

## Argonne National Laboratory (East) Work Group Board Review System (BRS) Discussions

**ANL-E Finding 1**

2/13/2017

*Status = Open*

Potential Missed Dose from Lack of Definition of Radionuclide Compositions and Radionuclides Not Addressed in Site Profile

**Hughes, Lara, 3/8/2017**

The TBD does not specify uranium mixture values for enriched and depleted uranium for several reasons. Research on uranium composition is still underway. Meanwhile, bioassay results record uranium in units of mass (typically micrograms/1500mL or per sample) or activity (dpm/1500mL or per sample). Unless otherwise specified, uranium would be assumed to be natural uranium, with mass or activity units typically reported. If work with enriched uranium is involved, bioassay records are noted 'U-235' and results are reported as activity (SRDB 165264 pg 59-64).

The TBD currently provides two plutonium mixtures, one to be used for materials received from New Brunswick Laboratory and the other considered to 'bound' risks at ANL-E. The TBD currently provides direction to dose reconstructors on use of these mixtures. As the finding notes, ANL-E is a research (not a production) facility, so a diversity of materials may have been encountered, consequently, it is unlikely that a specific set of mixtures can be identified as representative of typical operations. Plutonium bioassay results may be recorded as 'Pu' or for the specific plutonium isotope (e.g., Pu-239, Pu-238).

Americium composition, as part of a plutonium mixture, may be inferred from the assumed age of the material using current methods. Specific americium identified in a bioassay monitoring record would identify exposure to isolated americium (i.e., not part of a plutonium mixture) and the isotope involved, which would typically be Am-241.

Review of early records demonstrate that, while the bulk of bioassay monitoring indicated work primarily with natural uranium, specific bioassay analyses were performed as needed based on the radionuclide involved (see for example Bioassay Program Reports in SRDB 165264, with specific analysis for polonium in 1949 (pg 19), radium in 1950 (pg 20), neptunium related to a spill in 1960 (pg 32), and individual radium and thorium isotopes related to an intake incident (pg 56)).

**Buchanan, Ron, 7/16/2017**

SC&A finds that the current TBD-5, ORAUT-TKBS-0036-5, Revision 00, of March 2006, does not provide adequate coverage of the many different radionuclides that potentially were present at a research lab, such as the percent enrichment of uranium, accelerator-produced radionuclides, and exotic radionuclides. The ability and knowledge needed to monitor for the many possible radionuclides present, especially in the early years, is likely questionable for ANL-E, as it was for other research facilities in the U.S. Department of Energy (DOE) complex at that time. See attachment for details.

**Attachments:**

- Finding\_No.\_1\_ANL-E\_Radionuclides\_by\_SCA\_2009.docx

**Lobaugh, Megan, 2/9/2018**

For a research facility with the broad range of activities that were in existence at ANL-E, identifying a "routine" enrichment value for enriched uranium or a site-wide mixture ratio for plutonium isotopes would not be expected. Research into ANL-E records indicates a variety of radionuclides in addition to uranium and plutonium were encountered, and bioassay procedures were implemented to monitor the specific radionuclides from early periods of operation. Records show that analysis results for at least 34 individual radionuclides were included in bioassay analytical reports from 1953 through 1976.

NIOSH acknowledges the difficulty this presents in performing dose reconstructions on mixtures of radionuclides, however, assumptions can be made to allow reasonable and claimant favorable assessments (see below).

Uranium in the workplace was typically in the form of natural uranium, based on the numerous

bioassay results found, which is adequate to develop dose reconstructions in the majority of claims (and which overestimates the dose if the results are not in units of activity and the mixture is depleted uranium that is not noted in the records). Work with enriched forms of uranium is documented in monthly reports and bioassay records from early periods, although the degree of enrichment was not generally provided for individual activities and was likely variable depending on the project. Additional records obtained since the previous TBD revision include typical enrichment values for medium and high enriched uranium with the highest recorded value of 93% U-235 (e.g. SRDB Ref. ID 108979, pg. 79-80). This value may be used to derive specific activities for individual uranium isotopes that can be used as bounding estimates for the few cases where enriched uranium is encountered and results are not in units of activity. This may result in high positive or missed doses for a limited number of cases.

The TBD currently lists two specific plutonium mixtures from a 1979 Draft Environmental Impact Statement, both of which are described as bounding typical risks for ANL-E operations. Five additional ratios, described as representing “assumed adverse cases,” are listed in SRDB Ref. ID 44149 (1975), pg. 34-36. It is not noted whether these mixtures are representative of actual operating conditions, but the ratios are similar to those currently in the TBD. Finally, SRDB Ref. ID 90471 (1966) describes a typical ratio content of plutonium used for the Zero Power Plutonium Reactor (ZPPR) fuel fabrication operations, with somewhat higher Pu-239 content relative to the other constituents. Again, given the diversity of ANL-E projects, it is not anticipated that an exact ratio will be available for each operation, but in the absence of specific information, it appears that adequate bounding assumptions can be made from the current TBD approach, modified if necessary, using additional data from the documents listed above.

Work with, or bioassay sampling for, specific Am-241 materials is noted in ANL-E records, including bioassay records. For Am-241 as a component of a plutonium mixture, the TBD notes that ANL-E assumed that either none of the Pu-241 had converted to Am-241, or that all had converted, and used the higher of the two for dose estimates, and suggests this method could be considered in dose reconstructions. However, more realistic methods involving the application of Am-241 ingrowth in the IMBA tool are also available, applying claimant favorable assumptions for the age of the material for cases where this information is not available from records.

