

To: Savannah River Site Work Group and SEC Issues Work Group
From: SC&A, Inc.
Date: November 12, 2019
Subject: Review of NIOSH's Refined Construction Trade Worker Stratification Comparisons for Plutonium

Background

An important facet of the use of Savannah River Site (SRS) coworker models developed in ORAUT-OTIB-0081, revision 04 (NIOSH, 2019a, "OTIB-0081") is the assumption that subcontractor construction trade workers (CTWs) had the same work duties, and by extension, the same exposure potential, as the prime CTWs. In order to aid in evaluating this assumption, the National Institute for Occupational Safety and Health (NIOSH) performed an analysis, which was presented to the SRS work group in October 2017, that compared available plutonium urinalysis results in the NIOSH/Division of Compensation Analysis and Support Claims Tracking System (NOCTS) for three different worker strata: DuPont operational workers, DuPont CTWs, and subcontractor CTWs (NIOSH, 2017). That analysis stated the following regarding plutonium exposures and provided a supporting figure (figure 3 of NIOSH (2017), shown below as figure 1):

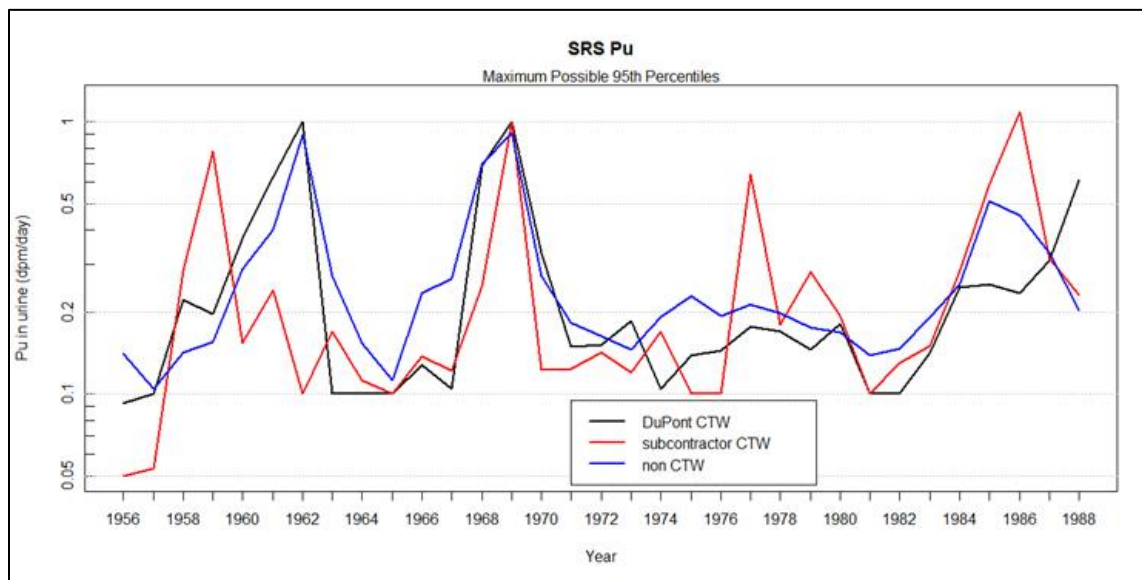
for most years there is little difference in the 95 percentile urinary excretion between DuPont CTWs and Subcontractor CTWs. The exception appears to be in the later 1970s and 1980s. This observation is somewhat supported by contemporary interviews with subcontractor CTWs. Subcontractor CTW indicated that they were called in for more contaminated work to save the exposure of the onsite CTWs. For some years (1977-1979 and 1984-1986) this appears to be the case in that the 95th percentile of the subcontractor CTWs is a factor of 2-5 higher. [NIOSH, 2017]

Subsequent discussion of this report with the SRS work group in November and December 2017 (SRS WG, 2017, and ABRWH, 2017, respectively) noted that the subcontractor estimates appear to closely mirror or bound DuPont CTW estimates from 1976 through 1987. Significant differences were noted in 1977, 1979, 1985, and 1986. These discussions prompted NIOSH to pursue a more rigorous analysis comparing DuPont CTWs to subcontractor CTWs during this time period. NIOSH provided its updated analysis in the white paper, "Savannah River Site Plutonium Construction Trade Worker Stratification Refinement" (NIOSH, 2019b). This memorandum represents SC&A's review of that white paper.

DISCLAIMER: This is a working document provided by the Centers for Disease Control and Prevention (CDC) technical support contractor, SC&A, for use in discussions with the National Institute for Occupational Safety and Health (NIOSH) and the Advisory Board on Radiation and Worker Health (ABRWH), including its Working Groups or Subcommittees. Documents produced by SC&A, such as memorandum, white paper, draft or working documents are not final NIOSH or ABRWH products or positions, unless specifically marked as such. This document prepared by SC&A represents its preliminary evaluation on technical issues.

NOTICE: This document has been reviewed to identify and redact any information that is protected by the [Privacy Act 5 USC §552a](#) and has been cleared for distribution.

Figure 1. NIOSH evaluation of plutonium urinalysis for DuPont construction trade workers, DuPont nonconstruction trade workers, and subcontractor construction trade workers from 1956 through 1988 (reproduced from NIOSH (2017))



Summary of NIOSH Results

The NIOSH white paper compiled additional data from available bioassay laboratory logbooks, where necessary,¹ and evaluated the years 1974, 1977, 1980, 1983, and 1986 for relative plutonium exposure. These data were then analyzed via current coworker analysis methods to derive annual excretion rates in order to model plutonium intakes in accordance with the current coworker modeling guidelines in the following NIOSH technical guidance:

- ORAUT-OTIB-0019, revision 01, “Analysis of Coworker Bioassay Data for Internal Dose Assignment” (NIOSH, 2005)
- (ORAUT-RPRT-0053, revision 02, “Analysis of Stratified Coworker Datasets” (NIOSH, 2014)
- ORAUT-OTIB-0060, revision 02, “Internal Dose Reconstruction” (NIOSH, 2018)

The resulting excretion rate comparison and derived intake rates from NIOSH (2019b) are shown in tables 1 and 2, respectively.

