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*Working Draft*

**ADVISORY BOARD ON  
RADIATION AND WORKER HEALTH**  
*National Institute for Occupational Safety and Health*

**FERNALD PLANT SITE PROFILE ISSUES MATRIX –  
DRAFT PRELIMINARY SC&A ASSESSMENT**

**Contract No. 211-2014-58081  
SCA-SP-IM2013-0045, Revision 4**

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**SC&A, INC.:**

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

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| <b>DOCUMENT TITLE:</b>               | Fernald Plant Site Profile Issues Matrix – Draft Preliminary SC&A Assessment             |
| <b>DOCUMENT NUMBER/ DESCRIPTION:</b> | SCA-SP-IM2013-0045   |
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**Record of Revisions**

| <b>Revision Number</b> | <b>Effective Date</b> | <b>Description of Revision</b>  |
|------------------------|-----------------------|---|
| 0 (Draft)              | 10/15/2013            | Initial issue of a complete issues matrix incorporating information from previous versions, white paper issue reviews, memorandums, Work Group meetings, etc. |
| 1                      | 4/13/2014             | Revision to incorporate NIOSH responses to Rev. 0 and SC&A responses to NIOSH responses.  |
| 2                      | 9/01/2014             | Revision to incorporate additional SC&A responses to NIOSH responses based on focused review of 2014 TBD revisions. An attachment has also been added.        |
| 3                      | 11/25/2014            | Revision to update matrix based on 9/03/2014 Work Group Discussions.  |
| 4                      | 05/18/2016            | Revision to update matrix based on 12/4/2014 Work Group Discussions.  |
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## ABBREVIATIONS AND ACRONYMS

|         |   |
|---------|---|
| ABRWH   | Advisory Board on Radiation and Worker Health         |
| Ac      | actinium  |
| AEC     | Atomic Energy Commission                              |
| Am      | americium   |
| CATI    | computer-assisted telephone interview                 |
| Ci      | curie   |
| Ci/yr   | curies per year                                       |
| DAC     | derived air concentration                             |
| DOE     | U.S. Department of Energy                             |
| DR      | dose reconstruction                                   |
| DWE     | daily weighted exposure                               |
| EE      | energy employee                                       |
| ER      | evaluation report                                     |
| FEMP    | Fernald Environmental Management Project              |
| INL     | Idaho National Laboratory                             |
| IREP    | Interactive RadioEpidemiological Program              |
| K       | potassium   |
| kg      | kilogram  |
| LOD     | limit of detection                                    |
| MDA     | minimum detectable activity                           |
| mrad/hr | millirad per hour                                     |
| mrem    | millirem  |
| mrem/yr | millirem per year                                     |
| nCi     | nanocurie   |
| NIOSH   | National Institute for Occupational Safety and Health |
| NLO     | National Lead of Ohio                                 |
| Np      | neptunium   |
| Pb      | lead  |
| PFG     | photofluorography                                     |
| PRSC    | Procedures Review Subcommittee                        |
| Pu      | plutonium   |

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|-----------------|--|
| QA              | quality assurance                      |
| Ra              | radium                                 |
| RAC             | Radiological Assessments Corporation   |
| RU              | recycled uranium                       |
| SEC             | Special Exposure Cohort                |
| SOP             | Standard Operating Procedure           |
| SRDB            | Site Research Data Base                |
| TBD             | technical basis document               |
| Tc              | technetium                             |
| Th              | thorium                                |
| TLD             | thermoluminescent dosimeter            |
| U               | uranium                                |
| UF <sub>6</sub> | uranium hexafluoride                   |
| WG              | Work Group                             |
| WMCO            | Westinghouse Materials Company of Ohio |

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## INTRODUCTION

The attached updated *Fernald Plant Site Profile Issues Matrix – Draft Preliminary SC&A Assessment*, Revision 04 is the current matrix for use by the Fernald Work Group (WG); Revision 0 was originally provided in both Microsoft Word® and Excel® formats in October 2013, and summarized those issues that SC&A believed were still open following the addition of two classes of workers to the Special Exposure Cohort (SEC) at the July 2013 Advisory Board on Radiation and Worker Health meeting in Idaho. Revision 1 incorporated the National Institute for Occupational Safety and Health’s (NIOSH’s) responses to Revision 0 (column 6 in the current matrix) and SC&A’s responses to NIOSH’s responses. Subsequent to the release of Revision 1, a WG teleconference meeting was held on April 15, 2014, at which time 5 of the original 33 site profile findings were recommended to be closed.

In developing Revision 2 of the Fernald issues matrix, dated September 1, 2014, SC&A reviewed the transcripts from 16 successive WG meetings held from August 2007 to July 2013, as well as numerous white papers and memorandum reports related to SEC deliberations of the WG during that period. The matrix incorporated several unresolved findings from SC&A’s site profile review, delivered to the Advisory Board in November 2006; that report identified 33 original findings. It also considered issues that emerged from WG discussions of our review of the SEC-00046 evaluation report (ER), which was delivered to the Advisory Board in June 2007. SC&A’s SEC ER review identified 30 original findings, which were eventually merged into six general categories as a result of WG deliberations. Revision 2 also incorporated additional SC&A responses based on our focused review of new technical basis document (TBD) revisions provided in 2014. SC&A notes that, while a great deal of information and guidance is provided in the 2014 TBD revisions, we have not reviewed any of the TBD revisions beyond the level needed to close our findings from the 2006 review

Subsequent to the release of Revision 2, the Fernald WG met on September 3, 2014, to discuss the status and actions required to close out the remaining site profile findings. During that meeting, an additional 15 findings were recommended to be closed by the WG.

Revision 3 of the issues matrix presented an update based on discussions during the September 2014 Fernald WG meeting and associated changes in the status of several findings. Note that Revisions 2 and 3 also included an attachment containing responses for those findings requiring a detailed description; this attachment is also included in this updated matrix for reference.

The most recent WG meeting occurred on December 4, 2014, in which another seven findings were recommended to be closed.

This current issues matrix (Revision 4) reflects the discussions and recommendations based on the December 4, 2014, WG meeting and provides an updated status on the remaining site profile and SEC issues not currently recommended for closure. It is SC&A’s hope that this update will assist the WG and provide a road map to effectively resolve the remaining issues at Fernald.

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**ISSUES RESOLUTION MATRIX FOR FERNALD SITE PROFILE AND SEC PETITON**

| Doc | No | Finding Text   | History   | SC&A Comments   | NIOSH Response to Revision 0 | Status |
|-----|----|--|---|---|------------------------------|--------|
| TBD | 1  | The list of facilities in which thorium-232 was processed, the time periods of thorium processing, and the thorium production data shown in the TBD have significant gaps. Entire periods of processing and plants in which the work was done have been missed. These gaps may affect the feasibility of dose reconstruction for workers for certain time periods and in certain plants. | <p>This is identical to SEC Issue 4.3-5. NIOSH responded as follows:</p> <p><i>Additional thorium production documents have been located and interviews have been conducted with people knowledgeable of the thorium processes at FMPC. The knowledge gaps have largely been eliminated in the draft revision of ORAUT-TBKS-0017-5. The current default thorium intake recommendations are applicable to any location and time after 1954 in which thorium exposure is deemed reasonable... Knowledge of the process and locations of processes is now comprehensive, based on interviews, documents, and additional research... See the Thorium Timeline with AA 2-29-07.doc in the following directory O:\Document Review\AB Document Review\Fernald.</i></p> <p>All plants for 1955 and 1966 and Plant 6 for 1960 were identified by the Work Group as the buildings and the time periods that will be used to create the database and demonstrate its completeness and reliability for performing dose reconstructions. The Work Group agreed that it was not necessary to create such a compendium of data and analyses for all buildings and work years, given the magnitude of the effort, and that the selected years should provide the evidence that such a coworker model can, in fact, be developed and implemented.</p> <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012: SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978. [Cell continued on next page.]</p> | <p>10/15/2013: SC&amp;A suggests closing this finding because the NIOSH coworker model for 1979–1988 does not employ air concentration data.</p> <p>This finding pertained mainly to the availability of air sampling data pre-1968.</p> <p>The NIOSH coworker model for thorium-232 intakes based on activity measurements of the gamma-emitting progeny Pb-212 and Ac-228 is under discussion by the Fernald WG, last discussed at the July 1, 2013, WG meeting.</p> <p>This issue is no longer relevant to the post-1978 coworker model, which is based on bioassay data. SC&amp;A's <i>Completeness and Adequacy of Thorium In-Vivo Records (1979–1989)</i>, November 2012, states:</p> <p><i>It is clear from the completeness analysis that there are no significant temporal gaps in the in-vivo data reported in nCi Ac-227 and Pb-212 that might preclude its use in a coworker model.</i></p> <p><b>4/15/2014 – WG recommends closure (ABRWH 2014a, p. 71).</b></p> | Agreed.                      | Closed |

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| Doc | No | Finding Text  | History   | SC&A Comments  | NIOSH Response to Revision 0 | Status        |
|-----|----|---|---|--|------------------------------|---------------|
|     |    |   | <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of th-232 with sufficient accuracy from DWE data.</p>  |  |                              |               |
| TBD | 2  | Air concentration data for thorium in the TBD are sparse and incomplete, though considerably more data are available in the NIOSH Site Research Database. The TBD contains no thorium-232 bioassay or in-vivo data. | <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012 – SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978.</p> <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data.</p> | <p>10/15/2013: SC&amp;A suggests closing this finding because the NIOSH coworker model for 1979–1988 does not employ air concentration data.</p> <p><b>4/15/2014 – WG recommends closure (ABRWH 2014a, pp. 71–72).</b></p> | Agreed.                      | <b>Closed</b> |

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| Doc | No | Finding Text  | History   | SC&A Comments  | NIOSH Response to Revision 0 | Status        |
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| TBD | 3  | Thorium intakes due to fugitive emissions and resuspension in production areas may have been significant for some locations and periods. The TBD does not address the issue of fugitive emissions in production areas. Furthermore, the TBD does not provide a method to estimate resuspension intakes in the pre-1986 period and for those workers without lapel air sampling in the post-1986 period. | <p>This is identical to SEC Issue 4.3-8. NIOSH responded as follows:</p> <p><i>Many thorium air samples, including GA samples from inside the plants, are available. These GA samples from operating areas are sure to bound the concentrations in non-operating areas. A series of contemporary time and motion studies are being considered. These studies characterize intakes for people in clerical areas inside the operating facilities. The Battelle model based on air sample data is also available. Dose reconstruction is possible, the best method is still being considered... An approach to thorium dose reconstruction has been devised using newly available thorium exposure assessments. See the DWE Reports white paper in the following directory: O:\Document Review\AB Document Review\Fernald.</i></p> <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012 – SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978.</p> <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data.</p> | <p>10/15/2013: SC&amp;A suggests closing this finding because the NIOSH coworker model for 1979–1988 does not employ air concentration data.</p> <p><b>4/15/2014 – WG recommends closure (ABRWH 2014a, p. 72).</b></p> | Agreed.                      | <b>Closed</b> |