Bioassay program procedures denoting specific accelerator-produced radionuclides are typically not noted in the records, even for recent periods. This is not unexpected, given the wide variety of radionuclides it is possible to produce. However, as noted above, analysis of at least 34 specific radionuclides were included in bioassay analytical reports from 1953 through 1976, including exotics such as protactinium and polonium in 1953 (SRDB Ref. ID 89280), neptunium in 1960 (SRDB Ref. ID 165282), and californium in 1974-1976 (SRDB Ref. IDs 16666, 16660, and 16656). Some of these reports specifically denote the radionuclides as accelerator related (e.g. Co-57, Co-58, and Zn-65 identified in routine urine sampling associated with workers in the Building D-211 cyclotron area in 1964, SRDB Ref. ID 165302, pg. 27-46). The records appear to indicate that methods were implemented to assess risk from a variety of nuclides as the need arose.

Guidance in the TBD will be modified or added where appropriate based on the available information to aid dose reconstructors in interpreting mixtures of radionuclides. TBD will be revised to provide dose reconstructors with additional definition, assumptions, and details as outlined above, as well as any information derived from recent data capture and interviews, to aid in assessment and interpretation of early bioassay records.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

**ANL-E Finding 2**

2/13/2017

*Status = Open*

Potential Missed Dose from the use of Gross Alpha Counting for Bioassay (1946 to 1972)

**Hughes, Lara, 3/8/2017**

ANL-E provided gross alpha bioassay results from early operational periods which included plutonium, americium, neptunium, thorium, actinium, and curium. Results below detection limits were listed as zero. When results were positive, follow-up may have included analysis for specific radionuclides. For example, SRDB 16712, pg 21-24, documents a plutonium intake incident where the gross alpha results were followed up by a plutonium-specific analysis, noting that more time and a larger sample size was needed for the latter analysis type.

Missed doses are assessed based on the detection limits listed in the TBD (Table 5-11) for the specific period, assessing the most claimant favorable nuclide, although a specific nuclide could be assumed if the work records demonstrate occupational exposure to that specific nuclide (see footnotes to the sampling results page for the example listed above, SRDB 16712 pg 23). The earliest listed detection limit for the gross alpha analysis in the TBD is 0.4 dpm/1500 mL in 1948, based on the lowest reported positive value in the records (note that recently obtained records (SRDB 165285) demonstrate a lower value of 0.2 dpm/1500 mL in 1949-50); there is no indication the procedure was different prior to this period. There is nothing further in the records that indicates the effectiveness of the analyses was in question or considered unreliable based on the factors mentioned in the finding.

The finding that guidance is needed for interpreting results from the gross alpha analysis process is valid, and clearer direction will be provided in the next TBD revision.

**Lobaugh, Megan, 2/9/2018**

Gross alpha analysis, also termed “fluoride insoluble” analysis, was used as a screening method to evaluate exposure to several alpha-emitting radionuclides at once. Detection limits for early periods are derived for the TBD using the lowest positive reported amounts found in ANL-E records. Additional record acquisitions and records of previous DOE reported values are being evaluated and will possibly result in refinements to these values. It is noted that a specific procedure for analyzing plutonium may have existed separately from the gross alpha analysis method prior to the earliest period described in the TBD (for example, SRDB Ref. ID 165282 includes a record for a Pu-239 result of <0.5 dpm/1500 mL for a urine sample in 1951, along with a positive fecal sample result).

Additional guidance will be provided in the TBD to direct dose reconstructors on how to interpret bioassay data for gross alpha analysis. Current practice has been to apply the bioassay results to all nuclides represented and use the most claimant favorable of the results unless the particular radionuclide can be determined from the records. Based on the programmatic limitations of the bioassay program for this period, this is considered adequate as a claimant favorable approach to interpreting the results.

It is noted that identification of specific nuclides is sometimes available from bioassay information in ANL-E monthly program reports. This source of information will be further evaluated to determine if additional resources can be made available to the dose reconstructors (i.e., in addition to the individual bioassay records provide by DOE) to identify the radionuclide of interest.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released. SC&A would like to caution that the use of data obtained from gross counting of bioassay samples to project specific radionuclide intakes (from an assortment of potential radionuclides) presents issues as outlined in SCA’s report for Lawrence Berkeley National Laboratory [SC&A Evaluation of NIOSH White Paper, “Method to Assess Internal Dose Using Gross Alpha, Beta, and Gamma Bioassay and Air Sampling at the Lawrence Berkeley National Laboratory” SCA-TR-2018-SP003, Revision 0 (Draft), SC&A, Inc.,

Vienna, Virginia. April 18, 2018.]

**ANL-E Finding 3**

2/13/2017

*Status = Open*

Assumption of Default Inhalation Pathway May not be claimant favorable

**Hughes, Lara, 3/8/2017**

Ingestion intakes are considered as appropriate. Inhalation is the default intake mode for the NIOSH project (see ORAUT-OTIB-0060, section 3.2.1) because it is the most likely route of entry in an occupational setting. Ingestion must be assigned in addition to inhalation when an intake is based on air monitoring (OCAS-TIB-009), which is not the case for ANL-E assessments.

