PREDECISIONAL DRAFT

ADVISORY BOARD ON
RADIATION AND WORKER HEALTH

National Institute for Occupational Safety and Health

REVIEW OF PROPOSED STABLE METAL TRITIDE DOSE RECONSTRUCTION METHODOLOGY AT PINELLAS

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ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation Worker Health
cm^2	square centimeters
dpm	disintegrations per minute
dpm/100cm^2	disintegrations per minute per 100 square centimeters
GE	General Electric
HP	Health Physics
µCi	microcurie
µCi/cc	microcuries per cubic centimeter
µCi/in^2	microcuries per square inch
m^{-1}	per meter
m^3	cubic meters
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
NUREG/CR	Nuclear Regulatory Commission – Contractor Technical Report
ORAUT	Oak Ridge Associated Universities Team
SMT	stable metal tritide
SRDB	Site Research Database
TBD	technical basis document

EXECUTIVE SUMMARY

The most current version of the internal dose technical basis document (TBD) for the Pinellas Plant, ORAUT-TKBS-0029-5, Revision 02 (hereafter referred to as "ORAUT 2012"), prescribes a methodology for reconstructing doses from intakes of insoluble forms of tritium (also referred to as stable metal tritides (SMTs)) during the operational period. Subsequent to the release of ORAUT 2012, the issue of reconstructing doses to these insoluble forms of tritium was discussed during the Pinellas Work Group meeting on November 19, 2012. One of the main concerns stemming from those discussions was that the proposed methods were not contemporary with the approach that was developed for a similar exposure situation at the Mound Plant (ABRWH 2012). In particular, the completeness of the available dataset and the appropriateness of the chosen resuspension factor were of particular import.

On December 11, 2015, NIOSH released its updated methodology and associated justification: *Review of NIOSH's Current Approach to Reconstruction of Insoluble Tritium Particulate at the Pinellas Facility* (hereafter referred to as "NIOSH 2015"). While not specifically discussed, that document was announced as ready for release at the November 2015 Advisory Board meeting, and SC&A was tasked with reviewing it when it became available. This white paper presents the results of SC&A's review, which identified seven observations and one finding, as follows:

Observation 1: SC&A identified several supplemental periodic health physics reports that had recently been uploaded to the Site Research Database (SRDB) and that account for some of the observed gaps in the primary reference (GE 1957–1973) forming the basis for characterization of tritium contamination at Pinellas (NIOSH 2015).

Observation 2: SC&A concurs with NIOSH that individual contamination survey results are limited until the late 1980s. No monthly or quarterly health physics reports (which generally report the highest contamination value for the given period) were observed by SC&A after the third quarter of 1973.

Observation 3: SC&A agrees with NIOSH's assertion that contamination values in the millions of disintegrations per minute per 100 square centimeters (dpm/100cm^2) would have been unusual and likely of short duration. Nonetheless, if the intention is to use the maximum contamination value observed in available site records, SC&A has identified 3 years in which the maximum contamination exceeded the proposed value of 4.4×10^6 dpm/100cm^2.

Observation 4: Available monthly health physics reports indicate that when contamination was discovered through either routine surveys or incidents, the area was immediately decontaminated.

Observation 5: SC&A observed evidence in survey logbooks from the 1980s and 1990s that indicated situations where contamination above the control limit was often recounted and then the area was decontaminated and resurveyed.

Observation 6: Based on a review of available health physics reports, it appears that the health and safety staff recognized situations that posed an elevated threat of tritium contamination and took precautions to minimize exposures.

Observation 7: The potential for particulate SMT material to be trapped in the wetted cotton ball prior to filtration, and thus possibly hindering the transfer of SMTs into the measured rinsate liquid, should be investigated and/or clarified in NIOSH's proposed approach for the reconstruction of insoluble SMTs.

Finding 1: NIOSH 2015 recommends a worker exposure duration of 2,000 hours per year. However, ORAUT 2012 had prescribed an exposure duration of 2,600 hours per year, based on documented statements from former workers indicating regular 50-hour work weeks. Absent additional information to the contrary, the original assumption of a 50-hour work week appears appropriate.

1.0 INTRODUCTION AND BACKGROUND

On December 11, 2015, NIOSH released its updated methodology and associated justification: *Review of NIOSH's Current Approach to Reconstruction of Insoluble Tritium Particulate at the Pinellas Facility* (hereafter referred to as "NIOSH 2015"). That document focused on five main facets of the methodology used by the most current version of the internal dose technical basis document (TBD) for the Pinellas Plant, ORAUT-TKBS-0029-5, Revision 02 (hereafter referred to as "ORAUT 2012"):

1. The appropriateness of the chosen resuspension factor
2. Use of the highest contamination survey (swipe) value reported between 1957 and 1973
3. Suitability/applicability of available survey measurements for the purposes of detecting stable metal tritides (SMTs)
4. Magnitude and extent of tritide contamination at Pinellas
5. Solubility assumptions concerning metal tritides

As indicated in ORAUT 2012and prior discussions on insoluble forms of tritium, SMTs are problematic from the standpoint of dose characterization because normal bioassay and air sampling methods for detecting tritium intakes are not appropriate for insoluble forms. NIOSH 2015 proposes a dose reconstruction methodology that utilizes area contamination surveys (swipe samples) along with assumptions characterizing the resuspension of the contaminated material and typical worker breathing rates and exposure time.

ORAUT 2012 examined a collection of available periodic[1] health physics reports (hereafter referred to as "GE 1957–1973") available on the Site Research Database (SRDB) in order to characterize tritium contamination levels and associated Health and Safety actions in response to contamination events. Specifically, the internal dose TBD determined the following concerning the contamination swipe data contained in GE 1957–1973:

> *These reports indicate that as early as 1959, areas greater than 2×10^{-5} µCi/in^2 (688 dpm/100 cm^2) were recommended for decontamination. In 1969, the control limit was reported as 440 dpm/100 cm^2. This indicates that a routine contamination control program was in place throughout the history of the site and that it would be unlikely to see high contamination levels for extended periods.*

The monthly health physics reports found in GE 1957–1973 often provide information on the maximum tritium surface contamination levels. Between 1957 and 1973, the highest surface contamination level reported was 4.4×10^6 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) in 1970 (10,000 times the known control limit). The next highest value reported

[1] The majority of reports during this time were issued on a monthly basis; however, beginning in 1970, reports were issued quarterly.

in GE 1957–1973 was 1.4×10^6 dpm/100 cm^2 (3.3×10^{-2} microcuries per square inch (µCi/in^2)) in 1959. The majority of the rest of the surface contamination levels reported in this reference are at least an order of magnitude lower than these two sample values. The currently proposed methodology utilizes the maximum observed value (4.4×10^6 dpm/100 cm^2) to represent the insoluble tritium area contamination for all potentially exposed workers.

This white paper focuses on the appropriateness and bounding nature of the chosen contamination value as well as the completeness of the available contamination data used in making this determination (Section 2). Although the focus of this review is on the available contamination survey data, the remaining assumptions characterizing the proposed approach are discussed briefly in Section 3.

2.0 REVIEW OF AVAILABLE CONTAMINATION DATA AND HEALTH PHYSICS PRACTICES AT THE PINELLAS PLANT

As stated in the introduction, NIOSH has reviewed a collection of health physics monthly reports to determine a bounding contamination value to use as the basis for assigning intakes of SMTs for relevant workers[2] at Pinellas. NIOSH has elected to use the highest value observed (4.4×10^6 dpm/100cm^2) in a collection of reports found in GE 1957–1973. The number of monthly reports contained in that document is displayed in Table 1 and Figure 1. Individual monthly reports were available for all 12 months in 5 of the 17 years covered in GE 1957–1973. No monthly reports were available for 1968 and 1971.

Also indicated in Table 1 is the number of reports that appear "complete." The majority of available monthly reports were incomplete. The available documentation indicates that monthly reports were generally between 5 and 9 pages up through 1967; after this time, reports ranged from 13 to 17 pages. However, as evidenced by column 3 of Table 1, very few of these reports were complete documents, with only 5 of the 114 available reports (approximately 4.4%) containing all indicated pages.[3] An example of a complete monthly report contained in GE 1957–1973 is shown in Appendix A.

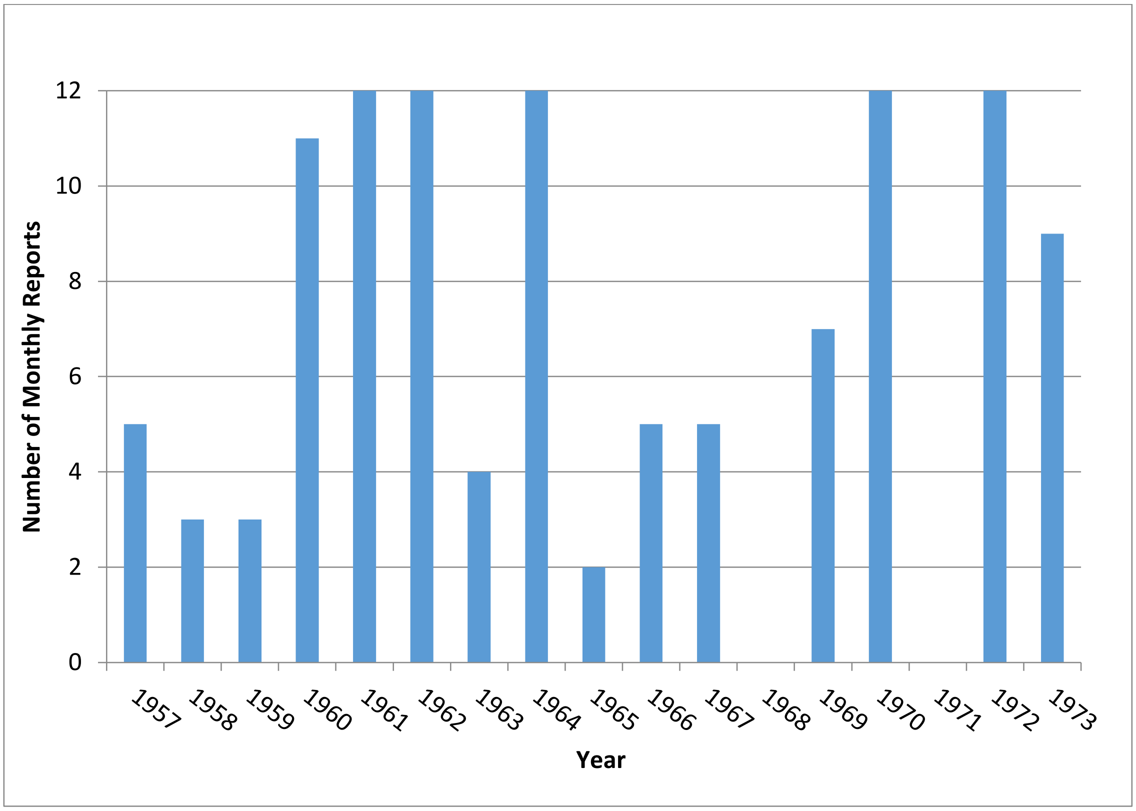
[2] NIOSH 2015 states that intakes of SMTs will be assigned only to workers who were on the tritium bioassay program. ORAUT 2012 states that workers who were not monitored for tritium would only be exposed to environmental levels of radioactive materials.

