Review of NIOSH Response to SC&A Comments on ORAUT-RPRT-0092 re Bioassay Data for Subcontracted Construction Trade Workers at SRS

Joe Fitzgerald, MS, MPH

Bob Barton, CHP

Ron Buchanan, PhD, CHP

To the Advisory Board on Radiation and Worker Health SRS and SEC Issues Work Groups

November 2020

Introduction

- ORAUT-RPRT-0092, rev. 00: NIOSH issued on June 14, 2019. SRS WG tasked SC&A to review.
  - Provides results of NIOSH's sampling analysis of subCTW permit-indicated, job-specific bioassay data completeness at SRS for 1972–1998.
  - Responds to 2017 SC&A review that raised questions of data completeness in light of job-specific bioassay gaps identified by WSRC in 1997 that were subject of DOE enforcement action in 1998.
  - SC&A 2017 review performed in parallel with NIOSH review of Bldg 773-A for 1981–1986. Board concerned about limited scope of NIOSH's timeframe and SRS facilities.
- SC&A review issued Nov. 12, 2019: Addressed three aspects of NIOSH review: sampling premise, sampling execution, and co-exposure datasets.
- Dec. 6, 2019: SC&A presented findings at joint WG meeting.
- Aug. 18, 2020: NIOSH issued response to SC&A's review.

SRS RPRT-0092 conclusions

OVERALL: "The chief conclusion of this report is that a large percentage of subCTWs were monitored for potential intakes while working under a Job Plan, SWP or RWP."

- When considering subCTWs identified from job plans, SWPs, and RWPs from 1972 through 1998 as a combined unit of time, 1,271 (89%) of the 1,389 subCTWs were monitored for at least one radionuclide.
- Effective rates of monitoring are consistent across the three sets of data used for the combined 1972 to 1998 period…averaging 97%.
  - "effective rate" = number monitored plus those unmonitored that had a coworker who was monitored
- Effective monitoring rates for Pu, Am, U, Sr/FP, Np for time intervals within 1972–1998 varied from 0% to 99% by radionuclide.

SC&A's Review of RPRT-0092

- SC&A reviewed NIOSH's evaluation from three vantage points:
  - **Sampling premise:** Were guiding assumptions upon which evaluation was planned and conducted borne out for time periods in question?
  - **Sampling execution:** Did NIOSH successfully "randomly select radiological workers from the various areas at [SRS], such than an evaluation of monitored and unmonitored workers can be conducted"?
  - **Co-exposure datasets:** Did the evaluation satisfy its stated objective of demonstrating that "monitored [subCTWs] and unmonitored [subCTWs] worked side by side in the same radiological environment at the same time"?
- SC&A focused its review on two distinct SRS operational periods, 1972–1989 under DuPont, and 1990–1998 under Westinghouse.
- SC&A sought to test central thesis of RPRT-0092: Can bioassays be linked to corresponding work permits so that monitored subCTWs can be compared with unmonitored subCTWs and data completeness established?

Finding 1

No SWPs or job plans sampled by NIOSH for 1972–1990 contain any requirements or indications for job-specific bioassays, despite respiratory protection being required, bringing into question the approach taken to satisfy RPRT-0092's first evaluation objective.

SC&A summary of NIOSH response: Finding 1

- NIOSH can rely on the “ample” number of bioassays whose dates can be “associated” with those of these permits and job plans, with the assumption that these bioassays would have been obtained.
- NIOSH also points to the WSRC era Farrell and Findley (1999) report and DuPont procedural requirements as a further basis for the bioassay control procedures that were being implemented in 773-A and elsewhere at SRS.

SC&A response: Finding 1

- NIOSH's response retreats from its original sampling approach: to identify and relate job-specific bioassays based on specific permits or job plans for individual subCTWs. This cannot be accomplished for 1972–1990 because RWPs were not used, and SWPs and job plans did not have job-specific bioassays that could be linked to them.
  - SC&A added 1990 to an expanded 1972–1989 DuPont operating period in recognition of the lack of RWPs.
- Associating bioassays with permits by only date does not account for whether required bioassays for specified radionuclides were actually obtained. Nor does assuming bioassays were performed.
- NIOSH used respiratory protection as a backup indicator for follow-on bioassays for these workers. However, this assumption is not supported by DuPont procedures nor substantiated for 1972–1990 by results in RPRT-0092.
- DuPont procedures (DPSOLs) were general and implemented facility by facility; cannot be relied upon for bioassay specification, as NIOSH acknowledged in RPRT-0092.

