NIOSH Response to SC&A Review of ORAUT-RPRT-0081 (SRS)

Response Paper

National Institute for Occupational Safety and Health

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PURPOSE

In 2017, NIOSH produced ORAUT-RPRT-0081, Appropriateness of Using 1997 Gross Alpha Air Sampling Data as a Method of Bounding Thoron Intakes at the SRS H-Area Tank Farm Between 1972 and 1994 (ORAUT 2017a), which calculated the lognormal distributions of the air concentration due to thoron for three different periods (1982–1983, 1984–1985, and 1990) for comparison to the 1997 data (Sigg, et al. 1997). Subsequently, the Advisory Board on Radiation Worker Health tasked SC&A with reviewing the methodology and rationale presented in ORAUT-RPRT-0081. This resulted in SC&A issuing Memorandum: SC&A Review of RPRT-0081 Methods for Thoron Dose Reconstruction (SC&A 2018). This NIOSH white paper responds to SC&A observations in that memorandum.

SC&A OBSERVATIONS AND NIOSH RESPONSES

SC&A Observation 1

To characterize and bound potential thoron exposures for the period October 1972–1995, NIOSH analyzed data from three periods: 1982–1983, 1984–1985, and 1990. However, the actual temporal coverage of the data constitutes only approximately 8% of the period of interest. It is not known whether additional air sampling data are available to evaluate the temporal gaps in the NIOSH analysis.

SC&A acknowledges that the data comparison presented for the years that were analyzed demonstrates that the 1996 derived thoron exposures significantly bound the limited earlier data by an order of magnitude or more for these periods. Therefore, further data capture and analysis may not be deemed necessary to assure the approach is bounding.

NIOSH Response

ORAUT-RPRT-0081 proposed to use thoron air concentrations reported in Sigg, et al. 1997, not data from 1996, to derive thoron doses for the period 1972 through 1994 (ORAUT 2017a). However, these same data can be used to derive thoron doses through 1997.

In order to assess whether thoron air concentrations fell below the results captured in 1997, NIOSH collected additional air monitoring data for the H Tank Farm (HTF) that were recorded in the years 1999 and 2000. By that time, SRS used the process shown in Figure 1 to determine whether air samples contained thoron (Westinghouse 1998). Only filters and planchets meeting the condition were recounted after 24 hours for thoron. Less than 1 percent of all samples were suspected to have thoron contamination.

