Draft White Paper

FEASIBILITY OF IDENTIFYING WORKERS WITH SPECIFIC PLANTS/AREAS OF FERNALD FOR IDENTIFICATION WITH THORIUM OPERATIONS (1953–1967)

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ABBREVIATIONS AND ACRONYMS

CATI	Computer-Assisted Telephone Interview
DOE	(U.S.) Department of Energy
dpm/m^3	disintegrations per minute per cubic meter
DWE	Daily Weighted Exposure
FEMP	Fernald Environmental Management Project
FMPC	Feed Materials Production Center (also known as Fernald)
GSD	geometrical standard deviation
MAC	maximum allowable concentration
MIVRML	Mobile In-Vivo Radiation Monitoring Laboratory
NIOSH	National Institute for Occupational Safety and Health
NOCTS	NIOSH OCAS Claims Tracking System
OCAS	Office of Compensation Analysis and Support
PP	Pilot Plant
SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort

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1.0 INTRODUCTION

Starting in 1968, thorium exposures at Fernald[1] were monitored via the Mobile In-Vivo Radiation Monitoring Laboratory (MIVRML). However, there was no defined monitoring program (either bioassay or in vivo) for thorium intakes before 1968; therefore the National Institute for Occupational Safety and Health (NIOSH) had to develop an alternate method for reconstructing thorium doses received during 1953–1967. Before the introduction of in-vivo monitoring, Fernald employed an air sampling program that was used to develop Daily Weighted Exposures (DWEs) for various job types based on the concentration of alpha activity in the air (dpm/m^3). Job-specific DWEs were developed by measuring alpha air concentrations near the workers' "breathing zone" on a task-by-task basis for all tasks comprising a job and normalizing by the amount of time taken to perform each task. In this way, the average alpha air concentration that workers were exposed to during a given work day could be estimated. Because the DWE data were derived from alpha air activity concentration measurements, the method can be used for estimating chronic daily intakes of uranium and thorium, their progeny, and other associated radionuclides.

NIOSH has proposed to use the DWE reports to bound potential exposures to thorium during the period prior to in-vivo counting at Fernald (1953–1967). Various white papers and formal Work Group discussions have examined the feasibility of using DWE reports for reconstructing thorium intakes; these are summarized in Section 2. However, still unexamined is the feasibility of implementing this approach (as described in Morris 2009) using the worker data available for the timeframe 1953–1967. Therefore, this memorandum focuses on the possibility of associating specific individuals who worked at Fernald during the 1953–1967 timeframe with the plants and buildings that processed thorium during that period.

2.0 BACKGROUND AND MILESTONES TO DATE

In March 2008, NIOSH released the report, *White Paper on the Use of FMPC DWE Reports for Estimation of Chronic Daily Intake* (Morris 2008), which describes the available DWE reports at Fernald, and also how these DWE data can be used to calculate inhalation and ingestion intakes of alpha emitters at Fernald for the purposes of dose reconstruction. This report was first discussed at the March 26, 2008, Work Group meeting. NIOSH released another revision of this report in February 2009, adding a section comparing DWEs to uranium concentration in urine (Morris 2009).

Further discussions of the DWE issue occurred at the April 22, 2009, Work Group meeting. In July 2009, SC&A provided a white paper response (SC&A 2009) to NIOSH's DWE report, which was presented in detail at the January 29, 2010, Work Group meeting. In response, NIOSH released a third version of the DWE methodology in October 2010 (Morris 2010), which was subsequently discussed in-depth at the Work Group meeting on November 10, 2010. This issue was also discussed briefly in the February and April 2011 Work Group meetings. In April 2011, based principally on the revised approach to quantifying uncertainty described in Morris

[1] Fernald is also referred to as the Feed Materials Production Center (FMPC) or the Fernald Environmental Management Project (FEMP). All three titles may appear in this document.

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(2010), SC&A recommended that the issue of reconstructing internal doses from thorium intakes was likely not a Special Exposure Cohort (SEC) issue for the 1953–1967 timeframe when DWE data are available, and instead could be considered a site profile issue.

3.0 BRIEF DESCRIPTION OF MORRIS (2010) APPROACH

As stated in Section 1, this report is not intended to further explore the validity of using DWEs to reconstruct doses to workers in the 1953–1967 timeframe. Rather, this report explores potential issues in the implementation of the methods set forth in Morris 2010, particularly the identification of workers within specific plants who were potentially exposed to thorium. As stated in Morris (2010):

> *Due to variations in job assignments is* [sic] *unlikely that unambiguous exposure scenarios can be defined for most workers. In addition, fugitive dust emissions have not been quantified except as a general air sampler indicator. To ensure thorium intake potential is not underestimated, the DWE value associated job title or job description with the highest DWE value in FMPC plant* [sic] *where thorium was handled for a specific year should be assigned to every worker in that facility. A GSD of 5 should be assumed.* (Morris 2010)

Implicit in the NIOSH methodology is a degree of granularity in the available data that would allow the identification of worker placement by plant and year. The principal purpose of this report is to investigate the extent to which this assumption holds true.

