SC&A Presentation Handout

# Findings and Discussions of Document Reviews Presented to the Advisory Board on Radiation and Worker Health

Meeting of the Advisory Board on Radiation and Worker Health
August 18, 2021

This presentation handout gives details about documents reviewed by the Subcommittee for Procedure Reviews (SCPR) that have previously been presented to the Advisory Board on Radiation and Worker Health (ABRWH, Board) but have not been formally approved/closed. The following documents are discussed in this handout.

**March 12, 2013, ABRWH Meeting**

- ORAUT-OTIB-0070, "Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities"
- OCAS-IG-001, "External Dose Reconstruction Implementation Guideline"

**July 17, 2013, ABRWH Meeting**

- OCAS-TIB-0010, "Best Estimate External Dose Reconstruction for Glovebox Workers"
- ORAUT-OTIB-0023, "Assignment of Missed Neutron Doses Based on Dosimeter Records"

**October 17, 2013, ABRWH Meeting**

- ORAUT-OTIB-0010, "A Standard Complex-Wide Correction Factor for Overestimating External Doses Measured with Film Badge Dosimeters"
- OCAS-PER-012, "Evaluation of Highly Insoluble Plutonium Compounds"

**April 11, 2018, ABRWH Meeting (closeout deferred awaiting National Institute for Occupational Safety and Health (NIOSH) followup)**

- NIOSH-OVER-0009, "Skin Exposure"
- ORAUT-OTIB-0017, "Interpretation of Dosimetry Data for Assignment of Shallow Dose"

## ORAUT-OTIB-0070, Rev. 0, "Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities"

SC&A reviewed revision 0 of ORAUT-OTIB-0070 (OTIB-0070) in August 2008. The findings and resolutions of findings were presented to the ABRWH at the March 12, 2013, meeting.

**Summary:** This technical information bulletin provides guidance for (1) estimating dose to workers at Atomic Weapons Employer (AWE) facilities when NIOSH determines "significant residual contamination" and (2) reconstruction of internal doses due to the resuspension of particulate surface contamination.

*Table 1. Fifteen total findings for ORAUT-OTIB-0070, revision 0*

| # | OTIB-0070 finding | Resolution |
|---|---|---|
| 1 | Inconsistent use of the resuspension factor (RF) – The default source term depletion value of 1% per day implies an RF of 8e-05 per meter, which is nearly 2 orders of magnitude higher than NIOSH's recommended RF of $10^{-6}$ $m^{-1}$ | Closed on July 31, 2012.<br>OTIB-0070, revision 1, changed the source term depletion rate from 1% $day^{-1}$ to 0.00067 $day^{-1}$, which is consistent with an RF of $10^{-6}$ $m^{-1}$. |
| 2 | OTIB-0070, section 2.5, references refer to outdoor soil contamination, which involves conditions with little resemblance to building surfaces, building uses, room heights, and ventilation rates. | Closed on July 31, 2012.<br>OTIB-0070, revision 1, recalculated the default source-term depletion rate during the residual radiation periods based actual data from four AWE sites (Blockson, Dow Madison, General Atomics, and Simonds Saw) rather than being based on literature sources where outdoor measurements were preponderant. |
| 3 | Implicit in deriving the source term depletion rate (λ, Section 2.6) is that airborne contaminants are (1) uniformly distributed throughout the interior volume and (2) removed with 100% efficiency. Neither assumption is likely to exist. | Closed on July 31, 2012<br>OTIB-0070, Revision 1, Section 4.1 recalculated the default source-term depletion rate during the residual radiation periods based on averaging observed depletion rates at four AWE sites. |
| 4 | Battelle-TBD-6000 and TBD-6001 identified relatively large job-specific air concentrations during facility operations. In contrast, OTIB-0070, attachment B, identifies a single value for each of three thorium sites that excludes process air sampling data. | Closed on January 5, 2011.<br>Air samples were selected to be indicative of general area conditions within the facilities at the start of the residual period and not potential exposure during the operational period. |
| 5 | Attachment B cites survey data for three thorium facilities but provides no further guidance on how these data sets are to be used. | Closed on January 5, 2011.<br>Since it has never been used for dose reconstruction (DR), attachment B has been deemed unnecessary for the purpose of OTIB-0070 and has been removed from revision 1. |

| # | OTIB-0070 finding | Resolution |
|---|---|---|
| 6 | Use of attachment B Horizons summary survey data as a default value for operational air concentration at a thorium-refining facility is inappropriate and not claimant favorable. | Closed on January 5, 2011.<br>Since it has never been used for DR, attachment B has been deemed unnecessary for the purpose of OTIB-0070 and has been removed from revision 1. |
| 7 | It is unclear how the attachment B Horizons geometric mean value of 4.8 disintegrations per minute per cubic meter (dpm/$m^3$) was derived from the Atomic Energy Commission data. | Closed on January 5, 2011.<br>Since it has never been used for DR, attachment B has been deemed unnecessary for the purpose of OTIB-0070 and has been removed from revision 1. |
| 8 | The derivation of attachment B air concentration values (i.e., a geometric mean of 1.2 dpm/$m^3$ and a geometric standard deviation of 3.9 dpm/$m^3$) for Nuclear Metals was not adequately explained. | Closed on January 5, 2011.<br>Since it has never been used for DR, attachment B has been deemed unnecessary for the purpose of OTIB-0070 and has been removed from revision 1. |
| 9 | The derivation of the attachment B Lindsey air concentration values was not adequately explained, and the values do not appear to correspond to those reported in the survey. | Closed on July 31, 2012.<br>Since it has never been used for DR, attachment B has been deemed unnecessary for the purpose of OTIB-0070 and has been removed from revision 1. |
| 10 | NIOSH's recommended RF of $10^{-6}$ $m^{-1}$ is inappropriate. The scientific literature indicates RF values of $10^{-4}$ to $10^{-3}$ $m^{-1}$ for indoor activities involving substantial industrial activities. | Closed on July 31, 2012.<br>A footnote added to table 5-1 indicates that a site-by-site analysis should be conducted to establish the RF at sites where no postoperational clean-up has been performed, rather than simply accepting an RF of $10^{-6}$ $m^{-1}$. |
| 11 | Use of NUREG-1400 is inappropriate and technically not feasible since the total absence of data precludes a quantitative assignment to the source term that reflects residual contamination. | Closed on July 31, 2012.<br>Consideration of NUREG-1400 as a possible method for estimating residual contamination has been deleted from OTIB-0070, revision 1 (refer to table 5 of OTIB-0070). |
| 12 | Use of Battelle-TBD-6000 for assigning operational air concentration values may not be claimant favorable. | This finding is being addressed in Battelle-TBD-6000, issue 4 as of July 26, 2010.<br>This finding will be closed when documentation from the TBD-6000 Work Group is received indicating that TBD-6000, issue 4, has been closed. |
| 13 | It is not possible to judge whether the basic approach to developing inhalation doses in TBD-6001 is claimant favorable. | Closed on July 31, 2012.<br>Since TBD-6001 has been cancelled, all references to and data from TBD-6001 have been removed from OTIB-0070, revision 1. |
| 14 | Use of Battelle-TBD-6001 for determining inhalation doses may not be claimant favorable. | Closed on July 31, 2012.<br>Since TBD-6001 has been cancelled, all references to and data from TBD-6001 have been removed from OTIB-0070, revision 1. |

| # | OTIB-0070 finding | Resolution |
|---|---|---|
| 15 | Many of the assumptions that form the basis of the OCAS-TIB-009 ingestion model are too restrictive and may yield low ingestion estimates. | Closed on February 5, 2013.<br>Since finding TIB-009-01 has been resolved and closed, finding OTIB-0070-15 has also been closed. |

### *Board Discussions*

There was some discussion about the use of a default RF of 10-6 m-1 (pp. 149–157 of the March 12, 2013, transcript).