Finding 2

"Radionuclides of interest" assumed for sampled permits in RPRT-0092 are of questionable accuracy given cited lack of adequate radiological source term characterization prior to 1990.

SC&A summary of NIOSH response: Finding 2

- NIOSH contends that prior to 1990, the radiological source terms for SRS facilities and operations were adequately characterized by evidence of the "multiple" ways DuPont could have done so.
  - including isotope production and inventory records, routine reporting of radionuclide material production, records of contamination incidents and DPSOL requirements for radionuclide bioassay type and frequency determination

SC&A response: Finding 2

- DuPont procedures (DPSOLs) were general and applied facility-to-facility by managers. Unlikely that facility "radionuclides of interest" for bioassay purposes were accurate and updated for changes in operations or experience during DuPont era.
- DOE headquarters-led Tiger Team review of 1990 found:

  > The internal dosimetry program does not comply with the requirements of DOE 5480.11. Radiological areas have not been sufficiently characterized to provide a technical basis for the assignment of bioassay sample types and frequencies. [DOE, 1990, p. 4-193]

- DOE found (1) only one facility so properly characterized and (2) that sitewide, particle size and solubility were not well known or used to help decide bioassay type and frequency.
- Evidence that SRS characterized radiation work environments in multiple ways is not the same as demonstrated practice or implemented requirement.
- WSRC agreed that facility radiological characterization needed; developed TBD for internal dosimetry and conducted first such sitewide characterization in early 1990s.

Finding 3

The scope of permit sampling for 1972–1990 at SRS is essentially limited to one facility, 773-A, falling short of achieving NIOSH's sampling objective and the representativeness called for in NIOSH's coworker [co-exposure] guidelines.

SC&A summary of NIOSH response: Finding 3

NIOSH contends that subCTWs were adequately monitored in areas outside 773-A between 1972 and 1990, based on:

- CTWs being monitored for radionuclide intakes based on the radionuclides of interest in a similar manner as prime contractor workers
- A review of available plutonium logbooks to enumerate the total subCTWs sampled for Pu by year and their facility location
- Number of subCTWs having Pu and FP urinalyses and whole-body counts (WBC), by year, based on ORAUT-RPRT-0094 (NOCTS data analysis)

SC&A response: Finding 3

- NIOSH survey in RPRT-0092 did not satisfy its objective of sampling from “various areas” at SRS.
- Despite addition of substantial additional set of records (852 boxes), can still only base its determination of permit-indicated, job-specific bioassay data completeness for DuPont era on data from only one facility, 773-A.
- NIOSH’s citing of sitewide subCTW bioassay data for plutonium and fission products does not change this conclusion: Sitewide routine bioassay monitoring at SRS was only prescribed for plutonium, tritium, and fission products, not for other radionuclides of concern (ROCs) and permit-indicated, job-specific bioassays.
- NIOSH’s inability to produce permit sampling records for ROCs for any other of the 30+ major facilities at SRS negates NIOSH’s ability to demonstrate bioassay data adequacy for subCTWs and CTWs during the DuPont era.
- RPRT-0094 indicates that 20–77% of subCTWs who are claimants working 1972–1989 have some form of internal monitoring data. However, overall percentage of workers bioassayed does not address representativeness of subCTWs on SWPs and job plans.

Finding 4

SRS incident-based/special bioassays were provided by workers on a more stringent procedural basis and should not be used to supplement the evaluation of permit-related, job-specific bioassays for 1972–1989 as a measure of historic data completeness.