¹ Per NIOSH (2019b), additional coding of laboratory logbook bioassay results was only necessary for subcontractor workers during the years 1974, 1983, and 1986.

Table 1. Geometric mean and 95th percentile urinary excretion rates reported in NIOSH (2019b)

Year	Geometric mean DuPont CTW excretion rate (dpm/1.5 L)	Geometric mean subcontract CTW excretion rate (dpm/1.5 L)	Geometric mean ratio (DuPont/Sub)*	95th percentile DuPont CTW excretion rate (dpm/1.5 L)*	95th percentile subcontract CTW excretion rate (dpm/1.5 L)*	95th percentile ratio (DuPont/Sub)*
1974	0.004689	0.001439	3.26	0.122	0.039	3.12
1977	0.003447	0.001745	1.98	0.047	0.041	1.13
1980	0.005597	0.009319	0.60	0.110	0.165	0.67
1983	0.007492	0.005914	1.27	0.118	0.094	1.26
1986	0.01141	0.00917	1.24	0.091	0.121	0.75

*Value is not specifically reported in NIOSH (2019b) and is calculated by SC&A based on the reported geometric standard deviation.

Table 2. Geometric mean and 95th percentile derived intake rates reported in NIOSH (2019b)

Years, solubility type	Geometric mean DuPont CTW intake rate (dpm/d)	Geometric mean subcontract CTW intake rate (dpm/d)	Geometric mean ratio (DuPont/Sub)*	95th percentile DuPont CTW intake rate (dpm/d)	95th percentile subcontract CTW intake rate (dpm/d)	95th percentile ratio (DuPont/Sub)*
1973–1978, M	0.7732	0.325	2.38	14.349	8.00	1.79
1973–1978, S	15.71	6.97	2.25	268.7	169.4	1.59
1979–1987, M	1.426	1.293	1.10	16.215	19.17	0.85
1979–1987, S	26.38	22.65	1.17	279.2	326.1	0.86

*Value is not specifically reported in NIOSH (2019b)

NIOSH (2019b) concludes:

As can be seen by examination of the tables above, the geometric mean (GM) of the results for the DuPont CTWs are higher than that for the subcontractor CTWs for all years evaluated. For the 1973 through 1978 period, the 95th percentile intake results for the DuPont CTWs are higher as well. For the 1979 through 1987 period, the subcontractor CTWs do have a higher 95th percentile due to the higher geometric standard deviation (GSD) of the data. . . .

NIOSH believes it is reasonable to combine all CTWs into a single stratum for assignment of intakes in the SRS internal dose coworker study. [NIOSH, 2019b, pp. 6–7]

SC&A General Comments

As noted in the previous section and in NIOSH (2019b), at the 95th percentile, the subcontractor CTWs had higher excretion rates and derived intakes than DuPont CTWs for the period 1979 through 1987. This is consistent with figure 1, which was originally produced by NIOSH and previously demonstrated that urinalysis results for subcontractor CTWs were either comparable to, or higher than, those of the DuPont construction workers. This is significant because the coworker model assignments for unmonitored construction workers have been proposed by NIOSH to be assigned at the 95th percentile (SRS WG, 2017, p. 27).

Furthermore, a tabulation of the relative number of monitored claimant subcontract construction trade workers by year versus claimant DuPont CTWs found in NIOSH (2017) shows a significant increase in the number of monitored subcontractors beginning in approximately 1980 (see figure 2, below). In addition, figure 5-1 (page 13) of ORAUT-RPRT-0094, revision 00, “Bioassay for Subcontractor Construction Trade Workers at the Savannah River Site from 1972 to 1997” (NIOSH, 2019c), also indicates a general increase in the number of claimant subcontract workers beginning in the late 1970s and into the 1980s (see figure 3). Therefore, SC&A believes the fact that subcontract workers exhibit higher urinary excretion rates at the 95th percentile of the distribution during this period is significant from the viewpoint of appropriate stratification.

Finding 1: In SC&A’s opinion, the conclusion that subcontractor construction trade workers had higher excretion rates and derived intakes at the 95th percentile is significant from the standpoint of stratification because the 95th percentile is what is proposed for assignment to unmonitored subcontract construction workers.

Figure 2. NIOSH evaluation of the relative number of DuPont construction trade worker and subcontractor construction trade worker claimants monitored for plutonium from 1956 through 1988 (NIOSH, 2017)