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| Doc | No | Finding Text   | History  | SC&A Comments  | NIOSH Response to Revision 0   | Status |
|-----|----|--|--|--|--|--------|
| TBD | 4  | The guidance in the TBD regarding exposures from redrumming thorium is not well founded and is not claimant favorable. | <p>This is identical to SEC Finding 4.3-7. NIOSH responded as follows:</p> <p><i>See comments in response to Finding 4.3-1 and 4.3-6 above... Guidance will be claimant favorable and in the TBD.</i></p> <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012 – SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978.</p> <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data.</p> <p>6/24/2014 – NIOSH releases the white paper <i>Fernald Dose Reconstruction Methodology for the Post Special Exposure Cohort (SEC) Period, 1979–2006</i>.</p> <p>11/26/2014 – SC&amp;A completes its review of the proposed thorium dose reconstruction methodology covering thorium redrumming operations to be discussed at the Fernald Work Group meeting (12/4/2014).</p> | <p>10/15/2013: SC&amp;A suggests categorizing this finding as “in abeyance.” Redrumming was still an issue for the post-1978 period. We discuss redrumming in SC&amp;A’s <i>Completeness and Adequacy of Thorium In-Vivo Records (1979–1989)</i>. Basically, we do not know who performed redrumming, which is why the coworker model must be applied to all potentially exposed workers at the 95th percentile. NIOSH has agreed to do this, but we have yet to see the formal implementation.</p> <p>4/10/2014: The proposed method for 1990–1994 is new.</p> <p>According to ORAUT-TKBS-0017-02, Rev. 01, the site production mission has been terminated and the site underwent remediation and cleanup from 1989 to 2006.</p> <p>Table 2-2 indicates that thorium repackaging was going on 1990–1993.</p> <p>SC&amp;A will need to review the implications for thorium DR during remediation and cleanup and report back at a later WG meeting.</p> <p>4/15/2014 – WG recommends keeping this finding open (ABRWH 2014a, pp. 72–73).</p> <p>8/25/2014: SC&amp;A recommends keeping this finding open pending our formal review of the NIOSH white paper on post-SEC thorium methodology (mid-late October 2014).</p> <p>11/26/2014: SC&amp;A has completed its review of the NIOSH white paper and recommends the finding be designated “in progress” pending WG discussions on 12/4/2014.</p> <p><b>12/4/2014: The WG recommended closure of this issue (ABRWH 2014c, p. 125).</b></p> | <p>For the 1979–1994 timeframe, if in vivo results exist, then they will be used to reconstruct thorium dose.</p> <p>For 1979–1989, if there are no in vivo results, then coworker doses will be assigned. (A coworker thorium study is in development.)</p> <p>For 1990–1994, if there are no in vivo results, thorium doses can be assigned based on an intake of 10% of the derived air concentration (DAC) for the year, as appropriate.</p> | Closed |

| Doc | No | Finding Text  | History   | SC&A Comments   | NIOSH Response to Revision 0 | Status |
|-----|----|---|---|---|------------------------------|--------|
| TBD | 5  | The TBD has not evaluated exposures due to thorium fires. The TBD has also not evaluated other thorium incidents or failures of industrial hygiene. | <p>(ABRWH 2007a, p. 220):</p> <p><i>And it's well documented, and it's also accepted by NIOSH that small fires, spills, explosions were commonplace. And yet it is unlikely that most of the air sampling data that you're compiling will necessarily reflect them, those radiological incidents.</i></p> <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012 – SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978.</p> <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data.</p> <p>6/24/2014 – NIOSH releases the white paper, <i>Fernald Dose Reconstruction Methodology for the Post Special Exposure Cohort (SEC) Period, 1979–2006.</i></p> <p>11/26/2014 – SC&amp;A completes its review of the proposed thorium dose reconstruction methodology covering thorium redrumming operations to be discussed at the Fernald Work Group meeting (12/4/2014).</p> | <p>10/15/2013: SC&amp;A suggests closing this finding because the NIOSH coworker model for 1979–1988 does not employ air concentration data.</p> <p>4/10/2014: Preliminary review of ORAUT-TKBS-0017-02 Rev. 01 indicates possible relevance for 1990–1994 thorium redrumming operations. See response to Item 4.</p> <p>4/15/2014 – WG recommends keeping this finding open (ABRWH 2014a, p. 73).</p> <p>8/25/2014: SC&amp;A recommends keeping this finding open pending our formal review of the NIOSH white paper on post-SEC thorium methodology (mid-late October 2014).</p> <p>11/26/2014: SC&amp;A has completed its review of the NIOSH white paper and recommends the finding be designated “in progress” pending WG discussions on 12/4/2014.</p> <p><b>12/4/2014: The WG recommended closure of this issue (ABRWH 2014c, p. 128).</b></p> | Agreed.                      | Closed |

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| TBD | 6  | The approach suggested for estimating thorium intakes does not reflect the history of production or the available thorium air concentration data. It is likely to result in significant underestimates of internal dose from thorium. | <p>This was resolved for 1954–1967 in primary SEC Issues 6a and 6b.</p> <p>April 2012 – SEC voted based on inadequacy of the activity to mass conversion algorithm from 1968–1978.</p> <p>1979–1988 – Implementation of a coworker model is an ongoing site profile issue.</p> <p>July 2013 – SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data.</p> | <p>10/15/2013: SC&amp;A suggests closing this finding because the NIOSH coworker model for 1979–1988 does not employ air concentration data.</p> <p><b>4/15/2014 – WG recommends closure (ABRWH 2014a, pp. 73–74).</b></p> | Agreed.                      | <b>Closed</b> |

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| TBD | 7  | The TBD does not specify a method for estimating doses in the raffinate streams, which are uranium-poor, from ore processing in Plant 2/3. These doses may be very difficult to calculate, especially for high-grade ores, notably pitchblende ore from Congo. | <p><b>This also pertains to SEC Finding 4.2-2 and Primary SEC Issue #4:</b> “Review of radon breath data for adequacy for reconstructing doses due to the inhalation of Ra-226 and Th-230.”</p> <p>October 14, 2008 – NIOSH responded:<br/><i>NIOSH has radon breath analyses for raffinate transfer operations and air sample data in the Plant 2/3 raffinate handling area sufficient to bound possible intakes and allow claimant-favorable dose reconstructions of sufficient accuracy.</i></p> <p>The NIOSH approach is contained in ORAUT-RPRT-0052 (ORAUT 2011b). RPRT-0052, pp. 24–25: Transfer of drummed K65 raffinate to Silos 1 and 2 late 1952–June 1953; radon breath data available. Q-11 transfer 1954–1957; subsumed in SEC.</p> <p>The concern for the raffinate streams can be bounded by the extensive “radon breath analyses-to-radium deposition” performed during the K-65 raffinate drum disposal operation. In addition, confirmatory air monitoring data in Plant 2/3 specific to the raffinate operations provides assurance that exposures are adequately bounded. The raffinates were wet (minimizing air contamination production) and enclosed in process piping.</p> <p>Other uranium daughters in addition to Ra-226 intake can be adequately bounded by ratioing to Ra-226, using the isotopic analyses of the silo contents.</p> <p>A detailed discussion of SEC Issue 4 took place at the April 19, 2011, WG meeting (ABRWH 2011), where SC&amp;A agreed that NIOSH’s methods were bounding and sufficiently accurate.</p> | <p>10/15/2013: SEC recommends this issue be changed to “in abeyance” pending revised TBD.</p> <p>4/10/2014: New revision of ORAUT-TKBS-0017-5 not yet available. October 2013 recommendation holds.</p> <p>8/25/2014: October 2013 recommendation holds.</p> <p>11/18/2014: SC&amp;A believes this issue is far too complex to be put in abeyance without a formal review. SC&amp;A recommends that it be changed to “open” until we have an opportunity to review the revised internal dose portion of the Fernald site profile.</p> <p><b>12/4/2014: This issue was discussed during work group deliberations, and it was recommended this finding be put “in progress” while NIOSH develops methods for assessing dose to raffinates (ABRWH 2014c, p. 149).</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics,” provides a method for estimating raffinate streams, which will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” and ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions.</p> <p>ORAUT-OTIB-25, “Estimation of Radium-226 Activity in the Body from Breath Radon-222 Measurements,” which is included in ORAUT-RPRT-0052, provides a method for reconstructing doses from radon breath analyses results from 1952–1954 and this methodology will be included into the internal TBD revision.</p> | <b>In Progress</b> |

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|-----|----|---|------------------------------------|---|------------------------------|--------------------|
| TBD | 8  | Workers who may have worked with raffinates may be missed by the protocol specified in Vol. 5 of the TBD. The guidelines for determining which workers were exposed to raffinate dusts are too restrictive and place far too great a reliance on completeness of records for job assignments, or in the alternative, place the burden of proof on the claimant. They have not been adequately justified by measurements and are not claimant favorable. | See response to <b>Finding 7</b> . | <p>10/15/2013: See response to Finding 7.</p> <p>11/18/2014: SC&amp;A believes this issue is far too complex to be put in abeyance without a formal review. SC&amp;A recommends that it be changed to “open” until we have an opportunity to review the revised Internal Dose portion of the Fernald site profile.</p> <p><b>12/4/2014: This issue was discussed during WG deliberations, and it was recommended this finding be put “in progress” while NIOSH develops methods for assessing dose to raffinates (ABRWH 2014c, p. 149).</b></p> | See NIOSH response #7.       | <b>In Progress</b> |

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| TBD | 9  | The data on trace contaminants in RU in the Fernald TBD are incomplete and appear to be incorrect. Different official documents have very different values for various aspects of RU data, including production and contamination. The contradictions have not been sorted out in the TBD. | <p>This finding is the same as SEC Finding No. 4.1-6. NIOSH responded as follows:</p> <p><i>Some production data are admittedly conflicting. Since dose reconstruction does not depend directly on production data, sufficient data are available to enable a bounding estimate based on the ratio of RU contaminates to the uranium intake determined from the uranium urinalyses. Recommended defaults have been chosen that adequately bound all of the operational data. The shipment(s) from Paducah Gaseous Diffusion Plant were of short duration, the increased hazards were recognized and adequately controlled, and recognized as doubling the total inventory of RU contaminants at FMPC, which in turn was factored into the default assumptions.</i></p> <p>After many white paper exchanges and deliberations, NIOSH demonstrated that they could place a plausible upper bound on intakes from three principal RU constituents.</p> | <p>10/15/2013: SC&amp;A recommends finding be changed to “in abeyance” pending revised TBD.</p> <p>4/10/2014: New revision of ORAUT-TKBS-0017-5 not yet available. October 2013 recommendation holds.</p> <p>ORAUT-RPRT-0052 (April 2011), Section 4.5, Table 18 does not reflect agreed-upon constituent levels from WG discussions on February 9, 2012 [See SC&amp;A white paper titled “SC&amp;A’s Response to NIOSH’s Subgroup 10A Impact Analysis Dated November 1, 2011 (SC&amp;A 2012)].</p> <p>Need to verify that what was agreed upon in WG meetings is, in fact, incorporated into ORAUT-TKBS-0017-5 and any related guidance documents.</p> <p>8/25/2014: SC&amp;A recommends that this finding be kept in abeyance pending revision of ORAUT-TKBS-0017-5.</p> <p>11/18/2014: August 2014 recommendation holds.</p> <p><b>12/4/2014: August 2014 recommendation holds (ABRWH 2014c, p. 153).</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics” provides an upper bound on intakes from RU constituents, which will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” and ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions.</p> | <b>In Abeyance</b> |