Ingestion would also be considered for known incidents, for which the route of exposure is documented in bioassay program records (SRDB 165282, pg 3 and SRDB 165295, pages 42, 51, 56) and for acute intakes. Review of monitoring records indicates that route of intake for incidents is noted in bioassay program reports and non-inhalation pathways are uncommon in comparison to the inhalation pathway route. However, assuming intake by ingestion would not be a reasonable assumption for missed dose because a constant chronic ingestion intake over an entire employment period is not plausible. Finally, the example in the findings document suggesting that ingestion can result in larger doses is not pertinent to NIOSH dose reconstructions, where annual, not committed, doses are compared, and the document does not consider Type Super S, which would further increase the dose from inhalation relative to ingestion for given bioassay results.

**Buchanan, Ron, 4/4/2017**

SC&A's main emphasis in this finding was that the ingestion pathway should be considered along with the inhalation pathway. SC&A's example in their 2009 evaluation report was for one-year (not 50-year committed doses), and was to illustrate that ingested dose should be considered along with inhalation intakes in assigning annual doses. NIOSH indicated in their response that this is done during dose reconstructions. SC&A finds this issue resolved and recommends closure.

## **ANL-E Finding 4**

*2/13/2017*

*Status = Open*

Insufficient Information on the Calculation of Minimum Detectable Concentrations and Uncertainties in Bioassay Methodology

**Hughes, Lara, 3/8/2017**

MDCs are listed in the TBD based on all available information to date. Determination of MDCs becomes more difficult for earlier periods, where recorded MDCs are scarce or nonexistent, but which may be inferred from the smallest recorded positive values or reported standard deviations for sample results, as described in the TBD. Recent records from ANL-E are being reviewed to determine if they may refine the current estimates of MDC in the TBD (for example, for uranium analysis by fluorometry, the records in SRDB 165278, 165280, 165283, and 165297 clarify the reporting units and show an earlier starting date than the current TBD lists). The assertion in the original finding that MDCs inferred by such methods may result in large assessed doses is correct, but is an unavoidable aspect of the dose reconstruction process that is common to many sites.

**Buchanan, Ron, 7/17/2017**

From NIOSH's BRS response of March 8, 2017, SC&A understands that the recent records from ANL-E are being reviewed to determine if they may refine the current estimates of MDC in the TBD.

**Lobaugh, Megan, 2/9/2018**

From the review of previous and recently obtained records, it is likely that some refinements in uranium and plutonium MDC values, and their applicable dates, can be made in the TBD. Further analysis of this data will be performed to evaluate whether modifications are possible for MDCs and/or uncertainties of other nuclides as well.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

## **ANL-E Finding 5**

*2/13/2017*

*Status = Open*

Lack of Guidance for Estimation of Missed Dose for Unmonitored Workers

**Hughes, Lara, 3/8/2017**

Records from the earliest periods at ANL-E are available and indicate that individuals working in radiological areas were monitored for internal and external exposure. With the establishment of ANL-E came the establishment of a health physics program and a medical department. Naturally the program would ramp up and new methods would be developed and implemented as time progresses. The earliest bioassay seen in files is from mid-1945.

The potential need for assignment of unmonitored dose is still being assessed.

**Lobaugh, Megan, 2/9/2018**

According to ANL-E records and interviews with former workers and radiological program personnel (SRDB Ref. ID 12632), all employees in radiologically controlled areas were monitored; external dosimetry reports, bioassay results, and information in ANL-E monthly reports appear to confirm this. Review of 95 claims with employment dating back to 1946 and extending to 2008 revealed only three claims with no internal or external monitoring, with either short-duration employment (<3 months) or job titles consistent with non-radworkers. Therefore, information from environmental reports incorporated as internal environmental intakes in ORAUT-TKBS-0036-4 are most appropriate for unmonitored workers outside of radiologically controlled areas. These values would be considered overestimating since they include contributions from fallout for early years in addition to potential intakes from ANL-E operations. ORAUT-TKBS-0036-5 will be revised to direct the use of environmental intakes from ORAUT-TKBS-0036-4 to clarify this.

**Buchanan, Ron, 5/1/2018**

SRDB Ref. ID 12632 is a very lengthy document (347 pages) that covers many documents, decades, and situations. It would be helpful in verifying NIOSH's statement that "all employees in radiologically controlled areas were Monitored" if NIOSH could provide page numbers in that document that provides support for that conclusion. Additionally, SC&A will review the revised TBD when released.

**Lobaugh, Megan, 6/21/2018**

This post is in response to the request for page numbers in SRDB 12632, which is referenced in the NIOSH response. For that document, NIOSH specifically is referencing pages 11, 18, and 24.