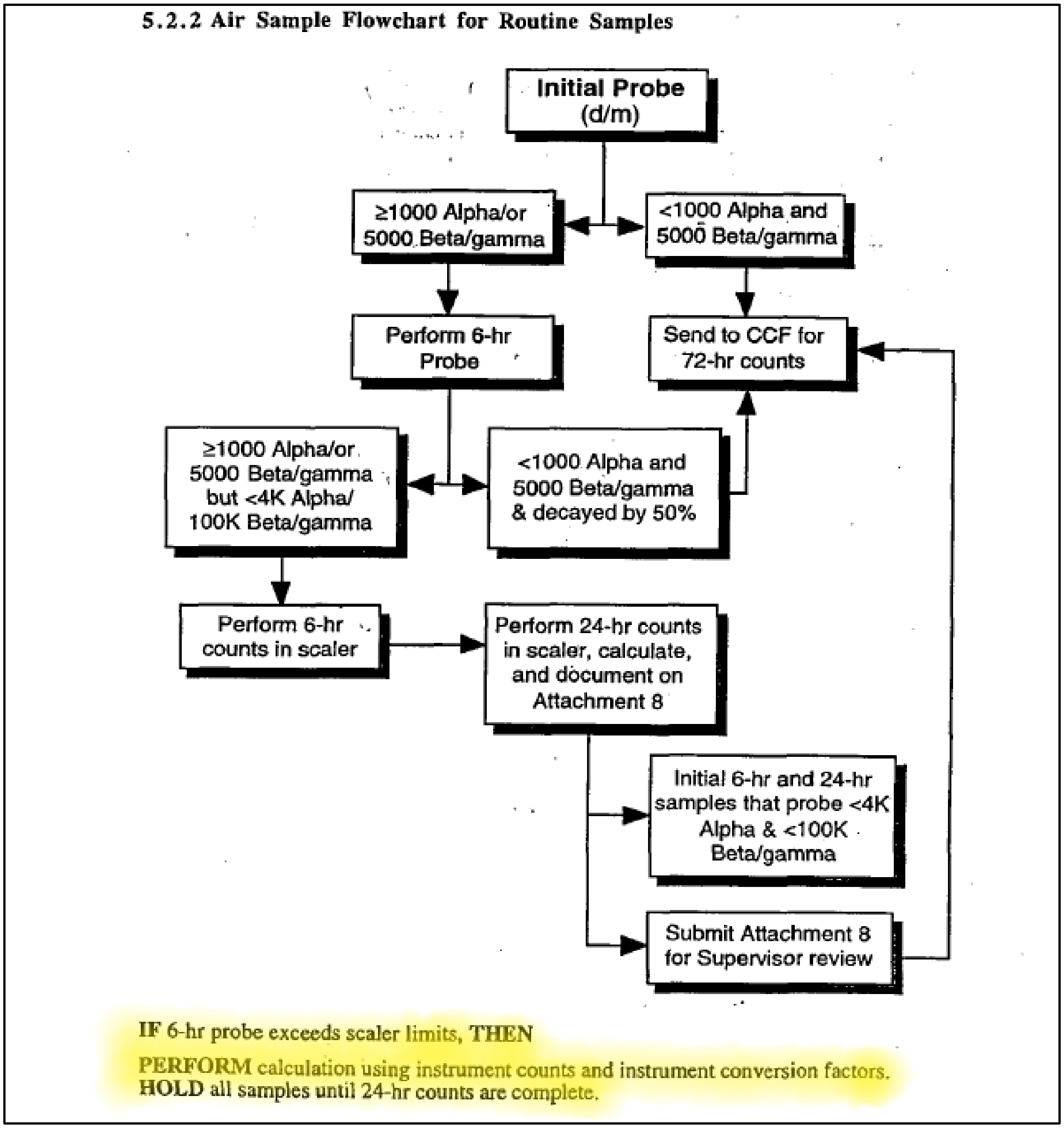


Figure 1: Air Sample Flowchart.

Thoron Air Concentrations, 2000

For 2000, NIOSH identified 60 samples for which both 6- and 24-hour counts were performed. Table 1 provides the location of these 60 samples. The location of these samples represents similar locations used for a Westinghouse study that sampled Tanks 11 through 17 and general areas within the H Tank Farm (Sigg, et al. 1997). These results are provided in Attachment A, Table A-1. NOTE: Only the samples given in Table 1 below indicated thoron. Hundreds of samples were taken at or around Tanks 11 through 15 for which counting revealed no indication of thoron.

Table 1: Thoron Sample Locations.

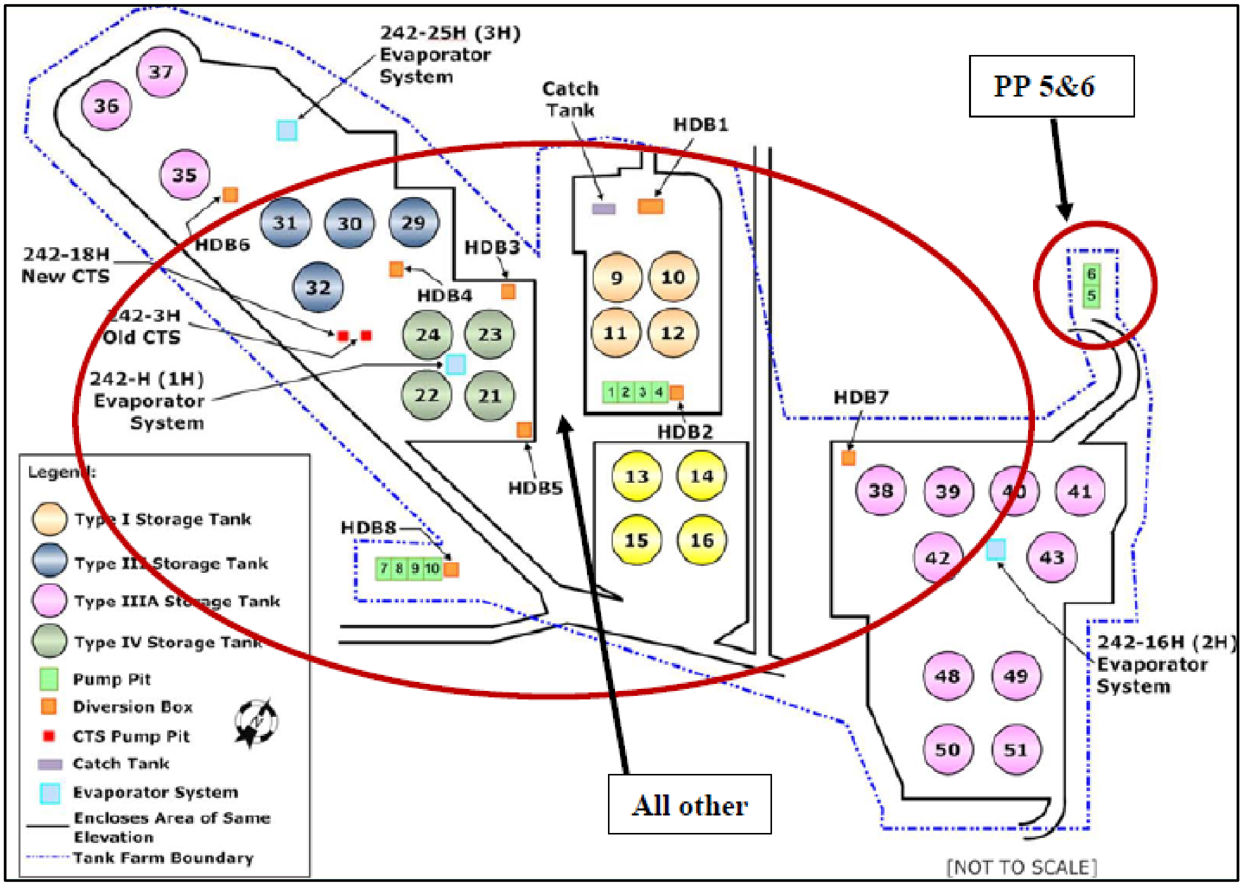
Location	Description	No. of results
HTF 241-57H	Evaporator system	1
HTF DB-2 GA	Diversion box general area	1
HTF TK 10-12 E	Tanks 10 and 12 east	7
HTF TK 13 N	Tank 13 north	1
HTF TK 13-16 BERM	Tanks 13 through 16 berm	5
HTF TK 30 Annulus	Tank 30 annulus	1
HTF TK 39 Annulus	Tank 39 annulus	2
HTF TK 9-12 GA	Tanks 9 through 12 general area	7
HTF PP 5&6	Pump Pit 5&6	35