Morris (2010) states that if DWE data are not available for a particular facility and year, the 95th percentile of the general air sampling data for that facility can be used. In cases in which neither air sampling nor DWE data are available, data from subsequent years (before and after the year in question) should be used as a surrogate. The recommended DWE values, by plant and year, were given in Table 2 of Morris (2010) and are shown in Figure 1. The highlighted boxes in Figure 1 represent plants and years with known thorium processing operations. DWE values in Figure 1 are reported in units of maximum allowable concentration (MAC), which were 70 disintegrations per minute per cubic meter of air (dpm/m^3) before 1963 and 100 dpm/m^3 thereafter.

Morris (2010) states that if further information is found that identifies additional plants that conducted thorium operations, available documentation would be reviewed to identify appropriate DWE reports. Those reports would then be used to derive thorium intakes for workers in those additional plants according to the methods described in Morris (2010).[2] It bears repeating that the approach outlined in Morris (2010), and briefly described above, requires a detailed knowledge of the work location of individual workers in a given year in order to determine whether each worker was potentially exposed to thorium. This document explores what information is available to identify workers with specific areas of Fernald.

[2] Note that a list of thorium workers was produced at the end of 1967 (Starkey 1967) that includes several "thorium workers" associated with Plant 5, but Plant 5 is not included in Table 2 of Morris 2010.

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	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Plant 1	a	16.4	4.3	1.5	1.0	2.1	0.5	0.6	1.1	0.6	0.7	0.6	1.0	1.2
Plant 4	4.5	3.2	0.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Plant 6	N/A	N/A	N/A	N/A	N/A	0.8	4.3	1.6	2.8	17	N/A	N/A	N/A	N/A
Plant 8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.1	N/A
Plant 9	b	686	b	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Pilot Plant	5.9	c	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	d	d	d	77

Notes:
a: Data are not available. Instead use the value for Plant 1, 1955.
b: Data are not available. Instead use the value for Plant 9, 1955.
c: Data are not available. Instead use the value for Pilot Plant 1954.
d: DWE data are not available. The value for Pilot Plant 1967 is based on the 95th percentile value of 18 air samples taken during thorium operations. Use this value for Pilot Plant 1964 through 1966.

Figure 1. Recreation of Table 2 from Morris 2010 Showing the Recommended DWE Values in Units of MAC by Plant and Year

4.0 FEASIBILITY OF IMPLEMENTING THE APPROACH DESCRIBED IN MORRIS 2010

In order to explore the feasibility of implementing the approach proposed in Morris (2010), SC&A performed two different analyses. The first analysis is based on the review of available claimant records in the NIOSH OCAS Claims Tracking System (NOCTS), and the second takes a site-wide view of the overall worker records found in the HIS_20 database. Section 4.1 describes SC&A's review of sampled claimant files and the work location information they contain. Section 4.2 describes the information available in the HIS_20 database in order to provide insight on the worker population as a whole.

4.1 REVIEW OF SEMI-RANDOM SAMPLE OF 20 CLAIMANT FILES

SC&A pulled a sample of 20 semi-randomly selected claimant files[3] for Fernald from the NOCTS system. Location-specific identifiers in individual claimant files were found in a number of different sources, including:

- Uranium urinalysis sampling reports
- Film badge investigation reports
- Radiation exposure investigation reports

[3] Claimants were selected to cover the higher risk job types, as well as to assure that the period of interest (1953–1967) was well represented by the worker population. In addition, a cross-section of workers noted in the 1967 Starkey memo that identifies thorium workers was also selected for review (see Claimant Reference Nos. 11–19 in Table 1 and Attachment 1).

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- Personal clothing and monitoring reports
- Health and safety information reports
- Periodic physical examinations
- Computer-Assisted Telephone Interview (CATI) reports and employment records

The first six sources on this list are found within the dosimetry files provided by the U.S. Department of Energy (DOE). CATI reports and employment records (the last source listed) were supplied by the claimant. Table 1 displays a summary of available location-specific data in the individual NOCTS files of the 20 claimants reviewed. Wherever possible, identifying information has been removed for Privacy Act compliance. A more detailed and complete review of the 20 selected claimant files is provided in Attachment 1.

As shown in Table 1, most location-specific information in the claimant files is found in the urinalysis results. However, of the nearly 1,400 urinalyses reviewed for the sampled claimant population, only 180 (or roughly 13%) contained information on work location. For 16 of the 20 sampled workers, less than 20% of their urinalysis results specified a work location; for 8 of 20 workers, less than 10% of their urinalysis results specified a location. Urinalysis results were also restricted to the mid-1950s, as shown in Figure 2.