In addition to the document referenced, interviews with past workers also corroborate the statement that "all employees in radiologically controlled areas were monitored": SRDB 70777 p. 4 and 5; SRDB 167633 p. 6; SRDB 167826 p. 6; SRDB 167827 p. 7; and SRDB 167842 p. 6

**ANL-E Finding 6**

*2/13/2017*

*Status = Open*

Failure to Adequately Define and Assess Occupational Medical Exposures in the Pre-1988 Years and Potentially Misses Special Employment Exams

**Hughes, Lara, 3/8/2017**

ORAUT-OTIB-0006 has been revised (in 2011) since the original SC&A review and the last revision of the TBD. The ANL-E Medical TBD will be evaluated and revised as necessary to incorporate ORAUT-OTIB-0006 recommendations regarding special screening exams.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

**ANL-E Finding 7**

*2/13/2017*

*Status = Open*

Lacking Techniques and Protocols for Medical Examinations prior to 1988 Increases the Uncertainty of DCFs listed in ORAUT-TKBS-0036-3

**Gogliotti, Rosanna, 2/13/2017**

In Finding 7 and Secondary Issues 3 and 4, SC&A was concerned with the lack of knowledge of the type of X-ray equipment used at ANL-E prior to 1988, along with the beam quality, calibration, protocols, and techniques used for dose calculations. Since ORAUT-TKBS-0036-3 references ORAUT-OTIB-0006, Revision 03 for this information, and SC&A has reviewed and approved this document, including the information pertaining to equipment, the doses derived from these assumptions are claimant favorable. Therefore, SC&A recommends closing Finding 7.

**Hughes, Lara, 3/8/2017**

NIOSH concurs with SC&A's recommendation to close this finding.

**ANL-E finding 8**

2/13/2017

*Status = Open*

Frequencies and Types of X-ray Exposures Are Uncertain

**Gogliotti, Rosanna, 2/13/2017**

As was previously mentioned, some of the PFG doses have changed from Revision 03 to Revision 04 of ORAUT-OTIB-0006; therefore, ORAUT-TKBS-0036-3 needs to be updated. In ORAUT-TKBS-0036-3, NIOSH recommends assigning PFG doses for the years 1946 to 1956. SC&A suggested that dose assignment from PFGs should extend to 1958. At the time the site profile review was written, SC&A referenced Januska and Smith 1961, which suggests that the equipment used through December 1958 would be capable of photofluoroscopy. In Attachment 4 of SC&A's 2009 site profile review, SC&A and NIOSH both respond to this issue, but it is not part of a formal issues resolution process. Therefore, the issue of PFGs is raised in Finding 8 and SC&A recommends that this finding remain open for discussion.

**Hughes, Lara, 3/8/2017**

Any new information collected from ANL-E since the original TBD was written will be incorporated in a revision. ORAUT-OTIB-0006 has been revised (in 2011) since the original SC&A review and the last revision of the TBD. Note that the 1961 Januska and Smith reference (SRDB 76496) mentioned by the finding states that the diagnostic X-ray facility was designed 'for diagnostic work using radiographic and fluoroscopic methods' and that 'approximately 80 percent of the studies made consist of posterior-anterior chest radiographs in conjunction with annual recheck, pre-employment, and termination physical examinations.' Nothing in the document that provides information on whether PFG exams were still performed or when they may have terminated.

The review of x-ray records in claimant files showed that PFG was rarely found after 1948, and was found only in conjunction with medical examinations that were performed at the University of Chicago. PFG examinations were only found through 1956 in a review of claimant files. The x-ray information in the ANL-E claim file records constitute a body of evidence that should be used in the TBD. ORAUT-OTIB-0006 should be used in the absence of such evidence.

**Buchanan, Ron, 7/17/2017**

SC&A understands this statement to indicate that ORAUT-TKBS-0036-3 will be revised to incorporate the revisions in Revision 04 to ORAUT-OTIB-0006, and, until then, the dose reconstructor is to use the current version of ORAUT-OTIB-0006.

**Lobaugh, Megan, 2/9/2018**

Pertinent information from ORAUT-OTIB-0006 will be incorporated in the ANL-E TBD, as stated above.

Evaluation of claimant files supports the SC&A concern that post-1980 X-rays may have been implemented more frequently than every four years. TBD will be revised to assume annual X-rays, rather than at four-year intervals, be applied for workers with no available X-ray records.

Claimant files and other record information will be evaluated to determine whether the ending date for the application of PFG exam should be extended from 1956 through 1958.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

## **ANL-E Finding 9**

*2/13/2017*

*Status = Open*

### Uncertainty and Undocumented Aspects of the Film Dosimetry Need Re-examination

**Hughes, Lara, 3/8/2017**

Further research into dosimeter characteristics will be performed to evaluate the similarity of ANL-E dosimeters to those used at INL and used for ANL-W workers and the validity of the under-response assumptions in the TBD. A simplifying table will be developed to aid dose reconstructors in application of dosimeter parameters. Since the 2009 SC&A evaluation, the ANL-E workbook has been revised to reflect the guidance and parameters of the current TBD.

**Lobaugh, Megan, 2/9/2018**

To date, no additional information has been identified from recently captured documents or from interviews with former ANL-E employees that is expected to significantly modify or enhance the current descriptions in the TBD. Review efforts will continue to identify more detailed specification information for film and neutron dosimeters for early time periods, including evaluating the need for additional data capture.

**Buchanan, Ron, 5/2/2018**

SC&A will review the additional data and/or revised TBD when released.

**ANL-E Finding 10**

2/13/2017

*Status = Open*

## Neutron Dosimetry is Inadequately Addressed

**Hughes, Lara, 3/8/2017**

NIOSH concurs that improvement on the guidance on neutron monitoring is needed. Any new information collected from ANL-E since the original TBD was written will be incorporated as applicable. For periods prior to the implementation of neutron dose monitoring (1953), or when neutron films were only read when the gamma dose was above 100 mrem (before 1960), evaluation of appropriate neutron to photon ratios for the reactor types in use at ANL-E would be suggested. Additional data evaluation is needed.