[3] The number of pages in a given monthly report could be ascertained by the page numbering scheme used, as pages were labeled as "1 of 6," "2 of 6," etc.

Table 1. Summary of Available Monthly Reports (GE 1957–1973)

Year	Total Number of Monthly Reports	Number of Complete Monthly Reports	Number of Smears Taken as Indicated in Available Monthly Reports	Number of Actual Smear Results Reported
1957	5	3	536	3
1958	3	Unknown	226	0
1959	3	Unknown	585	21
1960	11	0	1,514	10
1961	12	0	8,428	0
1962	12	1	9,943	0
1963	4	0	1,505	0
1964	12	0	1,637	0
1965	2	1	1,147	0
1966	5	1	Not Stated	1
1967	5	0	Not Stated	0
1968	NMR	NMR	NMR	NMR
1969	7	0	1005	4
1970	12	0	1492	1
1971	NMR	NMR	NMR	NMR
1972	12	0	1195	2
1973	9	0	1079	0

NMR = No monthly reports identified.



Note: Beginning in 1970, health physics reports were issued quarterly. For the purposes of this figure, each quarterly report was represented as covering 3 months.

Figure 1. Summary of Available Monthly Reports Referenced in GE 1957–1973

The magnitude of swipe results found in GE 1957–1973 is shown in Figure 2. Based on the data in GE 1957–1973, it is clear that the chosen value of 4.4×10^6 dpm/100cm^2 is significantly larger than most other swipe samples reported in the available records. Additionally, the chosen value clearly bounds all of the maximum swipe samples reported during this time.

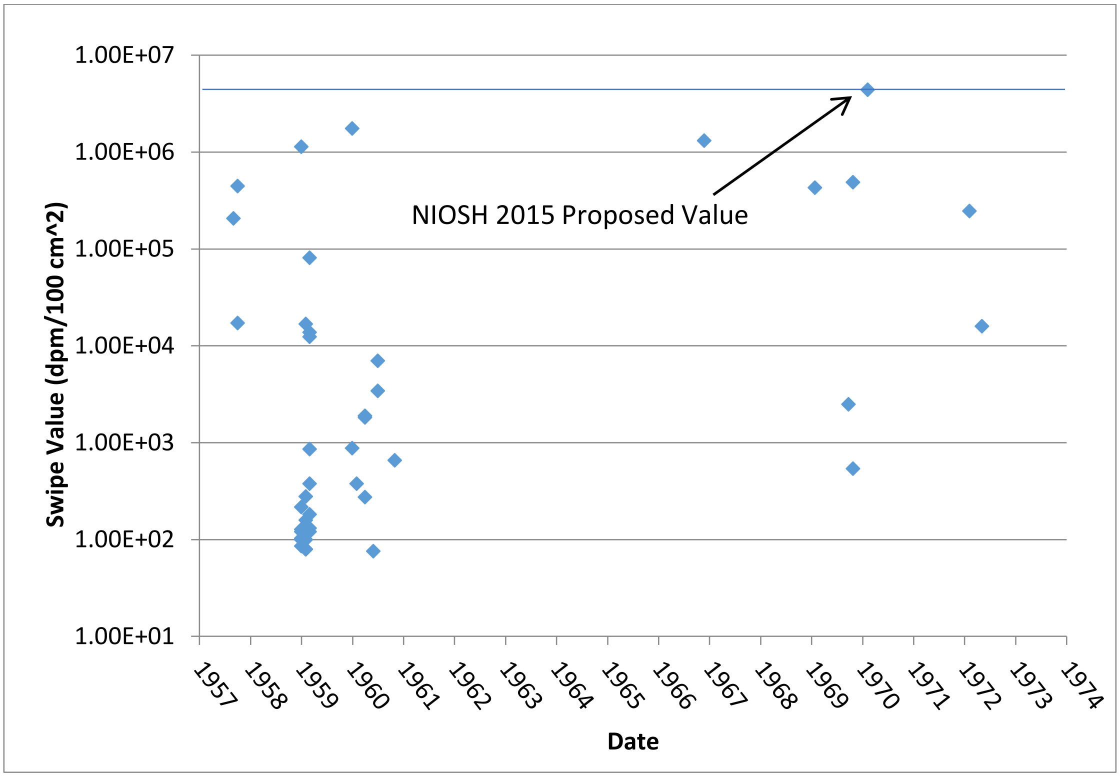


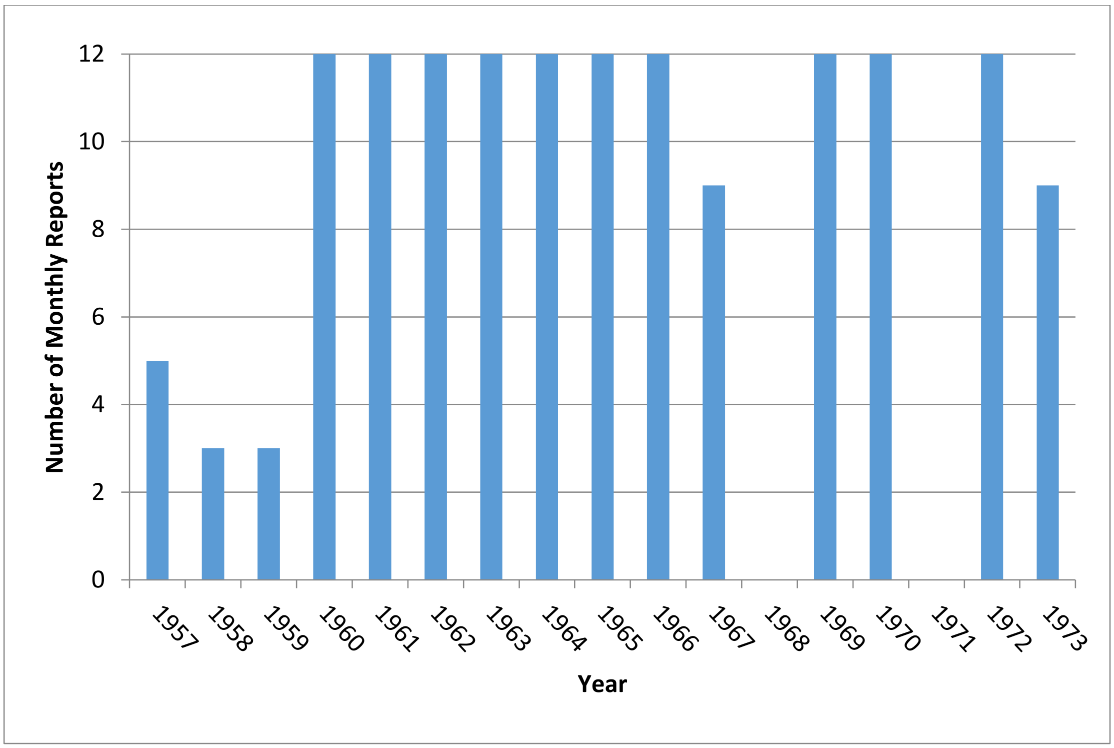
Figure 2. Magnitude of Swipe Results Provided in Monthly Reports Referenced in GE 1957–1973

Subsequent to the release of the methodology outlined in ORAUT 2012 (which forms the basis for selection of 4.4×10^6 dpm/100cm^2), more than 350 additional documents have been captured and uploaded to the SRDB. These documents include additional and supplemental monthly health physics reports as well as individual handwritten survey logs and incident reports. An example of a handwritten survey log is shown in Appendix B. SC&A examined these additional records with four main objectives:

1. Assess if the supplemental records will fill the observed gaps in GE 1957–1973 (see Section 2.1).
2. Explore any monthly health physics reports and associated data occurring after 1973 (see Section 2.3).
3. Determine if there is evidence of contamination values exceeding the proposed value of 4.4×10^6 dpm/100cm^2 (see Section 2.4).
4. Evaluate the extent to which observed contamination reported in available records was decontaminated (see Section 2.2).

Each of these facets is discussed in the subsections below.

As noted in the previous section, GE 1957–1973 contained several years for which the monthly health physics reports were missing, including at least 2 years for which no health physics reports were observed. Additional data capture has obtained supplemental monthly health physics reports that can be used in conjunction with GE 1957–1973. Figure 3 displays a combination of the reports available in GE 1957–1973 and the additional reports recently uploaded to the SRDB. As seen in Figure 3, complete sets of health physics reports are available for 1960–1966, 1969–1970, and 1972. SC&A was unable to locate any health physics reports for 1968 and 1970 in the supplemental records, nor any additional reports for 1957–1959 and 1973 (beyond what had already been contained within GE 1957–1973). Finally, SC&A did not observe any periodic health physics reports beyond 1973, although contamination swipe data were identified for several years post 1973 (see Section 2.2).