- **Question:** Is the default RF appropriate for outdoor settings?

  **Response:** OTIB-0070 recommends use of the default RF for indoor activities at facilities where postoperational decontamination has been performed.

- **Question:** Is the default RF applicable at all AWE sites?

  **Response:** OTIB-0070 also states that a site-by-site analysis should be conducted to establish an appropriate RF at sites where no postoperational cleanup has been performed, rather than simply accepting an RF of 10-6 m-1.

This explanation satisfied the Board members, and no further discussion was held regarding the review of OTIB-0070.

## OCAS-IG-001, Revisions 1, 2, and 3, "External Dose Reconstruction Implementation Guideline"

SC&A reviewed revision 1 of OCAS-IG-001 (IG-001) in January 2005 and revision 2 in October 2007. SC&A was tasked to perform a focused review of revision 3 the ensure all remaining findings were appropriately addressed. The results of these reviews were presented to the ABRWH at the March 12, 2013, meeting.

**Summary:** IG-001 provides general (not specific) guidance on the components, standards, and methods to be used to reconstruct external radiation dose for probability of causation (POC) calculations.

*Table 2. Twenty-four total findings (17 findings from review of revision 1 and 7 findings from review of revision 2) for OCAS-IG-001*

| # | IG-001 finding | Resolution |
|---|---|---|
| 1 | Deficiencies with procedure layout include (1) fragmented structure, (2) excessive amount of useless data and/or historical background in main body, and (3) critical data for DR found in appendices rather that main body. | Closed on July 31, 2012.<br>The SCPR determined that this finding is closed. Concerns raised by this issue are covered in finding 19. |
| 2 | Guidance for deriving (1) film and thermoluminescent dosimeter (TLD) uncertainty, (2) neutron dose from source term, and (3) occupational medical dose using x-ray machine operating parameters requires data and resources that are not available to the dose reconstructor. | Closed on November 1, 2012.<br>IG-001 provides general principles, not specific guidance. Detailed implementation guidance and related information are found in other documents and procedures. |
| 3 | IG-001 provides inadequate guidance for classifying a case as potentially <50% POC or >50% POC and should identify the role of Task 2 personnel. | Closed on October 29, 2007.<br>Revision 2 of IG-001 eliminated recommending inappropriate methods for TLD uncertainty and includes guidance that directs the dose reconstructor to site-specific documentation, when available. |
| 4 | IG-001 recommends inappropriate methods for estimating TLD uncertainty. | Closed on October 29, 2007.<br>Revision 2 of IG-001 eliminated recommending inappropriate methods for TLD uncertainty and includes guidance that directs the dose reconstructor to site-specific documentation, when available. |
| 5 | IG-001 recommends a range of limit of detection (LOD) values for 1956–1960 that the reviewer considers too low for the period. | Closed on October 29, 2007.<br>In revision 2, table 2.1 that referenced LOD values for the 1956–1960 period has been modified to remove any date-specific LOD values. |

| # | IG-001 finding | Resolution |
|---|---|---|
| 6 | Guidance implies that LOD for deep dose from gamma may also be applied to electron dose, which is inconsistent with historical data that show uncertainty for shallow dose is considerably higher than for deep dose. | Closed on October 29, 2007.<br>Revision 2 of IG-001 removes the example that implies LOD for deep dose from gamma is also appropriate for electron dose. |
| 7 | IG-001 assumes nuclear track emulsion, type A (NTA) film dosimeters were insensitive to neutron below 500 kiloelectron volts (keV); however, the reviewer contends that the dosimeter is insensitive to neutron. | Closed on October 29, 2007.<br>Revision 2 indicates that a variety of energy thresholds for NTA film dosimeters are cited in the literature and recommends reviewing site-specific information for determining actual threshold values. |
| 8 | Methods for reconstruction of neutron doses from survey data or source term data do not appear practical, achievable, and defensible. | Closed on July 31, 2012.<br>Revision 3 has included the use of more practical methods, such as employing neutron-to-photon ratios. |
| 9 | IG-001 does not acknowledge the likely use of neutron/photon ratio methods in neutron DR and erroneous states that “at most facilities, neutron exposures were generally less than 20% of the photon exposures.” | Closed on October 29, 2007.<br>Revision 2 modified section 2.2.2 to eliminate the inaccurate statement and introduced a statement acknowledging the use of site-specific neutron-to-photon ratios. |
| 10 | IG-001, appendix B, dose conversion factors (DCFs) for bone surface and red marrow are underestimated. | Closed on October 29, 2007.<br>Revision 2 recommends applying a correction factor to the rotational and isotropic DCFs for bone surface and red marrow (as well as esophagus and lung). |
| 11 | IG-001 does not account for additional laboratory uncertainty for film badge readings associated with exposure less than 200 millirem (mrem). | Closed on October 29, 2007.<br>Revision 2 added guidance to section 2.1.1.3 indicating that site-specific dosimetry data may be available in the site profile. |
| 12 | IG-001, appendix B, posterior-anterior (PA) geometry DCFs are in error and underestimate dose (i.e., assume the dosimeter is worn on the posterior). | Closed on February 5, 2013.<br>PA DCFs are not routinely used in DRs. However, since PA DCFs could prove useful in some special exposure scenarios (if used correctly), the PA DCFs should be kept in appendix B. |
| 13 | IG-001, appendix B, rotational and isotropic geometry DCFs are in error and underestimate dose. | Closed on October 29, 2007.<br>Revision 2 has introduced a discussion and table of correction factors to be applied to rotational and isotropic DCFs for bone (surface), bone (red marrow), esophagus, and lung. |
| 14 | Angular sensitivity not accounted for in correcting measured film or TLD values. | Closed on October 29, 2007.<br>Revision 2 added a discussion on the angular response of dosimeters to section 4 and guidance that directs the dose reconstructor to site-specific documentation. |