**Lobaugh, Megan, 2/9/2018**

To date, no additional information has been identified from recently captured documents or from interviews with former ANL-E employees that is expected to significantly modify or enhance the current descriptions in the TBD. Review efforts will continue to identify more detailed specification information for neutron monitoring.

It is noted that prior to 1961, there is little evidence of the routine use of neutron monitoring dosimeters. SRDB Ref. ID 12632 indicates that surveys were performed prior to 1960 using neutron survey instruments, but that neutron doses were not recorded from these.

The earliest record found in a review of claimant files of an NTA film result was from June of 1957, which is consistent with the TBD information that it was in use by 1956. There are annual dose summary sheets occasionally found which record neutron doses of zero for earlier years than this, but these are not supported by records of actual dose reports.

NIOSH will continue efforts to locate and evaluate ANL-E records to develop neutron to photon ratios from available monitoring data, as well as other methods of addressing these deficiencies (e.g., adopting appropriate ratios from sites with similar facilities, see comment below) and will update the TBD information accordingly. Additional data capture efforts targeted at film and neutron dosimeters specifications for early periods may be warranted.

For periods prior to the implementation of neutron dose monitoring (1953), or when neutron films were only read when the gamma dose was above 100 mrem (before 1960), it is suggested that the glovebox neutron to photon ratio developed for Hanford could adequately describe plutonium glovebox work at ANL-E. Since this ratio is more claimant favorable than N/P ratios for reactors at Hanford, it would be expected to overestimate neutron doses from sources at ANL-E (primarily test reactors and plutonium gloveboxes) for these periods.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

**ANL-E Finding 11**

2/13/2017

*Status = Open*

Quantification of External Exposures to Unmonitored Workers Outdoors is Inadequately Justified

**Gogliotti, Rosanna, 2/13/2017**

For time periods prior to 1972, there are virtually no data characterizing the external radiation fields outdoors. This finding has to do with remaining concerns SC&A has pertaining to the quality of data used to support the method used to estimate dose to outdoor unmonitored workers. Further description of this finding can be found on pages 47–49 of SC&A’s 2009 review. This finding still needs to be addressed in its entirety by NIOSH.

**Hughes, Lara, 3/8/2017**

No additional records have been identified which provide ambient on-site external exposures prior to the period currently described in the TBD (i.e., before 1972). For the period when monitoring is available, it is concluded that “unbadged workers would not be expected to receive a dose in excess of the normal background dose of 100 mrem/yr” which was determined to be the average annual dose measured at off-site locations not influenced by site operations (SRDB 14459, pg 55, SRDB 14461, pg 57). For the period prior to 1972, use of the average values for other DOE sites in ORAUT-PROC-0060 (Occupational Onsite Ambient Dose Reconstruction for DOE Sites) may be applied as an overestimating assumption since the doses average doses in that document exceed those at ANL-E for concurrent time periods.

**Buchanan, Ron, 7/17/2017**

SC&A finds that there should be more detailed information concerning the use of the average values for other DOE sites from ORAUT-PROC-0060 included in the ANL-E ORAUT-TKBS-0036-4 TBD document to ensure consistent application in dose reconstruction.

**Lobaugh, Megan, 2/9/2018**

Current estimates of ambient external dose from ORAUT-TKBS-0036-4 are based on overestimates of airborne exposure to short-lived, gamma emitting nuclides, primarily Ar-41 from the CP-5 reactor releases since onsite measurements of direct radiation based on TLD monitors were indistinguishable from offsite measurements given the uncertainty of the results. The maximum external dose currently assigned for non-monitored workers based on these values is 0.014 rem per year (assumed to be 2600 hours). By contrast, the average value of the maximizing onsite ambient doses from the sites listed in ORAUT-PROC-0060 range from around 0.150 rem in 1971 up to 2.7 rem in 1946. Because these values would likely be comparable to, or exceed, average external doses for monitored workers at ANL-E for the same periods, they would be anticipated to be very claimant favorable estimates of doses to non-monitored workers. These ORAUT-PROC-0060 values, or more reasonable estimates, if they can be derived, will be incorporated in the TBD direction to dose reconstructors.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

## **ANL-E Finding 12**

*2/13/2017*

*Status = Open*

Outdoor Inhalation Exposures Associated with Waste Disposal Operations In Area A and From Particulates Released During Accidents are not Adequately Addressed

**Gogliotti, Rosanna, 2/13/2017**

Our review reveals that NIOSH's conclusions about this matter are reasonable; however, some additional discussion is needed regarding the potential for short-term, but possibly large, inhalation exposures associated with the waste disposal operations in Area A and whether exposures to particulates that might have been released during accidents could have contributed significantly to the outdoor inhalation dose. Additionally, some discussion is needed about the exposures that some workers may have experienced during accidents where large amounts of radionuclides might have been released to the atmosphere over short periods of time. Further description of this finding can be found on pages 49–50 of SC&A's 2009 site profile review. This finding still needs to be addressed by NIOSH.

**Hughes, Lara, 3/8/2017**

The finding states that the conclusion in the TBD (that the potential for inhalation exposure to particulates outdoors in Site A up to 1954 was negligible) is reasonable, but that additional discussion is needed regarding the potential for short-term, but possibly large, inhalation exposures associated with the waste disposal operations in Area A.