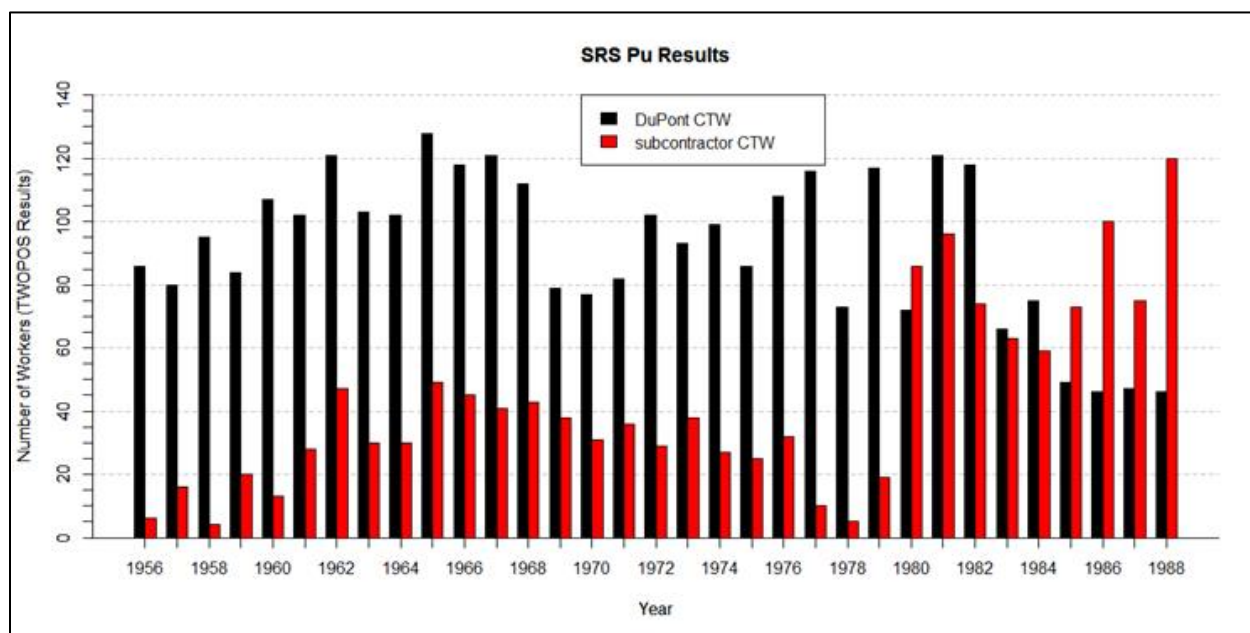
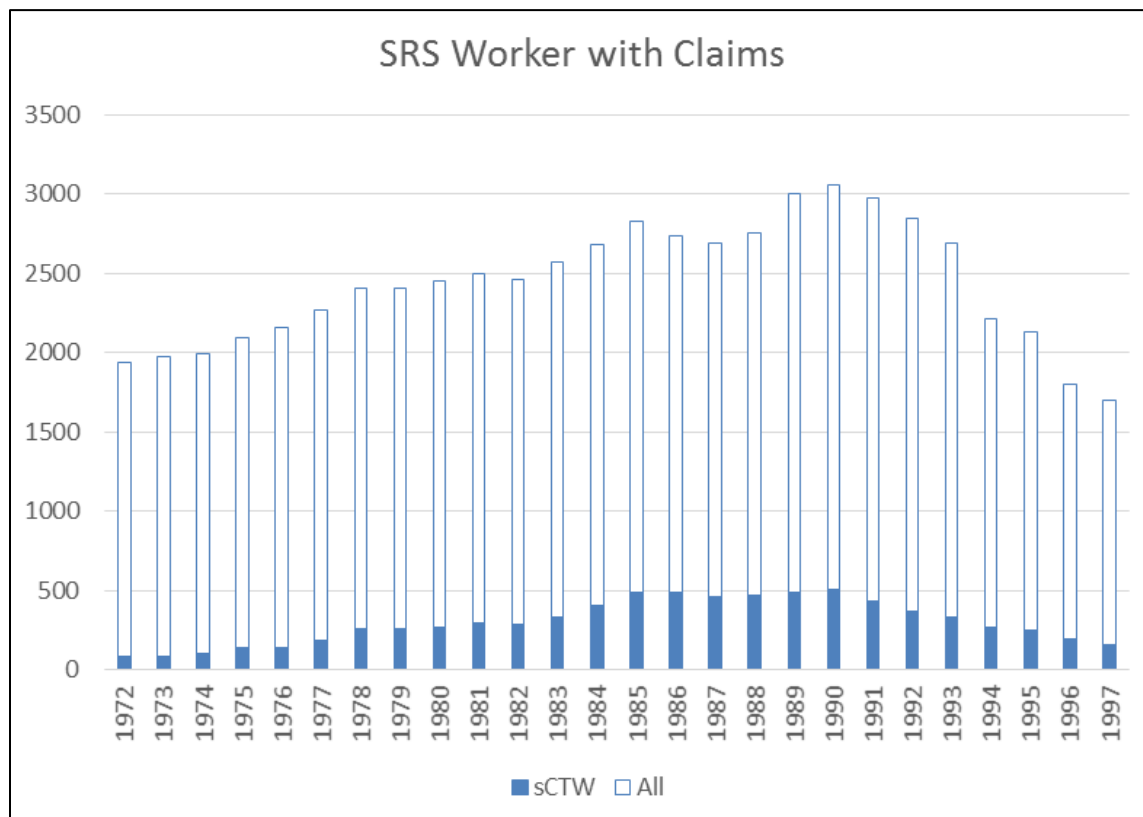


Figure 3. Number of subcontractor construction trade worker claimants compared to all other SRS workers with claims as of August 2018 (NIOSH, 2019c, p. 13)



It is important to note that the evaluation provided in NIOSH (2019b) only consisted of 5 of the 18 years during the DuPont period (pre-1990). Additional data were only coded from the SRS logbooks for subcontractors and then for only 3 of the 18 DuPont years (1974, 1983, and 1986). In light of subcontractor construction workers showing elevated urinalysis values and derived intakes at the 95th percentile during the 1979–1987 period, a more rigorous analysis may be warranted to determine the extent to which such differences exist (or do not exist) in other years during the Special Exposure Cohort (SEC) period (post-September 1972).

