



## MEMORANDUM

TO: Savannah River Site Work Group  
FROM: SC&A, Inc.  
DATE: January 11, 2018  
SUBJECT: Missing or Incomplete Radiological Source Terms

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At the November 14, 2017, Savannah River Site (SRS) Work Group meeting, SC&A noted in its presentation (under the slide, “Other concerns (yet to be reviewed in detail),” SC&A 2017), a finding that some SRS workers were enrolled in incorrect routine bioassay programs prior to 1999. In its presentation, SC&A noted that “*unrecognized Am-241 sources were not included in Radiation Work Permit (RWP) preparation*” and that some workers were unmonitored for americium (Am). We also noted that a site-wide formal radiological hazard characterization process was established on March 10, 1999. SC&A provided the Work Group and NIOSH the three primary Site Research Database (SRDB) references for this finding: SRDB Ref. IDs 167760, 167754, and 167753. The Work Group subsequently asked that SC&A detail its concern “*such that the work group and NIOSH can review for potential impact on monitoring methods*” (Taulbee 2017). SC&A provides its review in this memorandum in the chronological order of the SRDB document references that are the basis of this concern.

### **SRDB Ref. ID 167760 (Findley, November 7, 1997 (Rev. 3), “Understanding Urine Bioassay Sampling”)**

This note (it is not clear what form of Westinghouse Savannah River Company [WSRC] guidance this represented) underscored that “*being on a routine sampling program does not automatically cover the bioassay sampling requirement specified on the RWP.*” Findley goes on to state that:

*section 5.2.4. of 5Q1.1, 504 “Radiological Work Permit” used to require that the radiological control supervisor identify the RWP bioassay requirements so that they were consistent with 5Q1.1, 506 “In Vivo and In Vitro Bioassay Scheduling and Administration”. This link was eliminated because routine sampling programs may not be appropriate for work involving non-routine mixes or concentrations of radioactive material. [Findley 1997, PDF page 9]*

The implication from this note is that improper cross-referencing in WSRC procedures may have led radiological control supervisors to apply routine facility bioassay requirements for RWPs that entailed radiological source terms different from those of routine work.

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**SRDB Ref. ID 167753 (WSRC interoffice memorandum, ESH-HPT-98-0453, August 13, 1998, “Specification of Bioassay Requirements on Radiological Work Permits (U)”)**

This memorandum was written “*In response to a concern over prescribing the correct urine bioassay sampling program[s] on radiological work permits.*” It notes that WSRC staff “*are working in tandem on a pilot program to establish guidelines in determining the radionuclide(s) of concern for urine samples in the Burial Ground*” (WSRC 1998, page 1). In addition to noting the same concerns as in Findley 1997 (SRDB Ref. ID 167760), WSRC also adds that:

*Additionally, certain facilities such as the Savannah River Technology Center (SRTC) and the solid waste disposal facilities handle a wide array of radioactive materials, some of which may not be encountered in the typical radiological work environment by workers in those areas. For facilities such as 221-FB-Line, where the source term is well defined and not subject to change, this is not a concern unless there is a major change in the facility mission. To ensure that the proper radionuclide(s) is identified for the RWP urine sampling program it may be necessary to perform a thorough characterization of the work environment. It is important also that this characterization be performed on a routine basis to stay current on the source term present. [WSRC 1998, page 2]*

This memorandum goes on to note that a review by the Facility Evaluation Board of SRS solid waste management facilities identified concerns over how radionuclides were identified for urinalysis on RWPs. Specifically, curium was identified as a principal waste constituent but was not specified on RWPs for solid waste management workers. While a follow-up investigation resolved the concern (due to the physical inaccessibility of curium as a potential exposure source and the co-presence of plutonium), WSRC identified the underlying concern as one of “*how the Radiological Control organizations determine which radionuclide(s) of concern are identified on the RWP and how these determinations are made*” [WSRC 1998, pages 2–3]

WSRC indicated that “*To resolve this concern, guidelines that will aid the Radiological Control organizations in prescribing RWP urine bioassay sampling will be developed for each facility.*” Further, a “*pilot program for the development of RWP urine bioassay sampling guidance will be conducted in the Burial Ground.*”

The implication of all of the above is to raise questions and concerns over how facility source term characterizations at SRS had been performed before WSRC realized that they may be inadequate or incomplete. What are the ramifications to dose reconstruction with sufficient accuracy if RWP job-specific bioassays neglected to include relevant radionuclides, particularly for certain facilities where complex, mixed, or unusual radioactive sources existed, e.g., SRTC, solid waste, burial grounds, tank farms, and decontamination and decommissioning projects? Also, this issue may have transcended RWP job-specific bioassays and implicated routine pre-schedule bioassays for radionuclides that were not recognized at the time due to program or facility changes that took place (given the apparent lack of a procedural means for systematic facility source term characterization).

