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Advisory Board on Radiation and Worker Health
National Institute for Occupational Safety and Health

SC&A's Focused Review of ORAUT-OTIB-0088, Revision 02, "External Dose Reconstruction"

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Prepared by

Ron Buchanan, PhD, CHP

SC&A, Inc.
2200 Wilson Blvd., Suite 300
Arlington, VA 22201-3324

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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
LOD	limit of detection
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
SCPR	Subcommittee for Procedure Reviews
TBD	technical basis document

1 Introduction and Background

On November 3, 2021, the Subcommittee for Procedure Reviews (SCPR) tasked SC&A, Inc. with a focused review of ORAUT-OTIB-0088 ("OTIB-0088"), revision 02, "External Dose Reconstruction," issued June 11, 2021 (NIOSH, 2021). According to revision 02 of OTIB-0088, the "Revision [was] initiated 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" (p. 2).

This report presents SC&A's focused review to (1) compare the changes in OTIB-0088, revision 02 (NIOSH, 2021), to revision 01 (NIOSH, 2019) and (2) determine if the revisions in OTIB-0088, revision 02, addressed the observations identified by SC&A's review of revision 01 (SC&A, 2021).

2 Overview of ORAUT-OTIB-0088, Revision 02

The following is a brief outline of OTIB-0088, revision 02 (NIOSH, 2021):

- **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. 9) 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 (p. 10) summarizes the order of importance of data sources used for dose reconstruction (DR).

- **Level of worker monitoring** – Section 2.1 (pp. 10–14) recommends DR methods to be used for three levels of worker monitoring:

  – Worker was monitored adequately.
  – Worker was not monitored.
  – Worker was monitored inadequately.

- **Types of external radiation** –Section 2.2 (pp. 14–18) 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 (p. 17) 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** – Section 2.3 (pp. 18–19) provides DR guidance on converting external dose to organ dose (exposure, absorbed dose, ambient dose, and penetrating dose).

- **Uncertainty** –Section 2.4 (pp. 19–20) provides DR guidance on assessing uncertainty in assigning external dose.

- **Attachment A** – This attachment 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 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 (TBDs).

- **Attachment C** – This attachment provides 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.

3 SC&A's Focused Review of Changes in ORAUT-OTIB-0088, Revision 02

SC&A compared revision 02 of OTIB-0088 (NIOSH, 2021) to revision 01 of OTIB-0088 (NIOSH, 2019) and found that the notable changes were as follows:

- The following text was added on page 16:

> It is possible the site did not incorporate the ICRP 60 neutron weighting factors into the determination of the neutron LOD used for missed dose calculations after the implementation date (this issue should be addressed in the site TBD). If this is the case, or if this issue is not addressed in the current version of the site TBD, apply ICRP Publication 60 neutron

weighting factors to neutron dosimeter missed dose after the dates listed in Attachment C.

- The following facility was added to the list of DOE sites in attachment C, page 29: Oak Ridge Gaseous Diffusion Plant (K-25), ICRP 60 incorporated January 1, 2010.

SC&A concurs with these changes and has no findings or observations in this section.

4 SC&A's Focused Review of ORAUT-OTIB-0088, Revision 02, Addressing Previous Observations

During the November 3, 2021, meeting, the SCPR, the National Institute for Occupational Safety and Health (NIOSH), and SC&A discussed the five observations identified in SC&A's 2021 review (SC&A, 2021) of OTIB-0088, revision 01 (NIOSH, 2019). This report satisfies the SCPR's tasking of SC&A to perform a focused review of revision 02 of OTIB-0088 to determine if it has addressed SC&A's previous observations about revision 01. For completeness, SC&A has also included a discussion of those findings that were closed at the November 3, 2021, SCPR meeting. The following sections summarize the current status of each of the five observations.

4.1 Observation 1: Need to retain information contained in ORAUT-PROC-0060

Attachments A, B, and C of ORAUT-PROC-0060, revision 01 (NIOSH, 2006), 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.