| # | IG-001 finding | Resolution |
|---|---|---|
| 15 | No correction recommended for backscatter; may be significant factor for pre-1984 when calibrations were done “in air” as opposed to “on-phantom.” | Closed on July 27, 2006.<br>No correction for backscatter only makes the reported film dose higher, building some conservativeness in early years. |
| 16 | Environmental uncertainty (i.e., heat, humidity, light, etc.) was not addressed in IG-001. | Closed on February 5, 2013.<br>IG-001 contains general guidance information but does not provide specific instructions to follow during DR. Specific instructions are provided in site-specific or issue-specific technical documents and workbooks. |
| 17 | Guidance for the selection of uncertainty distributions for total organ dose raises question of consistency and requires professional judgment. | Closed on February 5, 2013.<br>IG-001 contains general guidance information but does not provide specific instructions to follow during DR. Specific instructions are provided in site-specific or issue-specific technical documents and workbooks. |
| 18 | SC&A’s review of IG-001, revision 1, identified several deficiencies regarding the clarity and structure of the document. | Closed on July 31, 2012.<br>Revisions 2 & 3 eliminated much of the excessive data and generally improved the clarity of the document. |
| 19 | A deficiency (finding 1) identified under the revision 1 review was the fragmented structure and illogical sequencing of information. | Closed on November 1, 2012.<br>What constitutes the logical, versus illogical, sequencing of information is a fairly subjective determination. Importantly, the sequence of information within the document is not a key factor in providing adequate guidance. |
| 20 | Guidance was not provided regarding the methodology for the assessment of neutron doses using source term data. | Closed on November 1, 2012.<br>IG-001 provides general principles, not specific guidance. Detailed implementation guidance and related information is found in other documents and procedures. |
| 21 | IG-001 does not consistently direct the dose reconstructor to technical and site-specific documents. | Closed on July 31, 2012.<br>This finding is virtually identical to finding 22. |
| 22 | OCAS-IG-001 should (but does not) direct the dose reconstructor to technical and site-specific documentation, where the dose reconstructor can find more specific guidance. | Closed on November 1, 2012.<br>IG-001 provides general principles, not specific guidance. Detailed implementation guidance and related information is found in other documents and procedures. |
| 23 | No discussion added to this revision regarding neutron-to-photon ratios. | Closed on July 31, 2012.<br>Revision 3 added a discussion to section 2.2.2.2.1 to clarify the evaluation of missed neutron data, by recommending the use of site-specific neutron-to-photon dose ratios. |

| # | IG-001 finding | Resolution |
|---|---|---|
| 24 | (1) All DCFs associated with PA geometries in appendix B are in error and underestimate dose. (2) Environmental uncertainty associated with dosimeters is not addressed. (3) Guidance for selection of uncertainty distributions raises questions of consistency and required professional judgment. | Closed on February 5, 2013.<br>PA DCFs are not routinely used in DRs. However, since PA DCFs could prove useful in some special exposure scenarios (if used correctly), the PA DCFs should be kept in appendix B.<br>IG-001 contains general guidance information but does not provide specific instructions to follow during DR. Specific instructions are provided in site-specific or issue-specific technical documents and workbooks. |

### *Board Discussions*

Board members posed the following questions about the review of IG-001 (pp. 171–181 of the March 12, 2013, transcript):

- **Question:** Would information provided in IG-001, such as differences in film badges and their limitations, be used simply as guidance and site-specific data used for details, such as limits of detection, etc.?

  **Response:** This guidance document essentially predates virtually every other procedure currently in use. It presents the principles of external dosimetry. At the time it was written, there was not a well-defined process for how the technical documentation was going to be defined. As the program progressed, it was recognized that there was a need for far more site-specific and issue-specific distinction to provide some consistent guidance. Therefore, IG-001 is a very general document. It is almost a primer on what DR consists. At this point, site-specific documents would be used to provide details of the external dosimetry program in use.

- **Question:** To what extent did this review use the experience in the individual DRs?

  **Response:** SC&A's review of IG-001 did not consider the experience of DR, because the review was performed very early in the program. At the time of the original review, there was not a significant amount of specific DR review experience available.

This explanation satisfied the Board members, and no further discussion was held regarding the review of IG-001.

## OCAS-TIB-0010, Revision 2, "Best Estimate External Dose Reconstruction for Glovebox Workers"

SC&A reviewed revision 2 of OCAS-TIB-0010 (TIB-0010) in June 2006. The findings and resolution of findings were presented to the ABRWH at the July 17, 2013, meeting.

**Summary:** This procedure provides correction factors for best-estimate DR to organs located in the lower torso from photons emanating from gloveboxes when a dosimeter is worn on the lapel. NIOSH calculated the gamma flux at 30 points covering the chest and at 30 points covering the abdomen and then determined the ratio of each abdomen flux to each chest flux. The mean ratio was then selected as the correction factor.

*Table 3. Nine total findings for OCAS-TIB-0010*

| # | TIB-0010 finding | Resolution |
|---|---|---|
| 1 | The TIB lacks transparency. The radioactive source is not identified; neither its exact dimensions nor location are given, nor is the thickness of the walls presented. | Closed on March 22, 2011.<br>The requested information was provided in appendix B, rev. 03. |
| 2 | Lower torso organs not specified. | Closed on April 11, 2012.<br>The phrase "other cancers that appear in the region of those organs" (i.e., stomach, liver, bladder, prostate, ovaries, testes, genitalia) was added to section 2.0 to allow for cancers such as sarcomas, Hodgkin's lymphomas, or other cancers that might occur anywhere but would only require the adjustment if they occurred in the region defined by the specified organs. |
| 3 | Correction factors do not represent worst-case assumptions. | Closed on October 14, 2008.<br>The SCPR is of the opinion that this is a NIOSH policy decision and has been handled appropriately. |
| 4 | Analysis is needlessly complex. | Closed on October 14, 2008.<br>This was more of an observation than a finding. |
| 5 | SC&A questions the design of the analysis that compares the particle flux over locations on the torso, rather than modeling the variation of dosimeter response with location. | Status changed to in abeyance on February 5, 2013.<br>The SSCPR agrees with the use of the 95th percentile instead of the mean for the correction factor. |
| 6 | SC&A questions the assumptions made concerning the glovebox model, e.g., wall thickness, Lexan window, etc. | Status changed to in abeyance on February 5, 2013.<br>The SCPR agrees with the use of the 95th percentile instead of the mean for the correction factor. |

| # | TIB-0010 finding | Resolution |
|---|---|---|
| 7 | SC&A questions the use of an anatomical illustration of a human torso rather than the International Commission on Radiological Protection (ICRP) Reference Man based anthropomorphic phantoms developed by Oak Ridge National Laboratory. | Closed on October 14, 2008.<br>Since the SC&A-calculated correction factor based on the Hp(10) dose rate was the same as the correction factor calculated using the anatomical illustration, the additional work to model the ICRP Reference Man is not warranted. |
| 8 | The use of the Attila software is questioned. | Status changed to in abeyance on February 5, 2013.<br>The SCPR agrees with the use of the 95th percentile, instead of the mean, for the correction factor. |
| 9 | The use of Rocky Flats to validate the model is questionable; Rocky Flats data are for glovebox and non-glovebox workers, information is lacking regarding the radiation sources, etc. | Closed on October 14, 2008.<br>Rocky Flats Plant (RFP) data were used only as a proof of principle; they were not used in the justification of the glovebox factor. The RFP data have been removed from DCAS-TIB-0010. |

### *Board Discussions*

Board members raised the following questions (pp. 31–45 of the July 17, 2013, transcript):

- **Question:** When this model was developed, were there specific designs of gloveboxes that were used?

