revision 02.

This report presents SC&A's evaluation of the technical approach, methods used, and documentation in OTIB-0088, revision 01.

2 Overview of ORAUT-OTIB-0088, Revision 01

The following is a brief outline of OTIB-0088.

- **General approach** – The OTIB-0088 methodology is based primarily on information in OCAS-IG-001, revision 3, "External Dose Reconstruction Implementation Guideline" (NIOSH, 2007).

- **Initial evaluation of a claim** – Figure 2-1 of OTIB-0088 (p. 7) 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 of OTIB-0088 (p. 9) summarizes the order of importance of data sources used for dose reconstruction (DR).

- **Level of worker monitoring** – OTIB-0088 (pp. 9–11) recommends DR methods to be used for three levels of worker monitoring:

  – Worker was monitored adequately.

  – Worker was not monitored.

  – Worker monitored inadequately.

- **Types of external radiation** – OTIB-0088, Section 2.2 (pp. 12– 16), summarizes the types of potential radiation exposures and recommended energy intervals.

  – **Photons** – The total photon dose consists of measured, missed, occupational medical x-ray, and environmental dose. Photons can be <30 kiloelectron volts (keV), 30–250 keV, or >250 keV in energy. Photon dose is typically assigned as an acute

exposure, except environmental photon dose is always assigned as a chronic 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 of OTIB-0088 (p. 15) provides the 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.

- **Conversion of reconstructed external dose to organ dose** – OTIB-0088, Section 2.3 (p. 17), provides DR guidance on converting external dose to organ dose (exposure, absorbed dose, ambient dose, and penetrating dose).

- **Uncertainty** – OTIB-0088, Section 2.4 (p. 18), provides DR guidance on assessing uncertainty in assigning external dose.

- **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:

  - overestimating approach
  - underestimating 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.

- **Attachment C** – This attachment of OTIB-0088 provides dates when DOE sites incorporated the recommendations of ICRP 60 for neutron weighting factors.

3 SC&A'S Evaluation of ORAUT-OTIB-0088, Revision 01

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 NIOSH's methods, equations, and recommendations in OTIB-0088. However, SC&A's previous review (SC&A, 2019) of OTIB-0088, revision 00 (NIOSH, 2018), did have one observation concerning the lack of information in OTIB-0088, revision 00, if it is used to facilitate cancellation of ORAUT-PROC-0060, revision 01 (NIOSH, 2006):

> **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:
>
> - **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 inconsistences in DRs among different claims.
>
> SC&A strongly suggests reconsideration of the cancellation of ORAUT-PROC-0060 without an equivalent replacement document.

This observation was discussed during the Subcommittee for Procedure Reviews meeting of February 13, 2019 (ABRWH, 2019, pp. 87–91). The subcommittee closed SC&A's (2019) observation 1 with the understanding that NIOSH would consider SC&A's recommendation further and issue an email with a path forward. To date, SC&A is not aware of NIOSH issuing an email addressing this observation further; therefore, SC&A has the following observation:

Observation 1: Path forward concerning ORAUT-PROC-0060 material in OTIB-0088

Although the Subcommittee for Procedure Reviews closed SC&A's (2019) original observation 1 in 2019 with the understanding that NIOSH would consider SC&A's recommendation and issue an email with a path forward, to date, SC&A is not aware of NIOSH issuing an email addressing this observation further.

3.3 Evaluation of documentation in ORAUT-OTIB-0088

SC&A evaluated the documentation in OTIB-0088 for assigning external dose and had no findings. A previous mathematical error in attachment A, page 21, of revision 00, identified as observation 2 in SC&A's 2019 review (SC&A, 2019, p. 7) was discussed during the Subcommittee for Procedure Reviews meeting of February 13, 2019 (ABRWH, pp. 88–91, 2019). The subcommittee closed SC&A's (2019) observation 2 with the understanding that NIOSH would correct the error in the next revision of OTIB-0088. This mathematical error was corrected in revision 01 of OTIB-0088.

However, SC&A did note several areas that would benefit from further clarification or explanation, which are listed in the following observations.

Observation 2: Clarification of covered x-ray examinations

The first paragraph of page 8 states that, "Only doses that were received before the diagnosis of the primary cancer are included in the dose reconstruction," and, "If the worker received medical X-ray examinations for occupational health screening and as a condition of employment at a covered site, dose reconstruction includes those doses." However, it would provide further clarification if the statement included the fact that x-ray examinations that were performed for diagnostic or therapeutic reasons are excluded.

Observation 3: Unmonitored worker potential exposure

Page 10 of OTIB-0088 states, "In general, it is expected that reconstructed dose to unmonitored workers will be less than dose to monitored workers." This statement does not appear to be substantiated because it does not consider the fact that "unmonitored" workers also include workers whose records have been lost or destroyed or are illegible. Also, some classes of workers had their radiation exposures controlled by their primary employer (e.g., subcontractor), who did not necessarily follow the same procedures as the prime contractors.

Observation 4: Use of multiple badge records

Page 13 of OTIB-0088 states, "However, for cases in which multiple badges were issued for a particular monitoring period, only one zero measurement should be assigned per monitoring period." While this policy may apply to multiple badges from the same facility worn during the same time period (e.g., the badges are redundant), there are instances where a worker may have worked at several facilities at a site and been issued different badges at each facility (e.g., Idaho National Laboratory). In those cases, all badge results should be analyzed (SC&A does believe this is standard practice in DR).

Observation 5: Clarification of application of NCRP-to-ICRP correction factors

Section 2.2.2 (p. 14) discusses the ICRP 60 neutron weighting factors are discussed, and Attachment C provides the dates that DOE sites switched to using the ICRP 60 neutron weighting factors. For consistency in DR, it would be useful to include a statement that indicates that the neutron National Council on Radiation Protection & Measurements (NCRP)-to-ICRP correction factors recommended in the site profile need *not* be applied after the implementation of the ICRP 60 neutron weighting factors in the 2009–2011 timeframe. A scan of several of the DOE site profiles for external dose issued after 2010 indicate that some instruct the dose

reconstructor not to apply the NCRP-to-ICRP correction factors after the ICRP implementation date, but some do not.

4 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 did have an observation that SC&A is not aware of NIOSH issuing an email addressing SC&A's concern with the cancellation of ORAUT-PROC-0060, as described in section 3.2.

Documentation – SC&A evaluated NIOSH's documentation in OTIB-0088 for assigning external dose and found the previous error in attachment A has been corrected in revision 01. However, SC&A did note several areas that would benefit from further clarification or explanation, which are listed as four observations (2–5) in section 3.3.

5 References

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