Note: Beginning in 1970, health physics reports were issued quarterly. For the purposes of Figure 3, each quarterly report was represented as covering 3 months.

Figure 3. Total Available Monthly Health Physics Reports from 1957–1973

Observation 1: SC&A identified several supplemental periodic health physics reports that had recently been uploaded to the SRDB and that account for some of the observed gaps in the primary reference (GE 1957–1973) forming the basis for characterization of tritium contamination at Pinellas (NIOSH 2015).

2.1 AVAILABILITY OF HEALTH PHYSICS AND CONTAMINATION DATA PAST 1973

As was noted in the previous Section, SC&A did not observe any periodic health physics reports past the third quarter of 1973. However, SC&A did find sparse examples of reported contamination levels in various other references for 1976, 1980–1981, 1986–1988, and 1991–1994. The highest observed value in each of these additional years, as well as the years covered by GE 1957–1973, is discussed in Section 2.3. Beginning in the late 1980s, and particularly in the 1990s, thousands of pages of contamination smear data are available for review in the SRDB.

It is not unexpected that additional periodic health physics reports and complete sets of contamination survey data were not available. NIOSH 2015 had noted the following:

> *For the Pinellas Plant, little individual contamination smear data is available. The primary data source that we have for the Pinellas Plant's contamination survey results were the monthly Health Physics Summary Reports that reported the highest contamination levels measured for a given month.*
>
> *An analysis of available data of the monthly Health Physics Summary Reports (SRDB 27095* [GE 1957–1973] *found the highest surface contamination level reported was 4.4E+06 dpm/100 cm^2, which is 10,000 times their control limit.*

Observation 2: SC&A concurs with NIOSH that individual contamination survey results are limited until the late 1980s. No monthly or quarterly health physics reports (which generally report the highest contamination value for the given period) were observed by SC&A after the third quarter of 1973.

2.2 BOUNDING NATURE OF CHOSEN CONTAMINATION VALUE IN NIOSH 2015

As discussed previously, NIOSH 2015 references a collection of monthly/quarterly health physics reports from 1957 to 1973 (GE 1957–1973) as the basis for selection of the maximum observed value of 4.4×10^6 dpm/100 cm^2. This collection of monthly reports is described in detail in Section 2.0. Additional reports, which supplement this collection, are discussed in Sections 2.1 and 2.2. NIOSH 2015 states the following about the chosen contamination value:

> *The likelihood of routine surface contamination level* [sic] *in the millions of dpm/100 cm^2 should be considered unusual and short in duration.*
>
> *As a comparison, the assumption of an average contamination level of 4.4E+06 dpm/100 cm^2 is one to two orders of magnitude higher (depending on the year) than the surface contamination levels at Mound, which had a similar process as Pinellas. Therefore, the approach applied at Pinellas is considered bounding and favorable to the claimant.*

In addition to the references found in GE 1957–1973, SC&A identified and reviewed supplemental periodic health physics reports and contamination surveys to determine if contamination exceeding the proposed value may have existed at Pinellas. Figure 4 displays the maximum observed contamination measurement for each year for which such data were available. Table 2 presents additional descriptions of each maximum result and also indicates the years for which no numerical swipe samples could be obtained.

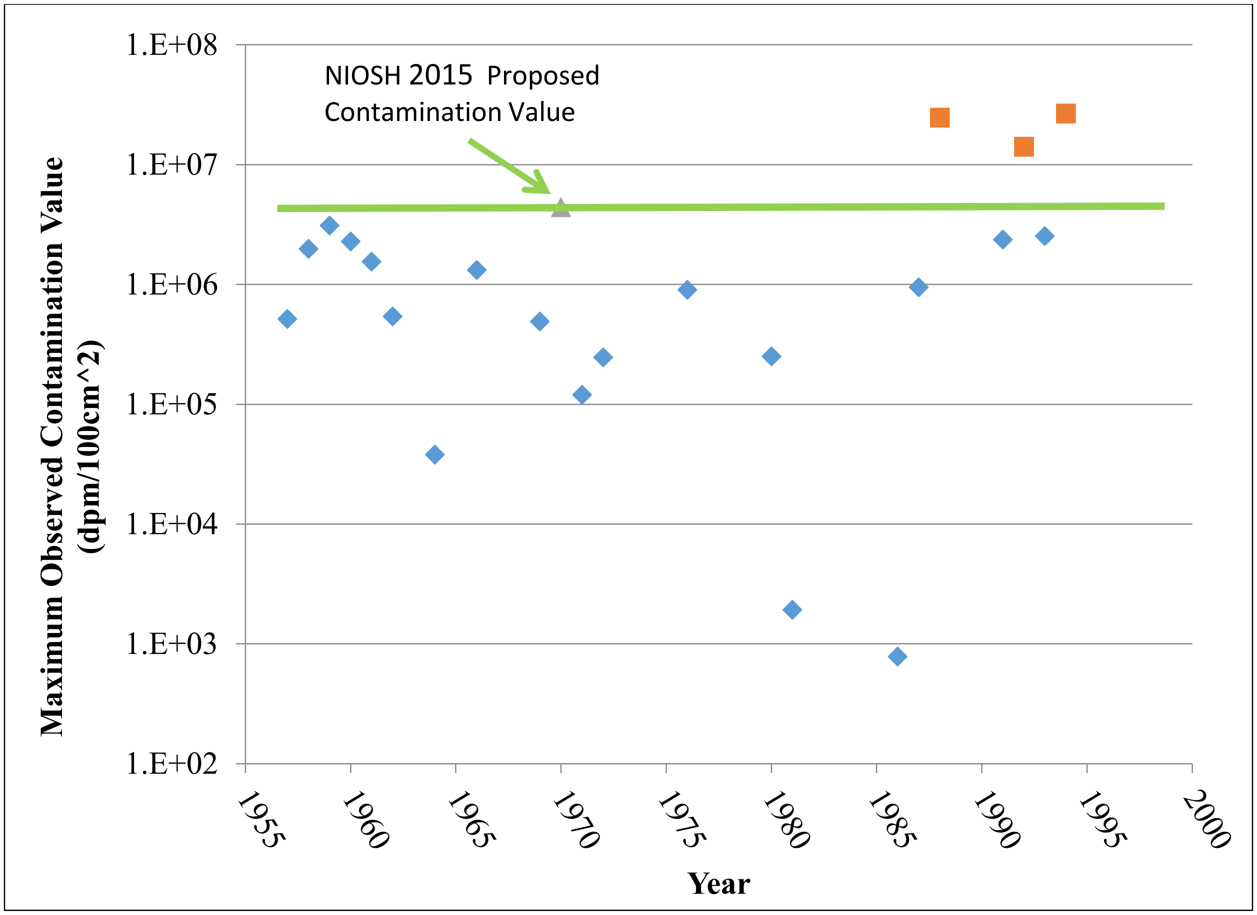


Figure 4. Maximum Observed Contamination Value by Year in dpm/100cm²

As seen in Figure 4 and described in Table 2, three of the years that had contamination swipe data displayed values greater than the proposed value of 4.4×10^6 dpm/100 cm². The maximum observed contaminations for these 3 years were as follows:

- 1988: Two contamination measurements were found on the order of 10^7 dpm/100cm²; these locations appear to be associated with the removal of a hood and/or glove box (the contamination was found on the floor either right near the removed equipment or directly under the removed equipment).

- 1992: Area 158B Flow Bench – Two surveys were performed for the area on consecutive days; both were on the order of 1.4×10^7 dpm/100cm^2. A handwritten note on the record indicates, "*Rad Exh Hood*."
- 1994: A swipe location was given as "Pipe B," and the record indicates it was from the inside tubing that was taken out of an accelerator. The next highest result observed in this year was 1.23×10^6 dpm/100cm^2 on a table top in Area 182C (this is below the NIOSH proposed value of 4.4×10^6 dpm/100cm^2).

For the contamination results in 1988, it appears that the highest values were the result of decommissioning and removal of equipment. Logically, contamination levels associated with such activities would not be encountered in an operational setting and not on a chronic, long-term basis. Similarly, the high contamination value observed in 1994 appears to be associated with the internal components of an accelerator, so any actual exposure potentially was likely limited in time and scope. The highest value for 1992 was associated with a "flow bench" in Area 158B (also referred to as a "Rad Exh Hood" based on a handwritten note on the computer printout); however, SC&A could not locate any other information to characterize the actual exposure potential of such contamination.

Table 2. Additional Information on Maximum Observed Contamination Values (dpm/100cm^2) by Year

Year	Maximum Contamination (dpm/100cm^2)	SRDB Ref. ID	Page	Location/Additional Comments
1957	5.16E+05	133591	6	Tube Exhaust Area
1958	1.98E+06	15169	75	Hood Room I – Doors
1959	3.10E+06	15169	139	Hood Room I – South Panel
1960	2.28E+06	15169	503	Location given as "inside of tube." Next highest value was 1.76×10^6 dpm/100cm^2 in Area 8 related to maintenance on the vacuum pump and increased system cleaning operations.
1961	1.55E+06	15180	99	Area 908 Hood Room – Hood
1962	5.40E+05	15406	75	Area 908 Hood Room – Interior
1963	NA	NA	NA	NA
1964	3.79E+04	133586	8	Area 8 during an equipment cleaning operation.
1965	NA	NA	NA	NA
1965	*None Available*			
1966	1.32E+06	133581	2	Area 62 – found on a vacuum dolly caused by experimental work. Health physics was involved with the planning of the operation but were not present during the actual execution phase.
1967	NA	NA	NA	NA
1968	NA	NA	NA	NA
1969	4.90E+05	27095		Cell 3, Building 400. Used tritium flasks were being stored in the area, an incident investigation was enacted, and a full report is available.