According to the TBD (ORAUT-TKBS-0036-2, Section 2.2.2), waste disposal operations at Site A were conducted from 1943 through 1949, with buried waste removed to Site D in 1949; consequently, all waste disposal operations at Site A were conducted during the period prior to 1954 when the TBD assumptions were considered to be adequate.

**Buchanan, Ron, 7/17/2017**

SC&A finds that NIOSH's response was supported during the visit to ANL-E on March 21, 2017, and recommends closing the issue.

## **ANL-E Finding 13**

*2/13/2017*

*Status = Open*

Lack of Consideration of Occupational Radiological Exposure at Site A and Plot M.

**Gogliotti, Rosanna, 2/13/2017**

In the Attachment 4 NIOSH responses on page 91 of SC&A's 2009 site profile review, NIOSH indicates that these facilities are part of the Metallurgical Laboratory (Met Lab) and will be addressed outside of the ANL-E TBD. There is currently no Met Lab TBD; however, SC&A located an internal guidance document that instructs dose reconstructors how to perform a dose reconstruction at the site (NIOSH 2012). This guidance document makes no mention of Plot M and only a vague mention of Site A. SC&A confirmed that the Met Lab covered periods begin in 1942, earlier enough to cover Site A and Plot M; however, SC&A recommends that this issue be transferred to the Board work group that oversees Met Lab so that this finding can be addressed in that forum.

**Hughes, Lara, 3/8/2017**

Site A and Plot M employment would be covered under the Metallurgical Laboratory site designation until June 30, 1946 and under the ANL-E site designation starting July 1, 1946. The operations at Site A and Plot M are discussed in the Site Description document. There does not seem to be an issue assigning claims to the respective site (Met Lab vs. ANL-E) by DOL based on claim review by NIOSH.

**Buchanan, Ron, 4/4/2017**

SC&A's main emphasis of this finding was to ensure that the workers at Site A and Plot M were included in the Met Lab SEC through June 30, 1946. According to NIOSH's recent reply this is correct; therefore, SC&A finds this issue has been resolved and recommends closure.

## **ANL-E Secondary Issue 1**

*4/7/2017*

*Status = Open*

### Potential Missed Dose from Skin and Clothing Contamination

**Buchanan, Ron, 4/11/2017**

SC&A Update: Since issuance of the original ANLE TBDs, NIOSH has addressed this issue in a number of venues and has developed a protocol for assigning skin dose, not only for direct deposition on skin (as provided in ORAUT-OTIB-0017, Revision 01, Interpretation of Dosimetry Data for Assignment of Shallow Dose), but also for contaminated clothing. On this basis, SC&A finds that this issue can be readily resolved by a revision to ORAUT-TKBS-0036-6 for ANL-E that makes appropriate reference to this guidance for reconstructing beta exposure of skin from direct deposition and clothing contamination.

**Hughes, Lara, 4/24/2017**

The TBD will be evaluated and revised to incorporate appropriate language to address dose reconstruction in accordance with OTIB-0017 from skin and clothing contamination.

**Lobaugh, Megan, 2/9/2018**

TBD revision will incorporate appropriate guidance from, or reference to, ORAUT-OTIB-0017 in assessing doses from skin and clothing contamination.

**Buchanan, Ron, 5/2/2018**

SC&A will review the revised TBD when released.

## **ANL-E Secondary Issue 2**

*4/7/2017*

*Status = Open*

Other Potential Medical Exposures Have Not Been Identified

**Buchanan, Ron, 4/11/2017**

SC&A Update: SC&A raised the issue that ANL-E workers could have been exposed to radiation from medical equipment other than X-rays. During the worker interviews summarized in Attachment 3 of SC&A 2009, it seems clear that this was not a possibility. Attachment 3 states: "There are no teletherapy units or radiation generating devices in the medical department except the x-ray units. There has been no administration of radioactive material for diagnostic or therapeutic reasons." Therefore, SC&A recommends closing Observation #2 (Secondary Issue 2).

**Hughes, Lara, 4/24/2017**

NIOSH concurs.

## **ANL-E Secondary Issue 3**

*4/7/2017*

*Status = Open*

Additional Factors Contribute to Medical Dose Uncertainties

**Buchanan, Ron, 4/11/2017**

SC&A Update: As with the X-ray equipment, ORAUT-TKBS-0036-3 references ORAUT-OTIB-0006, Revision 03 for this information, and SC&A has reviewed and approved this document, including the information pertaining to assignment of uncertainty. Therefore, the doses derived from these assumptions are claimant favorable. SC&A recommends closing Observation #3 (Secondary Issue 3).

**Hughes, Lara, 4/24/2017**

NIOSH concurs.

**ANL-E Secondary Issue 4**

4/7/2017

*Status = Open*

Internal Dose to Workers from Radon Exposures is Not Considered

**Buchanan, Ron, 4/11/2017**

ANL-E handled Ra-226, Ac-227, and Th-230 as part of R&D and other activities. SC&A is concerned about the lack of consideration of doses from the unmonitored gaseous radionuclides such as thoron, actinon, and radon.

**Hughes, Lara, 4/24/2017**

No records have been identified which indicate worker monitoring for radon was routinely performed; however no major sources of enhanced radon exposure have been identified for the ANL-E site. There were no large quantities of uranium or radium in ore stored or handled at ANL-E.

**Hughes, Lara, 4/24/2017**

No records have been identified which indicate worker monitoring for radon was routinely performed; however no major sources of enhanced radon exposure have been identified for the ANL-E site. There were no large quantities of uranium or radium in ore stored or handled at ANL-E.

