

SC&A Status Update: SEC-00219 INL and SEC-00224 ANL-W

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Contractor to:

**Advisory Board on Radiation and Worker Health/ABRWH
Centers for Disease Control and Prevention**

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INL SEC-00219 Class Definition

Last brought before the Board at the March 23, 2016, Board meeting in Tampa , Florida (previously at the July and November 2015 meetings)

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Idaho National Laboratory (INL) in Scoville, Idaho, and (a) who were monitored for external radiation at the Idaho Chemical Processing Plant (CPP) (e.g., at least one film badge or TLD dosimeter from CPP) between January 1, 1963 and February 28, 1970; or (b) who were monitored for external radiation at INL (e.g., at least one film badge or TLD dosimeter) between March 1, 1970 and December 31, 1974, for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

INL SEC-00219 Class Definition (cont.)

Recent INL Work Group/Board discussions regarding class definition:

- November 10, 2015 – WG meeting
- January 15, 2016 – WG teleconference meeting
- Jan. 25–28, 2016 – Initial WG/SC&A onsite data capture/interviews – with follow-ups on Feb. 16, Feb. 23–24, & March 15–16
- March 1, 2016 – WG meeting
- March 24, 2016 – ABRWH Meeting 110 in Tampa, Florida
- August 2, 2016 – WG meeting
 - SC&A white paper on new claimant evaluation:
<http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inldrrev-r0.pdf>

INL SEC-00219 – Class Definition (cont.)

Part b) accepted March 23, 2016; Part a) held in reserve based on Board concerns regarding:

1. The **completeness and adequacy** of INL visitor cards/temporary film badge reports (TBR) and monthly Dosimetry Branch Activity Reports (DBAR) from 1963 through 1970. Involved extensive research on NIOSH's part.

August 2, 2016, WG update:

- In March 2016, NIOSH captured the monthly DBARs from 1965 through 1974. These were the “missing reports” that enable NIOSH to evaluate the completeness of the visitor cards/TBRs.
- INL began indexing/coding the visitor cards in June and they are projected to be complete by the end of September 2016. Due to funding issues, TBR coding indeterminate – likely sometime after fiscal year turnover.
- SC&A to explore additional V&V strategies for WG consideration as the indexed visitor cards and TBRs become available.

INL SEC-00219 – Class Definition (cont.)

- NIOSH indicates only 1 CPP badge (annual or visitor) and documented 250 days on site for SEC inclusion.
 - Thus, missing 1 temporary badge (TB) (worn 1 month max.) not significant because would have 12 for 250 days.
 - Conversely, if a claimant had only 1 TB and it was missed, he or she would be excluded.
2. Where definitive location records are lacking, reliance on professional judgment based on “**weight of evidence**” to reject inclusion in the SEC.
- The WG remains concerned over how such criteria, which to date have been used in just one SEC class definition (Mound), would be implemented by DOL.
 - NIOSH indicates that 911 out of 913 claims evaluated can be clearly adjudicated by parts (a) and (b) of the proposed class definition.
 - WG remains concerned about Emergency Responder (fire fighter) badging protocols and the ability to identify CPP entry. Will require worker interviews (Nov 2016).

**Update – Evaluation of Areas and
Times that NIOSH Has Determined
Doses Are Reconstructable
SEC-00219 INL
and SEC-00224 ANL-W
(since November 2015)**

INL Background – Recap

Dose Reconstructability/Gap Analysis

- Approach: “Horizontal” and “Vertical” analysis
 - Horizontal – examine the DR methodology applied by NIOSH for all INL personnel – cross-cutting
 - Vertical – specific characteristics of the individual areas at the INL site
- 6 areas of investigation:
 1. Reactor Modeling (horizontal)
 2. Test Area North (TAN) (vertical)
 3. Central Facilities Area (CFA) (vertical)
 4. Fission and Activation Product (FAP) Bioassay Indicator Radionuclides (horizontal)
 5. Burial Grounds (vertical) pended
 6. Chemical Processing Plant (CPP) Pre-1963 (vertical) pended