Observation 1: The evaluation in NIOSH (2019b) was limited to 5 years during the DuPont Era (1972–1989), and additional data (beyond previously captured NOCTS data) were coded for only subcontractors during 3 of these 5 years. Given that subcontract construction workers showed higher derived intakes at the 95th percentile from 1979 through 1987, a more rigorous analysis during the SEC period may be appropriate to determine the extent to which such differences exist in other years, which may further prompt the need for stratification.

SC&A Review of Subcontractor Designations

NIOSH (2019b) identifies subcontract workers based on their payroll identification number (PRID) and states the following concerning the interpretation of PRIDs:

This original CTW dataset was stratified into prime versus subcontractor workers using SRS payroll identification (PRID) numbers. The PRID format protocol for subcontract CTWs is as follows:

- n-xxxxx where the prefix “n” is either 4, 5, 6, or a two digit number such as [REDACTED]. The number to the right of the dash must be 5 digits. Examples are [REDACTED]
- xxxxx where xxxxx is a 5-digit number with no dashes. An example is [REDACTED]. An example of a PRID to skip is [REDACTED]

Each result with a PRID meeting the above criteria was considered a subcontractor CTW. All other results were considered prime CTW related results. [NIOSH, 2019b, p. 3]

SC&A examined the U.S. Department of Labor case files for 35 randomly selected claimants designated as subcontractors in the NIOSH (2019b) analysis. SC&A found that 13 of 35 (~37 percent) reviewed claims indicate employment with the prime contractor despite their PRID numbers fitting the above criteria for subcontractors. A summary of these 13 claims is shown in table 3.

Table 3. Summary review of 13 claimants with potentially incorrect designation as a subcontractor

Case*	Claim	PRID(s)	Job Title(s)	DOL Initial Case Notes
A	[Redacted]	[Redacted]	Sheetmetal Worker	Only lists DuPont, Bechtel, and Westinghouse Savannah River Company (WSRC) as the covered employers (pp. 2–4, 8, 9). The Occupational Work History lists DuPont as the employer during the period of interest (p. 58). A copy of the energy employee’s (EE’s) resume also lists DuPont as the employer during the period of interest (p. 77).
B	[Redacted]	[Redacted]	[Redacted]	Page 19 indicates employment with E. I. DuPont Savannah River, then Bechtel in 1989, followed by Westinghouse for 1997–present. The general description of work duties also lists employment with the prime contractor (p. 147). A medical report from 1979 lists the employer as E. I. DuPont (p. 1094). Finally, [REDACTED], as well as a [REDACTED] from 1991, lists E. I. DuPont as the employer during the period of interest (pp. 768, 1123).
C	[Redacted]	[Redacted]	Carpenter	The only employers mentioned are DuPont and Bechtel on standard EE-3 form; there is no mention of any subcontractor employment (pp. 4–5). Termination of employment form from 1992 checks “Bechtel Savannah River” rather than “Other” (p. 15).

Case*	Claim	PRID(s)	Job Title(s)	DOL Initial Case Notes
D	[Redacted]	[Redacted]	Sheetmetal Worker	Page 3, which displays the NIOSH Referral Summary Document, lists E. I. DuPont as the employer. Form EE-3 lists three subcontractors in addition to E. I. DuPont. EE-3 indicates employment with DuPont was from 1952 through 1988; however, the actual covered employment is intermittent during this period. Two of the identified subcontractors indicate employment for just a few months, one of which was in 1973 (outside the covered employment periods). The other two subcontractor entries do not provide a timeframe (p. 7).
E	[Redacted]	[Redacted]	[Redacted]	On page 2, the Statement of Accepted Facts states: "The claimant reported on the EE-3 that [the EE] worked for Dupont Bechtel at Savannah River Site at Aiken SC from [redacted]. . . DOE verified and confirmed employment dates to be [redacted]. No other employment history is reported." Medical admission form contains an entry for "employer," but the entry is illegible (p. 35).
F	[Redacted]	[Redacted]	Sheetmetal Worker	Page 3 indicates DuPont and WSRC as the employers. The Verification of Employment form checks "verified" and "contractor" (does not check "subcontractor"). The file labelled as "DOL ANRSD Return" contains the "Statement of Case" on page 59, which states, "you specifically alleged that you had worked for E.I. Dupont and Westinghouse at the Savannah River Site. . . . The Department of Energy verified your employment history for the Savannah River Site." Additional note: Computer-assisted telephone interview conducted with EE indicates their supervisors from DuPont and Bechtel.
G	[Redacted]	[Redacted]	Construction Worker	Page 7 lists DuPont and Westinghouse as the employer. Pages 10–11 contain the Employment Verification Sheet, which lists DuPont and WSRC with "contractor" checked ("subcontractor" is not checked).

