NIOSH Response to SC&A's Review of SEC-00188 Sandia ER Addendum 2

Response Paper

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BACKGROUND

In Addendum 2 of the SEC-00188 Sandia National Laboratories-Albuquerque SEC evaluation report (ER) [NIOSH 2019], the National Institute for Occupational Safety and Health (NIOSH) provided dose reconstruction feasibility assessments for 1997–2011. This time period was previously left unevaluated in the SEC-00188 ER covering 1963-1994 [NIOSH 2012], and in the subsequent Addendum covering 1995-1996 [NIOSH 2018]. In those two reports, NIOSH defined classes of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. When combined, these previously-identified classes include all employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at Sandia National Laboratories in Albuquerque, New Mexico, from January 1, 1963 through December 31, 1996.

In Addendum 2 of the SEC-00188 ER, NIOSH presented dose reconstruction feasibility conclusions for all personnel who worked in any area at Sandia National Laboratories in Albuquerque, New Mexico, for the period from January 1, 1997 through May 21, 2011. Based on information obtained regarding post-1996 occupational monitoring, as well as program policies and procedures related to implementation of SNL-A's radiation protection program, NIOSH found no part of the class for which it cannot estimate radiation doses with sufficient accuracy.

PURPOSE AND SCOPE

On April 17, 2019, SC&A was tasked by the Advisory Board on Radiation and Worker Health (Advisory Board) with evaluating Addendum 2 of the SEC-00188 Sandia ER [ABRWH 2019]. On December 4, 2020, SC&A issued its findings and observations [SC&A 2020]. SC&A reviewed Addendum 2 with a focus on: (1) its assessment and conclusion for post-1996 internal dose reconstruction; and (2) remaining issues in the SEC-00188 ER for 1963–1994 related to its assessment and conclusions regarding occupational medical dose, environmental occupational dose, and external dose reconstruction [NIOSH 2012]. This Response paper provides NIOSH's response to SC&A's findings and observations.

SUMMARY

Four lines of inquiry comprised the core basis of SC&A's review of Addendum 2 of the SEC-00188 Sandia ER. Notwithstanding the comments described herein, SC&A reached the following conclusions [SC&A 2020, PDF pp. 52–53]:

1. ***Question 1: Is the weight of evidence presented by NIOSH in Addendum 2 (as supported by Addendum 1 and the original SEC-00188 ER) sufficient to support***

dose reconstruction with sufficient accuracy for external doses by December 31, 1994, and for internal doses by December 31, 1996?

SC&A concludes for external doses that there were no evident issues that would preclude dose reconstruction with sufficient accuracy, although there still remain several questions about how exposures by personnel to severe radiation gradients at the SPR were handled by SNL, and how NIOSH will apply the available dosimetry data to dose reconstruction. For internal dose, the weight of evidence supports the feasibility of dose reconstruction with sufficient accuracy for the time period in question.

However, SC&A was unable to verify fully the completeness of BZ monitoring results due to the lack of available records from which the total number of workers monitored via BZ, or the total number of BZ samples issued and processed, could be tabulated. These shortcomings are mitigated by the conservatism in NIOSH's approach, including (1) conservative selection of radionuclides of interest (e.g., Pu-239), (2) no credit taken for respiratory protection, and (3) the observed number of BZ samples per worker, which fell far short of the 200 events calculated in Addendum 2 as necessary to exceed the 100 mrem upper bound.

2. ***Question 2: Was the implementation of 10 CFR Part 835 requirements for internal exposure monitoring sufficiently adequate by December 31, 1996, to provide assurance that a 100 mrem (CEDE) annual radiation monitoring requirement was being adequately implemented at SNL-A such that use of that value as a bounding dose in NIOSH's co-exposure model is supported?***

   SC&A concludes that based on documented program implementation experience and oversight results before and after the end of 1996, the 10 CFR Part 835 provisions for radiation exposure monitoring and recordkeeping were adequately implemented to support the application of a 100 mrem (CEDE) maximum dose as a means to bound internal dose in NIOSH's co-exposure model for SNL.

3. ***Question 3: Are there any limitations or uncertainties related to dose reconstruction as a result of SNL-A reliance on personnel air sampling results as indicators for assignment of 100 mrem (CEDE) internal dose?***

   From SC&A's assessment, the weight of evidence supports the application of available personnel air sampling results as a means to justify the annual assignment of 100 mrem (CEDE) internal dose for workers who were not monitored, partially monitored, or solely monitored via BZ results. As previously noted, the lack of

available BZ monitoring records is mitigated by the conservatism of NIOSH's dose estimation approach.