The tank farms employ a network of transfer lines to transfer wastes between the waste tanks, process units, and various Savannah River Site (SRS) areas (i.e., H Area, S Area, and Z Area). These transfer lines are connected to diversion boxes that contain removable pipe segments to complete the desired transfer route. The use of diversion boxes allows flexibility in waste movement. The diversion boxes are usually underground, constructed of reinforced concrete, and either sealed with waterproofing compounds or lined with stainless steel. Pump pits are intermediate pump stations in the tank farm transfer systems. They contain pump tanks and hydraulic pumps or jet pumps. The pits are constructed of reinforced concrete and have a stainless-steel liner. Some pump pits are associated with diversion boxes.

NIOSH used Equation 3-7 in ORAUT-RPRT-0084 to derive the thoron concentration in air for each recorded set of 6-hour and 24-hour results (ORAUT 2017b). Many of the recorded counts appear to be rounded to the closest 100, which limits the number of significant digits. As a reminder, thoron was found in less than 1 percent of the air sampling data. Looking further at the results for the year 2000, the thoron data can be broken into two smaller distributions: (1) concentrations measured at Pump Pit 5&6; and (2) concentrations measured at all other HTF sampling stations, as shown in Figure 2 (SRS, 2015). In both distributions, the 95th- and 99th-percentile concentrations are about an order of magnitude less than the 1997 values. Thoron air contamination appeared to be persistent at Pump Pit 5&6. Table 2 provides summary statistics for the two distributions along with the summary statistics reported for 1997, as published in ORAUT-RPRT-0081.

Table 2: Thoron Concentration Summary Statistics by Location (μCi/cc).

Location	N	GM	95th	99th	GSD
HTF PP 5&6	34	5.9×10^{-11}	1.3×10^{-10}	1.8×10^{-10}	1.6
Thorium Tanks/Other	29	7.6×10^{-12}	2.1×10^{-11}	3.1×10^{-11}	1.8
Year 1997 Locations	22	2.8×10^{-11}	2.7×10^{-9}	1.8×10^{-8}	15.9



Source: SRS, 2015

Figure 2: H Tank Farm Map.

Figure 3 shows the plot for the Pump Pit 5&6 distribution; Figure 4 shows the plot for the Thorium Tanks/Other distribution.

Although the concentrations at Pump Pit 5&6 were higher than those measured for the tanks, Pump Pit 5&6 was isolated from most of the waste tanks where measurements were taken (see Figure 2 above). It is unlikely that operations or construction trade workers would have worked near those tanks full time. Operations workers would have been assigned tasks across the tank farm; construction trade workers would have been assigned to specific jobs with lesser frequency.

