

Review of ORAUT-RPRT-0092, Evaluation of Bioassay Data for Subcontracted Construction Trade Workers at the Savannah River Site

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Background

- Construction subcontracted construction trade workers (subCTWs) often performed nonroutine jobs involving unique radiological source terms or conditions, and permit-required, job-specific bioassays were important to verify intakes.
- SC&A's original evaluation of subCTW job-specific bioassay data found 66–84% completeness; concluded that RWPs before 1999 at SRS were neither complete nor consistently applied with respect to job-specific bioassays (SC&A, 2017).
- Further, a 1997 WSRC self-assessment found only 21% completeness and was contributing basis for 1998 DOE enforcement action at SRS and DOE-wide moratorium on compliance actions to enable corrective actions for site bioassay programs.
- SRS work group requested that NIOSH conduct further evaluation of subCTW data completeness for 1972–1998 based on recently discovered SRS permit records; evaluation reported in ORAUT-RPRT-0092.

NIOSH RPRT-0092 Evaluation

- RPRT-0092's sampling goal was to “randomly select radiological workers from various areas at [SRS]” (NIOSH, 2018c).
- Intended to “obtain an unbiased data set to evaluate subcontractor [bioassay] monitoring for both co-worker applicability [did monitored and unmonitored subCTWs work together]...and to evaluate specific radionuclides of interest [i.e., appropriate source term]” (Taulbee, 2018).
- Founded on similar sampling of subCTWs performed for 773-A for 1981–1986 but focused on “other operating areas from 1972 through 1998” (NIOSH, 2019a)
- Diverged from Sampling Plan for 1972–1989 by not applying statistically based random sampling; collected all available permit/bioassay records for only one facility: 773-A, SRS's analytical laboratory.

SC&A Review

- 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 the time periods in question?
 - Sampling execution – Did NIOSH successfully “randomly select radiological workers from the various areas at [SRS], such that an evaluation of monitored and unmonitored workers can be conducted?”
 - Coworker 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?

SC&A Findings:

1. Assumption and Basis for SubCTW Data Sampling, 1972–1989

Finding 1: No SWPs or job plans sampled by NIOSH and reviewed by SC&A 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 (determining fraction of subCTWs identified on RWPs of interest who were monitored for internal intakes).

- None of SWPs reviewed for 1972–1989 have job-specific bioassay requirements.
- None of job plans reviewed for 1972–1989 have any indicated job-specific bioassay requirements, although DPSOL procedures provided for it.
- No DuPont procedures found for job-specific bioassays tied to respirator use.

SC&A Findings: Assumptions and Basis, 1972–1989

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.

- Source terms based on (by RPRT-0092 priority): work area identified on permit, SRS procedures for bioassay type and frequency, and 1999 Farrell and Findley guidelines.
- However, radionuclides rarely identified on permits, DuPont procedures relied on incomplete expert and experience-based bioassay tables, and 1999 guidelines based on facility characterization that only existed after early 1990s.
- Some SRS facilities (e.g., 773-A and waste operations) handled wide array of nonroutine radionuclides.
- In 1990, DOE found SRS “radiological areas have not been sufficiently characterized to provide a technical basis for the assignment of bioassay sample type and frequencies”; cited noncompliance with DOE Order 5480.11.

SC&A Findings: Assumptions and Basis, 1972–1989

Finding 3. 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 representativeness called for in NIOSH’s coworker guidelines.

- Goal was to “randomly select radiological workers from various areas at [SRS]” and perform a similar statistical evaluation of subCTWs as performed for 773-A (1981–1986), but focused on “other operating areas from 1972 through 1998” (NIOSH, 2018c, 2019a).
- However, lack of documentation found in various data captures precluded random sampling and limited review (again) to just 773-A.
- Leaves out 30+ SRS major radiological facilities, e.g., canyons, tank farms, PuFF and PEF, ETF, RBOF, and Uranium Target Fabrication Facility, with large worker populations, notable contamination histories, and spectrum of source terms.
- While NOCTS may be more representative of SRS facilities and source terms, RPRT-0092 evaluation is not and precludes a conclusion regarding subCTW completeness on a sitewide basis.