4. ***Question 4: Is there evidence that security guards at SNL-A were potentially exposed to radioactive intakes of radionuclides that could have been in excess of 100 mrem CEDE per year that would not have been monitored?***

   Based on (1) extensive interviews with security guards who worked at SNL during 1997– 2011, (2) an onsite tour of surveillance locations, (3) review of relevant records pertaining to radiological incidents, and (4) a review of internal intakes of bioassayed personnel at SNL facilities, SC&A concurs with the conclusions of ER Addendum 2 that it is unlikely that security personnel would have received an intake for which a 100 mrem annual dose (CEDE) would have been exceeded.

SC&A FINDING 1: INABILITY TO LOCATE PARTICULAR REFERENCES

SC&A was unable to locate references, such as periodic health physics reports, which tabulate the total number of workers monitored via breathing zone nor the total number of breathing zone samples issued and processed. Thus, a direct evaluation of the completeness of captured breathing zone results is not currently feasible.

NIOSH Response: NIOSH agrees that the dataset of raw field-monitoring data sheets is incomplete. This fact is acknowledged in Addendum 2, Section 7.1.1.6 [NIOSH 2019]. However, a limited evaluation of the completeness of the captured breathing-zone results can be performed using the 1997–2002 DAC-hr tracking logs [Lockheed Martin 1997a, 1998a, 2000, 2000–2001, 2001a,b,c, 2002a,b]. These logs list BZ sample results associated with individual workers that were used to track internal dose based solely on breathing-zone sample data. NIOSH compared the individual sample entries on the 1997–2002 DAC-hr tracking logs to the breathing zone (BZ) sample datasheet collection for that same period [Lockheed Martin 1997b,c,d,e,f,g,h,i,j,k,l,m,n,o, 1998b,c,d,e,f,g,h,i,j,k,l,m, 1999a,b,c,d,e,f,g, 1999–2000]. This comparison was performed to determine whether all the samples listed in the DAC-hr tracking logs are also within the dataset used by NIOSH in its Addendum 2 analysis. Table 1, column 5 below shows the results of this analysis. Out of 965 sample entries on the 1997–2002 DAC-hr tracking logs, NIOSH identified 952 (or 98.7%) within the BZ data collection. These 952 confirmed tracking-log samples are a subset of the 3,741 BZ samples available for 1997–2002 (Sandia ER Addendum 2, Table 6-1e) [NIOSH 2019]. However, the tracking-log samples would be expected to be the most dosimetrically significant because they were the ones slated for internal dose-tracking purposes. From this analysis, it can be concluded that the most dosimetrically significant BZ samples are contained in the dataset used in NIOSH's evaluation.

Table 1. Comparison of the 1997–2002 DAC-hr Tracking Logs with the BZ Sample Datasheet Collection.[a]

Month	DAC-hr Tracking Log (SRDB Ref ID)	BZ Air Sample Data Sheet (SRDB Ref ID)	No. Samples on DAC-hr Tracking Log	No. Samples on DAC-hr Tracking Log Located in Data Sheet Collection
Jan 1997	175713	35231	8	8
Feb 1997	175713	35232	6	6
Mar 1997	175713	35230	14	14
April 1997	175713	35233	20	20
May 1997	175713	35234	20	20
Jun 1997	175713	35235	20	20
Jul 1997	175713	35236	15	15
Aug 1997	175713	35237	21	21
Sep 1997	175713	35238	14	14
Oct 1997	175713	32539	16	16
Nov 1997	175713	35245, 35246	43	43
Dec 1997	175713	35246	24	24
Jan 1998	175714	35320	60	60
Feb 1998	175714	35312	163	150
Mar 1998	175714	35309	189	189
Apr 1998	175714	35308	162	162
May 1998	175714	35307	4	4
Jun 1998	175714	35306	2	2
Jul 1998	175714	35305	5	5
Aug 1998	175714	35304	6	6
Sep 1998	175714	35303	8	8
Oct 1998	175714	NA	0	0
Nov 1998	175714	35255, 35256	22	22
Dec 1998	175714	NA	0	0
Jan 1999	031170	35254	5	5
Feb 1999	031170	35253	21	21
Mar 1999	031170	35252	21	21
Apr 1999	031170	35251	1	1
May 1999	031170	35250	1	1
Jun 1999	031170	NA	0	0
Jul 1999	031170	NA	0	0
Aug 1999	031170	NA	0	0
Sep 1999	031170	31060	4	4
Oct 1999	031170	NA	0	0
Nov 1999	031170	31060	8	8
Dec 1999	031170	31060	6	6
Jan 2000	136928	35532	13	13
Feb 2000	136928	35532	1	1
Mar 2000	NA	NA	NDS	NA
Apr 2000	136928	35532	8	8