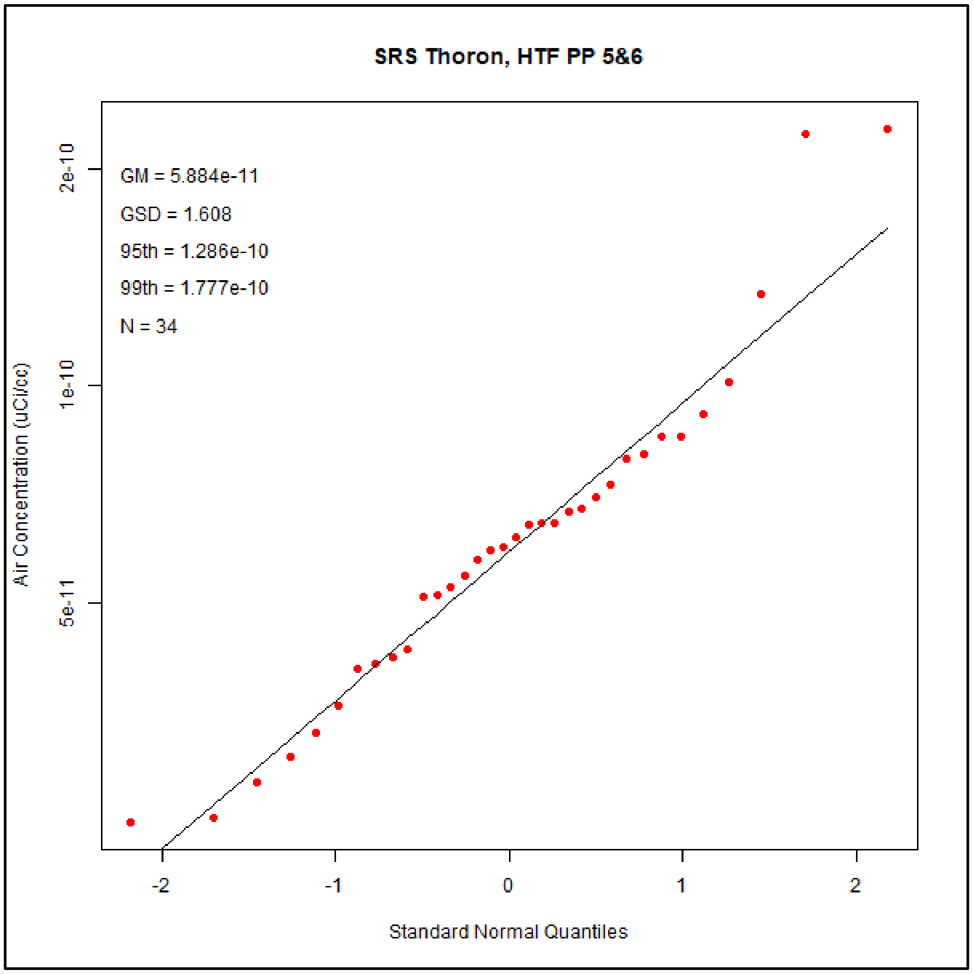


Figure 3: Thoron Air Concentration, HTF PP 5&6.

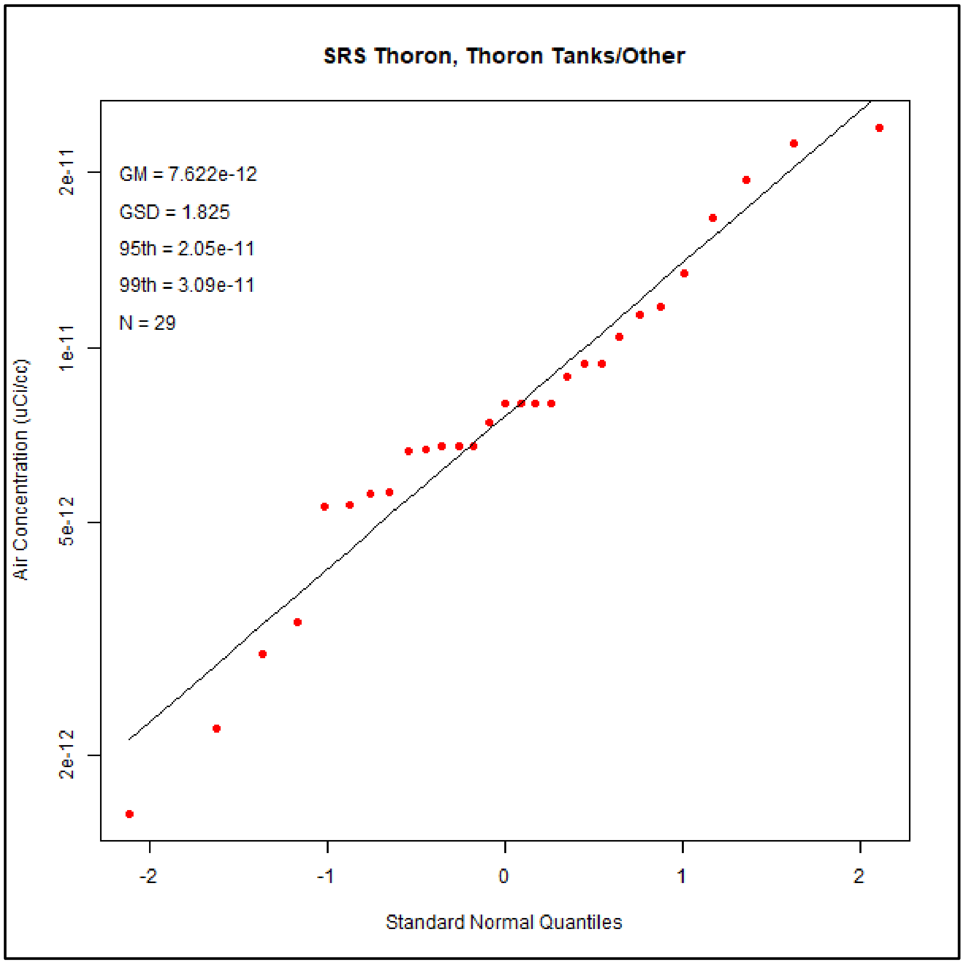
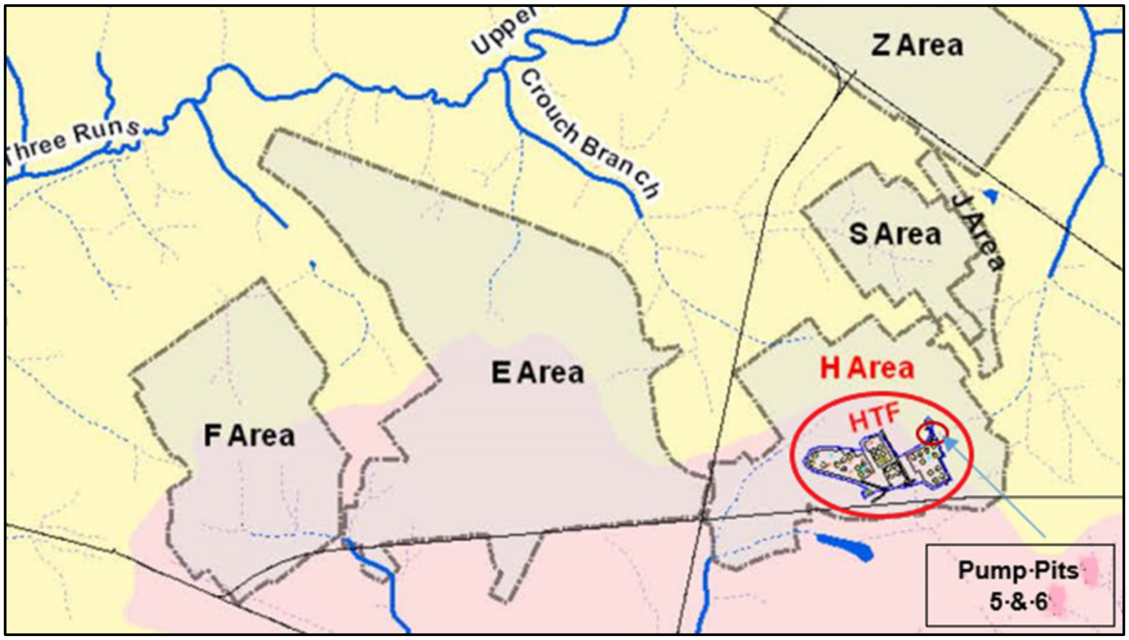