**Buchanan, Ron, 7/17/2017**

SC&A finds that there were opportunities for exposure to radium 226 (Ra-226), actinium 227 (Ac-227), and thorium. In fact, the ANL-E TBD acknowledges that the site used Ra-226 in Buildings 203 and 211 as part of the accelerator program. In Building 200, radon-200 was produced (ORAUT-TKBS-0036-2, Revision 00 PC-1, Table 2-2). Furthermore, there was a substantial incident involving rupture of an Ra-226 source that generated radon issues through time. Thorium was machined in the East Area and handled in research and development (R&D). Ac-227 was also handled in R&D (Manning 1950). Given the use of radium, actinium, and thorium at ANL-E, further investigation into potential occupational exposures to radon and possibly thoron and actinon are necessary.

**Lobaugh, Megan, 2/9/2018**

Radon filter traps were used for radium work in New Chem building and at Site A as early as 1948 (SRDB Ref. ID 16426, p.13, SRDB Ref. ID 16427, pg. 5, SRDB Ref. ID 16426, p.17). In addition, air sampling that found elevated levels of radon indicated a radium source leak in 1949, as noted above (SRDB Ref. ID 16427, pg. 22). This would indicate that protective measures were implemented from early operations for anticipated high exposures from radon. While more recent environmental reports show monitoring and reporting of offsite radon releases, no additional information has been located describing onsite routine radon monitoring programs. Recent interviews with former ANL-E workers indicated that air monitoring was routine, but no specific monitoring related to radon was recalled. While additional research into radon exposures will continue, no changes to the current method of assessing radon intakes in TKBS-0036-4, section 4.4, is anticipated.

**Buchanan, Ron, 5/2/2018**

In evaluating this issue it would be helpful to know if NIOSH has located any bioassay data for radium and/or its decay products in the NOCTS files they have evaluated; such as the 95 claims previously referred to in Finding 5. If workers were bioassayed for radium and its decay products this would indicate that there was potential exposure from radon and its decay products.

**Lobaugh, Megan, 6/5/2018**

Records obtained from ANL-E include over 800 bioassay sample results for radium (many of which were positive) between 1949 and 1979. These included urine and fecal samples and were identified as either Ra-223, Ra-226, or simply 'radium'. However, to date, documentation contains insufficient information to identify chemical/physical forms, quantities, or processes in which radium was encountered, although a few isolated incident reports have been found. NIOSH concurs that activities with radium could indicate potential exposure to radon and radon decay products, but as previously noted, has not found evidence of routine worker monitoring for radon exposure.

At this time, NIOSH is not proposing any changes to the current methodology. Currently, radon doses are assessed in Section 4.4 of ORAUT-TKBS-0036-4 (Environmental Dose). Justification for not assigning additional radon dose, aside from environmental dose, will be included in ORAUT-TKBS-0036-5 (Occupational Internal). See previous BRS responses for more information. If additional information regarding radon exposures or monitoring is found during the process of updating the TBDs, it will be assessed and included.

**ANL-E Secondary Issue 5**

4/7/2017

*Status = Open*

Lack of Treatment Provided to the Monitoring of Contractors, Transferees, and Visitors

**Buchanan, Ron, 4/11/2017**

Although “Rover Dosimeters” are mentioned, there is scant mention in the site profile of the monitoring of visitors, transferees, and contractors. Of particular concern, is the absence of information on the treatment of contract workers during the numerous D&D activities known to have been conducted at ANL-E. Since this issue has been a concern at other sites, it should be addressed in greater depth here.

**Hughes, Lara, 4/24/2017**

There is no information in records from ANL-E suggesting that contractors, transferees, or visitors would not have been monitored in accordance with applicable procedures. While no specific programmatic or policy information has been located regarding contractors, transferees, or visitors, records support that operations in radiologically controlled areas were conducted primarily by ANL-E employees (i.e. visitor or subcontractor entry in controlled areas would have been infrequent). Records further document that non-employee and transferred employees were monitored as needed (internal monitoring for a “transferee” occurring in 1951 (SRDB 165307, pg. 17), external monitoring for “visiting personnel” in 1954 (SRDB 165316, pg. 5), and internal monitoring for visiting personnel (Bioassay Program Report, SRDB 165293)).

**Buchanan, Ron, 7/17/2017**

SC&A finds that the details of visitor and subcontractor monitoring are lacking. According to page 51 of ORAUT-TKBS-0036-6, rover dosimeters were pocket ionization chambers (PICs) that were not permanently assigned and were typically worn by visitors or personnel who were not normally assigned to an area. Would these PIC doses be recorded for visitors from other DOE facilities, and for the ANL-E workers? The Site Research Database (SRDB) references provided by NIOSH were for the early years at ANL-E, but the majority of the decontamination and decommissioning work would have occurred in later years, perhaps by subcontractors. Have radiation work permits, or similar job plans, been searched for monitoring compliance, especially for subcontractors?