Month	DAC-hr Tracking Log (SRDB Ref ID)	BZ Air Sample Data Sheet (SRDB Ref ID)	No. Samples on DAC-hr Tracking Log	No. Samples on DAC-hr Tracking Log Located in Data Sheet Collection
May 2000	136928	35532	7	7
Jun 2000	NA	NA	NDS	NA
Jul 2000	136928	35532	1	1
Aug 2000	136928	35532	3	3
Sep 2000	136928	35532	3	3
Oct 2000	136978	NA	0	0
Nov 2000	136978	NA	0	0
Dec 2000	136978	NA	0	0
Jan 2001	136978	NA	0	0
Feb 2001	136978	NA	0	0
Mar 2001	136982	136960	3	3
Apr 2001	NA	NA	NDS	NA
May 2001	136978	NA	0	0
Jun 2001	136978	NA	0	0
Jul 2001	NA	NA	NDS	NA
Aug 2001	NA	NA	NDS	NA
Sep 2001	NA	NA	NDS	NA
Oct 2001	NA	NA	NDS	NA
Nov 2001	136911	136963	3	3
Dec 2001	136909	35614	1	1
Jan 2002	035843	136963	3	3
Feb 2002	NA	NA	NDS	NA
Mar 2002	136929	NA	0	0
Apr 2002	136929	NA	0	0
May 2002	136929	136912	1	1
Jun 2002	136929	136924	1	1
Jul 2002	136929	136924	1	1
Aug 2002	136929	NA	0	0
Sep 2002	136929	NA	0	0
Oct 2002	136929	136924, 136977	6	6
Nov 2002	136929	136924	1	1
Dec 2002	NA	NA	NDS	NA
TOTAL	**NA**	**NA**	**965**	**952**

a. NA = Not Applicable; NDS = No data sheet located for month.

SC&A OBSERVATION 1: DUPLICATE SAMPLES AND TOTAL BZ SAMPLES

SC&A identified 151 duplicate samples in the 2002 report and analyzed in NIOSH 2019a. These samples should not be included in reported BZ totals and should be removed from any exposure estimates. Furthermore, when reporting the total number of breathing zone samples, the distinct measurements (gross alpha, gross beta, low energy beta, and tritium) should not be counted as separate and distinct breathing zone samplers. These totals should be corrected in any subsequent revisions to the evaluation report to accurately reflect the number of individual workers/events who were monitored via BZ samplers.

NIOSH Response: Table 1 in SC&A's review [SC&A 2020] was based on tabulated data in Section 6 of the NIOSH ER (i.e., Table 6-1e). This tabulation lists the number of measurements available for each year and is not necessarily the same as either the number of individual analytical results (for a particular measurement type) or the number of samples collected from individuals. This is because gross alpha, beta/gamma, low-energy beta, and tritium results were sometimes recorded on separate data sheets. The presence of sample recounts also complicated the ability to consistently tally the number of samples available each year. For these reasons, the tabulation for Section 6 (i.e., Table 6-1e) is related to the number of line items of data available to NIOSH – with each line item potentially containing more than one result type. The actual number of measurements used in NIOSH's analysis is shown in Tables 7-1b, 7-1c, and 7-1d for gross alpha, gross beta (including low-energy beta) and tritium, respectively.

A more appropriate comparison between SC&A's analysis of the number of samples for each year as compared to the number of measurements used in NIOSH's analysis would be based on the data in Tables 7-1b, 7-1c, and 7-1d, as shown below. However, this comparison is complicated by the presence of "unusable measurements" which do not appear to be taken into account in SC&A's analysis. The fact is that some samples in the dataset (represented by Table 6-1e) were not used in NIOSH's analysis. This is explained in Section 7.1.1.6, as follows:

> *Some of the captured datasheets have either missing or illegible data that renders them unusable for the purpose of assessing potential internal exposure to the associated individual (e.g., for 2002, 32 of 585 records contain no duration entry* [NIOSH 2019, PDF p. 23].

