Memorandum

To: Dr. Henry Anderson, Special Exposure Cohort Issues Workgroup Chair and
Mr. Bradley Clawson, Savannah River Site Workgroup Chair

From: John Cardarelli II, DCAS Research Health Physicist

Subject: SC&A January 23, 2020 memorandum, "Response to ORAUT-RPRT-0091, 'Evaluation of Savannah River Site Americium-241 Source Terms Between 1971 and 1999 Using Bioassay Frequency Tables'"

Date: October 2, 2020

At the November 14, 2017 Savannah River Site Work Group meeting[1], SC&A stated concerns that workers were enrolled in incorrect bioassay programs prior to 1999 and that some workers were exposed to unrecognized Am-241 sources. The Work Group asked SC&A to detail their concerns which resulted in their January 11, 2018 memorandum[2] "Missing or Incomplete Radiological Source Terms." ORAUT-RPRT-0091 "Evaluation of Savannah River Site Americium-241 Source Terms Between 1971 and 1999 Using Bioassay Frequency Tables" (Report 91)[3] was created in response to that memorandum. The SC&A January 23, 2020 memorandum[4] is their response resulting from a review of Report 91.

There were no findings or observations in their review. SC&A concluded "*…that NIOSH's explanation regarding the two SRS facilities for which unrecognized Am-241 sources were not included in RWP preparation, as originally noted in a 1998 WSRC self-assessment serves to mitigate our original concern noted in SC&A's presentation before the Advisory Board on November 14, 2017.*"

However, the conclusion continues: "*While these circumstances provide a pathway for dose reconstruction of potential Am-241 doses for workers in these facilities, they do not resolve the larger question of whether source-term characterization in support of facility operations that underwent rapid change and diversification in the 1985-1998 timeframe were sufficiently accurate and complete to support job plan and RWP preparation.*"

The discussion in the January 23, 2020 memorandum is about SRS's Routine Bioassay Program, a screening program used to monitor and verify the effectiveness of workplace controls; any positive result in the Routine Program or any indication of contamination control failure placed the worker in

[1] https://www.cdc.gov/niosh/ocas/pdfs/abrwh/2018/wgtr020918-508.pdf
[2] https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-incmisradst-011118-508.pdf
[3] https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-91-r0-508.pdf
[4] https://ftp.cdc.gov/pub/FOIAREQ/179245_red-508.pdf

the Special Bioassay Program. This latter program is used by SRS to assess worker exposures and assign doses.

In the memo, SC&A states *"A broader concern is whether the enrollment of workers in SRS bioassay programs may have been historically affected by what was apparently incomplete characterization of facility radiological source terms."* SC&A suggests that the source-term characterization efforts of the E.I. Du Pont de Nemours and Company (DuPont), the original prime contractor until 1989, may have been inadequate based on observations during the Westinghouse Savannah River Company (Westinghouse) era which started in 1989. SC&A later acknowledges that "*…such a review would still not answer the essential question of whether more dynamic (short-term, campaign-driven) sources were adequately reflected in DuPont era job plans and accompanying job-specific bioassays."* NIOSH reaffirms our earlier conclusion that the workers were adequately monitored to reconstruct doses with sufficient accuracy for compensation purposes.

The rest of this memorandum addresses five questions raised by SC&A in their 2018 memorandum, NIOSH's responses to those questions, and SC&A responses to NIOSH's responses.

SC&A question 1: Ramifications to dose reconstruction

NIOSH believes this question has been addressed and has no further comment.

SC&A question 2: Completeness of pre-March 1990 bioassays

SC&A accepted the NIOSH response for the Westinghouse era (>1989) but rejected it for the DuPont era (<1989). SC&A made a similar finding (Finding 2) in their review of ORAUT-RPRT-0092 "Evaluation of Bioassay Data for Subcontracted Construction Trade Workers at the Savannah River Site."[5] NIOSH's response[6] to that finding is applicable to this question and states "*NIOSH believes that, prior to 1990, the radiological source terms at SRS were adequately characterized with sufficient accuracy for dose reconstruction purposes."* For a more detailed explanation, please review the full response in the referenced document.