SC&A summary of NIOSH response: Finding 4

- NIOSH contends that incident-based/special bioassay sampling was integral component of SRS bioassay program for both prime and subcontractor workers and cannot be disconnected from routine monitoring program.
- Some limited validation of incident-based/special bioassays in F and A Areas was performed, which found “a high measure of completeness” and “no systemic program issue.”
- NIOSH further cites its “*Criteria for the Evaluation and Use of Coworker Datasets*” as permitting its use as a basis for co-exposure modeling of unmonitored workers.
- However, NIOSH emphasizes that inclusion of incident-based data “not meant to complement completeness of non-incident/non-special bioassay data.”

SC&A response: Finding 4

- In context of RPRT-0092 subCTW completeness analysis, SC&A finds that incident or intake-driven “special bioassays” were not procedurally required in same manner as job-specific bioassays. The former were prescriptively mandated and overseen by management, while the latter were discretionary by facility manager based on general procedures (without RWPs).
- Accordingly, “completeness” of bioassay data for special bioassay program would undoubtedly (and was shown to) be consistently high, while same cannot be said for job-specific bioassays.
- NIOSH apparently now agrees incident-based data should not be used to complement non-incident/non-special bioassay data. However, statements and claims in RPRT-0092 are not consistent with this clarification.

Finding 5

The incompleteness of SRS dose records for 1972–1990 is substantiated by the acknowledged destruction of subcontractor records and firsthand worker accounts, coupled with DOE findings of missing occupational radiation dose data from many SRS personnel files, as well as systemic bioassay delinquencies, and wide gaps in NIOSH's capture of permit documentation.

SC&A summary of NIOSH response: Finding 5

- NIOSH does not agree that dosimetry records for workers were destroyed or lost, but rather, were stored offsite in approved permanent storage facilities.
- NIOSH finds that first part of Finding 5 (“The incompleteness of SRS dose records for 1972–1990 is substantiated by the acknowledged destruction of subcontractor records and firsthand worker accounts”) is a misleading statement and notes that “it implies that subcontractor records, including dosimetry records, were destroyed.”
- NIOSH finds that “the second part of Finding 5 (“DOE findings of missing occupational radiation dose data from many SRS personnel files”) is misleading and notes what it believes are inconsistencies in SC&A’s statements about availability of records stored at Federal Records Center (FRC) in Atlanta.

SC&A response: Finding 5

- SC&A's finding was made in specific context of NIOSH's finding that "only one area (A Area) appears to have routinely used SWPs and/or Job Plans in the 1972 through 1989 era (DuPont era)." SC&A disagrees that this finding is misleading given known destruction of DuPont era subcontractor records and past problems with accessing complete permit records from FRC in Atlanta.
- NIOSH's admits that "current and former employee interviews indicated that some records were destroyed in the late 1980s or early 1990s" and "SWPs or Job Plans for other areas might have been destroyed as part of that effort." SC&A's finding basis goes further and cites subCTW records destruction that involved "all kinds of records," including "monitoring records" and "time cards." This implicates the identity of subCTWs working at SRS and raises question of whether "monitoring records" included dosimetry data.

SC&A response: Additional finding 5 issues

- DOE headquarters Tiger Team in early 1990 also found: Comprehensive records related to occupational radiation exposure are not retained consistent with ANSI N13.6. There are many personnel files where radiation dose data are missing for many years. While SC&A acknowledges 2001 EEOICPA review and compilation of SRS dosimetry data forms valid baseline for routine dosimetry data, completeness of that database for subCTW bioassay data remains an issue.
- SC&A continues to raise issue of subCTW records destruction in context of SRS subCTW records completeness because:
  - NIOSH has not yet addressed the scope and implications of this acknowledged destruction other than to indicate that it may have occurred but that existing data are sufficient to support dose reconstruction.
  - While access to personnel records held at FRC was hampered at time of Tiger Team review, WSRC's corrective action (implementing RWP program) is indicative of records inadequacies linked to permit-indicated monitoring records in the DuPont era.

Observation 1

The back application of assumptions regarding work permits, job-specific bioassays, and target radionuclides to conduct a completeness review for 1972–1998 is not plausible given the significant changes in radiological policies, procedures, and practices that occurred in the early 1990s.

SC&A summary of NIOSH response: Observation 1

- NIOSH does not agree with premise that significant changes in radiological policies, procedures, and practices that occurred in early 1990s preclude the ability to conduct a completeness analysis during the 1972–1998 evaluation period.
- SRS policies, procedures, practices, and the required types and locations for routine bioassay analyses remained largely constant between 1972 and 1998.