Figure 4: Thoron Air Concentration, HTF Tanks/Other.

Figure 5 shows H Tank Farm and Pump Pit 5&6 in comparison to the major areas E, F, S, and Z (SRR, 2015). Given the distance from H Tank Farm to those areas and the lack of thorium source terms, it is reasonable to assume that thoron concentrations in major areas E, F, S, and Z would not exceed those recorded for H Tank Farm.

Finally, the distribution of the thoron air concentration reported for 1997 in ORAUT-RPRT-0081 is sufficient to bound thoron exposures of workers in thorium storage areas, as documented in the report, through 1997.



Source: SRR, 2015

Figure 5: H Tank Farm in Comparison to Site Major Areas.

Thoron Air Concentrations, 1999

NIOSH also identified job-specific, thoron-daughter, air-concentration data taken in November and December 1999 (SRS Air Data 1999a; SRS Air Data 1999b). While the data were not taken from the same tanks for which data were obtained for Sigg, et al. 1997 (Tanks 11 through 17), the 1999 data do represent tanks known to hold thorium (Tanks 40 and 51) (Thames 2000). Pump Pit 5&6 would also have been used to transfer waste to these tanks.

Table 3 below provides derived concentrations of thoron daughters. Table 4 provides summary statistics for these derived concentrations. The geometric mean, 95th- and 99th-percentiles derived for these results are much less than the statistics derived for 1997, and for samples taken from Pump Pit 5&6 in the year 2000. The 1999 statistics are comparable to the statistics derived from the sampling of Thorium Tanks/Other in the year 2000 (see Table 2). While the concentrations given for 1997 in Table 2 are sufficient to bound intakes of thoron daughters through 1999, concentrations derived from the sampling of Pump Pit 5&6 are reasonable for bounding thoron intakes from the year 2000 forward.

Table 3: Thoron Daughter Concentrations, 1999.

Tank	End Date	Concentration (μCi/cc)
HTF TK 40	11/10/1999	3.08×10^{-12}
HTF TK 40 airlock	11/10/1999	3.20×10^{-12}
HTF TK 40 airlock	11/12/1999	1.12×10^{-11}
HTF TK 40 airlock	11/17/1999	3.13×10^{-12}
HTF TK 40 airlock	11/18/1999	4.17×10^{-12}
HTF TK 40 airlock	11/23/1999	5.06×10^{-12}
HTF TK 40 airlock	12/17/1999	3.36×10^{-12}
HTF TK 40 airlock	12/28/1999	3.18×10^{-12}
HTF TK 40 annulus	11/18/1999	1.39×10^{-11}
HTF TK 40 coppus	12/28/1999	2.15×10^{-12}
HTF TK 40 exhaust	11/10/1999	7.10×10^{-13}
HTF TK 40 hut	11/10/1999	6.34×10^{-12}
HTF TK 40 hut	11/11/1999	2.36×10^{-12}
HTF TK 40 hut	11/18/1999	3.21×10^{-12}
HTF TK 40 hut	11/23/1999	1.18×10^{-11}
HTF TK 40 hut	12/17/1999	2.41×10^{-12}
HTF TK 40 hut	12/18/1999	1.03×10^{-12}
HTF TK 40 hut	12/28/1999	1.99×10^{-12}
HTF TK 40 purge	11/12/1999	2.26×10^{-11}
HTF TK 40 purge	11/20/1999	3.24×10^{-12}
HTF TK 40 purge	12/29/1999	2.89×10^{-11}
HTF TK 40 RBA	11/17/1999	5.98×10^{-12}
HTF TK 40 RBA	11/18/1999	4.83×10^{-12}
HTF TK 51 annulus	11/18/1999	7.58×10^{-12}

Source: SRS Air Data 1999a; SRS Air Data 1999b

Table 4: Statistics for Thoron Daughter Concentrations, 1999.

Statistic	Concentration (μCi/cc)
GM	4.34×10^{-12}
95^{th} percentile	1.82×10^{-11}
99^{th} percentile	3.30×10^{-11}
GSD	2.39

Finally, based on results identified for 1999 and 2000, the distribution of the thoron air concentrations reported for 1997 in ORAUT-RPRT-0081 is sufficient to bound thoron exposures of workers in thorium storage areas, as documented in NIOSH 2012, not only through 1997 but also through 1999.