**SRDB Ref. ID 167725 (Memorandum from T.R. LaBone to C.R. Morgan, August 25, 1998, “Missed Dose from Curium Intakes by Solid Waste Workers”)**

This memorandum contends that missed dose from curium intakes by solid waste workers is not a concern because such monitoring is not required, in the first place, by 10 CFR 835.402c(1), as such exposures are not “likely” to occur based on “professional judgement.” More specifically, this memorandum contends that including a worker on routine bioassay (presumably both pre-scheduled and job-specific) for a particular radionuclide is only necessary if there is a probability of greater than 1% chance of “*having one or more intakes in a year that deliver more than 100 mrem CEDE*” (page 2). In terms of any “missed dose” for routine bioassays not collected, this memorandum makes the following conclusion:

*Assigning missed doses for “tardy” routine urine samples would result in the assignment of significant internal doses to workers who are not being exposed to radioactive materials – a clearly undesirable situation.*

*The same logic can be applied to a routine urine sample that is collected a year late or not at all. In both cases there is no associated missed dose because the sample was not required to be collected in the first place, i.e., the sample is not required to assess the dose to the worker. [LaBone 1998, page 3]*

The implication of the memorandum and WSRC’s response is unclear. The author seems to be suggesting that there is no need to be concerned about missing radionuclides for bioassay purposes because any such routine monitoring is not required for dose assessment under 10 CFR Part 835 regulations, in any case. This position seems to be at odds with other WSRC documentation and will need further follow-up.

**SRDB Ref. ID 167754 (Memorandum from W.E. Farrell and W.M. Findley to M.D. Matheny, March 10, 1999, “Specifications of Urine Bioassay Requirements on Radiological Work Permits – (U)”)**

This WSRC interoffice memorandum establishes a formal “*methodology for determining workplace radionuclides of concern when determining RWP bioassay requirements*” (page 1). This directive includes the following discussion:

*Historically, bioassay requirements were identified by the Radiological Control Operations (RCO) organization through facility process knowledge (i.e., safety analysis documentation), procedural guidance and professional judgement. The methodology discussed in this memorandum was used by Health Physics Technology (HPT) to update and/or reverify facility specific radionuclides of concern for bioassay program compliance. The routine urine bioassay program is based on the premise that monitoring must be performed a posteriori (after the fact) to verify that radioactive materials are not being internally deposited in workers.*

...

*When a urine sample is submitted, it is imperative that the correct analysis be requested. This requires that the radiological source term be well know and characterized. [Farrell and Findley 1999, pages 1–2]*

The methodology provided by this memorandum is a detailed facility-by-facility baselining of relevant radiological source terms based on review of “*existing waste certification or process stream analysis data*,” coupled with alternative means such as isotopic workplace air and contamination sampling. The basis for including target radionuclides were those isotopes with “*dose fractions greater than 10%*” based on respective Annual Limit on Intake Values, which is indicative of “*which isotopes contribute the majority of internal dose to an individual for a specific source term*” (page 2).

The implications of this directive are clear: If WSRC instituted such a policy in March 1999 requiring the RCOs to base bioassay monitoring on actual, updated workplace characterization versus expert judgement or longstanding facility knowledge, how incomplete were bioassays (including RWPs) prior to this date with regard to appropriately targeted radionuclides? How does this impact dose reconstruction with sufficient accuracy if workers were incorrectly enrolled in bioassay programs, with potential exposure to key radiological sources not evaluated? What is the significance of an apparent lack of ongoing facility source term characterization to adequate internal dose monitoring during the 1990s with the advent and growth of new activities and programs involving new and complex radiological sources, e.g., decontamination and decommissioning (D&D), solid waste management, environmental cleanup, SRTC?

**SRDB Ref. ID 167676 (Memorandum from C.R. Morgan to M.D. Matheny, November 2, 1999, “Response to the Compilation of PAAA Internal Dosimetry Issues (U)”)**

This memorandum details WSRC’s review of the 31 general deficiencies cited by the U.S. Department of Energy’s (DOE’s) Office of Enforcement and Investigation as part of its “*120-day suspension of PAAA enforcement actions for issues associated with contractor Internal Dose Evaluation Programs (IDEPs)*” (page 1). This review highlights whether the issue applies to SRS and if so, what corrective actions were taken.

For Issue B.8, “Workers enrolled in incorrect routine bioassay program,” WSRC identified this as an SRS issue and indicated the following:

*Both the workers who require routine bioassay and the correct radionuclides for analysis are determined by RWPs under which they work. Earlier this year, it was determined that in some areas site workers were potentially exposed to americium, but that radionuclide was not recognized as an issue when preparing RWPs for those areas. As a result, radiological hazards are now more formally documented and both a periodic review and a method for re-evaluation is defined (see also items A.8 and B.14). An RCO self-assessment completed 4/30/99 determined that formally documented source terms are being properly used to designate bioassay requirement on RWPs. [Morgan 1999, page 6]*

The implication here is that improper worker enrollment, which had been identified by DOE enforcement reviews across DOE sites, had been found to be an issue at SRS, requiring action to implement a formal, ongoing facility characterization program that did not exist before. If key radionuclides such as americium had been missed, what other sources were not reflected on RWPs over time and what are the ramifications for dose reconstruction with sufficient accuracy for those workers potentially affected?