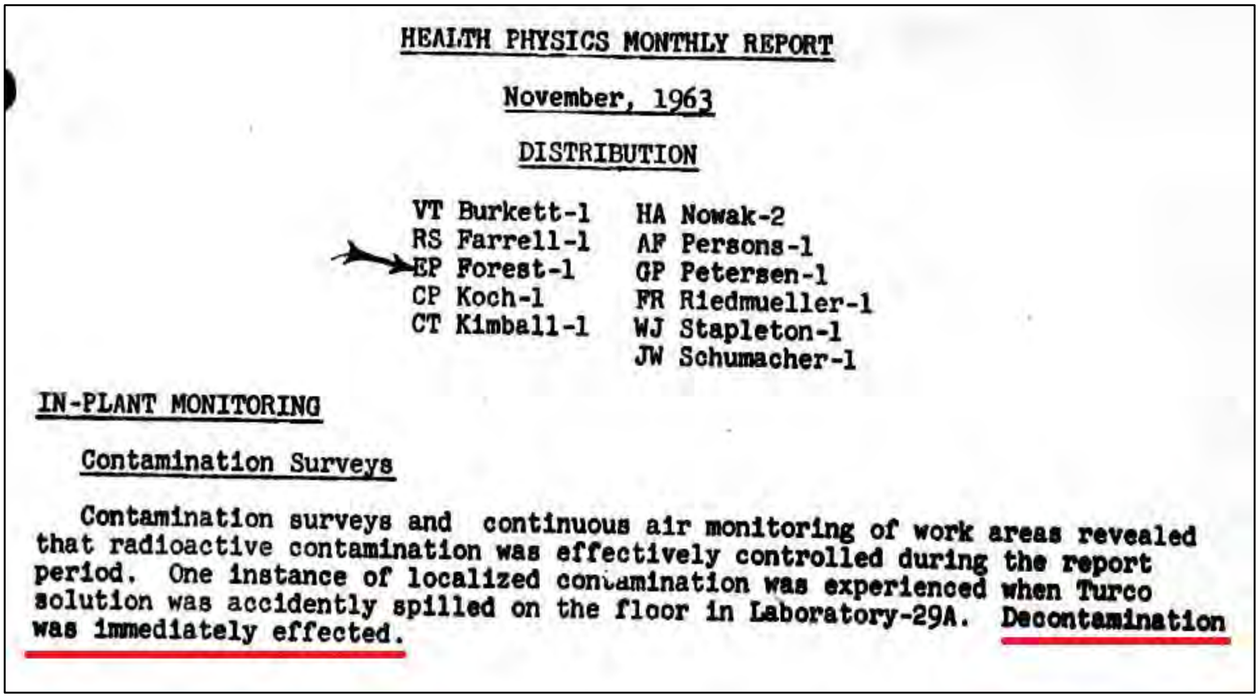
Year	Maximum Contamination (dpm/100cm^2)	SRDB Ref. ID	Page	Location/Additional Comments
1970	4.40E+06	27095		Area 108, Room 2. Resulted from maintenance operations on a metal system contained in a glove box. ***This is the proposed value to be used for all years in NIOSH 2015.***
1971	1.20E+05	12804		Area 108, Room 18.
1972	2.46E+05	27095		Area 182D. An evaporator fixture flaked while being packaged for disposal.
1973	NA	NA	NA	NA
1974	NA	NA	NA	NA
1975	NA	NA	NA	NA
1976	9.02E+05	133546	10	Room 182D, floor at the north east corner of the room.
1977	NA	NA	NA	NA
1978	NA	NA	NA	NA
1979	NA	NA	NA	NA
1980	2.51E+05	12808		Receiving dock – Scanning Electron Microscope.
1981	1.92E+03	133544	4	Location given as "inside" of "stack section 2" (note: other swipes from inside and outside "stack section 2" were below 220 dpm/100cm^2)
1982	NA	NA	NA	NA
1983	NA	NA	NA	NA
1984	NA	NA	NA	NA
1985	NA	NA	NA	NA
1986	7.84E+02	12808	113	Area 108 to Area 1000. A contaminated drum found in Area 1000 that had not been decontaminated prior to leaving Area 108.
1987	9.50E+05	133494	6	Discovered on weld bench surface.
1988	2.47E+07	133490	18	Discovered on floor by removed hood. Another swipe at 1.2e7 found on the floor under a removed glove box. Remaining swipes in year below proposed 4.4e6 value.
1989	NA	NA	NA	NA
1990	NA	NA	NA	NA
1991	2.37E+06	133426	242	Found on "Front Cart Top Shelf" in Area 182D.
1992	1.41E+07	133570	491	Area 158B Flow Bench – Area was verified with two surveys on consecutive days both on the order of 1.4×10^7 dpm/100cm^2.
1993	2.54E+06	133407	403	Area 108, Room 22 – Hood.
1994	2.67E+07	133512	71	Swipe location given is "Pipe B" and record indicates it was from the inside tubing that was taken out of an accelerator. The next highest result observed in year was 1.23e6 on a able top in Area 182C.

NA = None available.

Observation 3: SC&A agrees with NIOSH's assertion that contamination values in the millions of dpm/100cm^2 would have been unusual and likely of short duration. Nonetheless, if the intention is to use the maximum contamination value observed in available site records, SC&A has identified 3 years in which the maximum contamination exceeded the proposed value of 4.4×10^6 dpm/100cm^2.

2.3 CHARACTERIZATION OF HEALTH AND SAFETY PRACTICES

In reviewing available monthly health and safety reports, SC&A observed several instances in which it was reported that contamination had been found during normal radiation surveys and had been decontaminated immediately. One such example is shown below in Figure 5, and several other examples are described in Appendix C.



HEALTH PHYSICS MONTHLY REPORT

November, 1963

DISTRIBUTION

VT Burkett-1
RS Farrell-1
EP Forest-1
CP Koch-1
CT Kimball-1
HA Nowak-2
AF Persons-1
GP Petersen-1
FR Riedmueller-1
WJ Stapleton-1
JW Schumacher-1

IN-PLANT MONITORING

Contamination Surveys

Contamination surveys and continuous air monitoring of work areas revealed that radioactive contamination was effectively controlled during the report period. One instance of localized contamination was experienced when Turco solution was accidently spilled on the floor in Laboratory-29A. Decontamination was immediately effected.

Figure 5. Screenshot of a November 1963 Health Physics Monthly Report Indicating a Contamination Incident in which Decontamination was "Immediately Effected."

Observation 4: Available monthly health physics reports indicate that when contamination was discovered through either routine surveys or incidents, the area was immediately decontaminated.

This type of observation was also noted in NIOSH 2015:

> *These reports also indicate that surface contamination levels above the control limits of 2E-05 μCi/in^2 (688 dpm/100 cm^2), as early as 1959, and 440 dpm/100 cm^2 (reported in 1969) resulted in the initiation of decontamination efforts. This was confirmed in an interview of a past radiological control personnel who indicated that metal tritide contamination was cleaned up fairly quickly. Radiological Control personnel would take wipes in the morning and, if contamination was identified, they would then mop up the area and resurvey.*

SC&A confirmed the statements made in the former worker interview (a health physicist who worked from 1987 to 1997 at Pinellas) and also observed the practice of resampling a contaminated area after mopping in a 1992 smear survey dataset (see Figures 6–9 for examples). Figure 6 presents smear samples taken in three areas (182, 158, and 108) and indicates that one sample was well above the control limit of 440 dpm/100cm^2; this resulted in a recount of the sample (shown in Figure 7). Figure 8 displays a second request for recounting based on the results of the first recount in Figure 7. Finally, Figure 9 shows the results of a new survey of the area with markedly lower contamination values (~10% of the control limit) that occurred after the area was decontaminated (mopped). This type of example was observed in numerous in other survey logs in the late 1980s and 1990s.

USER ID # 8: DAILY SURVEYS

RUN DATE: JUN 01, 1992
RUN TIME: 08:51
SMEARED AREA: 1000 SQ. CM
COUNTING ERROR= 20%

SAM #	ID	CPM	EFF	DPM/100 sq cm
1	1 A158B STEP OFF	10	42	4
2	2 A158B NEAR DOOR	10	43	5
3	3 A182C STEP OFF	263	42	* 3002 SEE RECOUNT.
4	4 A182C NEAR DOOR	8	41	0
5	5 A108 LOBBY	9	42	0
6	6 A108 STEP OFF	8	42	0

Figure 6. Daily Survey of Areas 158, 182, and 108 Showing a Result for "A182C Step Off" that Triggered a Recounting of the Sample.

USER ID # 8: DAILY SURVEY - RECOUNT

RUN DATE: JUN 01, 1992
RUN TIME: 09:59
SMEARED AREA: 1000 SQ. CM
COUNTING ERROR= 20%

SAM #	ID	CPM	EFF	DPM/100 sq cm
1	3 AREA 182 C STEP OFF	273	41	3175 SEE RECOUNT

Figure 7. Recount of the Sample Identified in Figure 4 that Still Showed Contamination Levels Above the Limit of 440 dpm/100 cm^2

Analyst: DH
Sampled by: JG
Reviewed by:

HLB0601921002

USER ID # 8: DAILY SURVEY - RECOUNT

RUN DATE: JUN 01, 1992
RUN TIME: 10:02
SMEARED AREA: 1000 SQ. CM
COUNTING ERROR= 20%

SAM #	ID	CPM	EFF	DPM/100 sq cm
1	3 AREA 182 C STEP OFF	238	41	2817

Figure 8. Second Recount of the Sample that Still Showed Contamination Levels Above the Limit of 440 dpm/100 cm^2

USER ID # 8: AREA 182 C RE-SURVEY AFTER MOPPING

Daily Re-check

RUN DATE: JUN 01, 1992
RUN TIME: 12:54
SMEARED AREA: 1000 SQ. CM
COUNTING ERROR= 20%

SAM #	ID	CPM	EFF	DPM/100 sq cm
1	A STEP OFF LINE - FLOOR	12	42	40
2	B FLOOR NEAR DOOR	9	42	6
3	C FLOOR HALLWAY OUTSIDE	10	42	22

Figure 9. Area was Re-Surveyed after Mopping and Showed Markedly Decreased Contamination

Observation 5: SC&A observed evidence in survey logbooks from the 1980s and 1990s that indicated situations where contamination above the control limit was often recounted and then the area was decontaminated and resurveyed.