SC&A Observation 2

Based on the comparison of the limited air sampling data for the period of interest, it is clear that the 1996 thoron assessments bound the exposure potential for the earlier periods evaluated in RPRT-0081.

Finally, RPRT-0081 does not specify how NIOSH intends to assign thoron exposures to the relevant claimant population at SRS. RPRT-0081 (p. 12) states:

> *NIOSH concludes that concentrations of thoron daughters reported in the 1997 study are sufficient to bound thoron exposures of* ***workers in thorium storage areas****. [Emphasis added.]*

It is not clear if this methodology is intended to apply only to tank farm workers or any worker in an area of SRS where thorium might have been stored. Additionally, it is not clear whether NIOSH intends to assign the geometric mean, the 95th percentile, or the 99th percentile as presented in Table 3-1 of RPRT-0081. RPRT-0081 should explicitly define how the proposed dose reconstruction approach would be implemented.

NIOSH Response

NIOSH proposes to use these data to assign dose to workers assigned to areas where thorium was stored through 1999, but limited to the dates of material storage and to specified years in identified buildings. Storage locations are listed in Addendum 3 of the SEC-00103 SRS evaluation report (NIOSH 2012). Those locations are 773-A (1972 – 2007), 235-F (1975-1998), M Area (1972-1992), 100 K basin (1972-2005), 100 L basin (1980-2007) and 244-H, or the RBOF (1972-2004). Quantities of Th-232 are known to exist in Tanks 11, 12, 13, 14, 15, 40, 42, and 51 (Thames 2000) though thorium is primarily stored in Tanks 12 and 15; these are the tanks where the thoron air concentration study was performed and presented in Sigg et al. 1997. In Building 773-A, thorium was used in several labs over time; however, specific storage locations are not known. Thorium was also stored in vaults in both M Area and 235-F. For example, a claimant who worked at SRS from 1972 through 1995, but who worked only in a thorium storage area from 1980 through 1984, would be assigned thoron dose only for 1980 through 1984.

HP area codes (ORAUT 2016) listed on quarterly dosimetry reports through 1990 will be used to identify workers that worked in those locations. In some cases, SRS did not have a separate HP area code for a location, such as F Tank Farm from 1972 through 2003. In these cases, the HP area code for the overlying area, F Area for F Tank Farm, will be used to identify workers who potentially worked at the thorium storage location. HP sometimes assigned subcontract construction trade workers to an HP code for Central Shops (CS) or for a specific trade such as laborer (8L) rather than a specific area. Using the HP area code for an area will likely include more workers than would be included with a specific HP area code for the location. Table 5 lists HP area codes by location or craft.

Table 5: Location Identifiers for Thoron Dose Assignment.

Location	Start Year	End Year	Area Code in 1972	Area Code in 1973	Area Code in 1990	Area Code in 2004
773-A	1972	2007	5A	5A,	A15, A18	SRT
235-F	1975	1998	1A	2F, 3F, 8F, 5F	F03, F08, F05	235
M-Area	1972	1992	3A	3M	M03	none
100-K Basin	1972	2005	10A	1K	K01	NMM
100-L Basin	1980	2007	9A	1L	L01	LLL
244-H	1992	2004	2A	2F, 2H, 5H, 6H	F02, F05, H02, H05, H06	RBO
F/H Tank Farms	1992	2007	2F, 2H	2H, 1H, 3H	H02, H01, H03 H05, H06	EPT, FTF, HTF
Construction (craft)	1992	2007	12E, 12Z	7A, 7J, 7R, 7T, 8A, 8B, 8C, 8H, 8I, 8K, 8L, 8M, 8P, 8S, 8T	J02, J03, J12, J24, J20, J06, J14, J31, J18, J17, J21, J10, J08, J05	Use occupation given in NOCTS

Doses Calculated for Year 1997 Air Concentration Data

NIOSH proposes to use the lognormal fit of the distribution of the 1997 thoron air concentration given in ORAUT-RPRT-0081 for all workers in thorium locations with a 100% occupancy rate through 1999. Table 6 provides the parameters used in the distribution. Table 7 provides the dose conversion factors used in the dose calculations in units of rem/working level month (WLM), as presented in Tables 6-1 and 8-1 in DCAS-TIB-011, *Dose Conversion Factors for Radon WLM* (NIOSH 2018).

Table 6: Lognormal Distribution Parameters, 1997 Data.

Worker type	Air Concentration ($\mu Ci/cm^3$)
95^{th} percentile	2.67×10^{-09}
50^{th} percentile	2.84×10^{-11}
GSD	15.83

Table 7: Dose Conversion Factors (rem/WLM).