  **Response:** NIOSH stated that, because of the myriad designs even at a given facility, it was decided not to make adjustments based on design and rely strictly on a geometric consideration without accounting for other shielding. SC&A added that they ran MCNP calculations for a number of different glovebox designs and found that the different glovebox designs evaluated did not have a significant effect on the correction factor.

- **Question:** At Hanford, they put shielding on the front of the glovebox but nothing underneath. If a person is backed up against another, you are getting scatter radiation from underneath the glovebox. Was this scenario considered?

  **Response:** TIB-0010 contains a generic calculation that is bounding for the geometries considered. NIOSH stated that the math in TIB-0010 is adequate to describe the variance in the two measurements described therein. But if there are other special situations, they would need to be incorporated outside of the realm of TIB-0010. In addition, shielding did not come into play; it is a geometric correction factor.

- **Question:** Since this is a geometric issue, did the model take into account the height of the workers?

  **Response:** Yes, height of the worker was discussed, and it was decided to use the height of the Reference Man. However, since the model uses the 95th percentile of the dose ratio distributions, in reality it is taking the ratio of what the badge would read to probably the lowest organ.

- **Question:** Is the model adjusted for workers who wore lead aprons?

  **Response:** The lead apron would not be a question for the glovebox adjustment. It would be a question for the interpretation of the badge and was the badge worn under the apron or over the apron.

- **Question:** So, in summary, this is just to correct the geometric means of the dose that does not consider shielding, the manufacturing, etc.? And this is used as a best estimate?

  **Response:** OTIB-0010 is used for best estimates to organs located in the lower torso and is a geometric correction factor only.

These explanations satisfied the Board members, and no further discussion was held regarding the review of TIB-0010.

**Update:** During the preparation of this handout, SC&A reviewed revision 04 of TIB-0010 and determined that section 3.2 and section 5.0, table 1, still recommend applying the geometric mean values, rather than the 95th percentile values agreed upon in findings 5, 6, and 8.

## ORAUT-OTIB-0023, Revision 00, "Assignment of Missed Neutron Doses Based on Dosimeter Records"

SC&A reviewed revision 0 of ORAUT-OTIB-0023 (OTIB-0023) in June 2006. The findings and resolution of findings were presented to the ABRWH at the July 17, 2013, meeting.

**Summary:** The purpose of OTIB-0023 is to provide information to allow dose reconstructors to determine when it is appropriate to assign missed neutron doses at U.S. Department of Energy sites using the neutron missed dose central estimate (nLOD/2) method or an "alternative" method. The alternative method should be applied when the nLOD/2 exceeds 75 percent of the assigned photon dose (i.e., from recorded dosimeter dose + missed dose).

*Table 4. Eight total findings for ORAUT-OTIB-0023*

| # | OTIB-0023 finding | Resolution |
|---|---|---|
| 1 | The procedure lacks clarity by failing to provide clear definitions and is inconsistent in its terminology. | Closed on June 24, 2008.<br>OTIB-0023, revision 1, addressed this finding. |
| 2 | For the alternative method, detailed information is required that will not be readily available to the dose reconstructor. | Closed on June 24, 2008.<br>Revision. 00, Section 6, Condition #1 was eliminated by Rev. 01, which resolves Finding 2. |
| 3 | References OCAS-IG-001 as the basis for its guidance; however, guidance contained in OTIB-0023 and OCAS-IG-001 is inconsistent.<br>Review objective 1.4: "Is the procedure consistent with all other procedures that are part of the hierarchy of procedures employed by NIOSH for dose reconstruction?" | Closed on January 7, 2008.<br>OTIB-0023, revision 1 (and IG-001, rev. 3), corrected the inconsistencies between IG-001, section 2.2.2.2.1 and OTIB-0023, section 6. |
| 4 | It is questionable whether dose reconstructors are in a position or have the information to make the potentially subjective decisions required. | Closed on June 24, 2008.<br>Revision 00, section 6, condition 1, was eliminated by revision 01, which resolves finding 4. |
| 5 | Refer to finding OTIB-0023-03 for review objective 1.4.<br>Review objective 4.2: "Does the procedure adhere to the hierarchical process as defined in 42 CFR 82.2?" | Closed on January 7, 2008.<br>The SCPR indicated that issue OTIB-0023-03 was closed. Since this issue refers to issue OTIB-0023-03, it has also been closed. |
| 6 | The reconstruction of missed neutron doses from "numerous neutron measurements and accurate time information" is unrealistic. | Closed on June 24, 2008.<br>Revision 00, section 6, condition 1, was eliminated by revision 01, thus rendering finding 6 moot. |
| 7 | The regulatory recommendation for "striking a balance between the need for technical precision and process efficiency" has been ignored. | Closed on June 24, 2008.<br>Revision 00, section 6, condition 1, was eliminated by revision 01, thus rendering finding 7 moot. |

| # | OTIB-0023 finding | Resolution |
|---|---|---|
| 8 | The generic assumption of a neutron-to-photon ratio of 0.75:1 as a limiting value for the application of nLOD/2 is neither technically defensible nor claimant favorable. | Closed on June 24, 2008.<br>Revision 00, section 6, condition 1, was eliminated by revision 01, thus rendering finding 8 moot. |

### *Board Discussions*

Board members had no questions or comments regarding the review and finding resolution process of OTIB-0023.

## ORAUT-OTIB-0010, Revision 00, "A Standard Complex-Wide Correction Factor for Overestimating External Doses Measured with Film Badge Dosimeters"

SC&A reviewed revision 00 of ORAUT-OTIB-oo10 (ORIB-0010) in January 2005. The findings and resolution of findings were presented to the ABRWH at the October 17, 2013, meeting.

**Summary:** The objectives of this document are (1) evaluate the degree of standardization of typical U.S. Department of Energy film dosimeters and (2) develop a standard methodology for use by the dose reconstructor to assign a dose that will result in a reasonable overestimate of the organ dose. Since this is an overestimating approach for a quick evaluation of the potential for compensability, OTIB-0010 is used only for claims that are judged to be likely noncompensable.