INL Recap and Update

- November 10, 2015, WG meeting
 - White papers and progress reports on the six areas of investigation were delivered in September and October 2015
 - Those papers are available on the DCAS website at:
<http://www.cdc.gov/niosh/ocas/pubm2015.html>
 - Preliminary results presented at the November 18, 2015, Board session
- Since November 2015, at the WG's direction, SC&A has followed up on several areas:
 - Reactor Modeling
 - Fission and Activation Product (FAP) Bioassay Indicator Radionuclides
 - Burial Grounds
 - Chemical Processing Plant (CPP) Pre-1963

INL Update (continued)

- Data capture and worker interviews were conducted in conjunction with DCAS in March 2016.
 - SC&A efforts focused principally on the burial ground and CPP pre-1963.
 - Documents should be cleared and available to SC&A and DCAS by late August 2016.
- SC&A follow-on white papers on reactor prioritization and indicator radionuclides were discussed at the August 2, 2016, meeting and are available on the DCAS website:
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inlsec219rsp-r1.pdf>
(Reactor Prioritization)
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-inlwasterep-r0.pdf>
(FAP Indicator Radionuclides)

ANL-W SEC-00224

Petition Overview

- Petition received on December 4, 2014.
- Petition qualified on March 13, 2015.
- Notification to Petitioner and ABRWH in June 2015 that NIOSH would exceed 180-day deadline due to site complexity and need for multiple data capture efforts on site.
- Further delay in September 2015 due to dosimetry records issue between ANL-E and INL.
- Evaluation Report sent to ABRWH on February 24, 2016.
- Evaluation Report sent to Petitioner on March 8, 2016.
- Presented to the Board at the March meeting in Tampa, Florida.
- Board voted to accept the class as proposed.

ANL-W SEC-00224

NIOSH Class Definition

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Argonne National Laboratory-West between April 10, 1951 and December 31, 1957 for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days within the parameters established for one or more other classes of employees in the Special Exposure Cohort.

ANL-W SEC-00224

NIOSH Determination of Feasibility of Dose Reconstruction

- Up until 1958, the West site (EBR-I complex) was determined to be infeasible due to limited mixed fission product bioassay and potentially incomplete external dosimetry records.
- Dose reconstruction was determined to be feasible for the East site (EBR-II complex), as there were routine mixed fission product bioassay and air sample data indicating alpha exposures were controlled to less than 10% of the maximum permissible concentration (MPC).

ANL-W: SC&A Preliminary Investigations

Seven areas of inquiry – similar approach as used for INL. Several were discussed at the August 2, 2016, combined INL/ANL-W WG meeting and are the subject of this presentation.

1. Review OTIBs and TIBs referenced as basis for the SEC ER to identify open issues and assess their relative impact on the SEC class determination.
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwtibstatus-062816.pdf>
2. Review the ANL-W site profile and cross-walk the combined SP matrix and SEC matrix with ANL-W to identify potential commonalities.
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwinlspsec-r0.pdf>
3. Review ANL-W reactors for OTIB-0054 applicability and significance in an SEC context (e.g., years operated, frequency and intensity of operation, incidents, number of workers potentially affected) – same as done for INL.
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwrrp-r0.pdf>

ANL-W: SC&A Preliminary Investigations (continued)

4. Investigations into changes in the completeness and adequacy of dosimetry and air sampling data between 1951 and 1956 and from 1957 going forward (SEC break point).
 - 4a – Dosimetry completeness and adequacy (internal and external), including vertical analysis of neutron dosimetry and treatment in TBD-6
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwmtrprac-070816.pdf>
 - 4b – Area monitoring data (air sampling, swipe survey reports, area monitoring reports) completeness and adequacy – split between EBR-I and EBR-II (**to be discussed at the next meeting**)
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwamd-071416.pdf>

ANL-W: SC&A Preliminary Investigations (continued)

5. Investigate general air sampling data that NIOSH proposes for dose reconstruction of actinide intakes in the absence of FAP.
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwairsamp-r0.pdf>
6. Evaluate available data that would indicate the ratios of MFPs and actinides to Cs/Sr (OTIB-0054 ratio approach – same as done for INL).
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwintakes-071416.pdf>
7. Investigate the strategy of using the 10% Maximum Permissible Concentration rule in dose reconstruction (not discussed per se at the August WG meeting but related to Issue 5 above).
 - <http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-anlwsec224-071416.pdf>