In addition, SC&A noted that several of the monthly health physics reports indicated that there were certain activities that were expected to result in levels of contamination that might exceed the control limit. These reports also note that protective actions were taken and contamination control measures were put in place that minimized such events. For example, a monthly health physics report from December 1969 stated the following:

> *Anticipated contamination above the control limit of 440 dpm/100cm^2, was associated with work in Areas 108, 132B, 154, 155, 158, 162, 182A, 182B, 182C, and 182D. The maximum contamination level, 4.3×10^{-5} dpm/100cm^2, was detected on the work surface of a hood in Room 20, Area 108, following the disassembly of a vac-ion pump.*
>
> *Continuous monitoring was provided by Environmental Health during disassembly.*
>
> *Airborne tritium concentrations to a maximum of 1.3×10^{-3} µCi/cc were encountered by employees performing maintenance on a mass spectrometer in Room 3, Area 108."* [GE 1957–1973]

Interestingly, the currently proposed bounding contamination value of 4.4×10^6 dpm/100cm^2 was the result of a similar situation in which the contamination had been anticipated and actions had been taken prior to the activity. Specifically, the health physics report dealing with the situation states:

> *Contamination in excess of area control levels occurred in Area 108 and 154. Maintenance operations on a metal system contained in a glove box in Room 2, Area 108, resulted in tritium floor contamination exceeding area control levels by a factor of 10,000. Controls imposed prior to the commencement of work, confined the contamination to the room, however, the levels were considerable* [sic] *higher than expected.* [GE 1957–1973]

Finally, it appears that at times "paper" was used to cover floor and work surfaces prior to activities that might result in contamination. After the specific operation had taken place, the paper was removed and disposed of as contaminated waste. One such example is shown in Figure 10 from a health and safety manual from 1982. This type of activity would minimize the occurrence of significant contamination occurring for long periods of time.

A-5 USE OF PAPER IN THE CONTROL OF CONTAMINATION

Papering of work and floor surfaces in areas where work having a potential for contamination is to be performed will aid in maintaining contamination control.

1. Paper work surfaces and floor areas in the vicinity of the work. Apply masking tape to keep the paper in place.
2. When work is completed, remove the paper folding the outer edges to the center until it is of such a size that it may be placed in a plastic bag and disposed of as contaminated waste.
3. Request a contamination survey by Environmental Health, extension 8156.

Figure 10. Screenshot of a 1982 Health Physics Procedure Indicating that "Paper" Was Used to Limit Long-Term Contamination During Certain Operations.

Observation 6: Based on a review of available health physics reports, it appears that the health and safety staff recognized situations that posed an elevated threat of tritium contamination and took precautions to minimize exposures.

3.0 DISCUSSION OF REMAINING PARAMETERS IN SMT DOSE RECONSTRUCTION APPROACH

Aside from the selection of the area contamination value reviewed in detail in Sections 2.0–2.3, the remaining assumptions and parameter choices are pertinent in developing bounding and claimant favorable intakes of SMTs. These include the following:

- Selection of a resuspension factor
- Ability of the Pinellas measurement system to detect SMT contamination (mainly the effect of filtration prior to the actual measurement)
- Solubility type of the assumed SMT intakes
- Breathing rate and exposure duration

This section provides a brief discussion of each of the above characteristics of the proposed intake model for SMTs.

3.1 CHOICE OF RESUSPENSION FACTOR

NIOSH 2015 proposes the use of a resuspension factor of 5×10^{-5} m^{-1} based on the methodology developed for the Mound Site (see Issue #1 of NIOSH 2015). This represents an increase in the originally recommended value of 1×10^{-6} per meter (m^{-1}) found in ORAUT 2012. It is important to note that in the case of the Mound site, the 95th percentile contamination value had been selected along with a resuspension value of 5×10^{-5} m^{-1}. Because of the limitations on available survey data at Pinellas, this resuspension factor of 5×10^{-5} m^{-1} is being proposed in conjunction with the maximum observed contamination value.[4]

The resuspension factor used at Mound and currently proposed for Pinellas is based on recommendations in NUREG/CR-5512 (NRC 1992), which cites the International Atomic Energy Agency recommendation for indoor areas of nuclear facilities with surface contamination and moderate activity. SC&A finds that the choice of a resuspension factor of 5×10^{-5} m^{-1} is technically appropriate and claimant favorable in the proposed methodology for reconstruction of tritide intakes at Pinellas.

3.2 EFFECTIVENESS OF SURVEY MEASUREMENTS FOR CAPTURING STABLE METAL TRITIDES

NIOSH 2015 investigated the ability of the measurement system and contamination smear techniques used at Pinellas for detecting SMTs. Specifically, the concern was raised that the use of filters prior to counting the smear sample may have removed the applicable SMT particles, which would render the measurement system incapable of producing an accurate result. NIOSH 2015 states the following under Issue #3:

> *The three tritium contamination smear analysis procedures that are available indicate that the Pinellas Plant used wetted cotton balls to collect smear samples for tritium contamination monitoring. The available procedures also indicate that the cotton ball smear samples were rewetted in a paper cup with a prescribed amount of deionized water (8 to 10 ml, depending on the procedure), and that a rinsate was squeezed from the cotton balls while they were still in the paper cup. These procedures indicate that the rinsate from the cotton balls was then filtered through a Whatman #1 filter.*

NIOSH 2015 presents the following information to alleviate concerns with the use of filters on smear samples:

1. The practice of filtering the sample may have been limited to certain years:
    a. Two of three procedures that mention filtering through the Whatman #1 filter were undated but likely were from the late 1960s into the 1980s.
    b. Worker interviews indicate filters may not have been used by 1977.
        i. One health physicist who worked from 1987 to 1997 indicated no filtration took place.

[4] Note that in Section 2.3, SC&A has identified three other contamination surveys that exceeded the NIOSH 2015 proposed value of 4.4×10^{6} dpm/100cm^{2}.

   ii. Two workers from the chemistry department from 1977 to 1997 did not recall a filtration step in the analysis process.

2. The pore size for a Whatman #1 filter is approximately 11 microns, with a maximum of 12.7 microns (a non-respirable particle size). One reference indicated that titanium hydride (an SMT) had average particle sizes of 6–9 microns and, therefore, would not have been removed by filtration.

3. Soluble forms of tritium were in much greater abundance than the insoluble SMT material. Therefore, assuming that all contamination was 100% SMT would account for any limitations on the smear surveys due to filtration.

With regard to Item 1 on this list, SC&A verified the references contained in NIOSH 2015 and concurs with NIOSH's assessment of the material. One of the undated survey procedures that mentions the Whatman Filter #1 alluded to in NIOSH 2015 is consistent with Project Document Number 240001177 found in the internal TBD (ORAUT 2012); this reference was dated circa 1966. This would be consistent with the assertion that the use of Whatman #1 filters was restricted to certain time periods.

SC&A also confirmed that the Whatman #1 filter paper has a pore size of 11 microns5 (Sigma-Aldrich 2016) and so agrees that respirable particles would not have been removed from the sample in any significant amount prior to assessment of the contamination on the survey smear.

SC&A agrees that insoluble forms of particulate tritium make up only a fraction of the tritium contamination observed at Pinellas. Therefore, the assumption that all contamination on available survey smears was SMT material is considered claimant favorable and bounding. However, SC&A is concerned that the use of a "wetted cotton ball" for collecting the initial contamination may result in the "trapping" of particulate SMT material within the cotton ball and hinder the transfer of contamination from the swab to the rinsate. Because NIOSH (2015) does not specifically discuss this possibility, SC&A has requested clarification from NIOSH regarding this potential avenue for source degradation prior to measurement.

Observation 7: The potential for particulate SMT material to be trapped in the wetted cotton ball prior to filtration, and thus possibly hindering the transfer of SMTs into the measured rinsate liquid, should be investigated and/or clarified in NIOSH's proposed approach for the reconstruction of insoluble SMTs.

3.3 CHOICE OF SOLUBILTY TYPE FOR ASSIGNMENT OF SMT INTAKES

NIOSH 2015 has elected to assume that all intakes associated with resuspended contamination are considered insoluble. It is clear that many different solubility types might have been experienced by workers at Pinellas; however, it is not possible to differentiate between distinct solubility types for the purposes of assigning intakes of SMT material. It should be noted that

[5] By comparison, Type #2 filters have a pore size of 8 microns, and Type #3 have a pore size of 6 microns.

ORAUT 2012 had originally instructed dose reconstructions to consider both Type M and Type S tritium compounds when considering intakes of SMTs. SC&A agrees that the selection of Type S solubility for all intakes associated with resuspended contaminated material is claimant favorable and bounding.

3.4 WORKER BREATHING RATES AND EXPOSURE TIMES

NIOSH has assumed a worker breathing rate of 1.2 cubic meters per hour (m^3/hour) over a standard 2,000 hour work year. The choice of 1.2 m^3/hour is the assumed value for a reference worker performing "light activity" and is appropriate for the type of work expected to occur at Pinellas. The 2,000-hour work year is based on a typical 40-hour work week in conjunction with 50 weeks per year. However, ORAUT 2012 stated the following concerning the exposure duration to workers exposed to SMTs:

> *Assuming a breathing rate of 1.2 m^3/hour and the* ***exposure time assumption of 2,600 hours (based on a review of telephone interviews provided by former workers, 50-hour weeks were routine)****, annual inhalation and ingestion intake rates for insoluble tritium were calculated…* [emphasis added]

NIOSH 2015 does not provide a specific rationale for decreasing the assumed exposure time from 2,600 hours per year to 2,000 hours per year as prescribed in ORAUT 2012. Unless specific information has been obtained and identified for the decrease in annual work hours, the original claimant-favorable assumption of a 50-hour work week based on documented telephone interviews would appear appropriate.