**Thomas LaBone Interview (written response to questions), October 6, 2017**

Mr. LaBone responds to the following question (18):

*To what extent did this deficient RWP source term review process [as detailed in SRDB Ref ID 167676 above] extend to job-specific RWPs and in the larger sense, how much broader was this issue (improper bioassay enrollment) in terms of other radionuclide source terms on a site-wide basis in prior years (e.g., 1989–1999)? Did WSRC review prior RWPs to ascertain status on this question, or to address potential missed dose from americium and other radionuclides due to inadequate enrollment reviews?*

Response (partial):

*I think that when SRS moved from the production phase to the D&D phase in the 1990's there were changes in the source terms that were not fully anticipated because of the change in mission. This, combined with a change in the way we specified routine bioassay programs was most likely the cause of the problem with the routine program you cited with Am-241. I think ESH-RPS-2005-00054 has a good discussion of this issue. However, we did not have this problem for special samples where we always required specification of the source term by analysis of the contamination that triggered collection of the sample. [LaBone 2017]*

SC&A reviewed ESH-RPS-2005-00054 (SRDB Ref. ID 167846; Hadlock et. al. 2005) and found it to be essentially a “lessons learned” review, dated March 11, 2005, of experience gained with the WSRC source term characterization program originally implemented 6 years earlier in 1999. Key conclusions included that it was “*not necessary to perform an a priori determination of the radionuclides of interest for every task and worker within a Facility*” (page 8), and that there remained a need for “*professional judgement*” in the characterization process. There was also a need identified for radionuclides identified for monitoring through the characterization process to be validated, where possible, through the “*isotopic analysis of air samples within the facility.*”

The implication of what was provided in this interview was to substantiate that the disparities with source term identification had its roots in the rapidly changing nature of SRS’ mission, with new or more complex source terms not being fully anticipated as the site moved from a primary production mission to one that included D&D, as well as how routine bioassay programs were implemented.

## Conclusion

SC&A believes that based on the foregoing WSRC documentation for 1998–1999, there was a clear deficiency recognized that may have impacted the proper bioassay enrollment of workers under RWPs prior to the implementation of a new site-wide formal policy, “Specifications of Urine Bioassay Requirements on Radiological Work Permits,” issued on March 10, 1999. Lack of proper specification of radionuclides of significance for internal dosimetry may have led to unmonitored exposures for which dose reconstruction with sufficient accuracy may not be feasible. This concern should be investigated further to ascertain its significance, scope, and implications for dose reconstruction.

## References

Farrell and Findley 1999. Memorandum from W.E. Farrell and W.M. Findley to M.D. Matheny, “Specification of Urine Bioassay Requirements on Radiological Work Permits – (U),” ESH-HPT-99-0051, Westinghouse Savannah River Company. March 10, 1999. [SRDB Ref. ID 167754]

Findley 1997. Guidance document from W.M. Findley, “Understanding Urine Bioassay Sampling,” Revision 3, Westinghouse Savannah River Company. November 7, 1997. [SRDB Ref. ID 167760]

Hadlock et al. 2005. Memorandum from Dennis Hadlock, S. John Moxley, and R. Dean Thames to Theodore Padezanin, III, “Field Protocols for Determining Radionuclides of Interest in a Facility Radiobioassay Program (U),” ESH-RPS-2005-00054, Westinghouse Savannah River Company. March 11, 2005. [SRDB Ref. ID 167846]

LaBone 1998. Memorandum from T.R. LaBone to C.R. Morgan, “Missed Dose from Curium Intakes by Solid Waste Workers,” ESH-HPT-980459, Westinghouse Savannah River Company. August 25, 1998. [SRDB Ref. ID 167725]

LaBone 2017. Thomas LaBone Interview (written response to questions), October 6, 2017, forwarded by NIOSH via email on October 24, 2017.

Morgan 1999. Memorandum from C.R. Morgan to M.D. Matheny, “Response to the Compilation of PAAA Internal Dosimetry Issues (U),” ESH-HPT-99-0226, Westinghouse Savannah River Company. November 2, 1999. [SRDB Ref. ID 167676]

SC&A 2017. Presentation by Joe Fitzgerald, SC&A, at the Savannah River Site Work Group Meeting, “Summary of SC&A’s Concerns with SRS Subcontractor Bioassay Data Completeness.” November 14, 2017.

Taulbee 2017. Email from Tim Taulbee, NIOSH, to Savannah River Site Work Group and others, “Open Issues regarding Subcontractor Bioassay Monitoring, Rev. 1,” Draft action items for review. November 17, 2017.

WSRC 1998. WSRC interoffice memorandum, "Specification of Bioassay Requirements on Radiological Work Permits (U)," ESH-HPT-98-0453, Westinghouse Savannah River Company. August 13, 1998. [SRDB Ref. ID 167753]