Response to SC&A's "Focused Review of ORAUT-RPRT-0092, Revision 00, and Remaining Petition SEC-00103 Evaluation Report Period: 1991–2007"

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Savannah River Site Work Group Meeting

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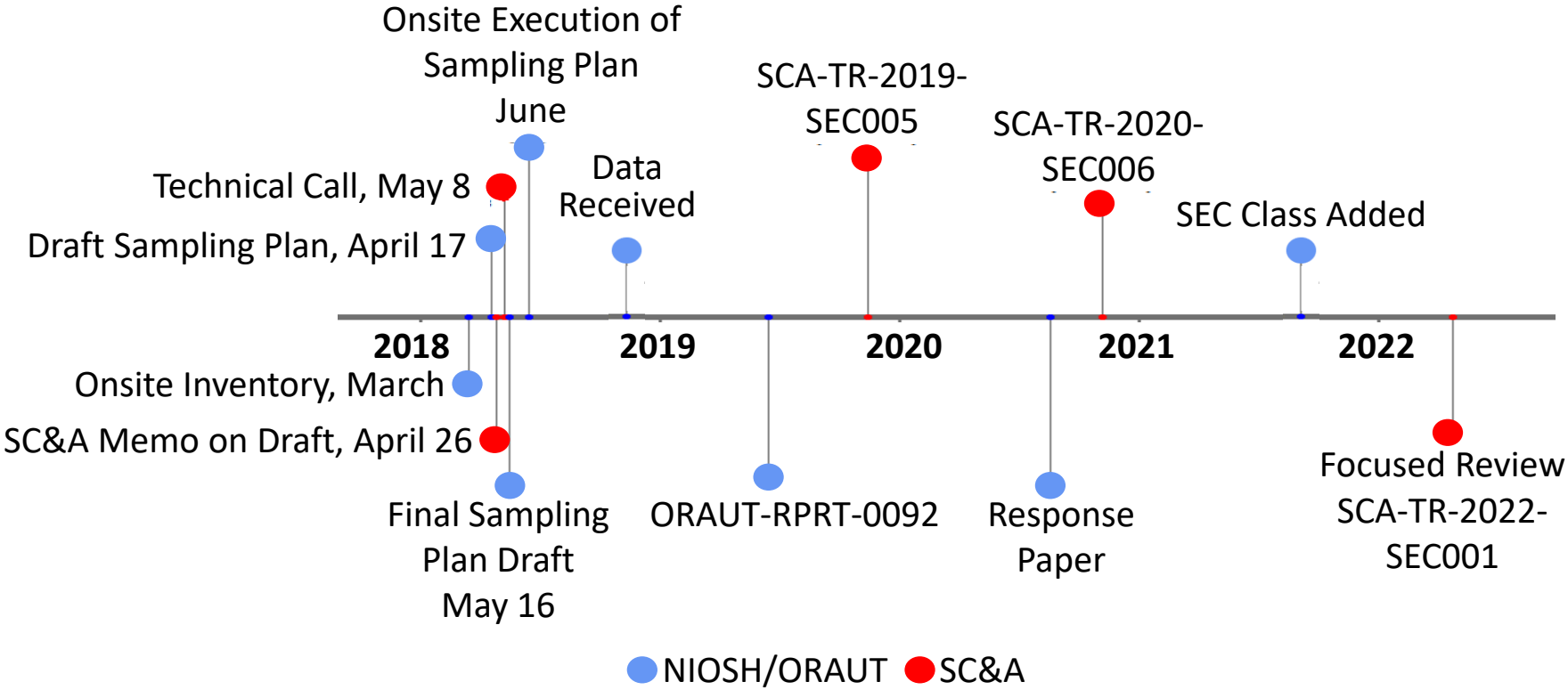
Overview

- Introduction
- NIOSH Responses to 5 SC&A Conclusions
- NIOSH Conclusion

Introduction

- ORAUT-RPRT-0092, *Evaluation of Bioassay Data for Subcontracted Construction Trade Workers at the Savannah River Site* [ORAUT 2019]
  - Original Purpose: use a Radiation Work Permit (RWP) sampling plan to determine whether subcontracted construction trade workers (subCTWs) were sufficiently monitored by bioassay such that their radiation doses could be reconstructed with sufficient accuracy

Timeline of Pertinent Events



Introduction – SC&A Conclusions

- SC&A Conclusions
  1. Sampling premise is not sufficiently grounded in historical SRS practices.
  2. Results for direct and effective monitoring may be overstated.
  3. Generalized matching is not sufficient.
  4. RWP-specified, job-specific bioassay data are incomplete.
  5. Feasibility of co-exposure model needs to balance RWP implementation with completeness of coworker data.
- Focus has shifted from feasibility of dose reconstruction to feasibility of co-exposure modeling

NIOSH Response to SC&A Conclusion 1

Sampling premise is not sufficiently grounded in historical SRS practices.