Finding 1: NIOSH 2015 recommends a worker exposure duration of 2,000 hours per year. However, ORAUT 2012 had prescribed an exposure duration of 2,600 hours per year, based on documented statements from former workers indicating regular 50-hour work weeks. Absent additional information to the contrary, the original assumption of a 50-hour work week appears appropriate.

4.0 SUMMARY CONCLUSION

Based on a thorough review of NIOSH 2015 and the underlying documentation, SC&A concludes that the methodology provides a framework that effectively bounds the potential for exposure to insoluble tritium compounds experienced at the Pinellas Plant. This conclusion is based on the following:

- Use of one of the highest observed contamination survey values in characterizing the resuspended material present for worker intake
- Use of a conservative resuspension factor to account for airborne particulate tritium material from contaminated surfaces

- Documentation (including health physics procedures, actual contamination surveys, and interviews with former workers) indicating that, when contamination was detected above the control limits, it was quickly decontaminated and the area resurveyed to assure compliance with the applicable limits
- Use of mitigating procedures, such as disposable paper on surfaces likely to be contaminated, to assure long-term contamination was not experienced by Pinellas workers

Although actual contamination smear survey data are sparse to nonexistent for many years, documentation suggests that events or incidents that would approach the assumed contamination value in NIOSH 2015 would not have existed for any significant amount of time. SC&A did identify 3 years in which the maximum measured contamination exceeded the proposed value in NIOSH 2015; however, it is questionable in at least two of the three cases whether substantial exposure potential was likely to have existed. Finally, SC&A recommends that, absent sufficient documentation or rationale, the original assumption of a 50-hour work week from ORAUT 2012 be adopted.

5.0 REFERENCES

ABRWH 2012. *Transcript of the Advisory Board on Radiation Worker Health – Work Group on Pinellas – November 19, 2012.* U.S. Department of Health and Human Services – Centers for Disease Control – National Institute for Occupational Safety and Health. November 19, 2012.

GE 1957–1973. *HP Summary Reports 1957–1973*. General Electric. Pinellas Plant, St. Petersburg, FL. Date Captured: June 8, 2004. SRDB REF ID: 27095. December 11, 2015,

NIOSH 2015. *Review of NIOSH's Current Approach to Reconstruction of Insoluble Tritium Particulate at the Pinellas Facility*, Revision 0. Division of Compensation Analysis and Support, National Institute for Occupational Safety and Health, December 11, 2015.

NRC 1992. *Residual Radioactive Contamination from Decommissioning – Technical Basis for Translating Contamination Levels to Annual Total Effective Dose Equivalent*. U.S. Nuclear Regulatory Commission, Contractor Technical Report, NUREG/CR-5512. October 1992.

ORAUT 2012. *Pinellas Plant – Occupational Internal Dose*. Gleckler, B.P., Sharfi, M.M., Oak Ridge Associated Universities Team, ORAUT-TKBS-0029-5, Revision 02. February 21, 2012.

Sigma Aldrich 2016. *Online Catalogue for the Sigma Aldrich Chemical Company – Product #Z271071*. Sigma-Aldrich Website, accessed January 19, 2016 at www.sigmaaldrich.com/catalog/product/aldrich/z271071.

APPENDIX A: EXAMPLE OF A COMPLETE MONTHLY HEALTH PHYSICS REPORT

~~CONFIDENTIAL~~

January 16, 1963

HEALTH PHYSICS' REPORT (U)

DECEMBER - 1962

DISTRIBUTION

AJ Barker-1	HA Nowak-2
VT Burkett-1	AP Persons-1
RS Farrell-1	OP Petersen-1
EP Forest-1	FR Riedmueller-1
CP Koch-1	JW Schumacher-1
CT Kimball-1	WJ Stapleton-1

UNCLASSIFIED

[redacted] DATE AUG 15 1973

THIS BINDER DATED APR 57 THRU DEC 62

IN-PLANT MONITORING

Contamination Surveys

Radioactive contamination and air-borne radioactivity were effectively controlled throughout the report period.

ENVIRONMENTAL MONITORING

Exhaust Stack Effluent

Radioactivity discharged in the exhaust stack effluent during December totaled 40 curies of tritium gas and 7.8 curies of tritium oxide in average concentrations representing approximately 0.2 percent and 28 percent of respective radioactivity concentration guides for continuous non-occupational exposure.

Average monthly radioactivity concentrations of tritium gas and tritium oxide are shown in Figure I.

Liquid Effluents

Radioactivity discharged in 36,650 gallons of process waste water totaled <0.02 curie in an average concentration of <0.12 μc/L. (<4.0 percent of the radioactivity concentration guide for continuous non-occupational exposure).

Page 1 of 6 pages

RESTRICTED DATA

CLASSIFICATION CONFIRMED -

GROUP 1

This d [redacted] as def: [redacted] 1954 [redacted] ON OCT of its [redacted] authori... person ... prohibited.

Excluded from automatic downgrading and declassification

~~CONFIDENTIAL~~

On-Site Monitoring

Analyses of 12 precipitation, 4 vegetation, and 4 drainage ditch samples collected during December revealed no significant concentrations of radioactivity.

Off-Site Monitoring

There were no significant indications of tritium in 10 vegetation and 5 surface water samples obtained in an area south to southeast from the Plant to a distance of approximately 6 miles.

A total of 4 routine air samples obtained during the report period revealed no detectable concentrations of tritium gas. Due to inoperative equipment, no oxide samples were taken during this report period.

Analyses of 4 milk samples obtained through the Florida State Board of Health from dairy farms in the vicinity of the Plant indicated no radioactivity content.

Analyses of 20 combined sewer effluent samples obtained during December 1962 revealed no significant concentrations of radioactivity.

PERSONNEL EXPOSURES

A total of 357 employees were monitored under Health Physics' Film Badge and/or Bio-Assay programs during the month of December.

The following is a tabulation of the exposures received by personnel in the listed components:

December 1 Through December 31

Plant Components	No. People Monitored	Maximum Exposure (mrem)	Average Exposure (mrem)
Manufacturing	194	23	0.5
A.E.C.	11	23	2.0
Quality Control	66	29	2.0
E & C R	12	0	.0
Laboratories	73	31	1.0
Engineering	1	0	.0

The maximum and average accumulated exposures for the year 1962 are shown in Figure II.

INDUSTRIAL HYGIENE

Recommendations were made concerning industrial hygiene requirements for cyanide plating operations.

[redacted]

[redacted]

MISCELLANEOUS

1. Introduction of a supply line for breathing air compressors into an Area 8 exhaust duct was investigated as a Radiation Hazard Incident.

2. A total of 16 lectures on Radiological Safety were given to second and third shift Tube Exhaust personnel by a representative of Health Physics.

3. A Health Physics' representative attended the 1962 General Electric Health Conference in Cleveland, Ohio.

STATISTICS

In-Plant Monitoring	Number
Surveys (Contamination)	837
Smears	1,477
Surveys (Radiation)	6
Special Work Permits	42
Oil Samples	4
Environmental Monitoring	
Precipitation	12
Surface Water (On-Site)	4
Surface Water (Off-Site)	5
Stack Condenser	27
Hold-Up Tank	5
Vegetation (On-Site)	4
Vegetation (Off-Site)	10
Combined Sewer Effluent	20
Milk Samples	4
Oxide Samples (Off-Site)	0
Air Samples (Off-Site)	4
SECS Condenser	15
Sewage Plant Samples	
Dissolved Oxygen	8
Free Chlorine	8
Solids Determinations	24
Bio-Assay Specimens	
Plant Personnel	2,322
Pre-Employment	20
Terminations	4

[redacted]

[illegible]

	Number
Counter Operation Determinations	
Sealed Standards	35
Efficiencies	101
Brackgrounds	71
Control Charts	8
Film Badge Program	
Gamma & X-Ray Film Badges	201
Neutron Film Badges	191
Medical Laboratory Analyses	
Complete Blood Counts	123
Urinalyses	26
Uric Acids	69
Milwaukee	
Bio-Assay	69
Smears	120
Neutron Film Badges	142
Water	2
Oil	2

[redacted]

1/16/63
EPF/meb

FIGURE I

1962

Average radioactivity discharge concentrations in percent of permissible continuous non-occupational exposure concentrations.

100 percent oxide = 5×10^{-7} µc/cc. 100 percent gas = 4×10^{-5} µc/cc.