SC&A question 3: Worker enrollment in bioassay programs

This topic was extensively discussed in the November 14, 2017 Work Group meeting[7] (see pages 139 - 189) and focused on the completeness of the bioassay data and a DOE Notice of Violation. In summary, SRS management sent four thousand form letters in 1998 to every site employee on a routine bioassay program asking them to compare their bioassay codes on their radiation qualification badge to those listed in the letter. Less than 100 discrepancies were identified, representing less than 2.5% of the monitored workers who were on an incorrect bioassay program. Further assessment showed that there were no internal doses that went undetected because there was very good control of the working environment, very few workers potentially affected, and a significant amount of workplace and individual monitoring (>10,000 bioassay samples in 1997). Bioassay programs are not without error, understanding the potential biases these may introduce into a dose reconstruction effort

[5] https://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-srsrprt92r0-508.pdf
[6] https://ftp.cdc.gov/pub/FOIAREQ/182968_red-508.pdf
[7] https://www.cdc.gov/niosh/ocas/pdfs/abrwh/2017/wgtr111417-508.pdf

is more important than noting that errors exist. A small amount of missing routine or job-specific bioassay samples did not invalidate the radiation protection program at SRS and do not automatically invalidate the vast amounts of available monitoring data to generate a coworker model. There is no new information that would modify NIOSH's earlier conclusion, stated on page 170, that *"…dose reconstruction is feasible and sufficiently accurate through the use of the coworker model."*

SC&A question 4: Facility source term characterization and adequate internal dose

SC&A stated that they found the NIOSH response to this question to be nonresponsive because it focused on the 1999 guidance and the impact it had on source-term characterization but did not address the implications for prior years in the 1990s (Westinghouse era). NIOSH provided a detailed discussion about the radiological policies, procedures, and practices that occurred in the early 1990s in our response to SC&A comments on Report 92, Observation 1.[8]

SC&A stated *"Toward the end of [the DuPont] era, SRS source terms became more diverse and dynamic due to emerging and expanding operations, including decontamination and decommissioning (D&D), environmental cleanup, and waste management."* Although large-scale D&D operations did not start until after 1999, NIOSH acknowledges that during the mid-1980s through the late-1990s operations began to change from production to D&D, environmental cleanup and waste management activities. During the DuPont era, the focus was on producing plutonium. Fresh plutonium has very little americium content and the only significant dosimetric constituent is plutonium. As plutonium decays (e.g., ages), americium builds in concentration and can become a radionuclide of concern that may warrant separate analyses (e.g., whole body and chest counts, routine or special bioassays), especially during the Westinghouse era (>1990). The following paragraphs provide examples of protective measures taken by DuPont and Westinghouse over these years.

D&D: Large-building D&D was begun in 1993 under Westinghouse. DOE appropriated additional funds to perform demonstration D&D activities in R Area (non-radiological support buildings) and the 232–F facility (old tritium facility last used in 1958 and locked down). D&D of 232-F was completed by 1997 [WSRC 1998, PDF pp. 93-94; NRC 2001, PDF p. 43]. Radiation surveys of 232-F showed transferable contamination less than 500 dpm alpha and < 10,000 dpm/beta-gamma/0.1 m^2. A tritium survey found the maximum reading of 527,916 dpm on the Process Room balcony hood. [WSRC 1995, PDF p. 14]

SRS formed the Facilities Decommissioning Division (FDD) in 1996 [WSRC 1998, PDF p. 93]. FDD served as caretaker of surplus facilities until 2001 (performing only scoping and stabilization work) when the first D&D was conducted (M Area buildings) [WSRC 2000, PDF p. 98; WSRC 2002, PDF p. 48]. Note that this work was started after the site-wide source-term characterizations in 1999.

Environmental Cleanup: An example of environmental cleanup facilities in the 1980s was 341-M, a pre-engineered wastewater treatment facility and associated tank farm 341-1M, which were built to handle wastewater from the major M Area production facilities [WSRC 2006, PDF p. 193]. The facility was in operation from 1985 through 1990. The February 1985 issuance of the bioassay control procedure DPSOL 193-302T, Bioassay Control (Rev. 0) lists "Natural U" for personnel in the 300 areas. The first procedure by Westinghouse, the December 1992 issuance of Manual 5Q1.1, Procedure

[8] https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-91-r0-508.pdf

506 (Rev. 0), "In Vivo and In Vitro Bioassay Scheduling and Administration," listed enriched uranium specifically for 341-M and 341-1M [WSRC 1992, PDF p. 48].

In Report 91, Table A-3 lists the routine bioassay requirements and frequencies from 1985; Table A-5 lists those requirements from 1992.

