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National Institute for Occupational Safety and Health

Review of ORAUT-OTIB-0093, Revision 00

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Prepared by

Rose Gogliotti, MS
Amy Mangel, MS, 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
Bq	becquerel
CFR	Code of Federal Regulations
CED	committed effective dose
CEDE	committed effective dose equivalent
E_{50}	committed effective dose
FR	Federal Register
$H_{T,50}$	committed equivalent dose
DCF	dose conversion factor
DOE	U.S. Department of Energy
DR	dose reconstruction
ICRP	International Commission on Radiological Protection
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical bulletin
Pu	plutonium
Sv	sievert
w_T	tissue weighting factor

1 Statement of Purpose

To support dose reconstruction (DR), the National Institute for Occupational Safety and Health (NIOSH) and the Oak Ridge Associated Universities Team (ORAUT) assembled a large body of guidance documents, workbooks, computer codes, and tools. One of those documents is ORAUT-OTIB-0093, revision 00, "Conversion of Committed Effective Dose to Annual Organ Dose" (ORAUT, 2023; "OTIB-0093"). OTIB-0093 provides guidance on the conversion from a committed effective dose (CED) to annual organ doses. NIOSH indicates that they intend to use this guidance document to help provide bounding internal dose estimates to workers who were unmonitored.

In November 2023, SC&A was tasked by the Advisory Board on Radiation and Worker Health's Subcommittee for Procedure Reviews to review ORAUT-OTIB-0093, revision 00 (ORAUT, 2023).

2 Background

In radiation protection, committed dose is a dose quantity that measures the stochastic health risk from an intake of radioactive material into the human body. A committed dose of 1 sievert (Sv) from an internal source represents the same effective risk as the same amount of effective dose of 1 Sv applied uniformly to the whole body from an external source.

On December 9, 1991, the U.S. Department of Energy (DOE) published a proposed rule (56 FR 64334). Title 10 of the Code of Federal Regulations (10 CFR) Part 835, "Occupational Radiation Protection," was issued December 14, 1993. The final rule became effective 30 days after issue. The rule allowed for submission of a radiation protection program for each DOE facility by January 1, 1995, and required full compliance by January 1, 1996.

Beginning January 1, 1996, internal dose evaluation programs at DOE facilities, including routine bioassay programs, were required by 10 CFR Part 835 for radiological workers who, under typical conditions, were likely to receive 0.1 rem or more committed effective dose equivalent (CEDE) in a year. CEDE is the risk-weighted sum of committed dose equivalents to tissue over the 50 years after an intake.

In June 2007, an amendment to 10 CFR Part 835 changed the dosimetric terms in the regulation to reflect the recommendations for assessing dose and associated terminology from International Commission on Radiological Protection (ICRP) Publication 60 and ICRP Publication 68 (ICRP 68). Full compliance with the amendment changes to 10 CFR Part 835 was required by July 2010. This resulted in the term CEDE changing to CED. As such, facilities with radiological workers likely to receive 0.1 rem or more CED (also known as E_{50}) were required to have internal dose evaluation programs. CED is the sum of the committed equivalent doses to various tissues or organs in the body (also known as $H_{T,50}$), each multiplied by the appropriate tissue weighting factor (w_T).

NIOSH notes that 1996 and 2010 are the latest dates required by DOE for implementation of the regulations and that some sites were in compliance before these dates.

3 Scope

The Energy Employees Occupational Illness Compensation Program Act requires DRs to assess annual organ doses, while the DOE monitoring requirement is based on a 50-year dose to the whole body. The relationship between annual organ doses and CED is multifaceted and does not allow direct conversion. NIOSH indicates that they intend to use the CED or CEDE values to calculate an intake quantity, which can then be used to calculate organ doses.

3.1 Implementation

Based on the monitoring requirements instituted by the 1996 and 2010 versions of 10 CFR Part 835, the assignment of a 0.1 rem CED in each year of potential exposure provides a bounding estimate of internal dose for unmonitored workers. The implementation of these monitoring requirements is determined and explained in the site-specific documentation. OTIB-0093 provides dose reconstructors guidance on the conversion from a CED to intake, which can subsequently be used to calculate the annual organ dose. The intake of a given radionuclide is determined using the appropriate ICRP 68 dose conversion factor (DCF), which has units of sievert per becquerel (Sv/Bq) (ICRP, 1994). NIOSH recommends using the DCFs provided in ICRP Publication 119 (ICRP 119), which are contained in a spreadsheet (ICRP, 2012). This spreadsheet gives inhalation DCFs and DCFs for soluble gases if the dose came from the vapor form of a material. OTIB-0093 states that all possible material types should be included when assessing the radionuclide intake. To determine the intake (Bq) that would result in a CED of 0.1 rem (0.001 Sv), OTIB-0093 uses the following equation:

$$\text{Intake (Bq)} = 0.001 \text{ Sv} / \text{DCF (Sv/Bq)}$$

SC&A agrees with NIOSH's use of the ICRP 119 DCFs and confirmed that the equation is correct. Table 2-1 of OTIB-0093 includes example organ doses that would result in 0.1 rem CED due to inhalation of plutonium (Pu)-239, to illustrate the variability in converting effective dose to an organ dose. SC&A reviewed the data and calculations for this table (ORAUT, 2023), and was able to reproduce NIOSH's values by dividing 0.001 by the Pu-239 inhalation dose coefficients from ICRP 68.

3.2 Exclusions

SC&A notes that the scope of this review is limited to the guidance in OTIB-0093 for calculating an intake based on a CED. Future application of the intakes discussed in the OTIB as a bounding assumption for internal dose, including criteria defining which unmonitored workers are assigned this dose, is dependent on site-specific information and is outside the scope of this review.

In addition, the approach specified in OTIB-0093 cannot be used for special forms of certain radionuclides that do not have specified DCFs in ICRP 119. As such, for the assessment of dose from special metal tritides, insoluble Pu-238, and Super S plutonium, NIOSH indicates DRs should instead follow guidance in ORAUT-OTIB-0066, revision 01 (ORAUT, 2020a), DCAS-RPT-005, revision 01 (NIOSH, 2018), and ORAUT-OTIB-0049, revision 02 (ORAUT, 2020b), respectively. SC&A agrees with referring to these documents for those special cases. SC&A has reviewed the current version of all three documents.

4 Conclusion

SC&A reviewed NIOSH's approach for converting CED to annual organ doses and found the methodology to be reasonable and consistent with current ICRP guidance. SC&A was able to reproduce doses in table 2-1 of OTIB-0093, which provides example doses for intakes of types M and S Pu-239. SC&A also concurs with the OTIB guidance for using alternative NIOSH documents for special forms of radionuclides where DCFs are not included in ICRP 119. SC&A agrees with the OTIB-0093 guidance that site-specific information takes precedence, including any co-exposure models or other exposure matrices. Therefore, SC&A had no findings or observations.

5 References

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