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| TBD | 10 | The radionuclide list for RU in the TBD is incomplete. Furthermore, the concentrations of trace radionuclides in the raffinates, which are much higher than those in the feed material, are not adequately discussed. | <p>This finding is the same as SEC Finding No. 4.1-5 and SEC Primary Issue 3. NIOSH responded as follows:</p> <p><i>Adequate material flow information is available to perform bounding analyses – with the recommended defaults being at least an order of magnitude higher than the average observed contaminant concentration in the processed materials...</i></p> <p><i>...Any external dose associated with U-232 and decay products would be adequately monitored by the external dosimetry device.</i></p> <p>After many white paper exchanges and deliberations, NIOSH demonstrated that they could place a plausible upper bound on intakes from three principal RU constituents.</p> <p>Subsumed into SEC pre-1979. Coworker model applicable 1979–1986 when WMCO took over M&amp;O from NLO and for non-SEC claimants.</p> | <p>10/15/2013: SC&amp;A notes that while NIOSH has provided a method for bounding intakes from Pu, Np-237, and Tc-99, other nuclides such as Am-241 and thorium isotopes are not included in the model and were not discussed in WG meetings. SC&amp;A recommends finding remain open and that WG discuss incorporating these other RU constituents into the coworker model.</p> <p>4/10/2014: New revision of ORAUT-TKBS-0017-5 not yet available. ORAUT-RPRT-0052 does not address these other constituents, nor have they been discussed in the WG setting. October 2013 recommendation holds.</p> <p>8/25/2014: SC&amp;A recommends keeping this finding open pending upcoming revision to ORAUT-TKBS-0017-5.</p> <p>11/26/2014: SC&amp;A recommendation from 8/25/2014 holds.</p> <p><b>12/4/2014: The issue of potential Am-241 in recycled uranium was discussed with the Work Group. NIOSH has agreed to specifically address whether significant Am-241 exposure is feasible at Fernald and, if so, how to account for it. The Work Group placed this issue “in progress” (ABRWH 2014c, pp. 154–167).</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics” provides an upper bound on intakes from RU constituents and has revised ratios for recycled uranium constituents that will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” and ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions.</p> | <b>In Progress</b> |

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| TBD | 11 | The suggested approach for RU dose estimation in the TBD is claimant favorable for many RU workers, but not claimant favorable for others and for some periods; it is not based on an evaluation of the available data. | <p>This is similar to SEC Primary Issue #3.</p> <p>After many white paper exchanges and deliberations, NIOSH demonstrated that they could place a plausible upper bound on intakes from the three principal RU constituents.</p> <p>Subsumed into SEC pre-1979. Coworker model applicable 1979–1986 when WMCO took over M&amp;O from NLO and for non-SEC claimants.</p> | <p>10/15/2013: SC&amp;A recommends finding be changed to “in abeyance” until agreed upon method is incorporated into the TBD.</p> <p>8/25/2014: SC&amp;A recommends keeping this finding in abeyance pending upcoming revision to ORAUT-TKBS-0017-5.</p> <p>11/26/2014: SC&amp;A recommendation from 8/25/2014 holds.</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 8/25/2014 holds.</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics” provides an upper bound on intakes from RU constituents for all workers, which will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” and ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions.</p> | <b>In Abeyance</b> |

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| TBD | 12 | The TBD notes that uranium batches with enrichment greater than 2% were processed at Fernald. NIOSH's assumption of 2% enriched uranium is claimant favorable most of the time, but not for periods and batches when uranium of higher enrichments were processed. | <p>This relates to SEC Finding 4.1-4. NIOSH responded as follows:</p> <p><i>The dose conversion factor for U-234 is applied to all uranium intakes. This results in a bias that is favorable to the claimant. The operational descriptions in the TBD are correct.</i></p> <p>11/11/07: SC&amp;A to review sample case along with default approaches (1% prior to 1964 and 2% after 1964). NIOSH to provide documentation to support the statement that most of the "enriched" material was very slightly enriched (slightly greater than 0.71% U-235).</p> <p>3/18/08: The following documents were provided to substantiate the assumptions: 8/7/2007 interview Weldon Adams and Robert Kispert (SRDB Ref. ID 41661); 9-11-07 interview with Kispert (SRDB Ref. ID 38132); 8-30-07 interview with Boback and Adams (SRDB Ref. ID 38124).</p> <p>10/28/08 (ABRWH 2008, pp. 200-217): SC&amp;A found documentation indicating enrichments of 3%-10%. NIOSH acknowledges that there were exceptions to normal work. SC&amp;A agrees dose can be reconstructed if the enrichment handled is known, but questions if those workers can be identified. NIOSH proposed assigning everyone 2% unless there is documentation indicating otherwise. After lengthy discussion, the Board accepts the 2% position and closed the finding.</p> | <p>10/15/2013: WG closed 10/28/08 (ABRWH 2008, pp. 200-217).</p> <p><b>4/15/2014: WG agrees with WG 10/28/08 closure recommendation (ABRWH 2014a, p. 74).</b></p> | Agreed.                      | Closed |

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| TBD | 13 | Female employees were not monitored for long periods at Fernald, even though at least some of them were at some risk of internal intakes of radionuclides. | <p>This is similar to SEC Finding 4.5-5. NIOSH responded as follows:</p> <p><i>The doses to those female workers who were not monitored during two operating periods can be reconstructed by at least three methods. They are: (1) If the worker in question is doing the same or very similar job during periods when she is monitored, that dose could be used to adjust the missing dose when she wasn't monitored; (2) Workers who were doing the same job and were monitored at the time the female wasn't, could have an equivalent dose assigned to the unmonitored worker, and (3) Assignment of the missed dose as stated in the TBD-Vol 6 of 500 mrem/yr for the missing time periods, which is known to be extremely claimant favorable.</i></p> <p>Discussed at 8/8/07 meeting. SC&amp;A raised the concern that women who worked in the laundry were not monitored but in some cases handled highly contaminated laundry. NIOSH stated assigning them a 500 mrem dose exceeds recorded doses by operators, which is claimant favorable. SC&amp;A states default dose does not address the following: (1) the shallow dose to the skin, (2) the extremity dose to the forearm/hands, and (3) potential internal exposure from airborne contamination created by handling contaminated items.</p> <p>Suggested linking the internal component to SEC Finding 4.1-3.</p> <p>Discussed at 11/13/07 meeting. Decided this was an issue isolated to a few individuals and should be evaluated on a case-by-case basis in DR.</p> <p>4/22/09 meeting: Issue closed. Decided three methods suggested are sufficient.</p> | <p>10/15/2013: Closed</p> <p>4/15/2014: WG decided to put in abeyance pending review of TBD revision (ABRWH 2014a, pp. 74-78). Virtually identical to Finding 21.</p> <p>8/29/2014: This finding predated the internal dose coworker models now in use for unmonitored workers – SC&amp;A recommends closure.</p> <p>Note that NIOSH's response to this finding actually pertains to Finding 21, which addresses the external dose to unmonitored female employees.</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 133-137).</b></p> | <p>Agreed.</p> <p>ORAUT-OTIB-0073, "External Coworker Dosimetry Data for the Fernald Environmental Management Project," will be incorporated into ORAUT-TKBS-0017-6, "Technical Basis Document for the Fernald Environmental Management Project – Occupational External Dose," and will be used for unmonitored workers.</p> <p>Due to changed project approaches towards unmonitored worker dose assignment, missed dose is no longer used to assign unmonitored doses and the 500 mrem upper bound dose methodology will be removed during the TBD revision process since the coworker model will bound unmonitored workers.</p> | <b>Closed</b> |
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| TBD | 14 | The TBD does not address the extremely high uranium dust concentrations, which were present at Fernald under a variety of circumstances, and their effect on dose reconstruction. Particle size and solubility assumptions for workers who experienced chip fires should be examined. | <p>Related to Primary SEC Findings 1, 2a, 2b, which have been closed.</p> <p>This finding was logged at a time when NIOSH had proposed using alpha air concentration data to reconstruct uranium intakes and before a U bioassay coworker model had been developed and the source data examined for completeness and adequacy.</p> <p>This finding is no longer relevant, because the uranium coworker model, which has been accepted by the Board (for prime contractor employees and subcontractors post 1983) is based on bioassay data, not air concentration measurements.</p> | <p>10/15/2013: SC&amp;A recommends that this finding be closed.</p> <p><b>4/15/2014: WG recommends closure (ABRWH 2014a, p. 79).</b></p> | Agreed.                      | <b>Closed</b> |

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| TBD | 15 | Ingestion doses are not considered in the TBD. | <p>Thorium ingestion is covered in SEC Finding 4.3-9. NIOSH responded as follows:</p> <p><i>Use of the intake model based on thorium air concentrations (the Battelle model) addresses this problem. Consequently, it is no longer an SEC issue. ...An approach to thorium dose reconstruction has been devised using newly available thorium exposure assessments. See the DWE Reports white paper [Morris 2009] in the following directory O:\Document Review\AB Document Review\Fernald.</i></p> <p><i>3/26/2008 – Once a reliable estimate is made of the inhalation rate of uranium, Th-232, and the radionuclides associated with raffinates and RU, ingestion intakes and doses would be calculated using OCAS-TIB-009 Rev. 0 (OCAS 2004). Hence, once the inhalation issues are resolved, the matter of ingestion exposures effectively becomes a review of TIB-009.</i></p> <p>This issue was partially resolved by the three SEC classes, for which it was determined that thorium intakes cannot be reconstructed for 1954–1978 and U doses cannot be reconstructed for subcontractors for 1951–1983. The thorium coworker model post-1978 relies on chest count data, and ingestion modeling is still an issue for discussion.</p> | <p>10/15/2013: SC&amp;A recommends finding be classified “open” as a topic for WG discussion.</p> <p>4/10/2014: Findings associated with OCAS-TIB-009, <i>Estimation of Ingestion Intakes</i>, have been closed by the Procedures Review Subcommittee (PRSC). SC&amp;A agreed that the NIOSH method is scientifically defensible and claimant favorable.</p> <p>8/25/2014: SC&amp;A recommends keeping this issue in abeyance pending ORAUT-TKBS-0017-5 revision.</p> <p>11/26/2014: SC&amp;A recommendation from 8/25/2014 holds.</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 8/25/2014 holds.</b></p> | <p>OCAS-TIB-009, “Estimation of Ingestion Intakes,” provides an approach toward thorium ingestion doses and will be included in the ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” revision.</p> | <b>In Abeyance</b> |