SC&A Findings: Assumptions and Basis, 1972–1989

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 completeness evaluation of job-specific bioassays for 1972–1989 as a measure of historic data completeness.

- Acknowledging lack of job-specific bioassay data for areas other than 773-A, NIOSH used incident reports documenting event-based bioassays as means to supplement its RPRT-0092 review.
- SC&A’s review of referenced incident reports confirmed many of them involved “special bioassays.”
- Under DuPont procedures, special bioassays were accorded particular emphasis and management accountability, with detailed instructions on bioassay response, notifications, and recordkeeping.
- Clear difference in management and procedural accountability between how “special” and routine bioassays handled – former should not be used to supplement review of the latter, if historical data completeness is being weighed.

SC&A Findings: Assumptions and Basis, 1972–1989

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.

- NIOSH acknowledges that “current and former employee interviews indicated that some records were destroyed in the late 1980s or early 1990s,” and “the SWPs or Job Plans for other areas might have been destroyed as part of that effort.”
- Same interviews indicated various kinds of records were shredded, e.g., monitoring records and time cards, and that significant employee records gaps exist.
- DOE 1990 Tiger Team found “many personnel files where radiation dose data are missing for many years” and cited DuPont policy of transferring records to the Federal Records Repository, for which retrieval proved problematic.

SC&A Observation: Assumptions and Basis, 1972–1989

Observation 1: The back application of assumptions [from the WSRC era] regarding work permits, job-specific bioassays, and target radionuclides to conduct a completeness review for 1972–1989 is not plausible given the significant changes in radiological policies, procedures, and practices that occurred in the early 1990s.

- Notable difference in how internal exposures monitored and controlled between DuPont and WSRC eras at SRS (e.g., 1972–1989, 1990–1998).
- DuPont operated under DOE Order 5480.1, Chapter XI, while WSRC operated under DOE Order 5480.11 (issued Dec. 1988, eff. Dec. 1989).
- DOE 5480.1, Chapter XI, contained general requirements for “periodic” bioassay analysis, whereas DOE 5480.11 introduced explicit requirements for combining internal and external dose equivalent, and a 100-millirem monitoring threshold, coupled with formal ALARA objectives and independent DOE oversight of field implementation.

Unprecedented SRS Change: Critical Timeline, 1988–1990

- Aug. 1988:** Production suspended at SRS reactors (L, K, and P, last for safety issues), followed by safety reviews, facility upgrades, restart initiatives – procedural gaps, program insularity found
- April 1989:** DuPont contract ends after 38 years; Westinghouse (WSRC) assumes role, with Bechtel managing construction
- Dec. 1989:** DOE Order 5480.11 implementation required; entails key changes to internal dosimetry monitoring and recordkeeping
- Mar. 1990:** Tiger Team assessment conducted at SRS by DOE/HQ team; key findings re bioassay, procedures, rad records compliance
- mid-1990:** Implementation of WSRC Radiological Improvement Plan begins, including “Internal Dosimetry Technical Basis Manual” and new WSRC radiation protection procedures, e.g., RWPs with job-specific bioassays