*Table 5. Ten total findings for ORAUT-OTIB-0010*

| # | OTIB-0010 finding | Resolution |
|---|---|---|
| 1 | Guidance is lacking for how to treat missed dosimetry data in which the number of zero readings is fewer than 12 cycles. | Closed on June 24, 2008.<br>Revision 01 provides guidance on how to handle missed (or zero) dosimetry data. |
| 2 | Guidance fails to acknowledge that missed dose based on LOD (as opposed to LOD/2) represents 95th percentile and requires no uncertainty. | Closed on June 24, 2008.<br>Revision 01 new table 2-1 provides specific instructions to the dose reconstructor regarding how the recorded and missed dose should be calculated and entered into the Interactive RadioEpidemiological Program (IREP). |
| 3 | Document contains too much upfront background information and does not provide DR with guidance for maximizing external dose until page 8. | Closed on June 24, 2008.<br>In revision 01, relevant background and technical basis information has been moved to the end of the document and incorporated into new attachment A. |
| 4 | Upfront background information not relevant to implementation of procedure. | Closed on June 24, 2008.<br>In revision 01, relevant background and technical basis information has been moved to the end of the document and incorporated into new attachment A. |
| 5 | Guidance does not address how to use the standard correction factor when recorded dosimeter dose is greater than zero but less the LOD (i.e., 40 mrem). | Closed on June 24, 2008.<br>Revision 01 specifies the use of 40 mrem as a reasonable default LOD. |
| 6 | Guidance fails to acknowledge that the use of the standard correction factor eliminates the need for uncertainty. | Closed on June 24, 2008.<br>Revision 01 new table 2-1 provides very specific instructions to the dose reconstructor on calculating uncertainty and how the dose data should be entered into IREP. |

| # | OTIB-0010 finding | Resolution |
|---|---|---|
| 7 | Guidance in OTIB-0010 differs from instructions in section 5.0 of ORAUT-PROC-0006. (ORAUT-PROC-006 does not employ a standard correction factor to dosimeter dose but does apply uncertainty; OTIB-0010 uses a standard correction factor with no uncertainty.) | Closed on June 24, 2008.<br>ORAUT-PROC-0006 was completely revised June 5, 2006, and no longer contains guidance that is inconsistent with OTIB-0010. |
| 8 | OTIB-0010 does not identify its hierarchical position among competing procedures; for example, does the dose reconstructor have the option to use either OTIB-0010 or attachment D-2 of ORAUT-PROC-0006? | Closed on June 24, 2008.<br>ORAUT-PROC-0006, attachment D-2, has been eliminated and ORAUT-PROC-0006, section 5.1.1, refers the dose reconstructor to OTIB-0010, when appropriate. |
| 9 | A standard correction factor of 2, which is described as encompassing a great deal of errors, does not actually appear to be excessively conservative based on the 1989 National Research Council report, "Film Badge Dosimetry in Atmospheric Nuclear Tests." | Closed on July 26, 2006.<br>A standard correction factor of 2 for every recorded dose is considered to be sufficiently conservative. |
| 10 | The use of a default LOD value of 40 milliroentgen (mR) should be considered a typical value as opposed to a highly conservative one. | Closed on July 26, 2006.<br>An assumed LOD of 40 mR for gamma radiation is a reasonably claimant favorable assumption and, when combined with the assumed monthly zeros, ensures missed dose is overestimated. |

### *Board Discussions*

Board members raised the following questions (pp. 37–47 of the October 17, 2013, transcript):

- **Question:** Is this OTIB currently in use, since the Board member was under the impression that the use of the overestimate approach was not being continued?

  **Response:** NIOSH stated that the OTIB was still active; however, it is rarely used. They also indicated that there are some overestimating methods that have stopped. However, when you talk about eliminating overestimates in general, it makes DR much more time consuming and expensive. Therefore, NIOSH did not feel they could completely eliminate the overestimating approach.

- **Question:** Given that facilities use film badges, some of which are more sensitive than others, and now TLDs are commonly used, how comfortable is NIOSH with the value of 40 mR as the LOD?

  **Response:** NIOSH stated that 40 mR is a good value to use for this procedure because the guidance is not just using 40 mR as the LOD; it also recommends maximizing the number of zero readings. Therefore, the DR not only overestimates the number of zeros,

it also uses the LOD instead of the LOD/2, which is considered a more precise estimate of the missed dose.

- **Question:** On finding 9, what does the standard correction factor of 2 correct for?

  **Response:** NIOSH indicated that they had not reviewed the OTIB recently, but there are several factors that influence the uncertainty of the film badges, and there were estimates of how large that uncertainty could be. When you sum these uncertainties, it comes to about 2. However, it was determined that the Board member would review the OTIB and attempt to answer his own question and, if necessary, get back to NIOSH with any additional questions.

- **Question:** How do you handle missed dose as compared to records where you see zeros or less than detectable or blank cycles?

  **Response:** For this OTIB, if you have a recorded dose in a year, you assume that occurred in one badge cycle. Then, the missed doses are calculated for all other cycles within the year, based on 40 mR per cycle. This is NIOSH's definition of maximizing zeros.

These explanations satisfied the Board members, and no further discussion was held regarding the review of OTIB-0010.

## OCAS-PER-012, Revision 0, "Evaluation of Highly Insoluble Plutonium Compounds"

SC&A reviewed revision 0 in March 2010. SC&A submitted a review of nine DRs affected by OCAS-PER-012 (a Subtask 4 report under SC&A's contract) in July 2012. The findings for the program evaluation report (PER) and Subtask 4 reviews were presented to the ABRWH at the October 17, 2013, meeting.

**Summary:** Internal DR considers solubility types F, M, and S of a given radionuclide. Under unique circumstances, plutonium (Pu) exists in highly insoluble forms, referred to as type Super S (type SS). Inhaled, this highly insoluble form of Pu has extended residence time in the lung, proportionately increasing dose to that tissue. The impact of type SS Pu target tissue dose was assessed in ORAUT-OTIB-0049, "Estimating Doses for Plutonium Strongly Retained in the Lung" (OTIB-0049). That assessment prompted the issuance of OCAS-PER-012 (PER-012).