ANL-W Item 1 – Review OTIBs and TIBs Referenced as Basis for the SEC ER

13 OTIBs and 2 Procedures Referenced

- 3 OTIBs with outstanding findings that may impact the SEC class determination:
 1. ***ORAUT-OTIB-0018, Revision 01, Internal Dose Overestimates for Facilities with Air Sampling Programs, August 9, 2005; SRDB Ref. ID 19436***

1 finding “in progress” awaiting NIOSH response on (a) does list of radionuclides include all worst case radionuclides, (b) does 10% of MPC account for time dependence, and (c) what does it mean to have a “robust” air sampling program.
 2. ***ORAUT-OTIB-0049, Revision 01 PC-2, Estimating Doses for Plutonium Strongly Retained in the Lung, November 29, 2010; SRDB Ref. ID 90666***

The second finding questioned, in part, calculating doses from urinalysis data with only a single intake or chronic intakes with time gaps between them. In NIOSH’s response, the question associated with intakes from urinalysis data was not addressed.
 3. ***ORAUT-OTIB-0054, Revision 02, Fission and Activation Product Assignment for Internal Dose-Related Gross Beta and Gross Gamma Analyses, March 6, 2014; SRDB Ref. ID 130852***

SC&A recommends a highly focused review to ensure that the revised Pm-147 intake fractions in Tables 7-3b and 7-3c were calculated and entered correctly.
- Open findings and unreviewed documents pertinent to the ANL-W SEC are under the Subcommittee on Procedure Reviews.

ANL-W Item 2 – Cross-Walk the Combined INL SP Matrix and SEC Matrix with ANL-W

Tables 4 (INL Site profile) and 5 (INL SEC) of SC&A's report identify commonalities with ANL-W:

- 3 outstanding site profile issues that may have the potential to become SEC issues:
 1. **Issue 16 – Potential need for an external dose coworker model**
 2. **Issue 31 – Neutron dosimetry completeness issues**
 3. **Issue 34 – Adequacy of neutron exposure monitoring**
- All 3 issues relate to our investigations of TAN but may have broader implications (November 2015 WG).
- NIOSH's response to Issue 16 was that they do not intend to develop an external dose coworker model. In response to Issues 31 and 34, NIOSH indicated that the data reviewed by SC&A are just a sampling and that more data will be made available.
- SC&A remains concerned that if, in the future, a coworker model is needed, there may not be enough granularity to identify worker location.
- At the November 2015 WG meeting, this was determined to be secondary priority pending the outcome of SEC evaluations.

INL/ANL-W Item 3 – Reactor Prioritization, Background

- As part of its review of the INL SEC-00219 and the ANL-W SEC-00224 evaluation reports, the Board tasked SC&A with investigating the issue of dose reconstructability.
- Inherent in the SEC framework is the assumption that doses can be reconstructed with sufficient accuracy for areas and time periods that lie outside the SEC class definitions.
- A primary tool that NIOSH uses for internal dose reconstruction is the guidance appearing in ORAUT-OTIB-0054, *Fission and Activation Product Assignment for Internal Dose-Related Gross Beta and Gamma Analyses*.
- SC&A, in two reports, performed preliminary assessments of whether the OTIB envelopes, with sufficient accuracy, the important conditions of the INL and ANL-W reactors, and prioritized the reactors into High, Medium, and Low categories for further detailed investigation.

Background (continued)

- Operations at the INL and ANL-W sites involving radioactive materials were very complex, and many unique nuclear reactors and experiments were built and tested. Different:
 - Fuel types (e.g., fissile materials, chemical forms, cladding, and physical arrangements)
 - Blankets (e.g., to breed more fuel) and reflectors
 - Moderators (e.g., light water, heavy water, or none)
 - Coolants (e.g., light water, heavy water, liquid metal, gas, organic)
 - Operating scenarios (e.g., steady-state, intermittent, pulsed, within design limits, outside of design limits)
 - Burnups – often low so that the long-lived decay products did not have the opportunity to build up in the fuel, resulting in different isotopic ratios than in the OTIB-0054 characteristic reactor cases