Monitoring Percentages

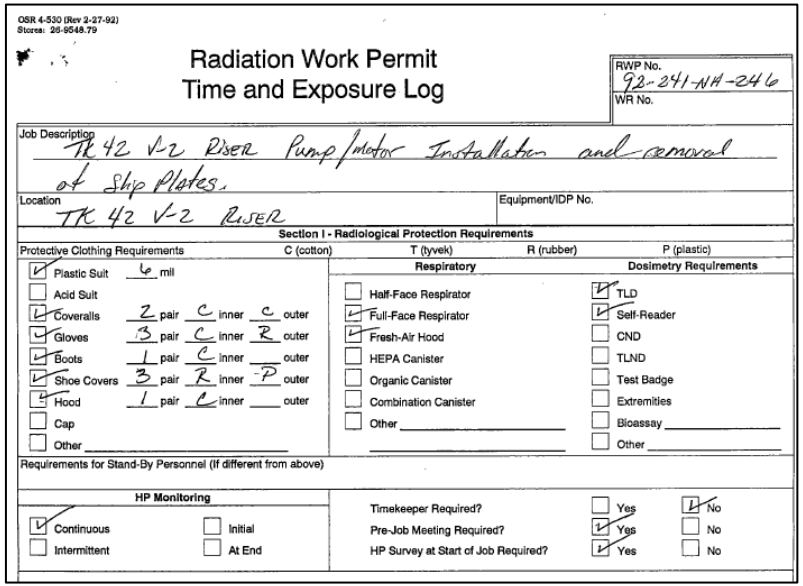
- Based on SC&A Figure 1 and Table 2 (reproduced below)
- Percent of Pu, Sr/FPs, Am, U, and Np bioassays required by RWP & number of RWPs

Year	% Pu	# RWPs	% Sr/FP	# RWPs	% Am	# RWPs	% U	# RWPs	% Np	# RWPs
1991	0%	16	0%	13	0%	4	25%	4	0%	1
1992	0%	23	0%	9	0%	12	0%	20	0%	2
1993	4%	27	0%	12	0%	13	9%	11	0%	11
1994	78%	32	72%	25	33%	9	33%	15	NA	0
1995	100%	15	100%	5	0%	2	100%	2	33%	3
1996	100%	7	100%	3	0%	2	NA	0	100%	1
1997	100%	9	100%	8	0%	1	NA	0	NA	0
1998	80%	10	71%	7	0%	1	NA	0	NA	0

Radionuclides included on RWPs

- 78% for Pu in 1994
  - 78% of the 32 RWPs (or 25 RWPs) sampled from 1994 have Pu marked as required on the RWP
  - remaining 22% (or 7 RWPs) are assumed to require Pu bioassay based on the work and/or area
- “Rise” from 0% (1991) to 78% (1994) to 100% (1995)
  - Transition between procedure-driven bioassay program and RWP-driven bioassay program
  - Check boxes on RWPs
    - Early 1990s forms did not have them
    - Middle and late 1990s forms have them

Example of RWPs



OSR 4-530 (Rev 2-27-92)
Stores: 26-9548.79

Radiation Work Permit
Time and Exposure Log

RWP No. 92-241-NH-246
WR No.

Job Description: TK 42 V-2 Riser Pump/Motor Installation and removal of Ship Plates.

Location: TK 42 V-2 RISER

Equipment/IDP No.