2. Sampling Execution and Results, 1972–1989

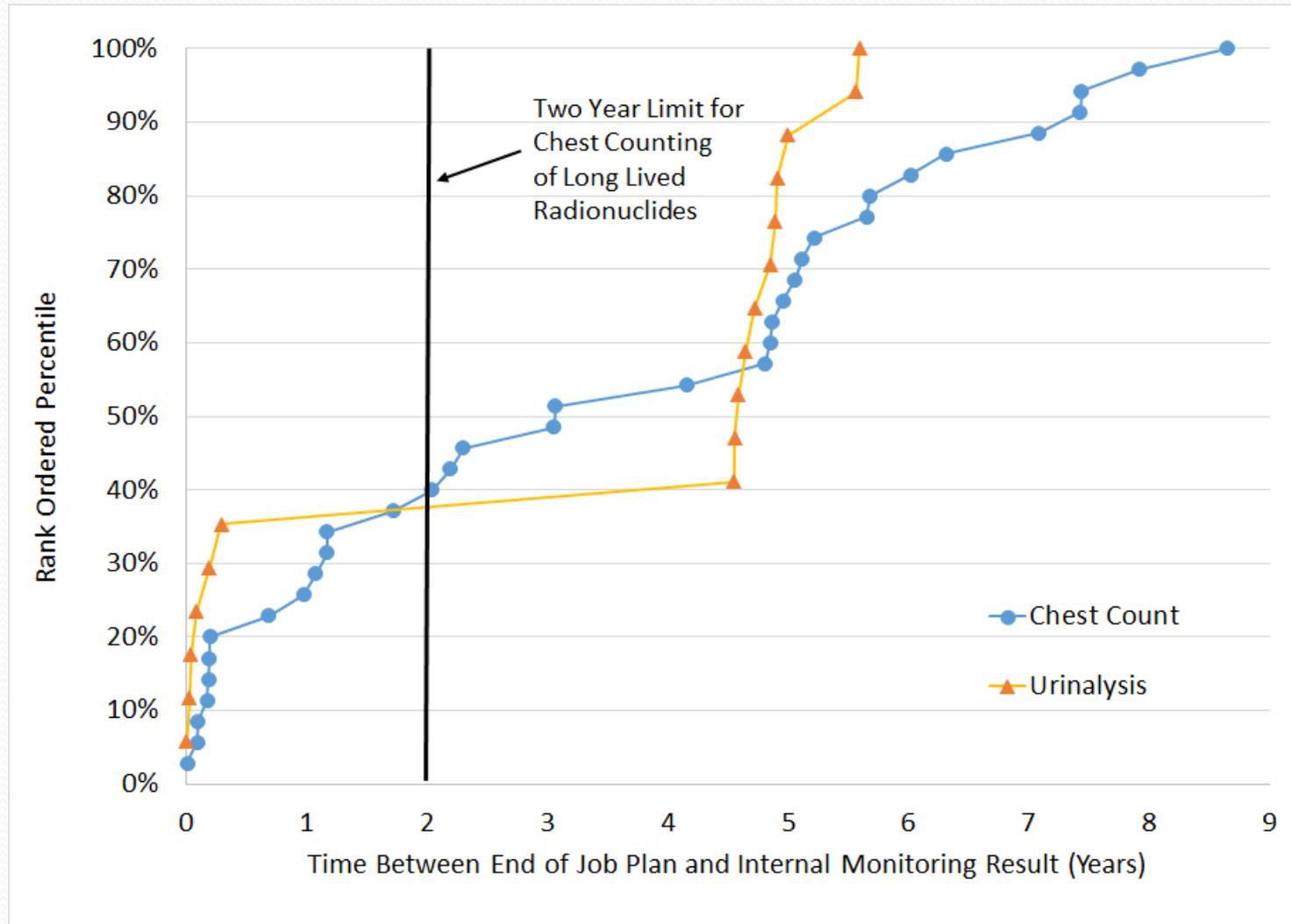
SC&A Adjustments to RPRT-0092 monitoring “match” criteria:

- Remove internal monitoring that was outside of acceptable timeframe between job plan and internal monitoring result.
- Remove identified coworker matches that involved different job plans (i.e., unmonitored on job plan “A” was matched to a monitored coworker on job plan “B”).
- Adjust “effectively monitored” population to reflect only internal monitoring results used in the coworker model. (Is the monitored coworker result actually used in the coworker model and thus represents the unmonitored worker?)