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| TBD | 16 | Protocols for reconstructing shallow external dose during the operations at FEMP need to be further developed. | <p>This relates to SEC Finding 4.5-3, yet is not entirely covered by it. See TBD Finding 18. SC&amp;A last tasked to look at several procedures.</p> <p>From SC&amp;A TBD review, Section 5.6.1, External Dose Reconstruction Protocols (SC&amp;A 2006):</p> <p><i>As a prefatory remark to external dose findings, SC&amp;A notes that Findings #16 through #20 are largely concerned with skin/shallow dose. The findings are made as technical arguments, but their impacts on potential claims may be modest. For example, while skin dose to the palm of the hand is likely to be underestimated, there may be few, if any, claims of skin cancer located in that area. However, since the procedure in the TBD is not adequate for estimating such doses, in case there are any claims, SC&amp;A concluded that a technical review of the matter was necessary as part of this TBD review.</i></p> | <p>10/15/2013: SC&amp;A recommends finding be classified “open” as a topic for WG discussion.</p> <p>4/10/2014: SC&amp;A agrees that ORAUT-OTIB-0017, <i>Interpretation of Dosimetry Data for Assignment of Shallow Dose</i>, largely puts this finding to rest. However, we have not yet reviewed ORAUT-TKBS-0017-6 to verify that the revision adequately addresses our concerns. Recommend keeping open until we can verify.</p> <p>8/25/2014: SC&amp;A recommends closure (see attachment for detailed description).</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 138–140).</b></p> | <p>ORAUT-OTIB-0017, “Interpretation of Dosimetry Data for Assignment of Shallow Dose,” is referenced in the ORAUT-TKBS-0017-6, “Technical Basis Document for the Fernald Environmental Management Project – Occupational External Dose,” revision and provides the protocols for reconstructing shallow external dose. ORAUT-OTIB-0017 was not available when ORAUT-TKBS-0017-6, “Fernald Site – Occupational External Dose” (04/20/2004), was approved.</p> | <b>Closed</b> |

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| TBD | 17 | Extremity doses appear to be underestimated. | <p>This is similar to SEC Finding 4.5-2. NIOSH responded as follows:</p> <p><i>Extremity doses were measured using "wrist dosimeters and a wrist to extremity ratio." This ratio varied with changes in the dosimeter; it decreased with the introduction of TLDs. However, previous extremity dose records were not adjusted downward to account for the new lower ratio. Consequently, extremity doses are deemed to be sufficiently accurate for dose reconstruction or are biased to produce a result that is favorable to the claimant.</i></p> <p>10/24/07: SC&amp;A will review data in HIS-20 to consider whether sufficient information is available to estimate extremity doses for individuals who did not have extremity data and who may have had significant extremity exposures.</p> <p>11/12/07: Extremity dosimeter not used until 1970. SC&amp;A will review data in HIS-20 to consider whether sufficient information is available to estimate extremity doses for individuals who did not have extremity data and who may have had significant extremity exposures. And then additionally, SC&amp;A will consider whether this should be considered in their review of data completeness.</p> <p>10/28/08: SC&amp;A acknowledges that this is not an SEC issue, because extremity cancers are uncommon. Until the 1980s, EEs were not monitored for extremity dose. Extremity monitoring was extremely limited in early years; however, those that were monitored had substantial exposures. SC&amp;A proposes ratio in write-up to apply to chest badge beta readings. NIOSH did not comment on adding this ratio to TBD.</p> <p>This issue was not discussed after this meeting.</p> | <p>10/15/2013: SC&amp;A recommends finding be classified "open" as a topic for WG discussion.</p> <p>4/10/2014: SC&amp;A notes that 5 of 6 findings associated with DCAS-TIB-0013 (DCAS 2010) have been closed under the PRSC. However, we have not yet reviewed ORAUT-TKBS-0017-6 to verify that the revision adequately addresses our concerns. Recommend keeping this finding open until we can verify.</p> <p>8/25/2014: SC&amp;A recommends that this issue remain open pending related investigations at INL (see attachment for detailed description).</p> <p>9/3/2014: Discussed (ABRWH 2014b, pp. 141–151).</p> <p>11/26/2014: 8/25/14 recommendation holds.</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 8/25/2014 holds.</b></p> | <p>The ORAUT-TKBS-0017-6, "Fernald Site – Occupational External Dose," revision references DCAS-TIB-0013, "Selected Geometric Exposure Scenario Considerations for External Dose Reconstruction at Uranium Facilities," and provides geometry factors for uranium dose and adjustments for wrist to hand, so that extremity doses are not underestimated. DCAS-TIB-0013 was not available when ORAUT-TKBS-0017-6, "Fernald Site – Occupational External Dose," (04/20/2004) was approved.</p> | Open |
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| TBD | 18 | Beta dose to the rest of the body would also be underestimated, based on the TBD guidance. | <p>This is similar to SEC Finding 4.5-3. NIOSH responded as follows:</p> <p><i>It is true that only contamination in close proximity to the dosimetry device will be recorded, because the dose rate associated with surface contamination is small—probably much less than 1 mrem/hour. In this case, the underlying physics limits the dose rate. The beta dose rate on contact with an unshielded infinitely thick slab of uranium metal is 233 mrem per hour. Knowing this fact, it is feasible to bound the dose from surface contamination. Thus, the finding assertion, given the complex processes and the many different tasks performed at FMPC, it is inconceivable that credible 'ball-park' and bounding estimates can be derived" can only be viewed as an error or exaggeration.</i></p> <p><i>Any amount of uranium contamination capable of producing a dose rate in excess of a negligible level is likely to be easily visible and be removed during the frequent showers and clothing changes taken by those workers who may be subject to conditions leading to possible contamination, thereby limiting the dose.</i></p> <p>10/24/07: NIOSH will examine whether an adjustment is necessary to account for this potential unmonitored dose.</p> <p>[This cell continues on next page of matrix.]</p> | <p>10/15/2013: SC&amp;A recommends finding be classified "open" as a topic for WG discussion. Contact beta dose is currently under review in the PRSC.</p> <p>4/10/2014: SC&amp;A's position summary on localized skin exposure, <i>SC&amp;A Position Regarding Skin Exposures Associated with the Direct Deposition of Fine Particles and Flakes of Uranium Oxide onto Skin and Clothing</i>, January 2014, has been discussed under the PRSC and is slated for discussion at the 4/16/2014 PRSC meeting. Recommend keeping this finding open until PRSC discussions are completed.</p> <p>8/25/2014: SC&amp;A recommends closure – virtually identical to Finding 16.</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 138–140).</b></p> | <p>The majority of these issues are global issues which are being addressed through the Procedures Review Subcommittee.</p> <p>For known skin contaminations, VARSKIN is used. Unknown skin contaminations cannot be addressed.</p> | <b>Closed</b> |

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|     |    |              | <p>3/18/08: See the 1958 radiation survey on clothing reported in SRDB Ref. ID 4136. These data are interpreted to be mrad per hour for clothing that was in use. Except for exposed skin, clothing is assumed to attenuate dose to skin and will lower the actual dose. All clothing dose rates are in mrad/hr, and most measurements of attenuation yield values between 15% and 20% reduction by the clothing. SRDB Ref. ID 4330, pp. 177–204, provides insight to extremity doses and includes a statement that measured workplace values should be reduced by some 14%.</p> <p>10/28/08 (ABRWH 2008, pp. 356–365): SC&amp;A will review the procedures NIOSH placed on O Drive (NLO document, several SOPs and SRDB Ref. IDs 3173, 33975).</p> <p>Issue was not discussed after this meeting.</p> |               |                              |        |

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| TBD | 19 | The TBD does not analyze the special problems associated with geometry of the source relative to the exposed organ and dosimeter in thorium handling and production. | This topic has not previously been discussed. | <p>10/15/2013: SC&amp;A recommends finding be classified "open" as a topic for WG discussion.</p> <p>Dosimeter geometry has been discussed at length in other WGs that may serve to inform this finding.</p> <p>8/29/2014: SC&amp;A recommends that this issue remain open.</p> <p>There are basically two issues with applying DCAS-TIB-0013 to Fernald:</p> <ol style="list-style-type: none"> <li>1. First, NIOSH has agreed that the correction factors apply to photons but not to electrons (betas), which are a significant source of exposure at Fernald. Consequently, the beta-dose correction to the film badge readings needs to be re-evaluated. Also see response to Finding 17.</li> <li>2. Notwithstanding the above comment, TIB 13 is "in progress." The last revision posted on the DCAS Web site is dated 2010. There have been several reviews, discussions, and correspondence from that date until February 2013, when the last NIOSH response was received. However, nothing has been done since then.</li> </ol> <p>Consequently, it is probably inappropriate to cite TIB 13 as a methodology for DR at Fernald when it has not been accepted by SC&amp;A or by the ABRWH Subcommittee on Procedures Review.</p> <p>9/3/2014: 8/25/14 recommendation holds.</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 8/25/2014 holds.</b></p> | <p>The revision to ORAUT-TKBS-0017-6, "Fernald Site – Occupational External Dose" references DCAS-TIB-0013, "Selected Geometric Exposure Scenario Considerations for External Dose Reconstruction at Uranium Facilities."</p> <p>Since the factor was determined by an analysis of photon fluence (not dose computation), the recommendations of the TIB would apply to workers exposed to thorium as well.</p> | <b>Open</b> |

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| TBD | 20 | Correction factors used during an initial period of use of thermoluminescent dosimeters (TLDs) at Fernald are not scientifically appropriate. | <p>It was discussed specifically during the August 8, 2007, meeting (ABRWH 2007a, pp. 321–331). Action Item: NIOSH will follow up on the doses assigned during beginning years with the use of TLD from 1983 to 1985.</p> <p>It was not discussed in meetings afterwards.</p> <p>A note in the October 2008 draft issues matrix indicates:</p> <p><i>A “Status Report - NLO Health Physics Appraisal” dated 7-10-84 (to Thiessen from Adams) [FEMP 1998] has been found indicating that changes to recorded doses may have made. Interviews are continuing to discover if additional corrections were applied. (SC&amp;A 2008a)</i></p> | <p>10/15/2013: SC&amp;A recommends finding be classified “open” as a topic for WG discussion.</p> <p>4/10/2014: SC&amp;A will need to check the cited references and TBD revision to verify. October 2013 recommendation holds – keep open.</p> <p>8/29/14: SC&amp;A has reviewed the process and believes the methodology is not without error; however, it is consistent with other NIOSH assumptions that have been accepted (e.g., LOD/2 for external dose and MDA/2 for internal dose).</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 152–158).</b></p> | <p>The appropriate TLD correction factors (based on the Gesell algorithm) were retroactively applied to dosimetry records from the beginning of TLD implementation (i.e., the period 1983–1985) as described in “Feed Materials Production Center, Final Phase-In Report, Volume 4 of 15, Environment, Safety, and Health” (SRDB 3247) and “Status Report - NLO Health Physics Appraisal, July 10, 1984” (SRDB 12405).<sup>1</sup></p> <p>Both references describe the deficiencies found in the original TLD algorithm developed by Plato, and the studies, comparisons, and field work undertaken to develop a more precise algorithm (the Gesell algorithm).</p> <p>The deficiencies of the Plato algorithm affected the precision of electron dose measurements and resulted in overestimates of electron dose.</p> | Closed |

<sup>1</sup> Note that the document at SRDB Ref. ID 3247 has a different title, *Fernald Litigation Depositions (1985–1994)*. Note that in SRDB Ref. ID 12405 we find a letter headed “Status Report – NLO Health Physics Appraisal – 1983” and stamped July 10, 1984. The document at SRDB Ref. ID 12405 is a duplicate of the document at SRDB Ref. ID 4330, referenced as FEMP 1998 elsewhere in this report.