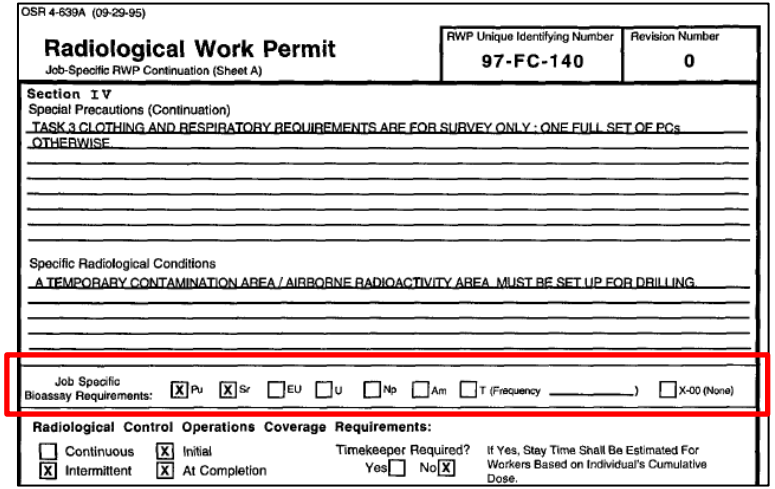
Section I - Radiological Protection Requirements

Protective Clothing Requirements	C (cotton)	T (tyvek)	R (rubber)	P (plastic)
☑ Plastic Suit	6 mil			
☐ Acid Suit				
☑ Coveralls	2 pair	C inner	C outer	
☑ Gloves	3 pair	C inner	R outer	
☑ Boots	1 pair	C inner	___ outer	
☑ Shoe Covers	3 pair	R inner	P outer	
☑ Hood	1 pair	C inner	___ outer	
☐ Cap				
☐ Other ___				

Respiratory	Dosimetry Requirements
☐ Half-Face Respirator	☑ TLD
☑ Full-Face Respirator	☑ Self-Reader
☑ Fresh-Air Hood	☐ CND
☐ HEPA Canister	☐ TLND
☐ Organic Canister	☐ Test Badge
☐ Combination Canister	☐ Extremities
☐ Other ___	☐ Bioassay ___
	☐ Other ___

Requirements for Stand-By Personnel (if different from above)

HP Monitoring				
☑ Continuous	☐ Initial	Timekeeper Required?	☐ Yes	☑ No
☐ Intermittent	☐ At End	Pre-Job Meeting Required?	☑ Yes	☐ No
		HP Survey at Start of Job Required?	☑ Yes	☐ No



OSR 4-639A (09-29-95)

Radiological Work Permit
Job-Specific RWP Continuation (Sheet A)

RWP Unique Identifying Number: 97-FC-140
Revision Number: 0

Section IV
Special Precautions (Continuation)
TASK 3 CLOTHING AND RESPIRATORY REQUIREMENTS ARE FOR SURVEY ONLY ; ONE FULL SET OF PCs OTHERWISE.

Specific Radiological Conditions
A TEMPORARY CONTAMINATION AREA / AIRBORNE RADIOACTIVITY AREA MUST BE SET UP FOR DRILLING.

Job Specific Bioassay Requirements: ☒ Pu ☒ Sr ☐ EU ☐ U ☐ Np ☐ Am ☐ T (Frequency ___) ☐ X-00 (None)

Radiological Control Operations Coverage Requirements:

☐ Continuous ☒ Initial
☒ Intermittent ☒ At Completion

Timekeeper Required? Yes ☐ No ☒

If Yes, Stay Time Shall Be Estimated For Workers Based on Individual's Cumulative Dose.

RWP from 1992

RWP from 1997

Uncertainty in Percentage Monitored

- "Rise" from 0% (1991) to 78% (1994) to 100% (1995)
- Purpose of the RWP sampling plan: Estimate the percentage of monitored subCTWs to within +/- 5% with 95% confidence
  - Uncertainty in percentage of monitored subCTWs can be calculated
  - Uncertainty in anything else can NOT be calculated, unless it was inventoried in March 2018
    - Year was inventoried.
    - Bioassay requirements were not.
- Uncertainties in SC&A Table 2 are unknowable

Summary Response to SC&A Conclusion 1

- SC&A Conclusion 1: Sampling premise is not sufficiently grounded in historical SRS practices.
  - Conclusion is based on a change from procedure-driven bioassay to RWP-driven bioassay
  - Any conclusion drawn from comparing statistics with unknowable uncertainties is suspect
  - Presence of bioassay requirements on all of the RWPs is not necessary for co-exposure modeling.
    - Having RWPs is not even necessary

NIOSH Response to SC&A Conclusion 2

Results for direct and effective monitoring may be overstated.