4.1.1 Discussion of observation 1

This observation was discussed during the SCPR 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.

4.1.2 Current status of observation 1

Although the SCPR had previously closed observation 1, this observation was discussed at the November 3, 2021, SCPR meeting, because SC&A was not aware of NIOSH providing a path forward regarding this issue. NIOSH indicated that the specific external ambient dose information (including the site-specific information previously in ORAUT-PROC-0060) for each DOE site would be included in revised site TBDs as they are updated. The SCPR accepted this explanation and closed the observation.

4.2 Observation 2: Clarification of covered x-ray examinations

The first paragraph of page 8 of OTIB-0088, revision 01, 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, SC&A suggested that 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.

4.2.1 Current status of observation 2

This observation was discussed at the November 3, 2021, SCPR meeting. NIOSH indicated that dose reconstructors are aware that x-ray examinations performed for diagnostic or therapeutic reasons are excluded. The SCPR accepted this explanation and closed the observation.

4.3 Observation 3: Unmonitored worker potential exposure

Page 10 of OTIB-0088, revision 01, 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.

4.3.1 Current status of observation 3

This observation was discussed at the November 3, 2021, SCPR meeting. NIOSH stated that this statement would be removed in the next revision of OTIB-0088. The SCPR accepted this explanation and closed the observation.

4.4 Observation 4: Use of multiple badge records

Page 13 of OTIB-0088, revision 01, 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.)

4.4.1 Current status of observation 4

This observation was discussed at the November 3, 2021, SCPR meeting. NIOSH indicated that this statement will be reviewed, and that NIOSH will revise this statement in the next revision of OTIB-0088. The SCPR accepted this explanation; however, the status of the observation was changed to "In Abeyance" in order to track whether the next revision of OTIB-0088 has included this change.

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

Section 2.2.2 (p. 14) of OTIB-0088, revision 01, discusses the ICRP 60 neutron weighting factors, 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 review of several of the DOE site profiles for external dose issued after 2010 indicates that not all site profiles instruct the dose reconstructor not to apply the NCRP-to-ICRP correction factors after the ICRP implementation date.

4.5.1 Discussion of observation 5

This observation was discussed at the November 3, 2021, SCPR meeting. NIOSH indicated that this section was revised in revision 02 of OTIB-0088 (NIOSH, 2021). The SCPR tasked SC&A with a focused review of revision 02 to determine if this observation was adequately addressed.

4.5.2 Current status of observation 5

SC&A reviewed revision 02 of OTIB-0088 and found that the text (p. 16), concerning the application of the ICRP 60 neutron weighting factors to **missed** neutron dose **after** ICRP neutron weighting factors were implemented at DOE sites, did not address observation 5. Observation 5 recommends that it would be useful to include a statement that indicates that the NCRP-to-ICRP neutron correction factors recommended in the site profile need *not* be applied to **measured** neutron dose after the implementation of the ICRP 60 neutron weighting factors at the site. SC&A recommends that this observation remain open.

5 Summary and Conclusions

SC&A performed a focused review of OTIB-0088, revision 02, to (1) evaluate the changes in OTIB-0088, revision 02 compared to revision 01, and (2) determine if the revisions in OTIB-0088, revision 02, addressed the previous observations identified by SC&A in its review of OTIB-0088, revision 01 (SC&A, 2021). For completeness, SC&A provided a summary of observations 1, 2, and 3, which were addressed and closed during the November 3, 2021, SCPR meeting. Based on SCPR discussions at the November 3, 2021, meeting, observation 4, concerning the use of multiple badge records, remained open pending the next revision of OTIB-0088.

SC&A's focused review of revision 02 finds that observation 5, on the application of NCRP-to-ICRP neutron correction factors to **measured** dose after the implementation of the ICRP 60

neutron weighting factor at the site, was not adequately addressed in OTIB-0088, revision 02. SC&A recommends that observation 5 remain open.

6 References

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