SC&A response: Observation 1

- SC&A finds that much of NIOSH's RPRT-0092 completeness analysis is founded on a premise that WSRC-era (post 1989) radiological practices were also implemented by DuPont (1972–1989).
- Three examples at the core of RPRT-0092's completeness analysis disprove this:
  1. **RWPs (WSRC) vs SWPs/job plans (DuPont):** WSRC implemented RWPs with prescribed job-specific bioassays. DuPont did not.
  2. **Respiratory protection:** WSRC required and implemented job-specific bioassays when respiratory protection was indicated. DuPont did not.
  3. **Source term characterization:** WSRC required and implemented comprehensive, analysis-based characterization. DuPont did not.
- While NIOSH apparently agrees with the significance of these programmatic changes, it disputes their implications for being able to conduct the completeness analysis in RPRT-0092. SC&A disagrees and points to RPRT-0092's shortfalls for bioassay data completeness analyses in the DuPont era.

Finding 6

For the period 1980–1989, only 20 percent of the identified subcontractor-job plan combinations identified by NIOSH as requiring americium sampling had internal monitoring performed within an acceptable timeframe (i.e., within 2 years for chest counting).

SC&A summary of NIOSH response: Finding 6

- Exposure potential limited
- Am-241 generally co-mingled with plutonium
- Separated Am-241:
  - F-Wing (773-A)
  - Multi-Purpose Processing Facility (F Area)
- 15 documented intakes of separated Am-241
- 81 subCTWs monitored via urinalysis from 1972 to 1989

SC&A response: Finding 6

- Only F-Wing (773-A) was analyzed (i.e. only separated americium operations).
- Scope is limited:
  - 1 job plan in 1973 (no associated monitoring)
  - Remaining job plans limited to 1981–1987 (34 total)
  - No job plans for MPPF
- Unclear if New Special Recovery (NSR) facility also included separated americium-241.
- NIOSH/SC&A appear to agree only 20% of the subCTW/job plan combinations were directly monitored (in vitro or in vivo).
- Key Question: Has adequate evidence been established that the job-specific monitoring program was sufficient to detect intakes of separated americium?

Finding 7

The total “effectively monitored” population for americium (those monitored directly or have a coworker on the same job plan with a urinalysis result) during the 1980–1989 period is approximately 33%. If a urinalysis sample taken during 1991 as a result of an incident in a different SRS location (and is not currently used in the SRS coworker model) is removed, the effective monitored population drops to 26.5%.

SC&A summary of NIOSH response: Finding 7

- "Effectively monitored" population should be 56%
  - 20% directly monitored (in vitro or in vivo)
  - 36% on job plan with workers directly monitored
- Only 3 of 43 subCTWs monitored during 1980s had potential for exposure.
- SubCTWs monitored for incidents (data included in co-exposure modeling).
- 1991 data can be used in co-exposure modeling.

SC&A response: Finding 7

- Credit for “effective monitoring” should only include unmonitored workers if a monitored worker on the same job plan is used in co-exposure modeling.
- If the samples are not used for co-exposure model (i.e., in vivo monitoring for Am-241), the unmonitored worker is not “represented.”
- At time of review, 1991 bioassay not considered in co-exposure model.
  - SC&A did include the 1991 bioassay in its assessment (33% effectively monitored).
  - NIOSH to add 1991 sample to co-exposure model.

Finding 8

Many of the workers (around 70–73%) who should have been monitored for fission products underwent appropriate internal sampling during the two periods evaluated prior to 1990 (1972–1974 and 1980–1989). However, very few of these monitored workers underwent in vivo counting for fission products. Thus, they are not included in the coworker model developed for SRS and are not considered representative of the unmonitored worker.

SC&A summary of NIOSH response: Finding 8

- SubCTWs by year included in the co-exposure model for fission products varied from a minimum of zero (1974 and 1975) to a maximum of 302 in 1990.
- SubCTWs were monitored by special urinalysis up to 1982.
- Prime CTWs performed similar work and are sufficient to bound exposures to subCTWs.
- WBC were considered valid up to 3 years from the date of the job plan.
- 70–73% who should have been monitored for fission products underwent appropriate intake monitoring.