*Table 6. Summary evaluation of PER-012 review*

| Review subtask | Action taken | Finding/recommendation |
|---|---|---|
| Subtask 1: Assess circumstances that necessitated the PER | • In development of the RFP technical basis document (TBD), NIOSH noted highly insoluble type S Pu and needed to assess its impact on internal dose.<br>• 42 CFR 82 require dose to be calculated using current ICRP metabolic models, which do not address highly insoluble forms of Pu (type SS).<br>• To account for longer retention and increased organ doses from type SS Pu, NIOSH developed and issued ORAUT-OTIB-0049 on 2/6/2007.<br>• ORAUT-OTIB-0049 specifies "dose adjustment factors" (generally a factor of 4) developed from cases of RFP and Hanford workers exposed to type SS Pu for four target organs and intakes based on lung counts, air concentrations, urinalysis, and fecal analysis. | SC&A's review of OTIB-0049, OCAS-PEP-012, and OCAS-PER-012 found that NIOSH properly characterized the significance of highly insoluble Pu and complied with OCAS-PR-008 in evaluating impact of the programmatic changes on previously completed DRs.<br>SC&A had no findings under Subtask 1 of the review. |

| Review subtask | Action taken | Finding/recommendation |
|---|---|---|
| Subtask 2: Assess specific methods for corrective action | • When a PER involves a technical issue supported by documents such as white papers, OTIBs, or procedures that have not yet been formally reviewed by SC&A, Subtask 2 assesses the scientific basis to ensure credibility of the corrective action.<br>• OCAS-PER-012 was prompted by ORAUT-OTIB-0049 issuance, critically reviewed by SC&A on October 29, 2007.<br>• SC&A was in full agreement with NIOSH's approach for dose modeling of Pu type SS.<br>• Subtask 2 was reduced to a brief summary of key technical elements defining ORAUT-OTIB-0049. | SC&A had no findings under Subtask 2 of the review. |
| Subtask 3: Evaluate approach for identifying the number of DRs requiring reevaluation | • To determine the total population of DRs potentially affected by OTIB-0049, PER-012 cited three criteria: (1) DR had been completed on or before 2/6/2007, (2) DR involved facilities with exposure to type SS Pu, and (3) POC was <50%. This identified 4,865 potential cases.<br>• OTIB-0049 has two additional screening criteria: (1) POC >16.97% for cancers other than lung and thoracic lymph node (LNTH) and (2) no Pu dose was assigned, or Pu intake was based on air monitoring. This reduced potential cases to 1,757. | SC&A agreed with the methodology used to identify and quantify claims potentially affected by OTIB-0049 and had no findings under Subtask 3 of the review. |
| Subtask 4: Recommend a sample of affected DRs for evaluation | • PER-012 indicates the need for dose reevaluation for four groupings of target tissues: (1) lungs and LNTH, (2) extrathoracic tissues of respiratory tract, (3) tissues of gastrointestinal (GI) tract, and (4) other systemic organs.<br>• Reevaluation of dose for these four groupings is dictated by one of four monitoring methods employed in original DR: (1) air sampling, (2) urinalysis, (3) in vivo lung counting, and (4) fecal analysis. | SC&A recommended a minimum of 1 case be selected from 10 permutations (1) lung/LNTH evaluated using urinalysis, lung count, fecal, and air sampling and (2) extrathoracic, GI tract, and systemic organs evaluated using urinalysis and fecal sampling.<br>The Board selected nine applicable cases. |

| Review subtask | Action taken | Finding/recommendation |
|---|---|---|
| Subtask 4: Review of sample set of DRs affected by PER-012 | Audit of the selected nine DRs was limited to evaluating methods/corrective actions in the DRs that relate only to issues addressed in OCAS-PER-012. Audit focused on determining whether internal doses associated with potential exposure to type SS Pu were performed accurately and in accordance with guidance in ORAUT-OTIB-0049. | • SC&A's audit concurred with NIOSH's approach and assumptions in calculating internal doses from exposure to highly insoluble Pu for all nine cases.<br>• SC&A found that NIOSH reevaluated each of these DRs using methodology consistent with guidance in ORAUT-OTIB-0049. The review had no findings.<br>• SC&A found development of the OTIB-0049 Workbook, which assists dose reconstructors in (1) entering appropriate data, (2) calculating fitted and missed organ doses and making comparisons of these data, and (3) generating IREP input, was very instrumental in successful implementation of PER-012. |

### *Board Discussions*

Board members had no questions or comments regarding the review of PER-012 and the evaluation of nine impacted cases.

## NIOSH-OVER-0009, "Skin Exposure"

NIOSH-OVER-0009 (OVER-0009) is a categorization of observations and findings that arise during reviews of DRs or technical guidance documents that will impact many. The findings and resolution of findings were presented to the Advisory Board at the April 11, 2018, meeting.

**Summary:** NIOSH-OVER-0009 specifically addresses SC&A's concerns about the modeling of fine and large particle deposition on the skin.

*Table 7. Three total concerns for NIOSH-OVER-0009*

| # | OVER-0009 concerns | Resolution |
|---|---|---|
| 1 | SC&A's concern involved a derived dose of 16 mrem/year to bare skin that is based on unsupported and unrealistic assumptions, which include:<br>1. daily skin contaminations for each of the 250 workdays per year that only persist for 8 hours<br>2. implication that after 8 hours, each skin contamination is 100% removed by a standard daily shower<br>3. only bare skin is subject to contamination and resultant radiation exposure | Closed February 18, 2015, based on the following.<br>NIOSH discussed its approach for addressing fine particle deposition to the satisfaction of SC&A, except for assumptions about the ease with which uranium could be removed from skin and clothing.<br>NIOSH prepared a white paper (February 2015), which assessed the literature that qualitatively and quantitatively supported the removal of uranium by washing with soap and water. |
| 2 | SC&A's concern involved the relationship between the derived dose and how IREP uses this dose to derive a POC, given that the skin dose only occurs to a small area. | Closed April 16, 2014, based on following NIOSH actions:<br>• Explained the relationship between derived dose and IREP to determine a POC.<br>• Identified that specific guidance for dealing with nonuniform exposure to the skin has been incorporated into ORAUT-OTIB-0017 (OTIB-0017).<br>• Consulted with SENES Oak Ridge to confirm OTIB-0017 guidance was appropriate. |
| 3 | SC&A had the same basic questions as described in concern 1, but for deriving doses for the skin deposition of large uranium flakes. | Closed April 16, 2014, based on following SC&A recommendation.<br>SC&A recommended using OTIB-0017 protocols, where the skin exposure under a hypothetical flake is averaged over the entire surface area of the body. |

### *Board Discussions*

**April 11, 2018, Board meeting:** Board members raised the following questions (pp. 63–73 of the April 11, 2018, transcript):

- **Question:** Are there any data to show that all facilities required daily showers and workers, in fact, actually took a standard daily shower in winter and summer?

**Response:** NIOSH stated that they did not look in tremendous detail at how we know that everyone took a daily shower. However, it was their experience that, in many of these facilities that they were familiar with, showering was part of their activity, especially when workers were involved in messy operations, such as rolling.

**Response Followup:** It might be worth taking a look at the frequency with which people really do take showers, not the efficacy of the soap and water.

- **Question:** How is this averaging (i.e., small particles versus large particles versus whole body) being resolved by IREP?

  **Response:** NIOSH stated that if you do not know where the contamination occurred, then this is not an IREP issue; it is an issue with input into IREP. NIOSH assigns a lognormal distribution that accounts for the various possible scenarios of how large an area could have been contaminated.