For example, for 2002, there were 585 available measurements; however, 32 were not usable, resulting in 553 usable measurements (as indicated in Tables 7-1b and 7-1c). Of these 553 usable measurements, NIOSH confirmed the presence of 148 duplicates (see discussion below), bringing the total measurement count to 405 (corrected in Table 2 below).

Table 2. Comparison of NIOSH and SC&A Datasets.[a,b]

Year	NIOSH Dataset (Available BZ results) Table 6-1e	NIOSH Dataset (No. of alpha measurements) Table 7-1b	NIOSH Dataset (No. of beta measurements) Table 7-1c	NIOSH Dataset (No. of H-3 measurements) Table 7-1d	SC&A Dataset (No. of samples)
1997	357	357	357	0	367
1998	1583	1581	1583	0	1568
1999	708	708	708	0	687
2000	336	334	336	0	336
2001	172	172	172	0	164
2002	585	405[b]	405[b]	0	436
2003	0	0	0	0	0
2004	274	131	137	119	128
2005	388	177	177	165	176
2006	208	75	72	88	108
2007	231	111	170	52	111
2008	445	189	358	8	174
2009	76	38	74	0	38
2010	26	23	26	0	20
2011	0	0	0	0	0

a. Source: NIOSH 2019; SC&A 2020.
b. Measurement count adjusted to remove duplicate measurements identified in SC&A's analysis.

Regarding duplicate samples, NIOSH was able to confirm that the 2002 dataset contained 148 duplicate data entries (Note: There were actually 150 duplicates, but two measurements were excluded due to the lack of flow-rate information). NIOSH was not able to confirm the presence of duplicate samples in other years, as identified in Table 1 of the SC&A review document [SC&A 2020]. The 148 duplicate values identified in 2002 were caused by overlaps in the sample datasets contained in three individual data files [Lockheed Martin 2002c,d,e]. Inconsistencies in how the location code for entries from different files were coded contributed to the inability to recognize these previously. NIOSH repeated the original analysis using the updated dataset (i.e., with 148 duplicate values from 2002 removed) and confirmed that the presence of these duplicates did not impact the results of the analysis [ORAUT 2020a,b,c].

Table 3 below shows the results of this re-analysis. It should be noted that the methodology used by NIOSH to evaluate the dataset (specifically the imputation of non-detect results) makes the final dataset relatively immune from the presence of duplicate samples. This is because most of the sample results were negative, and these negative values were replaced by a randomly-selected value from the positive results. If the duplicate results were positive, then the inclusion of both results would only skew the dataset higher. In general, duplicate results were introduced by the presence of recounted samples and the failure to identify these as such. Sample recounts are unlikely to result in a higher result; therefore, the presence of both an initial count and a recount in the dataset would only skew the results in a positive direction.

Table 3. Evaluation of BZ Dataset With and Without Duplicate Values by Event and by Date.[a]

Case	Original Dataset with Duplicates: Mean Person Dose by Event in mrem (GSD)	Revised Dataset without Duplicates: Mean Person Dose by Event in mrem (GSD)	Original Dataset with Duplicates: Mean Person Dose by Date in mrem (GSD)	Revised Dataset without Duplicates: Mean Person Dose by Date in mrem (GSD)
Alpha	0.48 (5.73)	0.48 (5.8)	0.52 (5.2)	0.51 (5.3)
Beta	0.00054 (8.0)	0.00058 (7.6)	0.00066 (7.0)	0.00066 (6.9)
Tritium	0.0065 (4.4)	0.0065 (4.4)	0.0070 (4.3)	0.0070 (4.3)

a. Note: An event is defined two ways: a radiological work task at a given location on a given day, and all radiological work on a given day [NIOSH 2019, PDF p. 25].

Regarding the decision to analyze alpha, beta, and tritium samples separately, NIOSH believes that doing so is both claimant-favorable and appropriate based on the fact that each individual sample component was evaluated against the most-limiting DAC value for that radiation type plus the fact that the alpha component is two to three orders of magnitude larger than the beta and tritium components, as shown below:

- Alpha: 0.52 mrem
- Beta/gamma: 0.0007 mrem
- Tritium: 0.007 mrem

The same logic also applies to low-energy beta measurements, which were present in some portions of the dataset.

SC&A OBSERVATION 2: INCOMPLETE DATA

It is SC&A's opinion that the observed temporal variation in the number of captured breathing zone (BZ) samples suggests that the available dataset does not represent a complete set of monitoring records for the affected worker population. Therefore, any conclusions regarding the exposure potential reflected in captured breathing zone samples is likely based on incomplete data. However, as stated previously, the level of incompleteness is not known at this time.