SC&A response: Finding 8

- No analysis of job plans was available for the years 1975–1979.
- Original sampling plan indicated bioassay would only be considered in evaluation if it was within 1 year.
- NIOSH dose reconstruction procedures consider periods greater than 2 years (not 3 years) to be unmonitored.
- Co-exposure model based on in vivo:
  - No workers monitored via in vivo (1972–1974)
  - Only 4% monitored via in vivo (1980–1989)
- SC&A and NIOSH agree on the percentage of directly monitored workers.
- SC&A and NIOSH disagree on the “effectively monitored” workers:
  - 70% vs. 94% (1972–1974)
  - 74% vs. 99% (1980–1989)

Finding 9

SC&A does not find that the data collected as part of the RPRT-0092 review support the premise that subcontractors on job plans that should have required internal monitoring for americium were either directly monitored (around 20%) or, alternately, appropriately represented in the derived coworker models for SRS (around 13%).

SC&A summary of NIOSH response: Finding 9

- Most Am-241 exposures comingled with plutonium.
- Appendix B of the NIOSH response provides 11 incident examples of subCTWs who were monitored.
- Effectively monitored population should be 56%, not 33% as calculated by SC&A.

SC&A response: Finding 9

- SC&A acknowledges majority of Am-241 exposures involved plutonium.
- SC&A acknowledges incident-driven bioassay did occur:
  - Incident examples limited to 1980s
  - Incident example 1 describes several issues with institutional controls (refer to table 1 of SC&A's November 2020 response report)
- Does not answer question of dose reconstruction feasibility for separated americium-241.
- Effectively monitored population should only consider unmonitored workers on same job plan of monitored worker who is included in co-exposure model:
  - i.e., work is represented in co-exposure estimate
  - 33% effectively monitored
- SC&A believes RPRT-0092 evaluation did not accomplish its goal for Am-241 (policy decision).

Observation 2

During the 1972–1974 period, RPRT-0092 only evaluates one job plan/worker combination (Job Plan 46) for potential americium exposure. However, attachment, table D-1 indicate at least one other job plan (Job Plan 47) requiring americium monitoring during this period. Neither of the workers were directly monitored nor had an appropriate coworker monitored for americium.

SC&A summary of NIOSH response: Observation 2

- Job Plan 47 should not have indicated that it was to be assessed for americium monitoring.
- Job took place in the high level caves rather than F-Wing.

SC&A response: Observation 2

- SC&A agrees with NIOSH clarification.
- Recommends observation 2 be closed by the work group.
- Only single job plan available for evaluation (1972–1974 period) with no associated monitoring.

Observation 3

Only 13% of the subcontractor-job plan combinations (17 total) had americium urinalysis performed that could be considered relevant to coworker modeling. Eleven of the 17 urinalysis data points represented a single worker who had a single sample taken in 1991 as a result of an incident that occurred in a different area (M Area) during that year (i.e., representative of a different area and different period).

SC&A summary of NIOSH response: Observation 3

- Intent of report was to assess if unmonitored workers worked in the same environments as monitored workers.
- Bioassay sample collected in 1991 reflects the exposure potential for both the individual worker and representative of the unmonitored workers on the job plan combinations.
- Datum from 1991 would be incorporated into any future revision of the co-exposure model.

SC&A response: Observation 3

- SC&A believes the original intent of the report was to establish that unmonitored workers on individual job plans are represented by monitored workers on the same job plan.
- Representation only established if monitored worker records are used in co-exposure modeling.
- SC&A agrees that 1991 sample reflects exposure potential to associated jobs.
- NIOSH has agreed to include 1991 sample in future co-exposure model.
- SC&A recommends observation 3 be closed by work group.

Finding 10

Data for 1990 are lacking. Therefore, 1990 should be included with the period of limited data, 1972–1989, and not bundled in with the year 1991.