- **Question:** We know that a skin cancer occurred on the bare skin. We do not know where the contamination occurred, but we're generating a bare skin estimate and then averaging it over the entire body. Is that claimant favorable or not?

  **Response:** NIOSH stated that all we have is a value. We know there was maybe 5,000 dpm per 100 square centimeters (cm2) but we have no idea where it was. Therefore, we have to have some accommodation to account for the unknown nature of where the contamination occurred. Was it over the tumor? Was it not over the tumor? How large an area? That is basically what this lognormal distribution accounts for.

Due to the lengthy discussions and the Board's inability to get all their questions answered to their satisfaction, it was determined that the Board would postpone action on approving the review of NIOSH-OVER-0009. The Board requested that NIOSH prepare additional information to clarify these issues and present those data at a future Board meeting.

**August 22, 2018, Board meeting:** As requested, NIOSH provided the Board with additional information regarding the resolution of concerns about assessing dose to contaminated areas of the skin under NIOSH-OVER-0009 (pp. 81–92 of the August 22, 2018, transcript). In summary,

- The issue is as follows: Assuming there is a probability of a hot particle depositing on the skin of a worker that was never measured, and you have a skin cancer, what is the risk associated with that?

- In this situation where you do not know if the skin was irradiated over the tumor or not, it falls into the realm of binomial distribution.

- Since there is currently no binomial distribution in IREP, SENES developed a lognormal approximation of the binomial distribution that was incorporated into OTIB-0017 that is considered claimant favorable. NIOSH stated that they are very confident it is claimant favorable because this lognormal approximation significantly overestimates the upper dose.

- Since this issue was raised, NIOSH has communicated with SENES, and they are in the process now of producing a binomial distribution test model for NIOSH to use in IREP to determine if what NIOSH is doing is definitely claimant favorable and whether or not NIOSH might want to move forward in the future and have the true binomial distribution for this situation.

- NIOSH stated that they are reopening OTIB-0017, and a couple issues are going to be refined for better detail.

- The Designated Federal Officer requested that SC&A perform a focused review of the revised OTIB-0017 to determine how these issues were handled.

To date, OTIB-0017 has not been revised since 2005. Therefore, the NIOSH-OVER-0009 concerns cannot be formally closed by the Board.

## ORAUT-OTIB-0017, Revision 01, "Interpretation of Dosimetry Data for Assignment of Shallow Dose"

SC&A reviewed revision 01 in June 2006. The findings and resolution of findings were presented to the Advisory Board at the April 11, 2018, meeting.

**Summary:** OTIB-0017 provides guidance for assigning shallow doses to the skin, testes, and breast from nonpenetrating radiation, including beta exposures and exposures to low-energy photons.

*Table 8. Fifteen total findings for ORAUT-OTIB-0017*

| # | OTIB-0017 finding | Resolution |
|---|---|---|
| 1 | OTIB-0017 suggested that the dose reconstructor check whether the site was reporting dose due to electrons or photons, and whether the dosimetry system had been calibrated for that type of radiation. It needs to provide additional guidance on how to interpret film badge data with respect to beta vs. low-energy photon exposure for the purpose of reconstructing shallow doses. | Closed October 2, 2007, based on following NIOSH response.<br>NIOSH explained that this OTIB is to be used together with the site profile and other OTIBs on a case-by-case basis. |
| 2 | The protective clothing used for each case was known in the majority of cases. Clothing-specific transmission factors should be used. | Closed October 2, 2007, based on following NIOSH response.<br>NIOSH explained that there is language in the OTIB that allows the dose reconstructor to choose the appropriate clothing shielding factors based on whether a minimizing, maximizing, or a realistic analysis of beta dose is being performed. |
| 3 | It is SC&A's opinion that individual monitoring for beta particles only works on a "yes/no" basis. SC&A's main concern is the potential for direct deposition of a hot particle on the worker's skin that is not detected, or localized undetected beta exposure. | Closed October 14, 2008: It should be noted that many of SC&A's concerns were ultimately addressed to SC&A's and the SCPR's satisfaction under overarching issues (NIOSH-OVER-0009).<br>NIOSH explained that whether such exposures might have occurred is determined based on frisking data (for hot particles) and knowledge of the working conditions at the facility.<br>SC&A recommends that finding 3 be closed, not because everything is resolved, but because OTIB-0017 cannot be improved much further. SC&A suggests the following:<br>• When the cancer site is on the hands, lower arm, or face, consider workplace monitoring data.<br>• When the cancer site is on the thorax, use individual monitoring data.<br>• When the cancer site is on the lower legs or feet, consider both. |

| # | OTIB-0017 finding | Resolution |
|---|---|---|
| 4 | It is possible to state definitely where the cancer site is, but not where the contamination was. | Closed October 2, 2007: The SCPR transferred this item to overarching issues, because it is being addressed and ultimately closed under finding 3.<br>Discussion about finding 3 applies to this issue. |
| 5 | A skin dose due to hot particle exposure will not be detected because of the localized nature of the exposure. | Closed October 2, 2007: The SCPR transferred this item overarching issues, because it is being addressed and ultimately closed under finding 3.<br>Discussion about finding 3 applies to this issue. |
| 6 | If dosimetry recorded an LOD, then this value should be used as the basis for the missed dose calculation. | Closed December 11, 2007, based on the following agreement between NIOSH and SC&A.<br>If it is known that the film badge dosimeter overstated the dose from low-energy photons, and if it can be further ascertained that the LOD was expressed in terms of this overstated dose rather than the corrected dose, then we agree that it is appropriate to apply a correction factor to the LOD in assigning a missed dose from low-energy photons. |
| 7 | It is not claimant favorable to consider that the employee had 4 millimeters (mm) of clothing thickness. | Closed October 2, 2007, based on following NIOSH response.<br>Due to the location of the organ of concern, the 4-mm assumption was made for pants and an undergarment, not a lab coat. |
| 8 | Attachment A provides a correction factor for the breast, penis, and testicle using a source that was modeled as a 10-$cm^2$ infinitely thin disc source located 2 cm away from the skin. This is appropriate for the breast area; however, if the source was near the testicles, the film dosimeter would not measure anything. | Closed October 2, 2007: The SCPR concluded that the guidance in OTIB-0017 for this issue is adequate based on following.<br>There was extensive discussion about other documents that address this issue. NIOSH explained that it relies on quality assurance and training to ensure that the full array of guidance documents are being correctly employed in individual DRs. |
| 9 | Tables A-1 and A-2 list correction factors for nonpenetrating doses based on radionuclide. In nearly all real cases, it is not possible to state the radionuclides that are responsible for the beta dose. | Closed November 7, 2007, based on following NIOSH response.<br>The table provides benchmark correction factors for a range of beta energies. Site profile documents will typically provide information that will help the dose reconstructor determine the proper energy range to use. In addition, the OTIB itself provides guidance with respect to uranium daughter products. |
| 10 | For low-energy beta radiation, the dosimeters were likely incapable of furnishing accurate doses. | Closed November 7, 2007, based on following NIOSH response.<br>DR staff would have to consider this on a case-by-case basis. The OTIB purpose is to provide general information for the DR staff to use along with other sources of information. If necessary, the hierarchy of data sources listed in IG-001 (table 1.1) and ORAUT-PROC-0006 (table 5.2) includes the use of source term modeling. |