Inconsistency of the term “monitored”

- SC&A states, *“NIOSH did not address all of the radionuclides listed in the RWPs…”* [SC&A 2022]
  - Final draft sampling plan – *“for all radionuclides listed on the RWP other than tritium”* [ORAUT 2018]
  - ORAUT-RPRT-0092 [ORAUT 2019]
    - Section 2.1 – *“for all radionuclides listed on the RWP other than tritium”*
    - Section 4.2 – *“at least one required bioassay”*
- SC&A is correct that the definition of “monitored” in ORAUT-RPRT-0092 is not consistent.
  - “All required nuclides” vs. “at least one required nuclide”

Re-evaluated monitoring percentages by type

- Monitoring Types
  - Direct monitoring
    - subCTW was monitored
  - Effective monitoring
    - Either the worker was monitored or their coworker was monitored
- NIOSH recalculated direct and effective monitoring percentages where “monitored” means “all required nuclides”

Purpose of Sampling Plan

- Purpose of the RWP sampling plan: Estimate the percentage of monitored subCTWs to within +/- 5% with 95% confidence
  - Uncertainty in percentage of monitored subCTWs can be calculated
  - Uncertainty in anything else can NOT be calculated, unless it was inventoried in March 2018
    - Year and area were inventoried.

Results showed no significant difference

Monitoring Type and Definition	Weighted Point Estimate	95% Confidence Interval
Direct (at least one required nuclide)	95.13%	(87.18%, 98.84%)
Direct (all required nuclides)	75.16%	(68.15%, 81.32%)
Effective (at least one required nuclide)	97.52%	(87.50%, 99.92%)
Effective (all required nuclides)	88.13%	(80.14%, 93.74%)

- Direct intervals do not overlap, so direct percentage decreases with change in definition.
- Effective intervals overlap, so change in definition does not have a significant effect.

Arbitrary monitoring threshold

- SC&A section 5.4 [SC&A 2022] suggests a monitoring threshold
  - *"SC&A's selection of the compliance value less of* [sic] *than 80 percent was arbitrary, but it was a reasonable value below which the rate of compliance certainly would be questionable"*
- Any suggested monitoring threshold would be completely arbitrary.
- Every interval on the previous slide is above or contains the arbitrary SC&A value of 80%.

Alternatives to monitoring threshold

- RWP sampling plan focused on subCTWs.

- Must Account for Exposure Potential of Unmonitored Workers
  - If unmonitored subCTWs represent a small fraction of the highest exposed group, then a CX model can be developed.
  - If 90% of subCTWs were unmonitored, but a large fraction of highly-exposed workers within the entire population were monitored, then a bounding CX model can be developed.

Summary Response to SC&A Conclusion 2

- SC&A Conclusion 2: Results for direct and effective monitoring may be overstated.
  - NIOSH agrees that we did not address all radionuclides when tallying results for ORAUT-RPRT-0092.
  - Updated tallies are presented here.
  - NIOSH conclusion has not changed: a co-exposure model can still be constructed.

NIOSH Response to SC&A Conclusion 3

Generalized matching is not sufficient.

What constitutes a coworker?

- For effective monitoring, what constitutes a coworker?
- Final draft sampling plan [ORAUT 2018]
  - "co-worker on the same RWP"
  - subCTW is implied since that was the sole focus
- ORAUT-RPRT-0092 [ORAUT 2019]
  - subCTW on same RWP, same date, same time (within no more than 15 minutes), any job title but "laborer" could be used for another craft
- SC&A suggestion [SC&A 2022]
  - subCTW on same RWP, same date, same time, same craft

Coworker matching criteria too restrictive

- NIOSH believes the criteria for coworker matching (in ORAUT-RPRT-0092 and SC&A suggestion) are more restrictive than necessary for developing co-exposure models.
- "Coworker" vs. "Co-Exposure" Misconception
  - Discussed during 12/5/19 SRS and SEC Issues WG meeting [NIOSH 2019a]
  - Discussed during 12/11/19 Advisory Board meeting [NIOSH 2019b]
  - Co-exposure models are based on workers with similar exposure potentials, not necessarily coworkers that worked right alongside them.