OTIB-0054

- NIOSH uses OTIB-0054 to determine internal doses to claimants using indicator radionuclides in cases where only gross beta or gross gamma measurements (from air sampling or urinalysis) are available.
- The OTIB assigns fission and activation product intakes for different radioisotopes that are directly tied to an indicator radionuclide (strontium-90 or cesium-137).
- Limitations: OTIB methodology does not:
 - Address predominately alpha-emitting radionuclides
 - Include radionuclides generated outside the fuel
 - Apply to operations involving decay times <10 days
 - Apply if radionuclides have been extracted and concentrated

OTIB-0054 (continued)

- The OTIB generated 9 different representative cases based on four reactors, which are intended to envelope the range of reactor and nuclear fuel types and operating scenarios.

Representative Reactors

Reactor Category	Reactor
High-flux reactors	Advanced Test Reactor (ATR)
Na-cooled fast reactors	Fast Flux Test Facility (FFTF)
Pu production reactors	Hanford N-Reactor
Research reactors	TRIGA with stainless steel cladding

INL Site Reactors

There were a total of 52 reactors on the overall INL site.

INL Site Reactors

Location	Number
INL	34 (28) *
ANL-W	12
NRF (Naval Research Facility)	4
Never Operated	2

- * SC&A had already evaluated 6 of the INL reactors in 2 separate reports:
- *NIOSH SEC-00219: Test Reactor Area Modeling, SCA-SEC-2015-0074-C, Rev. 0, 9/28/2015. (MTR, ETR, ATR)*
 - *Review of NIOSH Strategy for Reconstructing Internal Doses to Workers at Test Area North, SCA-TR-2015-SEC0074A, Rev. 0, 9/28/2015. (HTRE-1, -2, -3)*

SC&A Priority Rankings

- Following screening of each of the 28 INL and 12 ANL-W reactors, SC&A assigned priority rankings to each for further, detailed analyses, taking into consideration factors where the radionuclide mixtures in OTIB-0054 might result in an under- or unrealistic estimate of internal doses.
 - Type of fuel
 - Enrichment
 - Cladding
 - Moderator
 - Coolant
 - Operational mode and whether operations were inside or outside of design limits
 - Length of operation/overall burnup

SC&A Priority Rankings

- In addition to OTIB-0054 applicability, SC&A also considered (at the request of the INL WG) four additional factors, to the extent that they are known, that reflect the scope of the population potentially “at risk” of uncontrolled/unmonitored exposures.
 - Duration reactor was in operation
 - Frequency/intensity of operation
 - The approximate number of workers potentially exposed during its operation (this proved infeasible during the screening investigation)
 - Incidents or other factors with potential to contribute to the risk of unintended/unprotected exposures

INL Reactor Assessment

INL SEC-00219 Reactor Prioritization for Evaluation of ORAUT-OTIB-0054 Applicability, SCA-TR-2016-SEC002, Rev. 1, 6/10/16.

SC&A assigned priority classes to the 28 INL reactors:

Reactor Priority Classes

Priority Class	No.	Reactors
High	7	LOFT, OMRE, PBF, SPERT-I, -II, -III, -IV
Medium	6	CRCE, ML-1, SCRCE, SNAPTRAN-1, -2, -3
Low	15	ARMF-1, -2, ATRC, CFRMF, CET, ETRC, 710, GCRE, 630-A, HOTCE, FRAN, RMF, STPF, SL-1, THRITS

ANL-W Reactor Assessment

Argonne National Laboratory-West SEC-00224 Reactor Prioritization for Evaluation of ORAUT-OTIB-0054 Applicability, SCA-TR-2016-SEC010, Rev. 0, 7/13/16.

SC&A assigned priority classes to the 12 ANL-W reactors:

ANL-W Reactor Priority Classes

Priority Class	No.	Reactors
High	7	BORAX-I, -II, -III, -IV, -V, EBR-I, -II
Medium	1	TREAT
Low	4	AFSR, NRAD, ZPPR, ZPR-III

NIOSH Response

NIOSH Proposal for INL and ANL-W Reactor Prioritization for OTIB-0054 Evaluation, 7/28/16.