Case*	Claim	PRID(s)	Job Title(s)	DOL Initial Case Notes
H	[Redacted]	[Redacted]	[Redacted]	<p>The NIOSH Referral Summary Document indicates employment with the Nooter Corporation at SRS until April 1972 before changing employment to DuPont and then Bechtel (p. 3). The Employment Verification Sheet checks the box “contractor” and lists DuPont (p. 19). Page 60 contains the Occupational History Interview, which affirms employment with DuPont and Bechtel during the SEC period.</p> <p>Additional note: The bioassay records provided by DOE appear to have a sticky note on the record that indicates: [Redacted] (see DOE Response page 21). Whole body count records from 1988 and 1990 also reflect this PRID.</p>
I	[Redacted]	[Redacted]	[Redacted]	<p>The NIOSH Referral Document and EE-3 form both indicate DuPont and Westinghouse as the employer (pp. 3, 7). A Request for Review by Medical Panels form affirms employment with the prime contractors (p. 115). A [Redacted] form from 1988 indicates the employer was DuPont (p. 123). Page 141 contains a detailed work history, which indicates DuPont at the start of covered employment.</p>
J	[Redacted]	[Redacted]	Sheetmetal Worker	<p>Form EE-3 lists the employer as DuPont Construction (p. 5), which is also listed on pages 125, 130, and 137. The EE-5 Employment Verification form indicates employment by the “contractor,” not a “subcontractor” (p. 105). EEOICPA-related correspondence also indicates employment with DuPont (p. 125). The Occupational History Interview further affirms employment with the prime contractor (DuPont) (pp. 130, 137).</p>
K	[Redacted]	[Redacted]	Transportation	<p>For EE-3 only lists E.I. DuPont as the employer. Page 19 contains a medical form from 1988 that lists E.I. DuPont under “usual occupation.” Three additional medical admission forms from 1987 and 1988 indicate E. I. DuPont as the employer (pp. 41, 42, and 46).</p>
L	[Redacted]	[Redacted]	Sheetmetal Worker	<p>The NIOSH Referral Summary document lists the employers only as Bechtel and DuPont (pp. 3–4). The Employment Verification Sheet indicates “DUPONT” and checks “contractor” (does not check the “subcontractor” option) (p. 8).</p>
M	[Redacted]	[Redacted]	Laborer	<p>On page 2, the Statement of Accepted Facts states: “was employed with Westinghouse, a DOE contractor at Savannah River as a laborer from June [Redacted] 1978 to October [Redacted] 2000.” Page 24 contains a medical record that lists the employer as Westinghouse/Bechtel.</p>

*Arbitrarily assigned case designation for this report only.

Finding 2: A review of 35 randomly selected subcontractor claimants used in the NIOSH analysis indicated that 13 of 35 (~37 percent) may have been incorrectly categorized as subcontractors using the PRID number as the sole indicator.

The remaining 22 of the 35 reviewed claims all contained evidence of employment with subcontractors. SC&A also reviewed 25 randomly selected claimants designated as prime contract workers in the NIOSH (2019b) analysis, with all 25 appearing to be correctly assigned to the prime contract worker category.

SC&A Comments on Additional Data Coding

As noted above, NIOSH (2019b) coded additional bioassay data for subcontractors during the years 1974, 1983, and 1986 in order to increase the number of results to a sufficient level for analysis. In short, the subcontractor evaluation for these years contains a combination of claimant monitoring and nonclaimant monitoring, while all other evaluations use only claimant monitoring. SC&A presumes the guiding assumption to justify this expansion is that the claimant population represents the same exposure potential as the nonclaimant population, as concluded in ORAUT-OTIB-0075, revision 01, “Use of Claimant Datasets for Coworker Modeling” (NIOSH, 2016a).²

To gain additional information as to the effect of adding nonclaimant data in the narrow context of this review, SC&A evaluated the subcontractor claimant data and additional logbook data separately for the years 1974, 1983, and 1986 as shown in table 4. The first thing to note is that the amount of additional logbook data for these 3 years is roughly nine times greater than the amount of claimant data. Therefore, any evaluation of the combined subcontractor strata would be dominated by the additional logbook data. By most of the evaluation criteria presented in table 4 (e.g., arithmetic average, rank order 95th percentile, and lognormal geometric mean), the claimant population has higher urinary excretion rates than the additional logbook subcontractor population. This trend was also apparent for 1974 when examining the lognormally fit 95th percentile values.

Observation 2: The urinary excretion rates for claimant subcontractors at the average and lognormal geometric mean suggest a higher exposure potential than nonclaimant subcontractors for the years in which nonclaimant data were used to supplement the evaluation (1974, 1983, and 1986). Because nonclaimant data dominate the evaluated subcontractor population in these years, this could have a significant effect on the combined subcontractor analysis and subsequent comparison to prime contract workers.

² SC&A reviewed revision 00 of ORAUT-OTIB-0075 (NIOSH, 2009) in 2010 and currently has 13 active findings associated with that review.

Table 4. Comparison of claimant subcontractors and additional logbook subcontractors for the years 1974, 1983, and 1986

Category	1974	1983	1986	SC&A comments
Total number of subcontractors evaluated	216	641	1,130	The total evaluated subcontractor workers for the remaining 2 years was just 69 (1977) and 83 (1980). By comparison, the number of claims for 1985 (in which additional data were deemed necessary) was 97 (see row below).
Number of claimants (% of total)	26 (12%)	63 (10%)	97 (9%)	Claimant population represents just 10% of the evaluated strata.
Number of additional logbook workers (% of total)	190 (88%)	578 (90%)	1,033 (91%)	Additional logbook workers constitute approximately 90% of the evaluated strata.
Claimant arithmetic average	0.024	0.028	0.047	Claimant population bounds the additional logbook workers for all 3 years.
Logbook arithmetic average	0.011	0.023	0.043	<i>No additional comments.</i>
Claimant rank order 95th percentile	0.1000	0.1000	0.1183	Claimant population bounds the additional logbook workers for 1974 and is equal for 1983 and 1986.
Logbook rank order 95th percentile	0.0797	0.1000	0.1183	<i>No additional comments.</i>
Claimant lognormally fit geometric mean	0.0105	0.0139	0.0266	Claimant population significantly bounds the additional logbook workers for all 3 years.
Logbook lognormally fit geometric mean	0.0009	0.0037	0.0098	<i>No additional comments.</i>
Claimant lognormal 95th percentile	0.0568	0.0855	0.1533	Claimant population bounds the additional logbook workers for 1974 though is lower for 1983 and 1986.
Logbook lognormal 95th percentile	0.0352	0.0991	0.2011	<i>No additional comments.</i>