**NOTICE:** This report has been reviewed to identify and redact any information that is protected by the Privacy Act 5 U.S.C. § 552a and has been cleared for distribution.

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| TBD | 21 | <p>The method for estimating external dose to unmonitored female employees is incomplete and its claimant favorability has not been appropriately demonstrated.</p> | <p>This is similar to SEC Finding 4.5-5. NIOSH responded as follows:</p> <p><i>The doses to those female workers who were not monitored during two operating periods can be reconstructed by at least three methods. They are: (1) If the worker in question is doing the same or very similar job during periods when she is monitored, that dose could be used to adjust the missing dose when she wasn't monitored; (2) Workers who were doing the same job and were monitored at the time the female wasn't, could have an equivalent dose assigned to the unmonitored worker, and (3) Assignment of the missed dose as stated in the TBD-Vol 6 of 500 mrem/yr for the missing time periods, which is known to be extremely claimant favorable.</i></p> <p>Discussed at the August 8, 2007, meeting. SC&amp;A raised the concern that women who worked in the laundry were not monitored, but in some cases handled highly contaminated laundry. NIOSH stated assigning them a 500 mrem dose exceeds recorded doses by operators, which is claimant favorable. SC&amp;A states default dose does not address the following: (1) the shallow dose to the skin, (2) the extremity dose to the forearm/hands, and (3) potential internal exposure from airborne contamination created by handling contaminated items.</p> <p>Suggested linking the internal component to SEC Finding 4.1-3.</p> <p>Discussed at the November 13, 2007, meeting. Decided this was an issue isolated to a few individuals and should be evaluated on a case-by-case basis in DR.</p> <p>April 22, 3009, meeting: Issue closed. Decided three methods suggested are sufficient.</p> | <p>10/15/2013: SC&amp;A recommends finding be changed to “in abeyance” until agreed-upon method is incorporated into the TBD</p> <p>4/10/2014: October 2013 recommendation holds – keep in abeyance pending review of ORAUT-TKBS-0017-6 to verify that the revision adequately addresses our concerns.</p> <p>4/15/2014: WG decided to put #13 and #21 (internal and external dose aspects, respectively) in abeyance (ABRWH 2014a, pp. 74–78).</p> <p>8/29/2014: SC&amp;A has reviewed pertinent sections of ORAUT-TKBS-0017-6, Rev. 1 and Attachment A and confirmed NIOSH’s statements that missed dose is no longer used to assign unmonitored external doses and the 500 mrem upper bound dose methodology has been removed. Further, Section 6.6.2 of the TBD revision refers to ORAUT-OTIB-0017, <i>Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose</i> (10/11/2005). The section titled “Non-Uniform Exposure of the Skin” has been further clarified at numerous work group meetings. See SC&amp;A response to Finding 16 in the attachment for additional detail.</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 158–159).</b></p> | <p>See NIOSH Response #13.</p> | <p><b>Closed</b></p> |
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| TBD | 22 | The source term for atmospheric uranium emissions from Fernald is significantly underestimated.  | This was discussed briefly in the November 24, 2007, meeting (ABRWH 2007b, p. 247), but was not discussed further.   | 10/15/2013: SC&A recommends that this finding remain “open” as a topic for WG discussion.<br><br>4/10/2014: October 2013 recommendation holds – keep open. SC&A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.<br><br>8/25/2014: SC&A recommends closure (see attachment for detailed description).<br><br><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 160–165).</b> | From October 24, 2007, meeting, NIOSH believes that stacks were functional and that the majority of source material was released from here, by design, therefore; the emissions are not underestimated.<br><br>The stack emission data was used in the ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose” revision for the operational period.                                  | <b>Closed</b> |
| TBD | 23 | The TBD has not adequately considered various aspects of internal environmental dose, including the applicability of the Gaussian model, episodic releases, and particle size. | Episodic releases were discussed at the August 8, 2007, meeting (ABRWH 2007a, p. 38). NIOSH used RAC Report Number CDC-5 to establish the source term. The new model incorporates evaluations for episodic releases that occurred. NIOSH indicates that assuming a chronic exposure based on positive bioassays is more claimant favorable than reconstructing individual acute intakes.<br><br>It does not appear that Gaussian model and particle size have been discussed outside the K-65 radon issue (Primary SEC Issue 5). | 10/15/2013: SC&A recommends that this finding remain “open” as a topic for WG discussion.<br><br>4/10/2014: October 2013 recommendation holds – keep open. SC&A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.<br><br>8/25/2014: SC&A recommends closure (see attachment for detailed description).<br><br><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 168–171).</b> | ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revision uses a standard annualized Gaussian model including assumptions regarding atmospheric stability that are claimant favorable.<br><br>Short-term episodic releases are modeled using the “Puff” model instead of the continuous release model. A factor to account for respirable fraction of particles is included. | <b>Closed</b> |

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| TBD | 24 | Diffuse emissions of uranium and thorium may have produced significant internal exposures for some personnel.      | This topic has not previously been discussed. | <p>10/15/2013: SC&amp;A recommends that this finding remain “open” as a topic for WG discussion.</p> <p>4/10/2014: October 2013 recommendation holds – keep open. SC&amp;A will need to review ORAUT-TKBS-0017-4 revision to determine whether our concerns are adequately addressed</p> <p>8/25/2014: SC&amp;A recommends keeping this issue open for discussion (see attachment for detailed description).</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 171–177).</b></p>   | See NIOSH response to #22. In addition to stack effluent for the operational period, NIOSH has identified releases of thorium and uranium that emerged from building exhaust, waste pits, UF <sub>6</sub> release from storage containers and six specifically identified off-normal events. NIOSH is unaware of any additional significant sources.  | <b>Closed</b> |
| TBD | 25 | NIOSH’s modeling of radon dose is not claimant favorable and does not take actual working conditions into account. | This topic has not previously been discussed. | <p>10/15/2013: SC&amp;A suggests this finding be subsumed into SEC Primary Issue 5 (moved to TBD issues April 2011).</p> <p>4/10/2014: Recommend that this issue remains open. SC&amp;A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: See response to SEC Issue 5.</p> <p>9/3/2014: WG recommends issue remain open (ABRWH 2014b, pp. 178–218). NIOSH to prepare a response for the next WG meeting.</p> <p><b>12/4/2014: The issue was discussed during the Work Group meeting. It was determined that NIOSH would apply the 95th percentile of the modeled doses in the RAC report. The Work Group recommends closure (ABRWH 2014c, pp. 185–245).</b></p> | <p>ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revision incorporates radon intake modeling which has been included in Gaussian dispersion calculations. 100% of radon and progeny are assumed to respirable.</p> <p>An assumption regarding the equilibrium between radon and progeny has been made that is favorable to the claimant and likely to exist only indoors under stagnant air flow conditions.</p> | <b>Closed</b> |

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| TBD | 26 | <p>NIOSH has not considered a major source of radon dose—the storage source of pitchblende ore onsite near Plant 1.</p> | <p>This was discussed at the August 8, 2007, meeting. Pitchblende ore storage from the Q-11 silos was identified in the Pinney Report (O drive). They were added to the radon source term. It appears that the bins were located on the south side of Plant 1.</p> <p>10/24/07: Research compiled by Susan Penny of University of Cincinnati took into consideration in addition to the K-65 silos other potential source terms of radon. Those included some of those specific bins outside of the refinery, in which the Q-11 ore was contained.</p> <p>10/28/08 (ABRWH 2008, p. 258): Discussion again on how the Pinney Report included Q-11 silos as a contributor to radon exposures.</p> <p>4/22/09: Discussions on Q-11 became blended with discussions on SEC Issue 4.2-1. NIOSH indicated that they are already updating the TBD to include the Pinney report, which includes the Q-11. It was debated changing 4.2-1 to a TBD issue, but no decision was reached.</p> <p>1/29/10: The Q-11 source term is separate from the K-65 source term in the Pinney report and should be discussed separately when modeling dose. Q-11 appears to be the dominate source term in the beginning years. SC&amp;A will look at the report NIOSH prepared.</p> <p>11/09/10: More discussions on the pulmonary and skin implications in a DR of Q-11. SC&amp;A to produce white paper on disagreements in source term and if SC&amp;A can buy off on the NIOSH suggested approach.</p> <p>[This cell continues on the next page.]</p> | <p>10/15/2013: SC&amp;A suggests this finding be subsumed into SEC Primary Issue 5 (moved to TBD issues April 2011).</p> <p>4/10/2014: Recommend that this issue remain open. SC&amp;A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: See responses to Finding 25 and SEC Issue 5.</p> <p>9/3/2014: WG recommends issue remain open (ABRWH 2014b, pp. 178–223). NIOSH to prepare a response for the next WG meeting.</p> <p><b>12/4/2014: WG recommends closure (ABRWH 2014c, pp. 185–245).</b></p> | <p>The ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revision includes effluent from Q11 silos.</p> | <b>Closed</b> |
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|     |    |   | 2/8/11: Anigstein states our opinion is that NIOSH has not demonstrated that the ranges can be bounded, though SC&A thinks they can be. But to do that they have to have a model that is validated and scientifically robust. Board decides this should be considered a TBD issue and was no longer discussed. |  |   |                    |
| TBD | 27 | The TBD does not consider outdoor diffuse emissions in production areas as a source of external environmental dose. | This topic has not previously been discussed.  | <p>10/15/2013: SC&amp;A recommends finding be classified “open” as a topic for WG discussion.</p> <p>4/10/2014: Recommend that this issue remains open. SC&amp;A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.</p> <p>8/25/2014: SC&amp;A recommends closure (see attachment for detailed description).</p> <p>11/26/2014: This issue was discussed at the 9/3/2014 WG meeting. The WG agreed that the main issue could be closed, with the proviso that specific language be added to the TBD regarding direct deposition on the skin. Specifically, that the procedures present in OTIB-0017 be directly referenced and implemented in the Fernald TBD. NIOSH did not foresee any issues with this stipulation. Therefore, SC&amp;A recommends changing this status to “in abeyance” pending the modification of the site profile (ABRWH 2014b, pp. 223–229).</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 11/26/2014 holds.</b></p> | The “Exposure Areas” concept is also applied to external dose consistent with the NIOSH position on Item 22 for the ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose” revision. | <b>In Abeyance</b> |