NIOSH Response: As stated in the response to Finding #1, while NIOSH agrees that the BZ dataset is not complete, the dataset is biased high by the fact that all of the data transmitted to the internal dosimetry group for DAC-hr tracking purposes is included.

SC&A OBSERVATION 3: USE OF WEBDOSE

Comparison of breathing zone entries contained in WebDose to captured hardcopy records demonstrates that WebDose does not represent a complete data source reflecting who was monitored via breathing zone at SNL. Therefore, the use of WebDose to support the 100 mrem dose threshold may not be appropriate.

NIOSH Response: NIOSH concurs that the WebDose dataset does not contain entries for every BZ sample collected; however, it does represent a complete assessment of the most highly-exposed worker population and, as such, consideration of WebDose data is one part of the evidence used to support the ultimate conclusion. Sandia procedure RPO-04-425 (June 5, 1996) required that all BZ samples with a calculated DAC-hr value exceeding 0.10 be forwarded to Internal Dosimetry for review [Lockheed Martin 1996].

Comparison of the WebDose BZ rollup entries (i.e., entries with a dosimeter number beginning with "P") against the available 1997–2002 DAC-hr tracking logs indicates 100% agreement between WebDose entries and presence on the DAC-hr tracking logs. WebDose entries for April 2001, August 2001, and December 2002 could not be verified against the DAC-hr Tracking logs because corresponding logs for these periods are not available. However, NIOSH was able to locate BZ sample datasheets for these months with names corresponding to those on the WebDose entries and with a "reviewed by" ID stamp [Lockheed Martin 2001d, PDF p. 130, 2001e, PDF p. 4, 2002-2003, PDF p. 511]. NIOSH's analysis indicates that the WebDose logs are a complete and accurate accounting of individuals whose BZ samples were forwarded to Internal Dosimetry for DAC-hr tracking.

SC&A OBSERVATION 4: DISTRIBUTION OF BZ SAMPLES

A substantial portion of the available breathing zone samples per year are often assigned to just a few individuals. 8% of the total breathing zone samples were associated with just a single individual though over 195 monitored individuals were identified. Nearly 80% of the identified individual workers in a given year had 20 breathing zone samples or less.

NIOSH Response: NIOSH concurs with this observation and believes that the noted trend does not obviate the use of 100 mrem as a maximizing dose assignment to unmonitored workers.

SC&A OBSERVATION 5:

Seventy-nine of the 194 identified individuals in the captured 82 records also participated in the non-tritium bioassay program during the evaluated SEC period. This includes the identified workers with the highest number of BZ results per year as well as the 11 workers with the highest number of BZ results over the entire period. Therefore, evidence suggests that workers who were most often monitored via BZ were also often monitored via non-tritium bioassay.

NIOSH Response: NIOSH concurs with this observation and believes that individuals within the captured set of BZ monitoring records were among those with the highest potential for internal exposure. This conclusion is supported by their preferential inclusion in the internal monitoring bioassay program.

SC&A OBSERVATION 6: FLUCTUATIONS IN EXPOSURE POTENTIAL

SC&A's analysis of relative exposure potential demonstrates that noteworthy fluctuations in exposure potential can exist by year and by work area. Specifically, work in the general area designated by SC&A as "TA-V/6580" during the years 1997 and 1998 showed significantly elevated exposure potential when compared to all years and areas. However, SC&A does not believe these fluctuations necessarily obviate the use of 100 mrem as a maximizing dose assignment to unmonitored workers as several significantly conservative assumptions were included in the dose estimates.

NIOSH Response: NIOSH concurs with the stated observation and does not believe these fluctuations obviate the use of 100 mrem as a maximizing dose assignment to unmonitored worker.

SC&A OBSERVATION 7: SPR RADIATION GRADIENT DOSE

SPR radiation gradient dose issue. The issue of exposure to severe radiation gradients would not be applicable to personnel working outside the immediate area of the bottom of the reactor vessel. However, the potential exposures to maintenance and operating personnel while performing close-up work on the SPR has not been sufficiently addressed and resolved.

NIOSH Response:

The response below is intended to outline the issues associated with the development of external dose adjustments for SPR worker claimants who worked during the currently-defined SEC class period. For reasons explained below, such adjustments are not needed for the period that is not included in the currently-defined SEC class (i.e., 1997–2011).