SC&A Comments on Regression Analysis

NIOSH (2019b) noted that oftentimes the available hardcopy data did not provide a normalized volumetric urinalysis result (i.e., disintegrations per minute (dpm)/day or dpm/1.5 liters (L)) but rather provided only an activity per sample disc (i.e., dpm/disc). NIOSH notes that without specific knowledge of the laboratory practices and standard calculation steps, it is not possible to convert the results given in dpm/disc to a standard volumetric result (dpm/1.5 L) in a typical manner. Therefore, NIOSH adopted an approximate approach in which a regression line was fit to pairs of data containing a numerical result for both dpm/disc and dpm/1.5 L. The underlying assumption is that there is a linear relationship between the two bioassay quantities. NIOSH developed the following linear regression parameters for each of the five years under analysis:

- 1974: slope = 8.9815, intercept = -0.1165
- 1977: slope = 8.9292, intercept = -0.0886
- 1980: slope = 8.8899, intercept = -0.0877
- 1983: slope = 8.9682, intercept = -0.0897
- 1986: slope = 6.5474, intercept = -0.0385

Typically, when results are provided in the form of disintegrations per minute, as opposed to a raw quantity such as counts per minute, factors such as detection efficiency, chemical yield, and the branching ratios for the individual nuclide have already been taken into account. Therefore, the remaining unknown quantity would simply be the amount of aliquot that had been evaporated onto the disc prior to measurement. If the quantity of aliquot evaporated on each disc is reasonably constant, then a simple ratio should be sufficient to scale the result from dpm/disc to dpm/1.5 L.

However, SC&A's examination of the available database supplied by NIOSH identified sample results in which the dpm/disc result was zero or negative, yet a positive volumetric result (dpm/1.5 L) was recorded (see table 5). SC&A checked each of these pairs against the hardcopy logbook results to assure the accuracy of the transcription as found in column 5 of table 5. As seen in the table, several of the observed pairs used in the NIOSH (2019b) analysis appear to be in error. No quality assurance criteria were provided in NIOSH (2019b) to indicate the veracity of the transcription of hardcopy data underpinning the resulting analysis. Such an analysis should be conducted to assure that data transcribed from SRS laboratory logbooks are sufficiently accurate and within the acceptable bounds established in ORAUT-RPRT-0078, revision 00, "Technical Basis for Sampling Plan" (NIOSH, 2016b). That document establishes acceptable levels of transcription errors when data must be manually transcribed from hardcopy records.

Finding 3: NIOSH (2019b) does not provide a discussion of or evidence that a quality assurance evaluation of the transcribed plutonium logbook data was performed to assure that derived excretion rates are sufficiently accurate for an effective comparison of the two strata of interest (subcontractors and prime contractors).

In analyzing the plutonium disc data, SC&A identified several data pairs that contain a zero or negative result for dpm/disc but were associated with a volumetric bioassay result that was positive (see the first four rows of table 5). The verified data pairs call into question the use of a linear regression analysis to convert dpm/disc to dpm/1.5 L; however, such data pairs also raise questions about the veracity of the method in which a negative/zero measurement of an aliquot disc could result in a positively reported bioassay quantity.

SC&A raised similar questions regarding the americium (Am)/curium/californium bioassay results discussed in SC&A's review of the SRS coworker model (SC&A, 2019) in OTIB-0081. The SRS coworker model in OTIB-0081 uses claimant data in NOCTS for the formulation of coworker intakes; therefore, the variation of such data pairs in the hardcopy logbook results is not relevant to that document.

Table 5. SC&A-identified data pairs showing a negative/zero measurement with a positively reported volumetric bioassay quantity

SRDB Ref ID, PDF pages	Dpm/disc result	Dpm/1.5 L result	SC&A verification comment
51970, 24–25	0	0.002	Verified.
53263, 215–216	-0.003	0.113	Verified.
172166, 286–287	0	0.09	Verified.
172171, 42–43	0	0.038	Verified.
51970, 108–109	-0.013	0.008	In error: Transcription appears to equate raw Pu measurements (dpm/disc) with raw Am measurements (dpm/disc).
172169, 164–165	-0.005	0.0135	In error: Correct entry for dpm/1.5 L should be -0.135.
172169, 156–157	-0.001	0.098	In error: Correct entry for dpm/1.5 L should be -0.098.
172166, 250–251	0	0.091	Likely in error: Entries appear to read “-.000” and “-0.091.”
172169, 174–175	0	0.092	Likely in error: Entries appear to read “-.000” and “-.092.”
52022, 28–29	-0.038	0.7	Potentially in error: Interpretation of this record is difficult, as the dpm/disc results are listed in linear order and the dpm/1.5 L results are in block form. The actual data pairs may have been mixed up as a result.
172171, 103–104	-0.003	0.121	Potentially in error: Record is difficult to interpret; there is either a negative sign or a decimal on the record. If it is a negative sign, then there is no decimal and vice versa.
52022, 16–17	-0.001	0.448	Potentially in error: Dpm/1.5 L value is crossed out; therefore, it is difficult to tell if the result should have been “-.448.”

Observation 3: SC&A identified data pairs in which a zero or negative measurement of the activity on a given aliquot disc (dpm/disc) was reported as a positive volumetric bioassay result (dpm/1.5 L). SC&A believes this calls into question whether a reasonable numerical relationship between the individual aliquot measurements and normalized volumetric bioassay results can be effectively derived.