Finding 10: SC&A summary of NIOSH response

- NIOSH believes that 88% direct monitoring for subcontractors is not demonstrably incomplete.
- Results of an evaluation of NOCTS data indicate that 89% of the subCTWs who are claimants working in 1990 have some form of internal monitoring data.
- SRS continued monitoring all site workers during the change in prime contractors.

Finding 10: SC&A response to number of 1990 bioassays

- RPRT-0094 was issued just prior to SC&A's 2019 evaluation of RPRT-0092; therefore, not included in that analysis.
- 89% of the subcontractors bioassayed in 1990 is similar to the percentage bioassayed during the following period.
- However, the issue of the lack of 1990 RWPs still remains because the percentage of workers bioassayed does not address lack of RWPs.

Finding 10: SC&A response for lack of RWPs in 1990

- The 88% NIOSH quoted covers the entire period of 1990–1998 (not just 1990) and addresses the number of bioassays, not RWPs, so it cannot be used to address the lack of RWPs for the one year of 1990.
- Bundling 1990 with 1991 indicates that there is a lack of RWP information for 1990 and/or 1991 to stand alone.

Finding 11

For both the 1972–1989 and the 1990–1998 periods, when considering all radionuclides requiring internal monitoring per work permit, as opposed to “at least one radionuclide” requiring monitoring, the percentage of monitored workers drops significantly (particularly in the earlier periods). Directly monitored workers ranged from 47% to 77% (in comparison to 76–96% in RPRT-0092), and effectively monitored workers ranged from 55% to 89% (in comparison to 85–99% in RPRT-0092).

Finding 11: SC&A summary of NIOSH response

- The sampling plan, which was used only for the 1990–1998 data, called for calculating a point estimate and a 95% confidence interval for the percentage of subCTWs that had all required bioassay. However, in RPRT-0092, a worker was considered monitored if they had at least one bioassay.
- NIOSH believes the data given in the report shows that subCTWs were monitored similarly to other workers and that unmonitored subCTWs worked in the same environments as the monitored workers.

Finding 11: Additional summary of NIOSH response

- NIOSH stands by the results given for effectively monitored workers.
- Even without consideration of effective monitoring, sufficient numbers of subCTWs were monitored in the years 1972–1998 timeframe, coupled with internal monitoring data for prime CTWs, to develop a co-exposure model for use in reconstructing unmonitored doses.

Finding 11: SC&A response

- "At least one bioassay" should not be used to indicate that a worker was adequately bioassayed as specifically prescribed by a job plan or RWP.
- A worker could have been on a routine uranium bioassay program but could have been required by a specific job plan or RWP to also have a plutonium bioassay; the uranium bioassay would not count for a plutonium bioassay.

Finding 11: Additional SC&A response

- The limitations of using the “at least one bioassay” concept should be considered when weighing the adequacy of internal monitoring data.
- The original issue to be addressed by RPRT-0092 was to determine if subCTWs were monitored similar to other workers such that the subCTW data were representative of their potential intakes and they could be covered by a co-exposure model.

Observation 4

SC&A's analysis indicates that identified coworker matches may not be sufficiently representative of the subCTW intakes in all cases unless strict criteria are applied, such as the same craft designation as well as the same date and time of the work performed.

Observation 4: SC&A summary of NIOSH response

- When NIOSH compared the subCTW plutonium bioassays by craft for 1990–1998, there were no significant differences noted, as indicated in table 4-8 of RPRT-0092.
- NIOSH considered the following criteria for matching coworkers:
  - An RWP as a small work activity
  - An RWP on the same day and time
  - Similar time periods (i.e., morning or afternoon)
  - Not the same craft, but the same exposure environment
  - Exposure environment variation depending on the RWP work

Observation 4: SC&A response

- Comparing the percentage of subCTW plutonium bioassays by craft for 1990–1998 only indicates that the bioassay frequencies among crafts were similar, not necessarily that the exposure potentials were similar.
- SC&A found that 12 out of 48 of the RWP sign-in dates did not match when the co-exposure method was used in table C-3 of RPRT-0092.

Observation 4: SC&A conclusions

- This observation was to point out the cautions that should be taken into account when considering if subCTW bioassays were sufficiently complete when coworker monitoring information is included in analyzing the fraction of subcontractors monitored.
- SC&A finds that this observation has been discussed and the cautionary points brought forth.
- SC&A recommends closure of this observation by the SRS work group, in consultation with the SEC Issues work group.