**Lobaugh, Megan, 2/9/2018**

While no documentation has been found describing formal policy or contractual relationships involving radiation protection policy regarding contract workers, early monthly reports document that contractor company workers were included in monitoring (see for example, SRDB Ref. ID 16424 (1948), page 16, and SRDB Ref. ID 145772 (1952), pages 25, 26, 41, and 50). SRDB Ref. ID 145772, page 59, also describes visitors included in monitoring at the site. Transferees are also designated in ANL-E monthly reports and other documents (see SRDB Ref. IDs 165278, 165280, 165283, and 165297). Interview with former ANL-E workers (earliest employment date 1947) verified that contractors were not typically used for work in radiological areas, but that all individuals in these areas were monitored (SRDB Ref. IDs 167633, 167826, 167827, 167842). Consequently, there is no indication that visitors, contractors, or transferees would have been excluded from appropriate radiation protection or monitoring procedures.

**Buchanan, Ron, 5/2/2018**

SC&A reviewed recent interviews and related documents and did not find evidences of subcontractors and visitors being monitored differently than ANL-E employees. Therefore, SC&A recommends closure of this issue.

**ANL-E Secondary Issue 6**

4/7/2017

*Status = Open*

## Human Radiation Experiments Not Addressed

**Buchanan, Ron, 4/11/2017**

ANLE and its predecessor, the Metallurgical Laboratory, participated in human radiation experiments, including some involving employees. For example, six Metallurgical Laboratory employees volunteered to drink a solution with small amounts of plutonium. If exposure due to human radiation experiments should be included in the dose reconstruction, the TBD would benefit from inclusion of information related to these experiments. SC&A also has concerns if participation in experiments of that nature would be included in the energy employees' medical files; further research on this issue would be needed to determine if medical experiment participation is available and provided with employee medical files, and if this will be included in dose reconstruction.

**Hughes, Lara, 4/24/2017**

Doses received from participation in human radiation experiments are considered covered exposure under EEOICPA, however they typically have not been addressed in site technical basis documents. These doses would be assessed at an individual level based on the information that is available in the documentation (e.g. SRDB 31911 and 33842)

**Buchanan, Ron, 7/17/2017**

SC&A finds that while the ANL-E TBDs briefly mention human experiments, they do not explicitly instruct the dose reconstructor to include the doses and where to find the details of some of the human experiments. SRDB Ref. ID 33842, pages 127–147, provides a detailed list of 43 human experiments conducted at ANL-E and should be referenced in the internal dose TBD to provide further information for dose reconstruction. Additionally, SC&A has not seen verification that doses from the human experiments were calculated, recorded, and available in the participant's records.

**Lobaugh, Megan, 2/9/2018**

Revised TBD will include explicit direction to dose reconstructors that doses from human radiation experiments are covered exposures to be included in the assessments, and will cite references providing additional information.

Note that the facility referred to in the SC&A discussion (from SRDB Ref. ID 33842, pages 127–147) is the University of Chicago – Argonne Cancer Research Facility; this is described as a separate facility from ANL-E (SRDB Ref. ID 31911, page 63) and is not included as a covered facility under EEOICPA or described in the ANL-E TBDs; the studies described for this facility were on patients of that facility or the Chicago Lying-In Hospital, or inmates of the Illinois State Penitentiary, and not on employees of ANL-E. Studies related to the ANL-E facility are described on pages 5-13 of SRDB Ref. ID 33842; these studies described the involvement of both patients and employees; several of these studies are prior to the period in which the ANL-E facility is covered under EEOICPA.

**Buchanan, Ron, 5/2/2018**

SC&A concurs with NIOSH's explanation and will review the reviewed TBD when release.

**ANL-E Secondary Issue 7**

4/7/2017

*Status = Open***Incidents and Accidents Need to be Reexamined****Buchanan, Ron, 4/11/2017**

Exposure conditions that may present themselves during an incident or occurrence have not been addressed in the TBD. Although individuals involved in incidents are usually monitored, the incident itself may pose special exposure conditions that need to be considered in the dose reconstruction (e.g., injection versus inhalation; partial body exposure to an external beam; cleanup of a spill involving nontraditional radionuclides).

**Hughes, Lara, 4/24/2017**

Significant incidents and accidents are outlined in Section 2.4 of the site description TBD for ANL-E, with further detail provided in the 1979 Draft Environmental Impact Statement (SRDB 17809).

Additional records obtained indicate that radiological incidents are documented at least as early as 1950 in ANL-E program reports (SRDB 16712, 165264, 165293-165296, 165303, 165304, 165307), special incident reports (SRDB 165261, 165274) and monitoring records for individuals (SRDB 165278, 165280, 165283, 165297). Results of monitoring associated with these incidents would be included in individual monitoring records provided by DOE in support of EEOICPA dose reconstructions.

**Buchanan, Ron, 7/17/2017**

SC&A finds that these reports only cover accidents during the early period at ANL-E; i.e., pre 1979. Similar research needs to be conducted for 1979 and forward.

**Lobaugh, Megan, 2/9/2018**

Review of records has identified ANL-E documentation of minor incidents (spills, contamination, etc.) after 1979, but no compilation or description of major accidents. However, ANL-E documentation demonstrates that even in early periods, exposures associated with significant incidents are noted as such in records. Because major incidents would likely have been tracked by DOE on a site-wide basis during the later period in question, no revision or additions to this section are considered necessary to aid in dose reconstructions.

**Buchanan, Ron, 5/2/2018**

SC&A recent search for incidents at ANL-E did not result in any specific documentation of major incidents that would indicate unmonitored exposures. As at other DOE sites, incidents will be handled on any individual bases during dose reconstruction. Therefore, SC&A recommends closure of this issue.