To further evaluate the accuracy of the regression formulas presented in NIOSH (2019b), SC&A compared the available measurement pairs (dpm/disc and dpm/1.5 L) in cases where both quantities were positive against the predicted result based only on the dpm/disc result and the associated regression formula. While some data pairs were predicted by the regression formulas with reasonable accuracy (especially at higher relative values), SC&A found that the regression analysis had a particularly poor fit for the years 1980 and 1986, as shown in figures 4 and 5.

Finding 4: The use of a regression analysis to convert raw bioassay results (dpm/disc) to a volumetric result (dpm/1.5 L) has not been technically justified and does not appear scientifically defensible.

Figure 4. Comparison of the actual dpm/disc and dpm/day data pairs against predicted dpm/day values for 1980

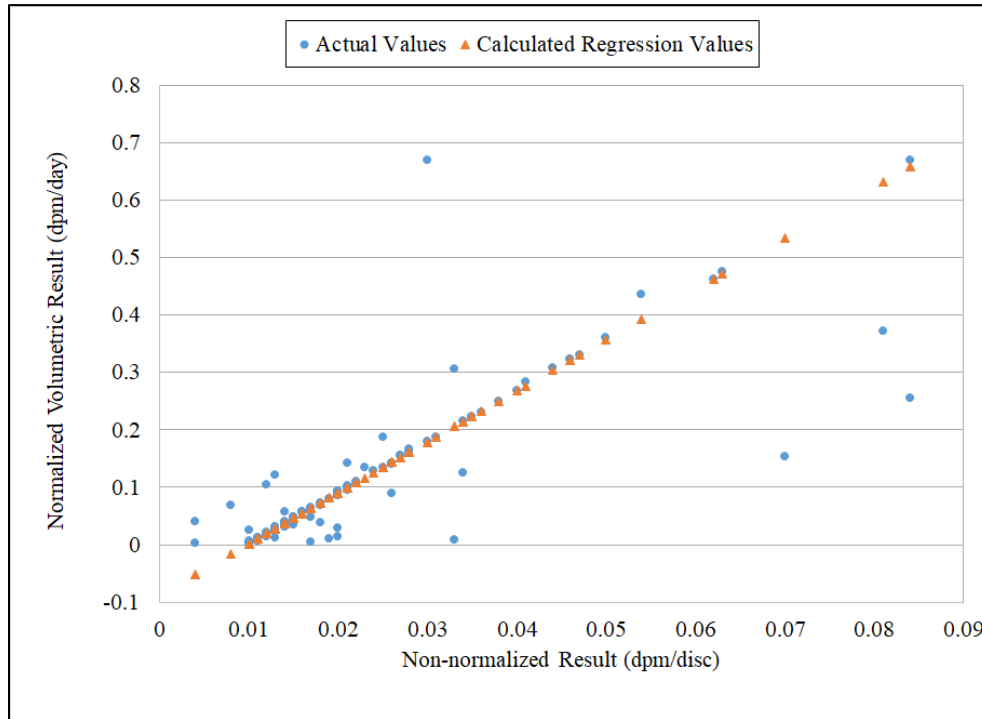
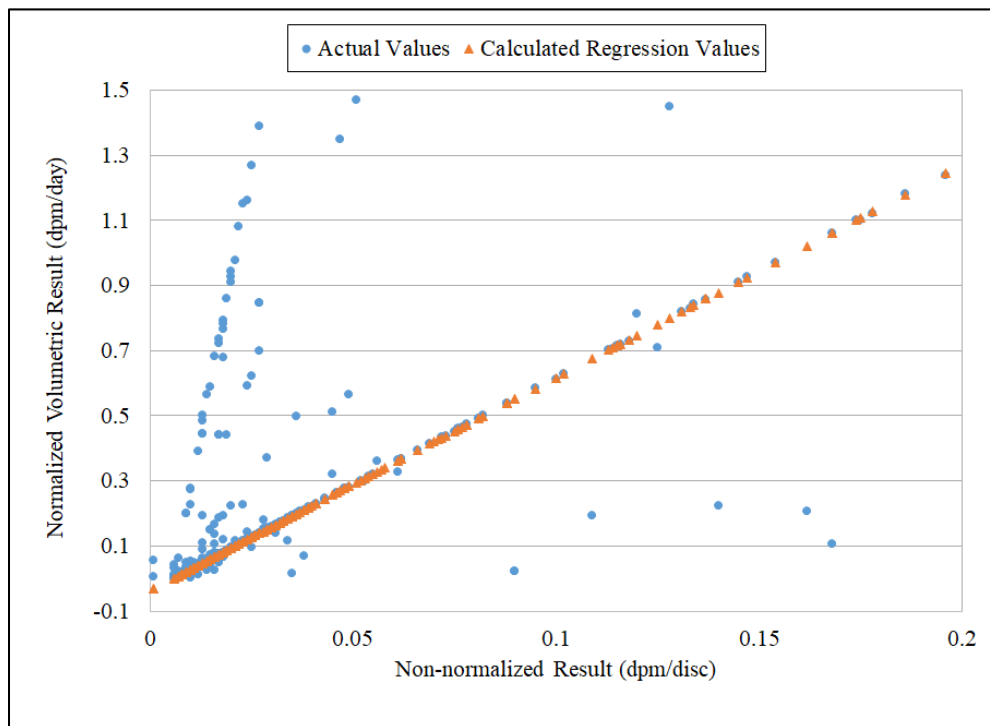


Figure 5. Comparison of the actual dpm/disc and dpm/day data pairs against predicted dpm/day values for 1986



Summary Conclusions

The analysis presented in NIOSH (2019b) is limited to only a handful of years for evaluation (1974, 1977, 1980, 1983, and 1986) and restricted to claimant data, with the exception of subcontractors in 1974, 1983, and 1986 for which additional data were coded (see observations 1 and 2). Evaluation of the additional data suggests that the exposure potential for claimant subcontractors during these years may be higher at the average and geometric mean levels than the nonclaimant subcontractors. This is also true for 1974 when the lognormal 95th percentile is higher for claimant subcontractors than for nonsubcontractors (see observation 2).