Matching criteria for co-exposure models

- No requirement that the monitored person works closely with unmonitored person
- Model is representative or bounding for unmonitored worker if those monitored had the same or higher exposure potential
- Sampling plan focused on subCTWs, but if any monitored worker (another subCTW, prime CTW, or nonCTW) with the same or higher exposure potential was monitored, the model would be representative or bounding

Summary response to SC&A Conclusion 3

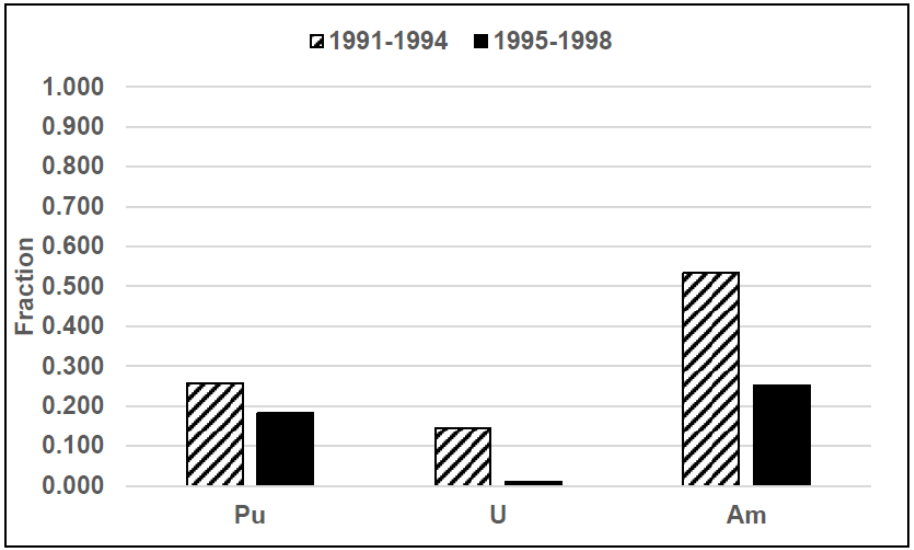
- SC&A Conclusion 3: Generalized matching is not sufficient.
  - For co-exposure modeling, coworkers used for effective monitoring matches need only have the same or higher exposure potential.
  - SC&A's criteria of same RWP, same date, same time, same craft are far too restrictive

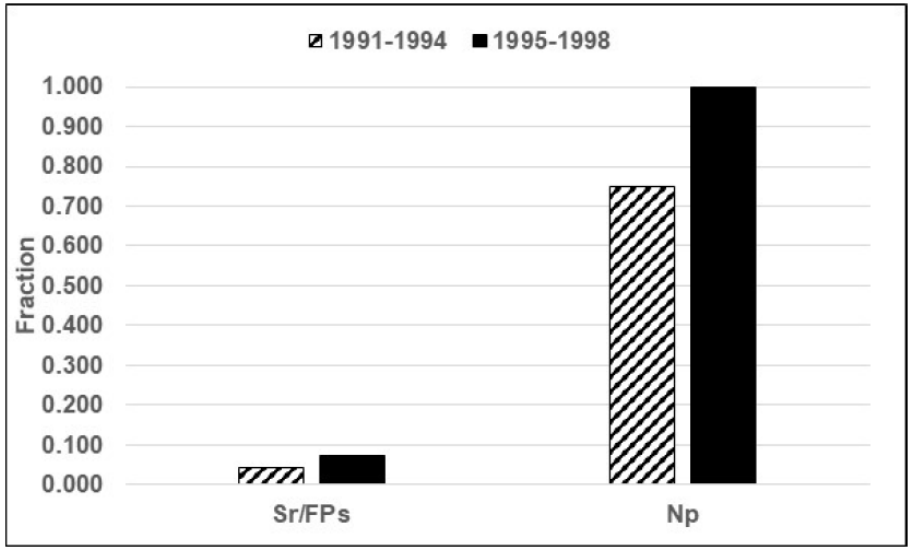
NIOSH Response to SC&A Conclusion 4

RWP-specified, job-specific bioassay data are incomplete.

Fraction of noncompliant monitoring

- Nearly half of conclusion 4 focuses on SC&A Figures 4 and 5
  - The fraction on the y-axis is a noncompliance fraction.





Nuclides in left (right) plot had a perceived decrease (increase) in noncompliance between the time periods.

Noncompliance uncertainties are unknown

- Uncertainties in noncompliance fractions are unknowable
  - Year was inventoried. Nuclide was not.
- Comparison of point estimates without their uncertainties is inappropriate.
- SC&A use of these phrases is inappropriate:
  - “significantly higher”
  - “statistically significant”
  - “essentially the same”
- With uncertainty considered, the sets of bars on the previous slide may not show any differences.