Sampling Execution and Results, 1972–1989, Americium

- Evaluation of job-specific americium monitoring limited to 1973 and 1981–1987 (i.e. no job plans requiring americium monitoring identified for 1972, 1974–1980 or 1988–1989).
- Evaluated internal monitoring included both urinalysis and in vivo samples.
- Only urinalysis data is used for coworker modeling of americium and is therefore relevant to identifying coworker matches (i.e., the “effectively monitored” population).

Sampling Execution and Results, 1972–1989, Americium



Sampling Execution and Results, 1972–1989, Americium

- **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 D, table D-1 [of RPRT-0092] indicates 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.
- **Observation 3:** Only 13 percent 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 incident-driven monitoring outside the period of interest and in a different area.

SC&A Findings: 1972–1989, Americium

- **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).
- **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 percent. If the internal monitoring related to an incident in a different SRS location and time period (and not currently used in the SRS coworker model) is removed, the effective monitored population drops to 26.5 percent.

SC&A Findings: 1972–1989, Americium

- **Finding 9** [out of sequence]: 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 percent) or, alternately, appropriately represented in the derived coworker models for SRS (around 13 percent).

Sampling Execution and Results: 1972–1974, Fission Products

- SC&A directly monitored total (~70%) closely matches NIOSH directly monitored total (~74%)
- Difference due to removal of samples greater than 2 years after the job plan
- All fission product monitoring identified was based on urinalysis not in vivo, coworker model is based on in vivo monitoring
- “Effectively monitored” population remains unchanged (70%) when not including coworkers matched via urinalysis
- By comparison, RPRT-0092 “Effectively Monitored” total was 94%

Sampling Execution and Results: 1980–1989, Fission Products

- SC&A monitored total (~73%) closely matches NIOSH monitored total (~78%)
- Difference due to removal of entries greater than 2 years after the job plan (23 entries) and inability to verify entry in source dosimetry file (11 entries)
- Majority of fission product monitoring identified was based on urinalysis, not in vivo
- “Effectively monitored” population only marginally increases to 74% when not including coworkers matched via urinalysis (RPRT-0092 “effectively monitored” total was reported as 99%)

SC&A Finding: 1972–1989, Fission Products

Finding 8: Many of the workers (around 70–73 percent) 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's SRS Area Analysis, 1990–1998

In view of lack of representativeness of various SRS areas for 1972–1989, SC&A surveyed the 1990–1998 RWP data as a function of area. SC&A found:

- The RWP data were from Areas A, E, F, H, M, and G for the period 1991–1998.
- There was only one RWP in 1990 (which was for Area F), with no monitored subCTWs.

SC&A Findings:

3. Coworker Datasets, 1972–1998

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.

- Although there were corporate changes taking place at that time, there was lag time in policy implantation.
- There was only one RWP with one unmonitored subCTW listed for 1990.
- 1990 should not be bundled with 1991 and treated as part of the period when additional data became available.
- The time intervals should be broken up into 1972–1990 and 1991–1998, so that 1990 is considered in the era with very limited data.

SC&A Findings: All Required vs. “at least one” Radionuclide

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.

For example:

- Directly monitored workers ranged from 47% to 77% (in comparison to 76% to 96% in RPRT-0092).
- Effectively monitored workers ranged from 55% to 89% (in comparison to 85% to 99% in RPRT-0092).
- Difference is particularly noticeable in the pre-1990 era.

SC&A Findings: Coworker Datasets, 1972–1998

Time Period	RPRT-0092 directly monitored for at least one radionuclide	SC&A directly monitored for all radionuclides on work permit	RPRT-0092 effectively monitored for at least one radionuclide	SC&A effectively monitored for all radionuclides on work permit
1972–1974	76%	47.1%	85%	55%
1975–1979	No data	No data	No data	No data
1980–1989	90%	51%	99%	66%
1990–1998	96%	77%	97%	89%

SC&A Observation: Coworker Datasets, 1990–1998

Observation 4: Coworker criteria – 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 as well as the same date and time of the work performed.