In addition, SC&A notes that no quality assurance tests were discussed in NIOSH (2019b), though SC&A identified erroneous transcription errors associated with the dataset (see finding 3 and observation 3). Furthermore, SC&A does not agree that the use of a linear regression method to further expand the dataset when normalized volumetric bioassay measurements are unavailable is scientifically accurate or defensible (see finding 4). SC&A has concerns about the quality assurance protocol used in transcribing the additional logbook data (see finding 3), and evidence also suggests that the methodology relying solely on PRID numbers to identify subcontractors may erroneously include prime contractors in the subcontractor strata (see finding 2).

Nonetheless, at face value, the NIOSH (2019b) evaluation demonstrates that subcontract CTWs had higher estimated intakes at the 95th percentile than nonsubcontract CTWs for 1979–1987. Thus, SC&A does not agree that it has been demonstrably shown that subcontracted and nonsubcontracted CTWs are part of the same worker stratification for the purposes of coworker modeling and thus can be appropriately combined (see finding 1). SC&A suggests that further analysis be provided before such a conclusion can be reached. Further analysis might include (1) expansion to the remaining years of SEC-103, (2) expansion to include logbook results in all strata evaluations, (3) quality assurance checks on the transcribed data, (4) confirmation of subcontractor designations, and (5) removal of the regression methods employed in NIOSH (2019b).

References

- Advisory Board on Radiation and Worker Health (ABRWH). (2017). *Advisory Board on Radiation and Worker Health 120th meeting Wednesday December 13, 2017* [Transcript]. Albuquerque, NM. Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/abrwh/2017/tr121317-508.pdf>
- E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1973–1979). *Pu-Am record book 10-22-1973 thru 2-1-1979*. Retrieved from SRDB Ref. ID 51970
- E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1975–1976). *Pu book #13 10-23-1975 to 10-21-1976*. Retrieved from SRDB Ref. ID 53263
- E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1982–1984). *Plutonium electrodeposition logbook 27, January 1982–June 1984*. Retrieved from SRDB Ref. ID 172166

E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1983–1984). Plutonium electrodeposition logbook 28, July 1983–May 1984. Retrieved from SRDB Ref. ID 172169

E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1986–1988). Plutonium electrodeposition logbook 31, July 1986–February 1988. Retrieved from SRDB Ref. ID 172171

E. I. DuPont De Nemours and Company, Savannah River Plant (DuPont). (1986–1989). *Pu-Am record book 6-25-1986 thru 8-9-1989*. Retrieved from SRDB Ref. ID 52022

National Institute for Occupational Safety and Health (NIOSH). (2005). *Analysis of coworker bioassay data for internal dose assignment* (ORAUT-OTIB-0019, rev. 01). Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/tibs/or-t19-r1.pdf>

National Institute for Occupational Safety and Health (NIOSH). (2009). *Use of claimant datasets for coworker modeling* (ORAUT-OTIB-0075, rev. 00). Retrieved from SRDB Ref. ID 67223

National Institute for Occupational Safety and Health (NIOSH). (2014). *Analysis of stratified coworker datasets* (ORAUT-RPRT-0053, rev. 02). Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-53-r2.pdf>

National Institute for Occupational Safety and Health (NIOSH). (2016a). *Use of claimant datasets for coworker modeling* (ORAUT-OTIB-0075, rev. 01). Retrieved from SRDB Ref. ID 157060

National Institute for Occupational Safety and Health (NIOSH). (2016b). *Technical basis for sampling plan* (ORAUT-RPRT-0078, rev. 00). Retrieved from SRDB Ref. ID 156949

National Institute for Occupational Safety and Health (NIOSH). (September 29, 2017). *Analysis of DuPont CTWs vs. subcontractor CTWs* [Email communication from T. Taulbee to B. P. Clawson and J. M. Melius]. SRDB upload pending

National Institute for Occupational Safety and Health (NIOSH). (2018). *Internal dose reconstruction* (ORAUT-OTIB-0060, rev. 02). Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/tibs/or-t60-r2-508.pdf>

National Institute for Occupational Safety and Health (NIOSH). (2019a). *Internal coworker dosimetry data for the Savannah River Site* (ORAUT-OTIB-0081, rev. 04). Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/tibs/or-t81-r4-508.pdf>

National Institute for Occupational Safety and Health (NIOSH). (2019b). *Savannah River Site plutonium construction trade worker stratification refinement*. Retrieved from https://www.cdc.gov/niosh/ocas/pdfs/dps/176875_red-508.pdf

National Institute for Occupational Safety and Health (NIOSH). (2019c). *Bioassay for subcontractor construction trade workers at the Savannah River Site from 1972 to 1997* (ORAUT-RPRT-0094, rev. 00). Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/orau/oraurpts/or-rprt-94-r0-508.pdf>

SC&A, Inc. (SC&A). (2019). *Review of ORAUT-OTIB-0081, revision 04, "Internal coworker dosimetry data for the Savannah River Site."* Retrieved from SRDB Ref. ID 178392

Savannah River Site Work Group (SRS WG). (2017). *U.S. Department of Health and Human Services Centers for Disease Control National Institute for Occupational Safety and Health Advisory Board on Radiation and Worker Health Work Group on Savannah River Site, Tuesday, November 14, 2017* [Transcript]. Hebron, KY. Retrieved from <https://www.cdc.gov/niosh/ocas/pdfs/abrwh/2017/wgtr111417-508.pdf>