Worker type	DCF
Lung	6.2
ET1	943.83
ET2	0.45
Kidney	0.24
Bone Surface	0.21
Prostate	0.0091
Stomach	0.01
Colon	0.015

Source: NIOSH, 2018

Example Dose Reconstructions

Viable examples of employment were written that demonstrate higher bounds of doses and probability of causation (POC) for all sets of workers and locations listed in Table 8. The examples are:

1. Chemist, Building 773-A, employment 1/1/1973–12/31/2007, lung cancer
2. Electrician, Building 773-A, employment 1/1/1975–12/31/1990, lung cancer
3. Electrician, H Tank Farm, employment 1/1/1990–12/31/1993, lung cancer
4. Engineer, H Tank Farm, employment 1/1/1982–12/31/1982, lung cancer
5. Maintenance worker, Building 773-A, employment 1/1/1973–12/31/2007, stomach cancer
6. Janitor, Building 773-A, employment 1/1/1973–12/31/2007, ET1
7. Operator, H Tank Farm, employment 1/1/1973–12/31/2007, colon cancer
8. Janitor, H Tank Farm, employment 1/1/1973–12/31/2007, ET2
9. Electrician, Building 773-A, employment 1/1/1975–12/31/1990, kidney cancer
10. Maintenance worker, Building 773-A, employment 1/1/1973–12/31/2007, bone surfaces cancer
11. Maintenance worker, Building 773-A, employment 1/1/1973–12/31/2007, prostate cancer

Cancer diagnosis date for all eleven cases is 1/1/2008. All workers are assumed to have been diagnosed at age 60 and are assumed to have no history of smoking.

Table 8: Dose Reconstruction Scenarios.

Scenario	Job Title	Facility	Employment Dates	Years of Exposure	Diagnosis	Annual Dose (rem)	PoC %
1	Chemist	773-A	1/1/1973 - 12/31/2007	35	Lung	0.287	95.93%
2	Electrician	773-A	1/1/1975 - 12/31/1990	16	Lung	0.287	94.34%
3	Electrician	H Tank Farm	1/1/1990 - 12/31/1993	4	Lung	0.287	80.79%
4	Engineer	H Tank Farm	1/1/1982 - 12/31/1982	1	Lung	0.287	52.45%
5	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Stomach	0.0005	2.37%
6	Janitor	773-A	1/1/1973 - 12/31/2007	35	ET1 (160.0)	43.699	99.79%
7	Operator	H Tank Farm	1/1/1973 - 12/31/2007	35	Colon	0.001	3.97%
8	Janitor	H Tank Farm	1/1/1973 - 12/31/2007	35	ET2 (161.0)	0.021	18.58%
9	Electrician	773-A	1/1/1975 - 12/31/1990	16	Kidney	0.011	29.99%
10	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Bone surfaces	0.010	35.14%
11	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Prostate	0.0004	1.04%

Doses Calculated for the Year 2000 Pump Pit 5&6 Air Concentration Data

NIOSH proposes to use the lognormal fit of the distribution of the year 2000 thoron air concentration data given in this report for all workers in thorium locations with a 100% occupancy rate from the year 2000 forward. Table 6 previously provided the parameters used in the distribution. Table 9 below provides thoron air concentrations (from Pump Pit 5&6) used in the dose calculations in units of rem/working level month (WLM).

Table 9: Lognormal Distribution Parameters, Year 2000 Data.

Worker type	Thoron Air Concentration ($\mu Ci/cm^3$)
95th percentile	1.3×10^{-10}
50th percentile	5.9×10^{-11}
GSD	1.6

NIOSH revised dose reconstructions for all scenarios where the end of employment exceeded 1999. Those are scenarios 1, 5, 6, 7, 8, 10, and 11. Table 10 below provides the revised dose reconstruction scenarios. For comparison, Table 10 includes the probability of causations previously presented in Table 8.

Table 10: Modified Dose Reconstruction Scenarios.

Scenario	Job Title	Facility	Employment Dates	Years of Exposure	Diagnosis	Annual Dose (rem)	PoC%	Previous PoC%
1	Chemist	773-A	1/1/1973 - 12/31/2007	35	Lung	0.287	95.93%	95.93%
5	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Stomach	0.0005	2.37%	2.37%
6	Janitor	773-A	1/1/1973 - 12/31/2007	35	ET1 (160.0)	43.699	99.78%	99.79%
7	Operator	H Tank Farm	1/1/1973 - 12/31/2007	35	Colon	0.001	3.91%	3.97%
8	Janitor	H Tank Farm	1/1/1973 - 12/31/2007	35	ET2 (161.0)	0.021	17.83%	18.58%
10	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Bone surfaces	0.010	33.19%	35.14%
11	Maintenance worker	773-A	1/1/1973 - 12/31/2007	35	Prostate	0.0009	0.99%	1.04%

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ATTACHMENT A

Table A-1: Thoron Air Concentration Data, Year 2000.