Analysis of RPRT-0092 data indicates:

- Unmonitored subCTW and coworker were both listed on the same RWP 96% of the time.
- Unmonitored subCTW and monitored coworker had the same job title 60% of the time when signed in on the same RWP.
- Unmonitored subCTW and coworker performed work under a given RWP on the same date 77% of the time.

Observation 4: Coworker Criteria (continued)

- Unmonitored subCTW and coworker both signed in on the same RWP and same date and worked during the same time interval 66% of the time.
- Coworkers only met all four of the required criteria 45% of the time to indicate a coworker and the unmonitored subCTW were working side by side performing similar tasks (e.g., same RWP, same craft, same date, and same time) to indicate similar intake potentials.

SC&A Observation: Not a Step Function in 1990

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 1990. It was not a step function that took place in 1990 (only one RWP with one subCTW listed for 1990). Instead, it took a number of years to identify, address, and effectively implement the changes.... Specific radionuclides were not generally required on the RWPs until the mid-1990s.

For example:

- Required plutonium bioassays on RWPs increased from 4% in 1993 to 78% in 1994, and to 100% in 1995.
- Required strontium and fission products bioassays on RWPs increased from 0% in 1993 to 72% in 1994, and to 100% in 1995.

Other Issues

- **Time span for monitoring percentages (ORAUT-RPRT-0094):** “Using a three year span between the time of potential exposure and the time of the bioassay for non-tritium radionuclides significantly increases the fraction of monitored sCTW.... The fraction of monitored sCTW would increase for each year the span between employment and bioassay was increased” (NIOSH, 2019b).

While useful as a dose assessment consideration, applying this adjustment to the subCTW completeness evaluation in RPRT-0092 is inappropriate.

NIOSH apparently agrees:

- “NIOSH considers any plutonium, uranium or fission products result obtained within one year of work to represent a valid internal monitoring interval” (NIOSH, 2018a).
- For in vivo counting: “Gaps of greater than 2 years between results are considered to be unmonitored” (NIOSH, 2018b).

Other Issues (continued)

- **Soundness of SRS internal dosimetry program.** SC&A's concerns relate to the *completeness* and *representativeness* of job-specific bioassay data sitewide at SRS for 1972–1998 as they pertain to the development of a coworker model that satisfies NIOSH's guidelines.
 - These concerns do not extend to the overall adequacy of the SRS routine and special bioassay programs, the amount of related data, or the overall SRS radiological control record, as reflected in historical exposure statistics.
 - However, as noted, SC&A finds that radiological procedures, practices, and accountability were inadequate during the DuPont era (in some cases, extending into the WSRC period of 1990s), which bears on the subCTW data completeness issue.

Other Issues (continued)

- **How complete is complete?** NIOSH claims “degree and direction of potential bias generated in a coworker model by missing samples is more important than the number of samples that were requested but not provided” (NIOSH, 2018a).
 - However, with DuPont era job plans, evidence of followup job-specific bioassays is lacking. Also, with monitoring fractions often less than 50–60% (for example), ability to demonstrate “representative” data is questionable.

Conclusions

In RPRT-0092, NIOSH concludes that “a large percentage of subCTWs were monitored for potential intakes while working under a Job Plan, SWP or RWP.”

- SC&A concludes that premise of RPRT-0092 evaluation is based more on WSRC than DuPont era practices; no evidence of standardized permit-related bioassays required or implemented in 1972–1990.
- SRS procedures and practices for RWP-required, job-specific bioassays, were not defined, codified, and implemented until late 1990 under WSRC’s Radiological Improvement Program.
- SubCTW monitoring percentages cited by NIOSH are based on questionable assumptions and adjustments, leading to unfounded claims of bioassay monitoring “success” rates.
- Issue of bioassay completeness not confined to subCTWs; extends to all CTWs subject to permit-required bioassays in 1972–1990.

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