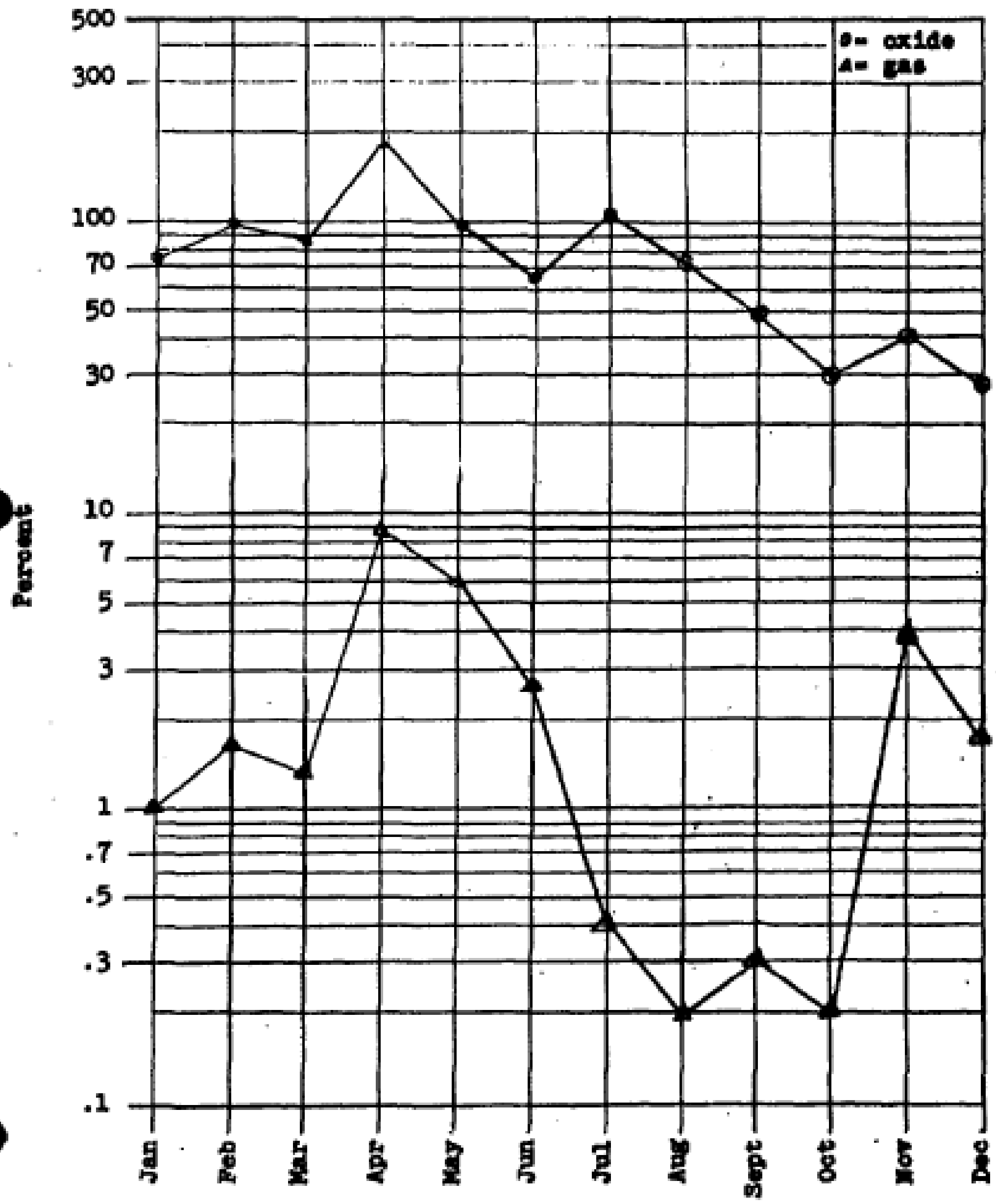
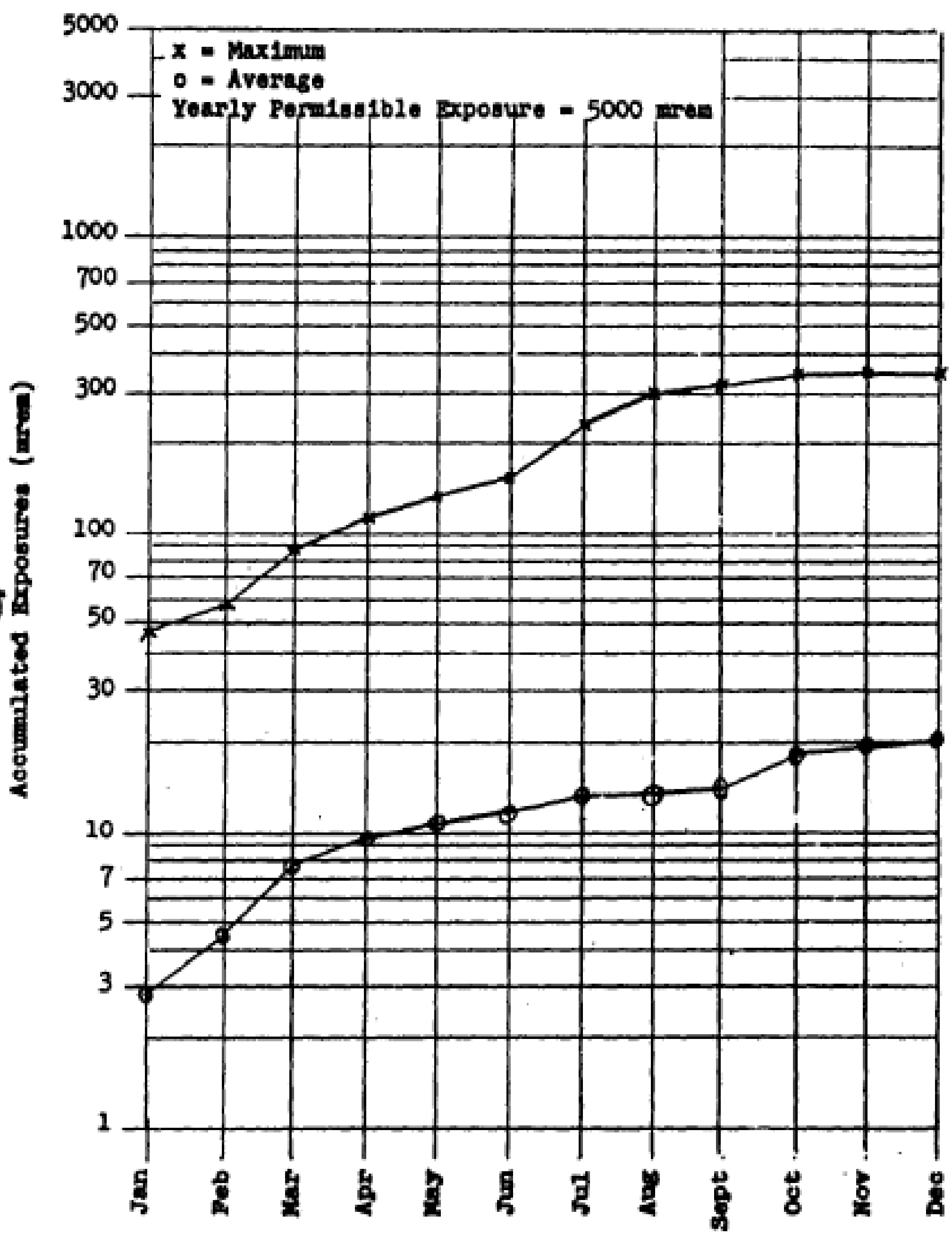


FIGURE II

Maximum and average accumulated radiation exposures - 1962

[redacted]



[redacted]

Page 6 of 6 pages

APPENDIX B: EXAMPLE OF A HANDWRITTEN SURVEY LOGBOOK FROM 1959

RADIATION SURVEY

Date	Time	Time Spent	Location	Survey No.
10-16-59	1500		Hood Rooms - Adjacent Areas	10-14

Survey Description: Smear Surveys in H Rooms & Adjacent Area.

Type of Inst.	Inst. No.	Calib. Check	Survey Type	Respiratory Protection
None	—		Routine W-29	None

Survey Data:	c/m	uc/in²	mrad/hr	mr/hr	mrem/hr	Distance
Smears						
8 - Hood Room 1 Door exits	0.033	3.3x10-5				
9 - " " " Floor	0.02	2x10-5				
10 - " " " Panels	0.053	5.3x10-5				
11 - Hood Room 2 Door exits	0.018	1.1x10-5				
12 - " " " Glassware	0.018	1.8x10-5				
13 - Main Exits	0.041	4.1x10-5				
14 - Decks UTE Office Area	0.011	1.1x10-?				
15 - Floor - UTE Office Area under desks.	0.004	4x10-6				
Soil-1 (East of Stack 500')	<1.5	3x10-6 uc/gm				
Soil-2 (North of Stack 800')	<1.5	? x 10-6 uc/gm				
Soil-3 (My Home)	<1.5	? x 10-6 uc/gm				

Comments & Recommendations:

The above sent to Florida for Analysis.
Soil samples were obtained on 10-9-58.
Significant level for soil samples - 1.55x10-6 uc/gm
" " " smears - 0.0043 uc

Maximum Radiation Measurement:

Surveyed by: [redacted]

APPENDIX C: EXAMPLES OF DOCUMENTED CONTAMINATION CONTROL AND CLEANUP ACTIVITIES

SRDB	Date	Description
133591	September 1957	"Surface contamination smear surveys in Tube Exhaust, generally revealed detectable levels of radioactivity. Decontamination was affected as required. Surveys in other plant areas revealed no detectable levels of contamination."
133591	October 1957	"Because of the increase in extent and magnitude of surface contamination in the area, a proposal pertaining to routine cleaning was submitted to, and accepted by, Tube Exhaust and Plant Facilities' supervision."
133582	December 1957	"Operations in Tube Exhaust resulted in four instances of personnel contamination. Two instances were associated with vacuum pump maintenance, one with glass system repair and one occurred when a high concentration of airborne radioactivity was encountered. Routine and special surveys disclosed lower levels of contamination in the Tube Exhaust Area attributable to a major decontamination effort and to decrease in the Area's work load. There were no appreciable levels of contamination detected in any other area."
133578	January 1959	"Tube exhaust had 3.3×10^{-2} µCi/in^2 in HR-18. Notes any area above 2×10^{-5} µCi/in^2 (688 dpm/100cm^2, decontamination was recommended."
133577	February 1960	"Exhaust corridors showed 12% smears above the control limit. Broken tube caused floor contamination of 1.1×10^{-5} µCi/in^2, decontamination was effected immediately."
133577	November 1960	"On August 12, 1960, during the transfer of a broken tritium flask from Room 14 to Room 18, Area 8, titanium hydride particles fell to floor causing a spread of radioactive contamination throughout Area 8 and into the Exclusion Area corridor. Decontamination efforts were continued on a three-shift basis on August 13 and 14."