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| TBD | 28 | External environmental dose for workers near the K-65 silos needs to be better evaluated. | <p>Finding 28 is discussed in Section 5.9.2 of SC&amp;A's 2006 review of the Fernald site profile. The full text of this issue is relatively brief and is repeated here:</p> <p><i>The TBD is silent on how external doses to workers from the silos were derived for persons that may have spent time in the area of Fernald containing the silos (i.e., EA-6). This is of particular concern for the early years before additional shielding was provided for the silos. It is also of concern for those unmonitored workers who may have taken breaks near the silos. For instance, it may especially affect female employees during the years when they were not monitored.</i></p> | <p>4/10/2014: Recommend that this issue remain open. SC&amp;A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: SC&amp;A recommends closure (see attachment for detailed description).</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 229–240).</b></p> | The external environmental dose for workers near the K-65 silos is addressed in the ORAUT-TKBS-0017-4, "Fernald Environmental Management Project – Occupational Environmental Dose," revision. | <b>Closed</b> |

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| TBD | 29 | Occupational internal exposure to radon is estimated based on just two radon data points from 1953. This is an inadequate basis to reconstruct occupational radon dose. | This issue is not related to radon emanating from the silos, but to the radon and radon progeny inhaled during drum unloading when Silos 1 and 2 were being filled. It is not clear whether this issue was discussed and/or resolved in the WG. Needs more research. | <p>10/15/2013: SC&amp;A recommends finding be classified "open" as a topic for WG discussion.</p> <p>4/10/2014: Recommend that this issue remain open. SC&amp;A will need to review ORAUT-TKBS-0017-4, Rev. 02 to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: NIOSH's recommendation that 1953 radon exposure be added to the SEC would make this finding moot. However, SC&amp;A has seen no description of the proposed class or mention of it other than in this issues matrix entry. We recommend keeping this finding open for discussion in the Work Group setting.</p> <p>11/26/2014: This issue was discussed at the 9/3/2014 WG meeting. It was agreed that estimation of radium body burdens has been addressed in prior discussions and that methods in RPRT-0052 will be employed in the site profile.</p> <p>Additional discussions regarding a different source term of Th-230 exposure (transfer of Th-230 bearing material from plant operations to Silo 3) that will need to be addressed. The WG recommended placing this finding "in abeyance" pending release of the new Fernald internal TBD.</p> <p>These issues remain in abeyance until we can review the next revision of TBD-5 (ABRWH 2014b, pp. 240–261).</p> <p><b>12/4/2014: This item was not discussed at the Work Group meeting. Recommendation from 11/26/2014 holds.</b></p> | Radon from the material stored in drums at Plant 1 is now a source term for 1951, 1952, and 1953 before the material was moved into the K65 silo in the ORAUT-TKBS-0017-4, "Fernald Environmental Management Project – Occupational Environmental Dose," revision. NIOSH has recommended that 1953 radon exposure be added to the SEC. | <b>In Abeyance</b> |

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| TBD | 30 | The possible use of photofluorography (PFG) at Fernald in the early years was ruled out in the TBD without adequate documentation. This is contrary to NIOSH general guidance and is not claimant favorable. | This topic has not previously been discussed. However, the same issue has been discussed in other WG meetings, which may inform the resolution of this finding. | 10/15/2013: SC&A recommends finding be classified "open" as a topic for WG discussion.<br>4/10/2014: Recommend that this issue remain open. SC&A will need to review ORAUT-TKBS-0017-3, Rev. 01 to determine whether our concerns are adequately addressed.<br>8/29/2014: See attachment for detailed response for Findings 30–32.<br><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 261–265).</b> | No evidence of PFG has yet turned up for Fernald. This includes no evidence in claim files, no historical documentation of PFG equipment, and no evidence in several reviews of actual film folders of Fernald workers that have been performed over the years. | <b>Closed</b> |
| TBD | 31 | The assumption that there was a 15% retake rate for x-rays is not adequately documented or analyzed.   | This topic has not previously been discussed.   | 10/15/2013: SC&A recommends finding be classified "open" as a topic for WG discussion.<br>4/10/2014: Recommend that this issue be held in abeyance until SC&A verifies the stated change to ORAUT-TKBS-0017-3, Rev. 01.<br>8/29/2014: See attachment for detailed response for Findings 30–32.<br><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 261–265).</b>                                     | The reference for this piece of information was not found in the historical information, and so it was removed from the revision of ORAUT-TKBS-0017-3, "Fernald Environmental Management Project – Occupational Medical Dose."                                  | <b>Closed</b> |
| TBD | 32 | The assumption that there was collimation is not technically justifiable based on the evidence provided in the TBD and is not claimant favorable.  | This topic has not previously been discussed. However, the same issue has been discussed in other WG meetings, which may inform the resolution of this finding. | 10/15/2013: SC&A recommends finding be classified "open" as a topic for WG discussion.<br>4/10/2014: Recommend that this issue remain open. SC&A will need to review ORAUT-TKBS-0017-3, Rev. 01 to determine whether our concerns are adequately addressed.<br>8/29/2014: See attachment for detailed response for Findings 30–32.<br><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 261–265).</b> | The current version of the ORAUT-TKBS-0017-3, "Fernald Environmental Management Project – Occupational Medical Dose," assumes poor collimation prior to 1970.   | <b>Closed</b> |

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| TBD | 33 | NIOSH has prematurely concluded that lumbar spine x-rays for laborers and construction workers were not conditions of employment. Based on the evidence provided, this assumption is not sufficiently documented and is not claimant favorable. | This topic has not previously been discussed. However, the same issue has been discussed in other WG meetings, which may inform the resolution of this finding. | <p>10/15/2013: SC&amp;A recommends finding be classified "open" as a topic for WG discussion.</p> <p>4/10/2014: Recommend that this issue remain open. SC&amp;A will need to review the stated claim file records to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: SC&amp;A has also reviewed more than 30 cases focusing on Laborers and other trades workers whose job duties might include heavy lifting and came to the same conclusion as NIOSH. Any sort of lumbar or spinal x-ray was designated as "dispensary." Pre-employment physicals only ever included a chest x-ray. The pre-employment questionnaire and medical evaluation (present in some reviewed claims) contains a section on x-rays with only a checkbox for "chest."</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 261–265).</b></p> | <p>It is very clear that the few lumbar spine x-rays in claim file records ( ) are indicated as having been performed for "dispensary" and not "annual," "pre," or "term"; very strongly suggesting that lumbar spine x-rays were performed for back pain (a common ailment), or for workplace injuries, not for screening.</p> <p>31 claims out of 1,790 work periods/claims were reviewed and there were 0 non-dispensary lumbar spines in this random sample.</p> | <b>Closed</b> |

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| SEC<br>P | 3  | Default concentrations (on U mass basis) of Pu-239, Np-237, and other isotopes associated with RU at Fernald may not be bounding for some classes of worker activities, buildings, and time periods. | After many white paper exchanges and deliberations, NIOSH demonstrated that they could place a plausible upper bound on intakes from the three principal RU constituents. | <p>10/15/2013: SC&amp;A recommends issue be placed “in abeyance” until implemented in site profile.</p> <p>4/10/2014: Recommend that related site profile issues be placed in abeyance. SC&amp;A will need to review relevant TBD revisions to determine whether our concerns are adequately addressed. See response to Finding 9.</p> <p>8/25/2014: SC&amp;A recommends that this finding be kept in abeyance pending revision of ORAUT-TKBS-0017-5.</p> <p>11/26/2014: August 2014 recommendation holds. However, note that only the three primary contaminants have been addressed and other radionuclides may be relevant to dose reconstruction (for example, Am-241 from Finding 10).</p> <p><b>12/4/2014: Based on discussions occurring during the Work Group meeting, it was recommended this finding be changed from “in abeyance” to “in progress” pending NIOSH investigations into potential exposures to Am-241 in recycled uranium. See also update to Finding 10. (ABRWH 2014c, pp. 154- 167)</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics,” provides an upper bound on intakes from RU constituents for all workers, which will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” and ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions.</p> | <b>In Progress</b> |

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| SEC<br>P | 4  | Review of radon breath data for reconstructing doses from inhalation of Ra-226 and Th-230. | <p>SC&amp;A agrees – radon breath analysis is a scientifically valid method for reconstructing the intake of Ra-226 and Th-230 when the intake ratios of the two radionuclides are known and the impacted worker population can be identified.</p> <p>April 15, 2011: NIOSH posted a response [in ORAUT-RPRT-0052 (ORAUT 2011b)] to SC&amp;A’s white paper, <i>Review of the NIOSH “White Paper on Fernald Th-230 and Other Associated Radionuclides – Rev. 7”</i> (SC&amp;A 2010c), that summarizes their position. Moved to site profile at the April 19, 2011, WG meeting (ABRWH 2011).</p> | <p>10/15/2013: SC&amp;A recommends issue be placed “in abeyance” until implemented in site profile.</p> <p>4/10/2014: Recommend that related site profile issues be placed in abeyance. SC&amp;A will need to review relevant TBD revisions when they become available to determine whether our concerns are adequately addressed.</p> <p>8/29/2014: SC&amp;A recommends that this finding be kept in abeyance pending revision of ORAUT-TKBS-0017-5.</p> <p>11/26/2014: August 2014 recommendation holds. See response to TBD Finding 29.</p> <p><b>12/4/2014: The Work Group recommends closure (ABRWH 2014c, pp. 249–252).</b></p> | <p>ORAUT-RPRT-0052, “Feed Materials Production Center Internal Dose Topics” provides a method for use of radon breath data for reconstructing doses from inhalation of Ra-226 and Th-230 which will be incorporated into ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose.”</p> <p>For ORAUT-TKBS-0017-4, “Fernald Environmental Management Project – Occupational Environmental Dose,” revisions, intake rates for Ra-226 and Th-230 have been modeled based on a source term associated with the uranium stack effluent from Plant 2/3. This material may have included Ra-226 and Th-230 impurities that were not removed in the ore milling process that occurred at different vendor facilities.</p> <p>Otherwise, radon breath analysis is not pertinent to environmental intake rates.</p> | <b>Closed</b> |