| # | OTIB-0017 finding | Resolution |
|---|---|---|
| 11 | It is not clear why the two tables providing examples of skin dose assignments on pages 21 and 24 give the recommendation to assign 30–250 keV for missed dose to the skin for 0 “OW reading” and 0 “S reading.” | Closed November 7, 2007, based on following NIOSH response.<br>This radiation type and energy range was chosen because it is, in fact, claimant favorable compared to assigning the dose as electron dose (refer to IREP technical document). |
| 12 | The logical order of the information in chapter 3, “General Approach,” could be improved. | In abeyance as of November 11, 2007, awaiting a revision to OTIB-0017.<br>NIOSH agreed with SC&A’s finding and will revise OTIB-0017 in the future. |
| 13 | The OTIB does not identify any cases where a possibly high POC can be determined early in the investigation. | Closed November 7, 2007, based on following NIOSH response.<br>ORAUT-PROC-0006, not OTIB-0017, is the document that would be used by DR staff to quickly triage a claim to determine the potential for high POC. It is important to consider the use of OTIB-0017 in the overall context of the DR process. OTIB-0017 does give guidance on the topic of low/high POC potential on page 6, items a, b, and c. |
| 14 | The OTIB is not claimant favorable in instances of unknown parameters affecting dose estimates. (Typically, the dosimeter location has no relationship to skin dose at the point of cancer incidence.) | Closed November 7, 2007, based on following NIOSH response.<br>The Division of Compensation Analysis and Support (DCAS) and Oak Ridge Associated Universities Team (ORAUT) disagree with this position. Consideration of geometry issues is discussed in the OTIB and is addressed on a case-by-case basis. In addition, the OTIB makes a recommendation (i.e., DCF = 1) to accommodate potential inaccuracies due to exposure geometry. The OTIB is claimant favorable in its recommendations regarding DCF, LOD, attenuation, and radiation type/energy range. |

| # | OTIB-0017 finding | Resolution |
|---|---|---|
| 15 | The OTIB does not employ scientifically valid protocols for reconstruction of doses regarding (a) assignment of nonpenetrating dose, (b) assumption of 4 mm clothing thickness, and (c) treatment of hot particles. | Closed November 7, 2007: The SCPR concurred with the following NIOSH response. It should be noted that the nonuniform dose was ultimately adequately addressed under NIOSH-OVER-0009.<br>DCAS and ORAUT disagreed with this position and provided the following discussion:<br>a. The guidance is given in order to assign the nonpenetrating dose as electrons or low-energy photons as necessary to complete a valid DR using IREP. Dose is often given as "OW" and "S" or "shallow" and "deep," not beta and gamma.<br>b. Since the organ discussed in this section of the OTIB is the penis, the 4-mm assumption was made for pants and an undergarment, not a lab coat (although that could have been added), sweater, or shirt as recommended in the general comments section.<br>c. The dose reconstructor can consider nonuniform dose using the guidance in the OTIB along with tools such as VARSKIN and guidance from site profile documents regarding the potential for hot particle exposure. |

### *Board Discussions*

**April 11, 2018, Board meeting:** Board members raised the following questions (pp. 74–80 of the April 11, 2018, transcript):

- **Question:** For finding 12 of the OTIB, it appears that NIOSH, SC&A, and the Subcommittee are all in agreement, but the revision has been in abeyance since 2007, which is a very long time. Is there any indication of when the OTIB will be revised?

  **Response:** Dr. Neton responded that "this procedure is currently undergoing revision for other items and I made sure that this would be incorporated into that revision that's being worked on right now."

- **Question:** Finding 7 relates to the assumption of 4 mm of clothing. The question is about how that is operationalized or what that means in terms of the shielding from 4 mm of clothing and what assumptions are implicit in that. Sometimes when you incorporate clothing as an additional barrier, there are various ways of implementing it. One of them is that you assume it's impermeable or nonporous. For the underpants, that would seem a stretch, as they are designed to breathe.

  **Response:** NIOSH indicated that they did not know the answer to the question and would have to do additional research. NIOSH stated, however, that the thicknesses were derived based upon the guidance within VARSKIN and clothing thicknesses.

Since several OTIB-0017 findings were associated with resolution of NIOSH-OVER-0009 and NIOSH's inability to answer all Board questions regarding other OTIB-0017 findings, it was determined that the Board would postpone action on approving the review of OTIB-0017. Therefore, the Board passed a motion to "defer action and to report back the clarification matters for those findings that deal with the skin dose and the undershorts and other garments."

**August 22, 2018, Board meeting:** As requested, NIOSH provided the Board with additional information regarding the resolution of concerns about assessing dose to contaminated areas of skin and the calculation of shielding from clothing (undergarments) under OTIB-0017 and NIOSH-OVER-0009 (pp. 81–92 of the August 22, 2018, transcript).

- For the discussion of skin contamination, please see the NIOSH-OVER-0009 section on the August 22, 2018, Board meeting in this handout.

- Regarding the question on OTIB-0017, finding 7:

  – NIOSH stated that they looked at three different sets of clothing and performed attenuation measurements that ranged from 1 to 5 mm, and the density around 1.5 grams per cubic centimeter for both the undergarments and the protective outer clothing is based on the fact that these are cotton garments.

  – NIOSH re-ran the calculations using the mean of the distribution of the values that were measured, which resulted in very similar values for strontium-90 and yttrium-91.

  – For rhodium, ruthenium, rhodium, ruthenium-106, and rhodium-106, the results differed by about a factor of 2. The attenuation factor was calculated to be 0.5, not 0.2 as reported in OTIB-0017.

  – NIOSH indicated that they are in the process of revising OTIB-0017 and will revise table A1 based on their new results.

  – NIOSH also recommended that this finding should not be closed at this time and that, when the revised OTIB-0017 is published, the SCPR should consider performing another review of the revision.

- Dr. Richardson stated that his question on finding 7 was in regard to "the permeability of the undergarment, not just the thickness but the assumption that you had a perfectly impermeable undergarment."

  – Dr. Neton stated, "I apologize if we misinterpreted your question then, but it's a good time because we're going to go back and revise it anyway, so we can take that issue up at that time."

To date, OTIB-0017 has not been revised since 2005. Therefore, the OTIB-0017 findings cannot be formally closed by the Board.