The issue of elevated exposure to SPR workers was identified during the early 1980s [DOE 1982]; as a result, SNL instituted a number of corrective actions related to monitoring and reduction of radiation exposure to SPR personnel. These actions are summarized in a July 23, 1982 memorandum [AT&T 1982c, PDF pp. 4–5] indicating that Sandia would commit to the following:

1. *Dosimetry would be supplied to measure the "head" doses of personnel performing SPR III maintenance.*

2. *Body dose information would be accepted for head measurements for the period it was not available since calculational efforts were not supportable.*

3. *Both head and whole body doses would be reported in SNLA dosimetry records.*

4. *An attempt would be made to get more uniformity in the location of dosimetry units were worn by SNLA personnel.*

Subsequent to the 1982 dose evaluations, Sandia instituted a dose-reduction effort for SPR personnel. This effort involved designing and implementing a shielding arrangement that provided significant dose reduction (between a factor of 5 and 30, depending on location) [AT&T 1982d]. An October 15, 1984 memorandum summarizes the results of the dose-reduction efforts and indicates the types of changes that were made [AT&T 1984]:

1. *Modifications to the KIVA*
2. *Modifications to the SPR-III reactor stand*
3. *Procurement of a remotely controlled forklift*
4. *Design, fabrication and use of a personnel maintenance shield*
5. *Administrative changes*

The stated goal of the program was a 33% reduction in personnel exposure during operation and maintenance activities.

The period under evaluation in this Addendum is January 1, 1997 through May 21, 2011. The SPR-III facility operated between 1997 and 2000 [DOD 2005, PDF p. 47], and again from January through September 2006 [Lockheed Martin 2007, PDF p. 2]. For these periods of SPR-III operation, NIOSH has located evidence that Sandia evaluated the potential for non-uniform exposures and implemented the use of multiple dosimeters, as necessary. This is evident from documentation of an incident report from February 1998 [DOE 1998], as well as from NIOSH's review of copies of radiological work permits for work in the SPR KIVA facility in 1998–2000 [Lockheed Martin 1998n, 1999h, 2000b,c, 1999i].

The 1998 incident report [DOE 1998] documented a weakness in the issuance of real-time electronic dosimetry that accompanied TLD dosimeters. In particular, only one real-time monitor was issued and was placed at the location of the chest badge worn during the job. This placement neglected to provide real-time dose monitoring for the higher-dose location (head), which was also monitored with a TLD badge. Consequently, the RWP dose limit was exceeded. During the investigation, dosimetry staff reviewed past multi-badging and found no significant difference between chest and head levels. Additional corrective actions related to issuance of multiple dosimetry badges were documented in a January 26, 1998 memo, "Radiation Protection Response to RPIR 98-005, Individual Exceeding RWP Dose Limit" [Lockheed Martin 1998o]. Corrective actions included performance of a "more detailed dose-gradient survey of the work area," discussions with workers to "Determine work locations and most likely worker positions," and "Compare these [work positions] to the pre-job survey and determine expected dose to various body position(s)."

A review of SPR-related radiation work permits identified RWP 11133 (active September–October 2000), which indicated the need for multi-badging and contains copies of multi-badge TLD results [Lockheed Martin 2000c, PDF pp. 15–24]. The ALARA Pre-Job Review form attached to this RWP includes the question: "Is whole body TLD sufficient to monitor potential exposures?" [Lockheed Martin 2000c, PDF p. 9]. In the case of this RWP, the response is 'no' and multi-badging is specified.

A review of Sandia dose-reporting practices during the period under evaluation (January 1,1997 through May 21, 2011), indicates that when multiple dosimeter badges are assigned, the individual location results are maintained in the record-keeping system as "work area measurements" and that the dose of record is calculated as a weighted average of these individual dosimeter results. Although both the weighted value (dose of record) and the individual dosimeter results are part of the data provided by Sandia for EEOICPA claimants [NTESS 2021, PDF pp. 2–3]. NIOSH plans to document this practice in an update of the external dose section of the Sandia site profile document [ORAUT 2013].

Regarding the need for adjustments to external exposures that might have occurred at the SPR facility prior to the period under evaluation (i.e., before January 1, 1997), further review is necessary to develop such an adjustment if the use of a chest dosimeter is not bounding. In addition, a NIOSH review of a 1998 occurrence report indicates that, prior to January 1997, measured dose to the head might not have been considered as a component of whole-body dose [DOE 1998]. NIOSH intends to perform additional research to gain further understanding of this practice and its potential impact on the interpretation of dosimetry results. Any guidance determined to be necessary will be included in a revision to the external dose section of the Sandia site profile document [ORAUT 2013].

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