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| Doc      | No | Finding Text   | History  | SC&A Comments  | NIOSH Response to Revision 0  | Status        |
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| SEC<br>P | 5  | Radon release rate from the K-65 silos as estimated by NIOSH is substantially underestimated. Method to derive the atmospheric dispersion factors, given the source term, is scientifically flawed, but results in an overestimate of the atmospheric dispersion factors at receptor locations (still does not compensate for underestimated source term). | <p>Numerous white papers have been exchanged; Both sides “agree to disagree.”</p> <p>NIOSH to consider rescinding its technical guidance regarding the K-65 silos based on what SC&amp;A believes is a flawed source term and atmospheric dispersion model and its conclusions regarding the validity of their model based on the Pinney reports.</p> <p>April 19, 2011: Board agrees to remove from SEC issues to TBD issues.</p> | <p>10/15/2013: Open site profile issue.</p> <p>4/10/2014: See response to Finding 28. Open issues will need to be taken up in a site profile context. – Topic for future WG deliberations.</p> <p>8/14/2014: Subsumes related site profile findings (25, 26). These issues have not been discussed since April 2011. SC&amp;A recommends that this issue and related site profile findings be resolved in the Work Group setting.</p> <p>SC&amp;A has prepared a series of white papers that have been discussed in several Work Group meetings. While we acknowledge that the number of affected claimants is likely small, given that the SEC for all workers extends from 1954 to 1978, we nonetheless stand by the positions articulated in those white papers (SC&amp;A 2008b, SC&amp;A 2010a, SC&amp;A 2010b, SC&amp;A 2011).</p> <p>9/3/2014: WG recommends issue remain open. NIOSH to prepare a response for the next WG meeting.</p> <p><b>12/4/2014: The Work Group recommends closure (ABRWH 2014c, p. 252).</b></p> | <p>ORAUT-RPRP-0052, “Feed Materials Production Center Internal Dose Topics,” presents what NIOSH believes is the best available analysis of annual radon effluent from the K-65 silos. The result of that analysis is 70.4 Ci/year. In the interest of being claimant favorable, ORAUT-RPRT-0052 recommends that the radon effluent values stated in ORAUT-TKBS-0017-5, “Technical Basis Document for the Fernald Environmental Management Project (FEMP) – Occupational Internal Dose,” be used.</p> <p>This value of 5,000 to 6,000 Ci/y is similar to the value of 6,700 Ci recommended in the RAC report.</p> | <b>Closed</b> |

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| Doc      | No | Finding Text   | History  | SC&A Comments   | NIOSH Response to Revision 0                | Status        |
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| SEC<br>P | 6b | Use of chest counts to reconstruct Th-232 exposures (1968–1988). | <p>1968–1978: Reported in milligrams thorium. SEC voted April 2012 based on inadequacy of the activity to mass conversion algorithm (now SEC class).</p> <p>1979–1988: Reported in activity (nCi) Pb-212 and Ac-228.</p> | <p>10/15/2013: Implementation of a coworker model is an ongoing site profile issue for 1979–1988.</p> <p>4/10/2014: Ongoing – topic for future WG deliberations.</p> <p>8/25/2014: This issue has been discussed extensively in Work Group meetings, and SC&amp;A is in general agreement with NIOSH on their methodology for using the chest count data reported in activity (nCi) Pb-212 and Ac-228 for 1979–1988.</p> <p>Nonetheless, SC&amp;A recommends keeping this finding open pending our formal review of the NIOSH white paper on post-SEC thorium methodology (mid-late October 2014).</p> <p>11/26/2014: SC&amp;A has completed its review of the NIOSH white paper and recommends the finding be designated “open” pending WG discussions on 12/4/2014.</p> <p><b>12/4/2014: Work Group recommends closure (ABRWH 2014c, p. 253).</b></p> | A thorium coworker model is in development. | <b>Closed</b> |

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| Doc | No    | Finding Text   | History   | SC&A Comments   | NIOSH Response to Revision 0  | Status |
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| SEC | 4.5-1 | Absence of Performance Standards/Quality Assurance for Personnel Dosimeters. This issue goes toward the availability of approved standardized procedures for performing external dosimetry and adequacy of the training and qualifications of personnel performing external dosimetry. | <p>NIOSH responded:</p> <p><i>The Oak Ridge film dosimeter, which was the dosimeter used at FMPC, was included in external dosimeter intercomparison studies and did compare with other AEC sites' dosimeters very well. Discussions held with former FMPC employees involved with the early dosimetry program from startup through 1985 have revealed that written instructions did exist, but to date none could be identified. ... NIOSH will attempt to recover QA intercomparison studies or internal studies (Herb Parker report and other reports). NIOSH will also attempt to identify procedures and/or QA reports from the early time period (53–85).</i></p> <p>11/13/2007: The Parker report (Parker, H.M., 1945, SRDB Ref. ID 439) showed that the three dosimeters performed very well in the measurement of exposures to uranium. The OR dosimeter was used at FEMP for several years and modifications were made to it.</p> <p>3/26/08: SC&amp;A raises concerns about qualifications of badge technicians.</p> <p>10/28/08: NIOSH will attempt to make more information available on O drive from data capture.</p> <p>It is not evident that this issue was closed by the WG.</p> | <p>10/15/2013: This issue is apparently open for WG deliberation.</p> <p>4/10/2014: Open – topic for future WG deliberations. SC&amp;A will need to review the cited SRDB references.</p> <p>8/25/2014: SC&amp;A has carefully reviewed the referenced SRDB reports 2921, 4330, 4618, 4204, 439, and 8599 provided by NIOSH and conclude these reports bear little relevance to Finding 4.5-1.</p> <p>Finding 4.5-1 specifically discussed several limitations identified in a document titled, <i>Response to Dosimetry Assessment Fact Sheet</i>, submitted by NLO, Inc. on September 11, 1981, in response to a DOE inquiry. As stated in the summary of our original finding (SCA-SEC-TASK5-0056, Section 4.5, page 112), SC&amp;A did not question the merits/use of the dosimetry data, but implies the need to consider the quality of these data in context with stated limitations. It is SC&amp;A's recommendation to account for these limitations by expanding the range of uncertainty that is normally afforded to personnel dosimeters that were used at the time.</p> <p><b>9/3/2014: WG recommends closure (ABRWH 2014b, pp. 267–270).</b></p> | <p>SRDB Reference ID #2921, "Health Protection Program Review," from November 1962 concurs with the proposal to issue an FMPC Nuclear Safety Guide. This Guide and the Industrial Hygiene and the Radiation Department Procedures Manual should provide sufficient criteria to permit operating groups to accept health and safety responsibility without excessive audit.</p> <p>Several other references exist in the SRDB that support the adequacy of the external dosimetry program at Fernald, some of which include 4330, 4618, 4204, 439, 8599.</p> | Closed |

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## ATTACHMENT – DETAILED SC&A UPDATES TO SELECTED FINDINGS

### FINDING 16

Section 6.6.2 of the Fernald site profile (ORAUT-TKBS-0017-06, March 25, 2014) refers to ORAUT-OTIB-0017, *Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose* (October 11, 2005; hereafter referred to as “OTIB-0017”). The section titled “Non-Uniform Exposure of the Skin” addresses this subject, which has been further clarified at numerous Work Group meetings. The section explains that, when only a portion of skin is exposed and there is reason to believe that a diagnosed skin cancer occurred within that location, the localized dose should be used as input to IREP (i.e., do not dilute the exposure over the entire surface area of the skin). OTIB-0017 does not explicitly address the direct deposition of particles onto the surface of the skin, but the natural extension of OTIB-0017 guidance would indicate that this strategy also applies to exposures of the skin directly beneath a particle deposited on the skin, if there is affirmative evidence that such exposures might have occurred, as might be indicated in the computer-assisted telephone interview (CATI) or the worker’s records. This latter interpretation of OTIB-0017 has been confirmed at meetings of the Procedures Review and Dose Reconstruction Subcommittees and at site profile work group meetings. (See *SC&A Position Regarding Skin Exposures Associated with the Direct Deposition of Fine Particles and Flakes of Uranium Oxide onto Skin and Clothing*, January 2014, and the resolution of this specific issue during the Procedures Review Subcommittee meeting held on February 13, 2014, page 42–52). Hence, SC&A recommends closure of this issue. However, we also recommend that dose reconstructors remain diligent in implementing this unique aspect of OTIB-0017.

### FINDING 17

Section 6.11 of the site profile, titled “Geometric Correction Factors,” cites DCAS-TIB-0013, *Selected Geometric Exposure Scenario Considerations for External Dose Reconstruction at Uranium Facilities* (NIOSH 2010; hereafter referred to as “TIB-0013”), as a means to address extremity doses. TIB-0013 is limited to the development of correction factors for photon exposures of the abdomen or extremities based on recorded photon exposures on lapel dosimeters and for specific geometries, such as cleaning up a spill on the floor, working with a uranium ingot, drum, or denitration pot. The correction factors, which range from about 1.5 to 3.5, were derived using models and also empirical data where both wrist and lapel dosimeters were used.

This procedure has been previously reviewed by the procedures subcommittee and its issues have been largely resolved. However, this procedure is silent regarding non-penetrating doses to the skin of the extremities. This issue is currently being reviewed as part of the site profile review for the Idaho National Laboratory (INL). In that review, NIOSH identified 62 skin cancer extremities, and SC&A is currently investigating the methods used to reconstruct those doses. SC&A recommends that this issue remain open while the INL investigations proceed.

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## FINDING 22

As indicated in the matrix, on April 10, 2014, SC&A recommended that this issue should remain open so that SC&A has an opportunity to evaluate this finding as now addressed in ORAUT-TKBS-0017-4, *Fernald Environmental Management Project – Occupational Environmental Dose*, Revision 2, March 13, 2014 (referred to here as the “Fernald 2014 site profile”).

By way of background information, this issue was first raised in SC&A’s November 6, 2006, initial review of the Fernald site profile dated April 6, 2004. We thought it prudent to reiterate the original issue and summarize how it is now addressed in the March 13, 2014, version of the Fernald site profile, within the context of all that has transpired with respect to issues resolutions on other matters and Special Exposure Cohorts (SECs) that have been granted.

Inspection of Finding 22 located in Section 5.7.1 of SC&A’s November 6, 2006, site profile review raises an issue with the estimated atmospheric release of uranium based on a series of reports that reveal that estimates of the atmospheric release of uranium were revised a number of times, and that the site profile at that time did not take into consideration the most recent estimates. The specific concern raised by SC&A was that the site profile uses data compiled by Boback et al. (1987) as updated by Dolan and Hill (1988)<sup>1</sup> and RAC (1995) as the bases for the estimated annual atmospheric releases. However, SC&A was critical of the site profile because it makes no mention of work by Clark et al. 1989.

A number of developments have transpired on this project since the preparation of the first Fernald site profile and SC&A’s review of the site profile in 2006, which makes this issue somewhat moot. First, the vast majority of internal uranium dose reconstructions for workers at NIOSH are based on bioassay samples because over 90% of the workers were under a bioassay program after the early 1950s. In addition, three classes of Fernald workers have been added to the SEC, including subcontractors at Fernald who were not adequately covered by the bioassay program (1951–1983). However, there is still a need to perform partial dose reconstructions for workers who are not covered by the SEC and/or who do not have bioassay data. Therefore, there are circumstances where internal doses associated with the atmospheric releases of uranium might be required. Section 4.4 of the March 13, 2014, site profile presents the methods NIOSH plans to use to reconstruct internal exposures to uranium in atmospheric effluents. Section 4.4.1.1 states that:

*For the purpose of environmental dose reconstruction, this TBD uses the larger of the emissions quantities from either Voillequé et al. (1995) or Boback et al. (1987). The values for routine and nonroutine uranium discharges from operations and episodic releases during the operating years are from Voillequé et al.*

This is the same language used in the original site profile, and any issues with these data as provided by Clark et al. 1989 are still not addressed.

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<sup>1</sup> The TBD erroneously refers to this publication as Dolan and Dolan 1988 (TBD Vol. 4, p. 9). The reference list for this publication should also be corrected from “Dolan, L.C. and C.A. Dolan...” to “Dolan, L.C., and C.A. Hill...”