NIOSH proposes:

- Merging the INL and ANL-W high-priority category reactors for detailed evaluation of OTIB-0054 applicability using the ORIGEN isotope generation and depletion code.
- Eliminating several reactors from the high-priority category: LOFT, BORAX-I, -II, -III, and -V. Reasons are given in the report.
- Modeling the most extreme experiment from all four of the SPERT reactor tests as a “bounding case.”
- Modeling the most bounding case of the last two EBR-I cores.

NIOSH Response

Summary: Reactors that NIOSH Proposes to Evaluate

OMRE	Organic Moderated Reactor Experiment
PBF	Power Burst Facility
SPERT I–IV	Special Power Excursion Reactor Tests
BORAX-IV	Boiling Water Reactor Experiments
EBR-I (Core 4)	Experimental Breeder Reactor-I
EBR-II	Experimental Breeder Reactor-II

August 2016 Work Group Update

- SC&A and NIOSH response paper discussed.
- SC&A is in basic agreement with NIOSH's proposed list of reactor groupings for further evaluation.
- SC&A tasked to evaluate in greater depth the approximate number of workers potentially exposed during its operation.
 - This was not feasible at the time that our report was being prepared.
 - NIOSH indicated that monthly dosimeter reports are now available for all the facilities and are relatively easy to access.
 - Can now look at numbers of badged workers during the years of operation for each facility.
 - SC&A expects to have a revised report prepared in time for a late September/early October WG teleconference.

ANL-W Item 4a – Evaluation of ANL-W Monitoring Practices

- SC&A randomly selected 50 ANL-W claims for evaluation of internal and external monitoring records.
- 10 additional claims purposely selected with a focus on employment at the end date of the SEC (12/31/1957).
- Review resulted in 4 Findings and 6 Observations.
- Discussed at August 2, 2016, Work Group meeting.

Evaluation of ANL-W Monitoring Practices – Review Findings

- Finding 1:
 - Claimant had no external monitoring for over a decade.
 - Claimant was on a consistent internal monitoring schedule (in vivo) during this time.
 - SC&A recommends further inquiry with DOE to gain sufficient information about the apparent gap.
- Finding 2:
 - There appears to be a sharp decrease in internal monitoring from approximately 1973–1979.
 - SC&A recommends further investigation to determine potential operational changes.
 - SC&A also recommends NIOSH evaluate the completeness and adequacy of records for use in a coworker model.

Evaluation of ANL-W Monitoring Practices – Review Findings (cont.)

- Finding 3:
 - Claimant has external monitoring records beginning in 1963; however, was employed several years prior to this.
 - Evidence suggests the claimant had positive external dose prior to 1963 based on career dose totals.
 - SC&A suggests further inquiry with the site on this worker.
- Finding 4:
 - Examination of claims with employment both before and after the SEC date (12/31/1957) showed a significant shift in radiation monitoring protection at the end of March 1958.
 - SC&A feels it appropriate to further examine this short period (first quarter of 1958) to assure dose reconstruction feasibility.

Evaluation of ANL-W Monitoring Practices – Observations

- Observation 1:
 - Some claims only have annual or career summaries for external dose.
 - Additional records are being obtained to assure a complete dose reconstruction for affected claims.
- Observations 2, 3, and 6:
 - Several claims have “gaps” in dosimetry records.
 - Often considerable uncertainty exists as to actual work history (exposure potential at the site).
 - Infeasible to reasonably determine if unmonitored exposure may have occurred in many cases.

Evaluation of ANL-W Monitoring Practices – Observations

- Observation 4:
 - Extremity monitoring is known to be sparse but is available for some claims.
 - SC&A recommends comparing available data to current dose reconstruction methods for unmonitored extremity claims (OTIB-0013).
- Observation 5:
 - Neutron monitoring was non-routine among the sampled claims.
 - NIOSH noted special investigations were conducted by ANL-W for unmonitored neutron exposures.
 - SEC Evaluation Report would benefit from further discussion of neutron monitoring protocols and special investigations.
- Discussed briefly at the end of the August 2, 2016, WG meeting – topic of discussion for the next WG meeting.