Observation 5

Bioassay data in the 1990s are not entirely free of the earlier data issues. The implementation of methods used to correct for the bioassay deficiencies seen in the 1970s and 1980s did not take place immediately with the change in the contracting company in 1989. It was not a step function that took place in 1989 or 1990; instead, it took a number of years to identify, address, and effectively implement the changes. For example, there was only one RWP with one subCTW listed for 1990 in RPRT-0092, and specific radionuclides were not required on the RWPs until the mid-1990s.

Observation 5: SC&A summary of NIOSH response

- None of these were consequential to operation of the Routine Bioassay Program or to dose reconstruction.
- It is true that radionuclides were not specified in early RWPs until about 1994. However, NIOSH used Farrell and Findley (1999) and other information given on the RWP to identify target radionuclides (e.g., task specifications).
- Even though the radionuclide of interest was not documented on the RWP, this did not mean that the subCTW did not have a bioassay taken.

Observation 5: SC&A response for number of bioassays

- While the number of bioassays is an indication of data availability, it is not necessarily an indication that subCTWs were monitored for the correct radionuclides while working in the same environment as other workers.
- This issue was what initiated RPRT-0092's analysis of job plans and RWPs.

Observation 5: SC&A response to assumptions for bioassays

- NIOSH based the assumption for bioassay requirements for the tables in RPRT-0092 on (p. 31):
  - Air monitoring and contamination survey results listed on the RWP
  - Bioassay requirements for similar RWPs for the same areas and location
  - Bioassay guidelines and procedures of 1990, 1992, and 1996
  - Farrell and Findley (1999)
- Therefore, there is not a direct linkage available between bioassays and exposure potential to determine if the CTW was appropriately monitored before RWPs were completely and correctly implemented.

Observation 5: SC&A response – potential issues remained in 1990s

- There were still issues in 1997 of workers not leaving bioassays.
- DOE 1998 Occurrence Report indicates that problems concerning the job-specific bioassay program had been repetitive and were first identified in November 1995.

SC&A 1991–1998 summary: Using one bioassay

- The limitations of using the at least one bioassay concept should be considered when weighing the adequacy of internal monitoring data.
- One bioassay does not necessarily satisfy all the internal monitoring requirements of a RWP, or indicate adequate internal monitoring.

SC&A 1991–1998 summary: Incomplete RWPs

- Marked improvements in bioassays with the introduction of RWPs in 1991–1992, but RWPs did not begin to consistently specify radionuclide bioassay requirements until around 1994–1995.
- Filling in the bioassay requirements for early RWPs that were incomplete, as was done in RPRT-0092 (p. 31) to derive the percentage of subCTWs bioassayed and effectively bioassayed, requires assumptions rather than direct linkage between radionuclide exposure and subCTW bioassays.

Conclusions: DuPont era, 1972–1990

- SC&A continues to conclude that NIOSH has been unable to demonstrate the completeness of subCTW job-specific bioassay data and did not accomplish the objectives defined in its sampling plan for the RPRT-0092 analysis.
- Limited analysis of americium by time period (1973, 1981–1987) and location (only 773-A, F-Wing) showed limited associated monitoring to conclude co-exposure models are representative of workers on the job-specific bioassay program.
- It remains unknown to what extent past job-specific bioassays are incomplete, but it is known that the gap in 1997 was significant and the weight of evidence provided by SC&A's review invalidates the inclusion of at least pre-1991 subCTW data as sufficiently complete and representative for use in the SRS co-exposure model.

Conclusions: Westinghouse era, 1991–1998

- SC&A concludes that subCTW job-specific bioassay completeness can be established, but with some qualifications that remain to be addressed.
- Most notable is defining when RWPs were sufficiently implemented such that job-specific bioassays can be adequately linked to subCTWs under those permits (e.g., with specific radionuclides and bioassays prescribed) to demonstrate that significant lapses in subCTW job-specific bioassays in 1996–1997 are not apparent in prior years (1991–1995) and would not preclude co-exposure model inclusion.