Noncompliance does not prevent development of co-exposure models

- Other half of conclusion 4 deals with job-specific sampling, audits, a 1990 Tiger Team finding, and the 1997-1998 Westinghouse Savannah River Company actions.
- ORAUT-RPRT-0102 states “compliance with the regulations in place at the time the radiological work was performed is not required in order to perform a dose reconstruction or develop a co-exposure model” [ORAUT 2021]
- Dr. Paul Ziemer made a very similar statement during 4/15/21 Advisory Board meeting [NIOSH 2021]
- Audits, Tiger Team findings, and Company actions do not necessarily prevent co-exposure modeling for SRS.

“Job-specific” sample definition is confusing

- SRS 5Q1.1-506 (emphasis added):
  - “Caution: It is EXTREMELY IMPORTANT to note that the effectiveness of the bioassay program in general depends on combining both the routine program and the non-routine, job-specific program. Any time unusual events occur, or jobs are performed that may expose personnel to unusual hazards, a job-specific program should be considered per Section 5.1.2.1.” [WSRC 1992, PDF p. 60]
  - “Any time jobs are undertaken with the potential for unknown radiological conditions to occur or unusual radionuclides to be present, a non-routine, job-specific bioassay program should be considered. In such cases, an in-vitro sample and/or in-vivo count may be required prior to commencing work and again at the conclusion of work. Such a sampling program is at the discretion of HPO supervision and is noted on the Radiological Work Permit for the task. Additional guidance on job-specific sampling programs is available from the Dosimetry Evaluation Group at x5-2931.” [WSRC 1992, PDF p. 57]

“Job-specific” samples are not “special” samples

- Portions of 5Q1.1-506 seem to imply that job-specific samples are non-routine (or special) samples.
- This contradicts a 2017 interview with former site internal dosimetrist at SRS [ORAUT 2017]
  - “Job-specific bioassay is a program prescribed in response to a specific event (the job) but is not a special bioassay”

DOE changed Notice of Violation

- Follow-up interview in August 2022 [ORAUT 2022a]
  - Job-specific samples were part of the routine program and were not special samples according to site practices, despite what the procedures say.
  - 1997 NOV was changed from Health and Safety violation to Procedures violation, because DOE agreed that job-specific samples were not special samples.
  - Special bioassay samples
    - Prescribed by RadCon prior to 1991
    - Prescribed by internal dosimetrist starting in 1991 [ORAUT 2022b]

Co-exposure models should include “special” samples

- A bounding co-exposure model can be constructed if a significant portion of the most highly-exposed workers are part of the dataset.
- If samples collected when there were suspected intakes of radioactive material are part of the dataset, a bounding co-exposure model could be constructed, regardless of job-specific sampling and RWP work.
  - Follow-up question in October 2022 [ORAUT 2022c]
    - Requests for special samples triggered by events were tracked by the internal dosimetrist in a computer program called *TRACK* starting in 1991.

Summary response to SC&A Conclusion 4

- Conclusion 4: RWP-specified, job-specific bioassay data are incomplete.
  - If the samples prescribed by the site internal dosimetrist when a suspected intake occurred (samples in the *TRACK* database) are part of NIOSH's co-exposure database, this is evidence that a bounding co-exposure model could be constructed, despite SC&A Conclusion 4.

NIOSH Response to SC&A Conclusion 5

Feasibility of co-exposure model needs to balance RWP implementation with completeness of coworker data.

Conclusion 5 Summary

- Email exchange [NIOSH/SC&A 2022]
  - NIOSH
    - *“It appears this conclusion is a general statement that if conclusions 1–4 are addressed, then SC&A ‘would consider NIOSH’s conclusion valid…to support development of a co-exposure model...’ ”*
  - SC&A
    - the NIOSH interpretation is correct
- No detailed response necessary

NIOSH Conclusions

Conclusions

- NIOSH addressed the five conclusions in the SC&A Focused Review and concludes:
  1. Absence of bioassay requirements on RWPs in the early 1990s is irrelevant because bioassay programs were prescribed by procedure.
  2. Changing the definition of “monitored” has the expected effect, but the new summary statistics do not prevent creating a co-exposure model.
  3. SC&A’s coworker matching criteria are far too restrictive because for co-exposure, the only necessary criterion is that the monitored worker has the same or higher exposure potential than the unmonitored worker.
  4. Regardless of the issues SC&A pointed out, if the samples from the most highly-exposed workers (in the *TRACK* database) are part of the co-exposure database, this is evidence that a co-exposure model could be constructed.
  5. NIOSH has addressed the SC&A issues from the Focused Review and maintains that co-exposure models can be developed.

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