Location	Date	6-hr dpm	24-hr dpm	Thoron Concentration (µCi/cc)	SRDB Ref ID	PDF Page
HTF PP 5&6	1/31/2000	5000	1600	3.36×10^{-11}	175888	135
HTF TK 10-12 E	1/31/2000	1400	390	1.20×10^{-12}	175888	152
HTF TK 13-16 BERM	1/31/2000	1400	405	1.18×10^{-12}	175888	151
HTF TK 9-12 GA	1/31/2000	600	363	2.81×10^{-13}	175888	151
HTF TK 30 Annulus	2/7/2000	538	164	7.88×10^{-12}	175888	164
HTF PP 5&6	2/15/2000	6000	800	1.40×10^{-10}	175888	191
HTF TK 13 N	2/28/2000	1398	600	1.54×10^{-12}	175888	274
HTF TK 13-16 BERM	2/28/2000	1810	800	1.68×10^{-12}	175888	274
HTF TK 9-12 GA	2/28/2000	1810	700	1.85×10^{-12}	175888	274
HTF PP 5&6	3/6/2000	3600	1400	2.19×10^{-10}	175888	299
HTF TK 39 Annulus	3/6/2000	600	400	4.11×10^{-12}	175888	298
HTF TK 39 Annulus	3/6/2000	800	400	8.27×10^{-12}	175888	299
HTF PP 5&6	4/13/2000	5000	2000	7.00×10^{-11}	175893	9
HTF TK 10-12 E	4/17/2000	2000	600	2.05×10^{-12}	175893	3
HTF PP 5&6	4/24/2000	5000	1000	1.03×10^{-10}	175893	5
HTF PP 5&6	4/27/2000	4400	2800	3.70×10^{-11}	175893	7
HTF PP 5&6	5/8/2000	5000	2000	6.48×10^{-11}	175893	11
HTF PP 5&6	5/15/2000	4000	1000	8.21×10^{-11}	175893	13
HTF TK 10-12 E	5/15/2000	2000	600	1.65×10^{-12}	175893	15
HTF PP 5&6	5/16/2000	5000	1000	6.90×10^{-11}	175893	17
HTF PP 5&6	6/9/2000	4000	2000	2.19×10^{-11}	175889	43
HTF PP 5&6	6/9/2000	4000	1000	4.26×10^{-11}	175889	45
HTF TK 10-12 E	6/12/2000	2000	200	2.34×10^{-12}	175889	57
HTF TK 10-12 E	6/19/2000	2000	300	1.95×10^{-12}	175889	85
HTF TK 10-12 E	6/26/2000	800	500	3.50×10^{-13}	175889	99
HTF 241-57H	7/10/2000	1800	600	1.40×10^{-12}	175889	167
HTF TK 10-12 E	7/10/2000	4000	800	4.14×10^{-12}	175889	158
HTF TK 13-16 BERM	7/10/2000	2000	600	1.81×10^{-12}	175889	157
HTF TK 10-12 E	7/24/2000	2000	800	1.54×10^{-12}	175889	204
HTF TK 13-16 BERM	7/31/2000	2000	800	1.40×10^{-12}	175889	239
HTF TK 13-16 BERM	8/7/2000	2000	600	1.63×10^{-12}	175889	272
HTF TK 9-12 GA	8/7/2000	2000	800	1.46×10^{-12}	175889	272
HTF PP 5&6	8/15/2000	6000	2000	1.04×10^{-10}	175889	281
HTF PP 5&6	8/21/2000	6000	2400	3.35×10^{-11}	175889	311

Location	Date	6-hr dpm	24-hr dpm	Thoron Concentration (µCi/cc)	SRDB Ref ID	PDF Page
HTF PP 5&6	8/23/2000	5000	2000	3.03×10^{-11}	175890	3
HTF PP 5&6	8/23/2000	6000	2200	1.78×10^{-11}	175890	9
HTF PP 5&6	8/26/2000	5600	2000	7.69×10^{-11}	175890	7
HTF PP 5&6	8/27/2000	5000	1200	1.41×10^{-10}	175890	20
HTF PP 5&6	8/28/2000	5000	2000	3.83×10^{-10}	175890	22
HTF PP 5&6	8/28/2000	4000	2000	7.44×10^{-11}	175890	31
HTF PP 5&6	8/28/2000	5000	2000	1.67×10^{-10}	175890	39
HTF PP 5&6	8/29/2000	6000	2400	1.90×10^{-10}	175890	48
HTF PP 5&6	9/4/2000	4000	2000	9.47×10^{-11}	175890	54
HTF TK 9-12 GA	9/4/2000	2800	2000	9.70×10^{-13}	175890	98
HTF PP 5&6	9/5/2000	4000	2000	3.07×10^{-10}	175890	69
HTF PP 5&6	9/6/2000	4000	2000	6.21×10^{-11}	175890	77
HTF PP 5&6	9/6/2000	5000	1600	3.02×10^{-10}	175890	78
HTF PP 5&6	9/6/2000	4000	1000	2.51×10^{-10}	175890	82
HTF PP 5&6	9/8/2000	2800	800	1.20×10^{-09}	175890	86
HTF PP 5&6	9/21/2000	4000	2000	3.66×10^{-11}	175890	144
HTF PP 5&6	9/25/2000	10000	3000	8.67×10^{-10}	175890	174
HTF TK 9-12 GA	9/25/2000	1000	600	1.72×10^{-12}	175890	195
HTF PP 5&6	9/27/2000	6000	1500	3.64×10^{-10}	175890	184
HTF DB-2 GA	10/16/2000	2000	200	2.33×10^{-12}	175891	10
HTF TK 9-12 GA	10/16/2000	3000	400	3.36×10^{-12}	175891	10
HTF TK 9-12 GA	10/16/2000	5000	2000	3.88×10^{-12}	175891	117
HTF PP 5&6	11/13/2000	8000	3000	4.94×10^{-11}	175891	126
HTF PP 5&6	12/11/2000	4000	2000	2.70×10^{-11}	175891	211
HTF PP 5&6	12/22/2000	8000	3000	1.31×10^{-10}	175891	240
HTF PP 5&6	12/30/2000	5000	2000	1.24×10^{-10}	175891	267