ANL-W Item 5 – Use of Air Sampling Data for Dose Reconstruction of Actinide Intakes in the Absence of FAP Assessment

The SC&A review is limited to the proposed internal assessment for U, Th, and Pu for exposure conditions in the absence of MFPs by means of air sampling data.

NIOSH's Approach for Assigning Internal Exposures to U, Th, and Pu without MFPS by Means of Air Sampling

- NIOSH explains the role of air monitoring for the protection of workers in the SEC Petition ER in the following statements:

The conventional [fixed] air-sampling units used were continuously-operating devices sampling at relatively low flow rates. Typical units sampled room air at 2 cfm on 2-in.-diameter HV-70 or Millipore filters. Samples were removed daily, Monday through Friday, and counted for alpha and beta-gamma activities. [Emphasis added.]

...In the instances where the air samples were counted for alpha radioactivity more than once due to the presence of short-lived alpha-emitting radionuclides, the latest result for gross alpha radioactivity will be used... [Emphasis added.]

NIOSH's Approach for Assigning Internal Exposures to U, Th, and Pu without MFPS (cont.)

NIOSH believes that air sampling data assessed for gross alpha activity are sufficient for bounding internal radiation doses to U, Th, and Pu by means of the following criteria:

- Uranium. Without MFPS, U intakes will be bounded by using 10% MPC_{air} values from available air monitoring data.
- At the Fuel Cycle Facility (FCF), estimates of internal dose to U (without MFPS) for August 1967 to June 1983 assessed using gross alpha radioactivity of air samples.
- Thorium. For 1963–1967, dispersible Th without MFPS may have exposed workers at the FCF in Room 25. NIOSH intends to bound potential intakes of thorium by assuming intakes at 10% of the ANL-W MPC_{air} .
- Plutonium. The plutonium-bearing Mark-II loops that were handled at the FCF mostly contained enriched UO_2 with lower quantities of PuO_2 . But due to the much shorter half-life of Pu, NIOSH will conservatively assume that 100% of gross alpha activity represents Pu.

Limitations of Air Sampling Data for Assignment of Internal Dose to FCF Workers

U, Th, Pu without MFPs:

- Most recorded air sampling data for ANL-W facilities typically show results below 10% of the MPC_{air}
 - SC&A questions whether fixed area air sampling data accurately represent levels of air contamination breathed by workers.
- The assumption that measured air concentrations from general air (GA) sampling represent air concentrations respired by workers during facility operations is questionable at two levels:
 - (1) long air sampling times
 - (2) limitations and uncertainties with GA air sampling for assessing worker intakes

Summary Conclusions – Air Sampling

- On the basis of recorded/available GA air sample data, NIOSH concluded that an air concentration of 10% MPC_{air} defined for a 40-hour work week provides a bounding value for potential intakes of U, Th, and Pu at the FCF (and other work locations at ANL-W).
- Support and commitment for the use of the 10% MPC value rely on the unconfirmed assumption that GA air concentrations closely correspond to operational air concentrations to which workers were exposed.
- SC&A's review of FCF air data, typical daily operations, and assessment of NIOSH's proposed use of GA air sampling data identified two issues of concern.

Summary Conclusions – Air Sampling (cont.)

- First concern – Low air flow rates for GA samplers.
 - Sampling times of up to 4 days, often when normal facility operation/activities were not in progress. Likely that air concentrations during non-working hours differed significantly from air concentrations during normal facility operations (likely limited to an 8-hour shift Monday through Friday).
- A second and more serious concern is the lack of parity between GA and BZ air concentration measurements. Studies have consistently shown poor correlation between GA and BZ air sample data with BZ/GA ratios spanning several orders of magnitude.
- Given the high degree of uncertainty surrounding GA sampling data at the FCF (and possibly other locations at ANL-W), SC&A concludes that NIOSH's proposed value of 10% MPC(40) as a bounding value for internal dose assessment lacks credibility.

Path Forward

- SC&A's report was discussed extensively at the August 2, 2016, INL/ANL-W WG meeting.
- The WG considers this to be a high-priority issue with potential SEC implications.
- NIOSH was tasked to provide a response paper for further WG discussion.