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In order to help close out this issue, we reviewed the Clark et al. 1989 report to determine if the source term information is somehow incompatible with the current source terms used in the 2014 version of the Fernald site profile. Table 4-5 of the 2014 site profile presents estimates of the total atmospheric release of uranium by year from 1951 through 1988 for each of 12 different sources of emissions. The grand total is 308,495 kilograms (kg). The question is whether the information provided in the Clark et al. 1989 report incompatible with the values used in the site profile in Table 4-5.

As described in the introduction of Clark et al. 1989:

*The review for additional radionuclide air sources required a re-creation of the history of operations at the FMPC. This was done by reviewing plant records and interviewing long term employees. While these efforts enabled the authors to prepare a revised estimate, the 37-year history of FMPC radionuclide air emissions cannot be prepared without some degree of uncertainty. The factors which introduce uncertainty into the historic air emission estimate include:*

- *Documentation of all operations and events did not exist or could not be found.*
- *Personal recall of events was useful, but is incomplete and was not always consistent.*
- *Some measurements necessary to calculate emissions were not recorded or archived.*

The summary of the report states the following:

*This study results in estimated uranium air emissions of 179,000 kg and an estimated thorium air emission of 6500 kg for the years of 1951 through 1987.*

It certainly appears that the estimate of the total uranium emissions to the atmosphere used in the 2014 Fernald site profile of 308,495 kg is substantially larger than the estimate provided by Clark et al., 1989. Hence, SC&A recommends that this issue be closed.

As a postscript to this finding, SC&A believes that any internal doses associated with uranium atmospheric releases for workers who do not have bioassay data and are not covered by the SEC are best performed using a coworker model constructed using bioassay data and not atmospheric releases and dispersion modeling, especially considering the large uncertainties associated with reconstructing such doses; i.e., you need some knowledge of the location of the worker at the time of the releases, information that is generally not available. In addition, if, the source terms are needed for dose reconstructions, such as for workers outdoors, without bioassay data, and are not covered by the site profile, the source term data provided in the 2014 version of the site profile certainly appears to be scientifically sound and claimant favorable.

## **FINDING 23**

Section 5.7.2 of SC&A's 2006 review of the Fernald site profile explains that many of the source terms are episodic, and we expressed concern that standard Gaussian modeling using annual joint

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frequency data to derive average annual chi/Q values at receptor locations to reconstruct doses to workers without bioassay data might not be claimant favorable. Section 4.4.1.3.6 of the Fernald 2014 site profile explicitly addresses the methods that NIOSH plans to use to reconstruct outdoor exposures to episodic releases (presumably for workers without bioassay data and not covered by the SEC). Table 4-6 of the 2014 site profile lists six significant episodic releases that occurred over a period of less than 1 day (we agree that these are the types of releases that were of concern to SC&A in our original review of the site profile in 2006). Equation 4-7 of the 2014 site profile presents the atmospheric diffusion equation that will be used to model the atmospheric dispersion factors for these releases. This model was taken from Slade (1968), which is recognized as one of the seminal documents on atomic energy and meteorology. The model specifically takes into consideration the wind speed, direction, and stability class at the time of the episodic release, using conservative values for these parameters if the joint frequency data are not available for the specific time of a given episodic release. SC&A believes that this material is fully responsive to our original concerns and recommends that this finding be closed.

## FINDING 24

This issue is discussed in Section 5.7.3 of SC&A 2006 review of the Fernald site profile. SC&A's concern at the time was that, though the site profile addressed the diffuse emissions from the waste pits caused by wind erosion, it did not address potentially important sources of diffuse emissions at Fernald, many of which are described in SC&A's review of this issue, such as:

- “*Outside Williams Mill*” (General Air, 44.3 MAC)
- “*Breaking Salt at outside mill*” (Breathing Zone, 30.8 MAC)
- “*Shovelling onto conveyor at outside mill*” (Breathing Zone, 137.80 MAC)
- “*Changing drums at outside mill*” (Breathing Zone, 122.90 MAC)

These are issues separate from episodic releases because they are highly localized, ground-level releases that cannot be readily modeled. What is needed is an upper-bound estimate of the localized airborne concentrations (such as the above bulleted items) of these types of windblown fugitive emissions, and then use these concentrations and appropriate exposure durations to derive intakes and doses. Of course, this would only apply to workers who were not on a routine bioassay program for the radionuclides of interest and were not covered by the SEC.

The 2014 site profile does not explicitly address this issue, but explains in the matrix that:

*In addition to stack effluent for the operational period, NIOSH has identified releases of thorium and uranium that emerged from building exhaust, waste pits, UF<sub>6</sub> release from storage containers and six specifically identified off-normal events. NIOSH is unaware of any additional significant sources.*

It is not apparent that identifying the quantities of releases from building exhaust, waste pits, UF<sub>6</sub> release from storage containers and six specifically identified off-normal events adequately addresses this issue, because we can envision a worker located near these localized fugitive

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emissions for protracted periods of time, and the atmospheric modeling methods, even the episodic release protocols, do not address this unique set of potential conditions. We suspect that this level of granularity is not possible, because it would require placing specific workers at specific locations for known periods of time. Nevertheless, we recommend leaving this issue open, so that we can discuss it a little more at the next Work Group meeting.

## FINDING 27

Issue 27 is discussed in Section 5.9.1 of SC&A's 2006 review of the Fernald site profile. The full text of this issue is relatively brief and is repeated here:

*Given the documentation regarding high diffuse emissions and high uranium and thorium concentrations outdoors (discussed above), it is possible that the external environmental dose, other than that from the K-65 silos, may have derived mainly from deposition of uranium and thorium dust on workers. For thorium dust, this could involve considerable deep dose as well as shallow dose, while for uranium it would mean mainly the latter. NIOSH should evaluate the extent of the problem, which may have been significant in some outdoor production areas.*

NIOSH's response to this issue as provided in the issues matrix is as follows:

*The "Exposure Areas" concept is also applied to external dose consistent with the NIOSH position on Item 22 for the ORAUT-TKBS-0017-4, "Fernald Environmental Management Project – Occupational Environmental Dose" revision.*

Section 4.5 of the 2014 Fernald site profile addresses external exposure from ambient radiation. This issue applies to unmonitored workers who might have been externally exposed outdoors to deposited radionuclides and are not covered by the SEC. Section 4.5 of the 2014 site profile explicitly addresses outdoor radiation fields and exposures to the K-65 silos, thorium residues in various warehouses throughout the site, and the radionuclides in the Production Plants and other onsite facilities. To a lesser extent, the radioactive waste pit area was another direct radiation source for unmonitored personnel who worked in that area. Table 4-19 of the 2014 site profile presents the results of thermoluminescent dosimeter (TLD) measurements at 10 locations at the site boundary from 1976 to 1995. Table 4-20 presents the results of TLD measurements at other locations, and Figure 4-11 presents the locations of TLD measurements in the vicinity of the waste pits from 1996 to 2005. Figures 4-14 and 4-15 present external dose rate contour maps for 1976 and 1985. Section 4.5.4 presents onsite ambient dose rate estimates, 1952 to 1975. This section explains that, since there are no usable external dose rate measurements before 1976, a protocol is provided to reconstruct external outdoor exposures due to residual radioactivity outdoors at the site.

Taken in its entirety, it appears that the 2014 site profile provides guidance that can be used to reconstruct external exposures outdoors from all sources of stored and residual radioactivity at the site. We recommend that this issue be closed with one proviso; we recommend that a statement be made in the site profile that exposures to skin will be reconstructed in accordance

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with OTIB-0017 and the commitments agreed to by NIOSH and the Board on how localized doses to skin from direct deposition will be reconstructed.

## FINDING 28

Issue 28 is discussed in Section 5.9.2 of SC&A's 2006 review of the Fernald site profile. The full text of this issue is relatively brief and is repeated here:

*The TBD is silent on how external doses to workers from the silos were derived for persons that may have spent time in the area of Fernald containing the silos (i.e., EA-6). This is of particular concern for the early years before additional shielding was provided for the silos. It is also of concern for those unmonitored workers who may have taken breaks near the silos. For instance, it may especially affect female employees during the years when they were not monitored.*

NIOSH's response to this issue as provided in the issues matrix is as follows:

*The external environmental dose for workers near the K-65 silos is addressed in the ORAUT-TKBS-0017-4, "Fernald Environmental Management Project – Occupational Environmental Dose," revision.*

Section 4.5.1 of the 2014 Fernald site profile addresses external exposure from ambient radiation associated with the K-65 silos and production plants for 1976–2005, based on TLD measurements taken at various locations on the site and at the fence line boundary. Section 4.5.4.1 of the 2014 Fernald site profile address external exposure from ambient radiation associated with the K-65 silos prior to 1976. Prior to 1976, average direct dose rates at the K-65 silo fence line were modeled based on a combination of interpreted historic description of the K-65 silo radiation levels and the application of measured dose rate values.

It appears that the 2014 site profile provides guidance that can be used to reconstruct external exposures outdoors from the K-65 silos. We recommend that this issue be closed.

## FINDINGS 30–32

The Fernald technical basis document (TBD) or site profile for Occupational Medical Dose (ORAUT-TKBS-0017-3, Revision 1) was issued on January 2, 2014. We have reviewed this TBD and other NIOSH guidance to assess the degree to which these three issues can be closed at this time.

The three issues deal with matters that have been of concern on numerous occasions since the inception of this program; i.e., under what conditions is it appropriate to assume that workers at a given facility should be assigned occupational medical dose, including chest anterior-posterior and lateral x-rays, lumbar spine x-rays, and photofluorography (PFG) examinations, and what should be taken into consideration when assigning a given dose, such as type of equipment, retakes, collimation, uncertainty, etc. A review of the Fernald 2014 site profile reveals that a comprehensive set of instructions are provided on how to reconstruct occupational medical exposures at Fernald. Section 3.2 of the TBD explains that pre-employment, annual, and termination examinations were required as a condition of employment from the beginning of

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operations in 1952, but evolved over time. The instructions also state, lacking information to the contrary, it should be assumed that all workers received annual chest x-rays from 1952 to 2006. The year 2006 is established as the end date because all x-ray equipment was removed from the site in that year.

Information is provided on the different types of x-ray equipment that were used and, based on that information and guidance in ORAUT-OTIB-0006 (Revision 4, June 20, 2011), which was previously favorably reviewed by SC&A, x-ray exposures are assigned to different organs and as a function of time. A review of ORAUT-OTIB-0006 reveals that collimation is addressed in Section 3.4 and retakes are addressed in Section 7.0 in making these assignments.

Tables 3-3 through 3-8 in the TBD provide convenient look-up tables for doses to various organs as a function of time for 1952–2006. Since the records reviewed by NIOSH are quite detailed with respect to the types of equipment and examinations performed, we conclude that there is no basis to assume that either lumbar spine or PFG examinations were performed, and that the three issues identified above have been adequately addressed. On this basis, SC&A recommends closing these findings.