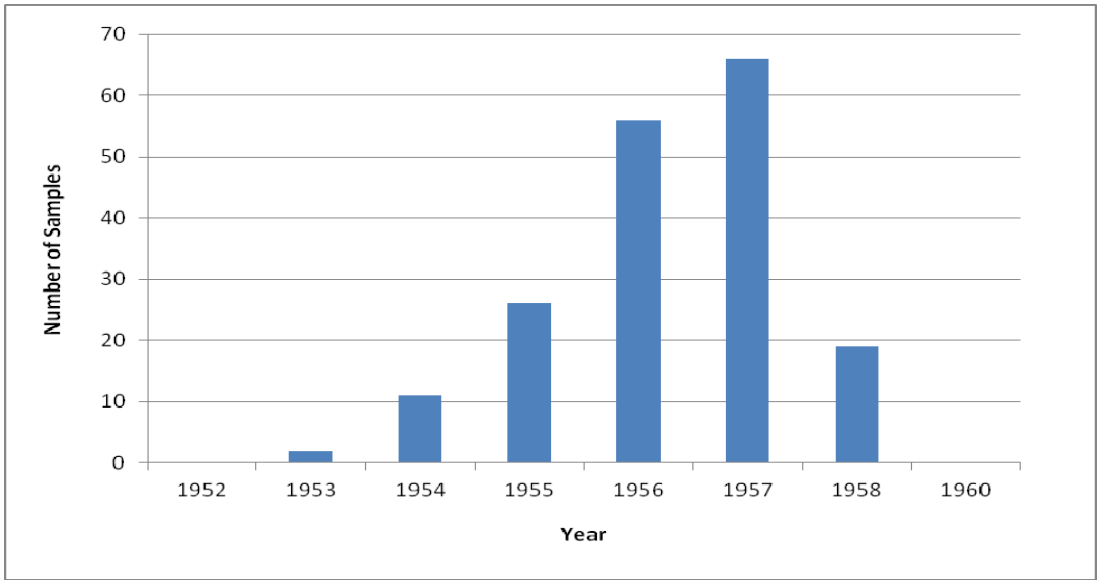

Figure 2. Number of Urinalysis Samples Identifying Location by Year

Film badge investigation reports appear to be restricted to the early portion of the period. The only such reports in the sampled claimant files were made in 1953 and 1954 and covered 9 of the 20 sampled workers. Radiation exposure investigation reports were much less common. Of the 5 total reports covering 4 of the 20 surveyed claimants, 2 reports were made in 1963, and the rest in the mid-to-late 1950s. Film badge investigation reports only cover 1 week, and radiation exposure investigations and personnel clothing and monitoring reports generally only cover a day or two.

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The claimant files contained only one personal clothing monitoring report (1955) and one health and safety information report (1960). One of the 20 surveyed claimants had reports documenting annual physicals that specified a work area and covered all the employed years of interest, although it is not clear whether the work designation actually covers all locations within each given year.

The remainder of location-based information is contained in the CATI reports. However, these often do not specify timeframes for work in individual plants or, alternatively, do not indicate if the worker was in multiple locations. In some CATI reports, the work location was unknown. Furthermore, not every sampled claimant had a CATI report in their file. Many of these CATI reports were conducted with the claimant's survivor, who often does not have detailed knowledge of the claimant's job duties or placement.

One claimant possessed official employment records that did specify his work location throughout the period of employment. However, even this official record contradicted other documents in the claimant's file, such as a radiation exposure investigative report. The other 19 sampled claimant files did not contain similar official employment records.

Based on the records for the surveyed claimants, it appears that location-based information is severely limited for Fernald workers during the 1953–1967 timeframe. Furthermore, it has been established through interviews with Fernald workers that many workers did not perform their duties in one plant, but instead moved around from plant-to-plant as needed. Additional information can sometimes be taken from CATI reports and documents received by the individual claimants, but it is probably not reasonable to expect this type of information to be included in claimant files on a consistent basis.