SRDB	Date	Description
133585	February 1961	"Two instances of contamination in exclusion area corridors. Analyses of material containing radioactivity, resulted in two instances of floor contamination in the Chemistry Laboratory. On both occasions the contamination was contained within the laboratory area which had been established as a 'Contamination Zone'. Decontamination, subsequent to each analysis, was effected without difficulty."
133585	February 1961	"Removal of a vacuum pump from the stack effluent control system resulted in contamination of the floor in the Fan Room. The contamination was contained within the room and was easily removed at the completion of the operation."
133585	April 1961	"1 of 259 smears was above the control level in exclusion area corridors. Breakage of a system in room 20 resulted in a spread of radioactive contamination throughout Area 8. Decontamination of the area was completed within five hours."
133585	May 1961	"1 of 322 smears was above the control level in the exclusion area corridors. On two occasions, radioactive contamination was detected in the Area 8 corridors. In one instance the contamination was associated with cleaning operations in Hoodroom 18 while the other resulted from the reappearance of contamination which had been deposited under deteriorated floor tile in Hoodroom 20. In both instances, the contamination was contained within Area 8. Decontamination was effected without difficulty."
133585	July 1961	"There were no indications of radioactive contamination exceeding control levels in the exclusion area corridors or the Tube Exhaust corridors during the report period. An increase in contamination frequency, attributed to shut-down operations, was noted in the Area 8 hoodrooms. Radioactive contamination, exceeding control levels, was detected in the Fan Room following repairs on the SEC system and in Tube Test when a tube was broken. In both instances, the perimeters of contamination were controlled and decontamination immediately effected."

SRDB	Date	Description
133585	September 1961	"On September 22, a tritium flask was broken in Hoodroom 24, Area 8, resulting in high levels of radioactive contamination inside the hood. Immediately following the breakage, the flask was packaged to prevent further release of radioactive material. Subsequent to disposal of the flask as contaminated waste on September 25th, decontamination of the hood's interior was initiated. During this operation, low-level contamination of the room's floor occurred. Decontamination within the room was completed without difficulty."
133585	November 1961	"1 of 442 smears was above the control level in Area 8 corridors. The contamination was effectively contained within Area 8. During the month two instances of localized radioactive contamination occurred in Area 32B and 15 resulting from broken tubes. The areas were decontaminated and bioassay specimens obtained from the involved personnel. No significant body depositions of tritium were detected."
133587	January 1962	"One instance of floor contamination in excess of the detectable level occurred in Area 15, as a result of tube breakage. Decontamination was immediately effected."
27095	April 1962	"Low level contamination occurred in Area 15 in connection with tube breakage. Decontamination was immediately effected."
27095	May 1962	"Low level contamination occurred in Area 12 in connection with tube breakage. Decontamination was immediately effected."
27095	August 1962	"Low level contamination occurred in Area 12 and Area 15 as a result of tube breakage. Decontamination was immediately effected."
27095	October 1962	"Low level contamination occurred in Area 15 in connection with tube breakage. Decontamination was immediately effected."
133580	July 1963	"One instance of localized contamination occurred in the Receiving Well when condensate from a refrigerator being transferred under regulated release status, spilled on the floor. Decontamination was immediately effected without spread of the radioactive material."
113580	September 1963	"One instance of localized contamination occurred in the Industrial X-Ray Viewing Room of Area 9 as a result of product tube breakage. Decontamination was immediately effected."

SRDB	Date	Description
113580	November 1963	"One instance of localized contamination was experienced when Turco solutions was accidently spilled on the floor in Laboratory-29A. Decontamination was immediately effected."
113580	December 1963	"One instance of localized contamination was experienced when a product tub was accidentally dropped in Area 15. The area was immediately decontaminated."
113586	February 1964	"Contamination, resulting from breakage of a number two flask, was contained within the room in which the breakage occurred. Decontamination was completed without difficulty."
133586	June 1964	"An instance of floor contamination was detected during renovation in Hoodroom 3, Area 8. The area was effectively decontaminated."
133586	September 1964	"Floor contamination on the order of 1×10^{-5} µCi/in^2 resulting from a tube puncture in Area 65 was effectively removed."
133586	November 1964	"Floor contamination was experienced during equipment cleaning in Area 8. Decontamination was effective in reducing activity to permissible levels."
133579	February 1965	"The construction of cathode replicas in Area 54 resulted in low-level floor contamination. Previously established control measures effectively contained the radioactivity within the area. Decontamination was effected at the completion of the job."
133581	March 1966	"100 times the applicable limit was detected in the main section of the Test and Analysis Laboratory, Area 65. The contamination had been tracked from the 'Contamination Area' of the laboratory. Decontamination was effective."

SRDB	Date	Description
133581	September 1966	"Radiological assistance continued to be provided at G.E.X.M. relative to the re-location of Engineering Development in Florida. Through September a total of 1054 smears had been obtained and processed for radioactivity analysis. There was one instance of contamination resulting from transfer of material from Milwaukee to Pinellas Plant. The source of contamination, a flexible metal connecting line, caused low level contamination of the transport van, some containers in the shipment, packing blankets and of the Plant's warehouse. Excepting for the blankets, decontamination was effected without difficulty. A total of 371 blankets containing an estimated 3×10^4 μCi of tritium were disposed of as contaminated waste. Associated personnel exposures were negligible."
133581	December 1966	"Continuous monitoring was provided during the unpacking and assembly of the glove box line in Area 82c. One instance of contamination in the Exclusion Area corridor, at the 82c entrance, occurred during the transfer of contaminated equipment to the overhead. Decontamination was immediately effected."
27095	September 1967	"Routine area surveys and continuous air monitoring revealed contamination controls to be effective with the exception of an incident occurring in Area 7, an uncontrolled area. On September 21, 1967 a contamination incident occurred when radioactivity was released from a glove box in Area 7, causing contamination of employees' shoes, the corridor area between Areas 7 and 8, and localized sections of Areas 7 and 8. The incident occurred when a hack saw, used in opening a container of tritium loaded material, was removed from the glove box line without benefit of contamination survey, and was carried to Area 8. There were no significant radiation exposures associated with the incident and decontamination was effective."
27095	May 1969	"A total of 305 contamination surveys were performed during the report period. Instances of contamination above area control levels were experienced on several occasions during maintenance on metal exhaust systems in Area 108. Controls, instituted prior to the commencement of work proved adequate in confining the contamination to the immediate work area. Decontamination was effected with no significant exposures."

SRDB	Date	Description
27095	September 1969	"A total of 217 contamination surveys were performed during the report period. Instances of contamination above area control levels were experienced during maintenance work on the Source Loading Station, Area 108, in Area 165A following work on a portion of a metal exhaust system, and in Room 2, Area 108 following removal of a vac-ion pump from a glove box. Decontamination was effected."
27095	1st Quarter 1970	"Contamination occurred in Area 154 when a flaking tube part was removed from its container for microscopic examination. On noticing the flaking, the technician requested a survey by Environmental Health. Survey results indicated contamination of tools, equipment and floors in the area. Controls to prevent further spread of contamination proved to be effective and decontamination was accomplished."
27095	May 1973	"A routine contamination survey performed in May revealed extensive floor and work surface contamination in area 158B. Additional surveys disclosed contamination spread into areas 156, 157, and the north-south corridor outside of area 157. Decontamination was effected."

APPENDIX D: EXAMPLES OF PREDICTED CONTAMINATION EVENTS THAT SHOW EVIDENCE OF PLANNING FOR SUCH OCCURENCES

SRDB	Date	Description
133579	February 1965	"The construction of cathode replicas in Area 54 resulted in low-level floor contamination. Previously established control measures effectively contained the radioactivity within the area. Decontamination was effected at the completion of the job."
27095	February 1969	"Anticipated contamination above the control limit of 440 dpm/100cm^2, was associated with work in Areas 108, 132B, 154, 155, 158, 162, 182A, 182B, 182C, and 182D. The maximum contamination level, 4.3×10^{-5} dpm/100cm^2, was detected on the work surface of a hood in Room 20, Area 108, following the disassembly of a vac-ion pump. Continuous monitoring was provided by Environmental Health during disassembly. Airborne tritium concentrations to a maximum of 1.3×10^{-3} µCi/cc were encountered by employees performing maintenance on a mass spectrometer in Room 3, Area 108."
27095	May 1969	"Instances of contamination above area control levels were experienced on several occasions during maintenance on metal exhaust systems in Area 108. Controls, instituted prior to the commencement of work proved adequate in confining the contamination to the immediate work area. Decontamination was effected with no significant exposures."
27095	November 1969	"Anticipated and controlled contamination occurred in Areas 108 and 158B in association with vac-ion pump maintenance and routine analyses respectively."
27095	December 1969	"Contamination detected in Area 108 and 182D, in association with maintenance of a leak detector and source loading respectively had been anticipated and provisions were provided for protection and control."

SRDB	Date	Description
27095	1st Quarter 1970	"Contamination in excess of area control levels occurred in Area 108 and 154. Maintenance operations on a metal system contained in a glove box in Room 2, Area 108, resulted in tritium floor contamination exceeding area control levels by a factor of 10,000. Controls imposed prior to the commencement of work, confined the contamination to the room, however, the levels were considerable [sic] higher than expected."
27095	2nd Quarter 1970	"A total of 316 contamination control surveys performed during the report period indicated controls were effective. Several instances of anticipated contamination within controlled areas occurred during planned work, associated with maintenance of metal exhaust systems, operations in Room 18, Area 108, disposal of oxidized beds, and work in 182D."
27095	3rd Quarter 1970	"Several instances of contamination within controlled areas occurred, however, controls were effective in preventing contamination spread, and minimizing tritium exposures to personnel."
27095	4th Quarter 1970	"A total of 331 contamination surveys were performed during the report period. Several instances of contamination within controlled areas occurred. Procedures for contamination control were effective in preventing contamination spread, and minimizing tritium exposures to personnel."
27095	1st Quarter 1973	"A total of 352 contamination surveys and 30 radiation surveys were performed during the report period. Localized contamination associated with work involving a high potential for radioactivity spread was effectively minimized and controlled through radiological safety procedures imposed prior to commencing the jobs. The work involved maintenance of metal exhaust and loading systems and removal of glass systems from room 13, area 108."