Waste Management: One of the examples provided by SC&A as a location with a diversity of sources is Building 773-A. In Report 91's Table A-8, the Routine Bioassay urine bioassay requirements resulting from the 1999 characterization are compared to the bioassay requirements in the prior procedure, Manual 5Q1.1, Procedure 506 (Rev. 5). The only two analyses for all of the waste streams from Building 773-A were Pu and Am. The 1996 procedure required Pu, Sr, and Am for Building 773-A.

In Report 91, Table A-8 compares all Routine Bioassay analyses for comparable locations in the 1999 procedure and the 1996 bioassay control procedure.

SC&A question 5: Ramification of missed radionuclides

SC&A disagreed with NIOSH's response that key radionuclides were not "missed" before 1999 in the Routine Bioassay Sampling Program. We offer additional explanation that supports our original conclusion that key radionuclides were not "missed" as part of the Routine Bioassay Sampling Program and that doses can be reconstructed with sufficient accuracy for compensation purposes.

The 1999 site-wide source-term characterization identified those radionuclides that contributed to 90% or more of the worker dose at any location and resulted in the March 2, 1999 issuance of the bioassay control procedure, Manual 5Q1.1, Procedure 506 (Rev. 10), "In Vivo and In Vitro Bioassay Scheduling and Administration" [WSRC 1999, PDF p. 16]. This revision of the procedure does not have a bioassay frequency table. The bioassay types for the Routine bioassays and for Job-Specific or RWP bioassays are listed in the March 10, 1999 memo that summarizes the results of the site-wide characterization [Farrell and Findley 1999, PDF p. 10]. The six bioassay sample analyses for routine urine bioassays are:

- plutonium (Pu-238 and Pu-239)
- uranium (U-234, U-235, and U-238)
- neptunium (Np-237)
- americium (Am-241, Cm-244, Cf-252)
- strontium (Sr-90)
- tritium (H-3)

To reiterate, worker exposure from all radionuclides that may produce 90% or more of the dose at any SRS location (as determined in 1999) was monitored by one or more of those six analyses. The procedure included a requirement for Special Bioassay Samples whenever an exposure was suspected (e.g., a positive sample result under the Routine Bioassay Program).

The choice of analyses was straightforward in most locations, such as tritium for tritium-separation areas or plutonium for plutonium-separation areas. Monitoring for americium was a concern presented by SC&A in the November 2017 Work Group meeting. Monitoring for curium, also detected by the

same Am/Cm/Cf analysis, was a concern identified by the SRS Facilities Evaluation Board for burial ground workers. Report 91 includes a discussion of the application of this bioassay analysis type in the procedures and includes (in Section 5.4) an examination of the application of this analysis through the RWPs covering work at a facility not specifically listed in the bioassay control procedures [ORAUT 2019, PDF pp. 28–32].

The Routine Bioassay Program did not stand alone but was part of the larger worker protection strategy described in 1997 as "Defense in Depth" [LaBone 1997, PDF p. 3]. Although the philosophy is not named in earlier procedures as "Defense in Depth," SRS used (1) engineered and procedural controls, (2) workplace air sampling, (3) radiological surveys, (4) personal protective equipment, (5) personal worker monitoring (frisking), (6) routine whole body and chest counts, and (7) routine urine and fecal bioassays, throughout the 1970s, 1980s and 1990s. Workplace monitoring provided immediate results that reflected exposure conditions, as opposed to bioassay results obtained weeks to months afterwards. The Routine Bioassay Program was used to verify the effectiveness of the programs. The Special Bioassay Program was used to assign worker exposures.

Regardless of the methods SRS used to assign exposure, NIOSH reviews all worker bioassay results when performing dose reconstruction, including results from samples collected under the Routine Bioassay Program and under the Special Bioassay Program. NIOSH is aware of the limitations of the bioassay data and applies appropriate corrections and claimant-favorable assumptions. NIOSH has developed the SRS Co-Exposure Model for cases in which bioassay data are incomplete. The question is not if and when SRS met DOE Order and DOE Federal Code requirements, but rather, whether enough data are available to perform dose reconstruction for compensation purposes. Report 91 and other reports that have been created to respond to specific SC&A concerns affirm our conclusion that doses can be reconstructed with sufficient accuracy for compensation purposes.

Please contact me (jjc0@cdc.gov) if you have any questions or concerns.

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