**SC&A's Evaluation of FAP Bioassay Indicator
Radionuclides
(in Conjunction with OTIB-0054 and TBD-5)
for Assessment of FAP and Actinide Intakes at
INL & ANL-W**

Important Assumptions for Assigning FAP and Actinide Intakes

- 1) Sufficient fission-activation product (FAP) bioassay records are available to assign Sr-90 and/or Cs-137 intakes.
- 2) Sr-90/Cs-137 ratios and their relationship to other FAPs and actinides are known with sufficient accuracy for INL and ANL-W to allow assigning consistent radionuclide intakes.

FAP and Actinide Intakes

- NIOSH's ER recommends using Sr-90 and/or Cs-137 bioassay results in conjunction with ratios in OTIB-0054 to assign FAP intakes.
- NIOSH's ER recommends using Sr-90 and/or Cs-137 bioassay results in conjunction with ratios in TBD-5 (TKBS-0007-5) to assign actinide intakes.

Evaluation of Ratios

- The NIOSH ratio values were derived mostly by computer simulation (ORIGEN).
- SC&A searched for documentation that would provide measured radionuclide ratios (e.g., benchmarks).
- SC&A searched the following:
 - NOCTS
 - SRDB
 - INL electronic bioassay database

Evaluation of Ratios (continued)

SC&A located measured quantitative radionuclide analyses of:

- Nasal swabs
- Urinalyses
- Fuel element scale
- Fuel storage contamination swipes
- Air filters
- Liquid, solid, soil, and air waste from INL and ANL-W waste records

Summary of INL Cs/Sr Results

The majority of the INL Cs-137/Sr-90 ratios were not centered on unity. Only 33% of 251 data points analyzed for Cs-137/Sr-90 from the 1957–1993 INL waste reports fell within a range of 0.5–2.0. Some ratio values were orders of magnitude above and below unity.

Summary of ANL-W Sr/Cs Results

The ANL-W Sr-90/Cs-137 ratios were more centered around unity (69% of 16 pair) than those for INL (33% of 251 pair), but there were only a very small number of data points located that could be used in this analysis.

Summary of Cs/Sr Results – Conclusions

The Cs-137/Sr-90 ratios are not always 1:1 as assumed in OTIB-0054 and TBD-5; frequently, large variations in the ratio exist. This brings into question the validity of using an indicator radionuclide when deriving FAP and actinide intakes. This may be the most important result of this study because a Cs-137/Sr-90 value of 1:1 is one of the cornerstones for use of the ratio method at INL and ANL-W.

Summary of FAP/Cs or FAP/Sr Results

The FAP/Cs-137 or FAP/Sr-90 ratios (as required by OTIB-0054 for assigning FAP intakes) may not be sufficiently constant (or known) for assigning intakes, even in situations where it can be assumed that the FAP is tied to an indicating radionuclide.

Summary of Actinide/FAP Results

Actinide intakes assigned using NIOSH's recommendations in TBD-5, Table 5-22 based on Sr-90 intake values, or Table 5-23 based on Cs-137 intake values, are sometimes significantly less than those derived from actual measured values.

Recommendation 1

It needs to be determined if records of analyses of INL dissolver contents (containing the fuel elements) are available; preferably, for a variety of INL reactor fuel elements, and also fuel elements from offsite reactors.

Recommendation 2

Further ANL-W document research is needed to evaluate NIOSH's recommended ratio values, especially for actinides and Cs-137/Sr-90. Records with quantitative radionuclide analyses are especially important.

Recommendation 3

Considering the results of this preliminary study and the numerous source terms at INL and ANL-W, the validity of using the present radionuclide indicator method (OTIB-0054 and TBD-5) for assigning FAP and actinide intakes needs to be addressed further.

Path Forward

- SC&A's report was discussed at the August 2, 2016, WG meeting.
- Based on a request by NIOSH, SC&A was tasked to break down the waste data ratios by month instead of year where those data are available.
- SC&A was also tasked to analyze the 60 new SRDB documents that NIOSH will provide.
- SC&A will revise its report in time for a WG meeting before the November Board meeting.
 - Revision will also include an assessment of NIOSH's regression analysis and some example dose calculations for FAP and actinides to show the fraction of internal dose they contributed.

Comments and Questions?