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Table 1. Summary - Location Information Identified in Claimant NOCTS Files for 20 Claimants Selected for Review

Ref #	Job Title(s)*	Relevant Employment	Work Location Reference from Dosimetry File	Details of Dosimetry Location Information	# of Work Locations in Dosimetry File	Information Supplied by Claimant and/or Additional Comments
1	[redacted]	1953–1963	Uranium Urinalysis	Specify location: 4 samples (17%) 1956–1957 No location: 20 samples (83%)	2	CATI report and claim application both specify an area but do not give a date (CATI given by survivor).
2	Chemical Operator	1953–1967	Film Badge Investigation	6 reports (1953–1954)	3	Two different CATI reports are provided that list two different locations, only one provides a timeframe (1953–1966).
			Uranium Urinalysis	Specify location: 17 samples (~15%) 1955–1958 No location: ~100 samples (~85%)		
3	Millwright	1953–1967	Film Badge Investigation	1 report (1953)	6	Four different CATI reports specify numerous locations, including “all buildings.”
			Uranium Urinalysis	Specify location: 15 samples (~16%) 1956–1957 Do not specify location: ~80 samples (~84%)		
4	Machinist	1953–1967	Uranium Urinalysis	Specify location: 0 samples (0%) No Location: ~50 samples (100%)	0	CATI report indicates claimant worked all over the site.
5	Millwright	1953–1967	Film Badge Investigation	1 report (1953)	6	Claimant CATI report indicates claimant worked “all over the site.”
			Uranium Urinalysis	Specify location: 14 samples (~14%) 1954, 1957–1958 No location: ~85 (~85%)		
6	Technician	1953–1967	Uranium Urinalysis	Specify location: 0 samples (0%) No location: ~35 samples (100%)	0	CATI report states that the worker was in “all locations, as required.”

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Ref #	Job Title(s)*	Relevant Employment	Work Location Reference from Dosimetry File	Details of Dosimetry Location Information	# of Work Locations in Dosimetry File	Information Supplied by Claimant and/or Additional Comments
7	Chemical Operator	1953–1967	Film Badge Investigation	3 reports (1953)	11	CATI interview was unsure of work location (CATI given by survivor).
			Uranium Urinalysis	Specify location: 7 samples (~4%) 1955–1957 No location: ~155 samples (~96%)		
			Radiation Exposure Investigation	1 Report (1963)		
8	Maintenance Man	1953–1961	Uranium Urinalysis	Specify location: 15 samples (~33%) No location: 30 samples (~67%)	15	CATI interview was unsure of work location (CATI given by survivor).
9	[redacted]	1953–1967	Uranium Urinalysis	Specify location: 13 samples (~40%) 1955–1958 No location: ~20 samples (~60%)	13	CATI specifies at least 7 different locations.
10	Forklift Operator	1954–1967	Uranium Urinalysis	Specify location: 0 samples (0%) No location: ~50 samples (100%)	0	CATI specifies four distinct buildings worked in and approximate dates. CATI also specifies “All other buildings” (CATI given by energy employee).
11	Operator*	1953–1967	Film Badge Investigation	2 reports (1953, 1954)	12	CATI report specifies more than 10 different locations. Official employment record as supplied by claimant contradicts at least one of the radiation exposure investigation reports. Employment record also indicates claimant was “loaned” to other plants at various times.
			Uranium Urinalysis	Specify location: 6 samples (~11%) 1953, 1956–1958 No location: ~50 samples (~89%)		
			Radiation Exposure Investigation	2 reports (1955, 1963)		
			Official Employment Record Supplied by Claimant	2 documents (1953–1967)		

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Ref #	Job Title(s)*	Relevant Employment	Work Location Reference from Dosimetry File	Details of Dosimetry Location Information	# of Work Locations in Dosimetry File	Information Supplied by Claimant and/or Additional Comments
12	Chemical Operator*	1953–1967	Film Badge Investigation	8 reports (1953, 1954)	12	CATI report lists 3 different locations (CATI given by survivor).
			Uranium Urinalysis	Specify location: 4 samples (~7%) 1956–1958 No location: ~50 samples (93%)		
13	Chemical Operator*	1953–1967	Film Badge Investigation	7 reports (1953, 1954)	11	No CATI report is available.
			Uranium Urinalysis	Specify location: 3 samples (~6%) 1955, 1957, 1958 No location: ~50 samples (94%)		
			Health and Safety Information Report	1 report (1960)		
14	Chemical Operator*	1953–1967	Film Badge Investigation	2 reports (1954)	12	CATI report specifies 2 plant locations.
			Uranium Urinalysis	Specify Location: 9 samples (~12%) 1955–1958 No location: ~65 samples (~88%)		
			Radiation Exposure Investigation	1 report (1957)		
15	Chemical Operator*	1954–1967	Uranium Urinalysis	Specify location: 12 samples (~13%) 1954, 1956–1958 No location: ~80 samples	13	CATI report states that claimant worked “all over the site” but spent most of his time in 2 main plants.
			Radiation Exposure Investigation	1 report (1958)		

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Ref #	Job Title(s)*	Relevant Employment	Work Location Reference from Dosimetry File	Details of Dosimetry Location Information	# of Work Locations in Dosimetry File	Information Supplied by Claimant and/or Additional Comments
16	Machine Tool Operator*	1953–1967	Film Badge Investigation	1 report (1953)	24	CATI interview was declined by claimant.
			Uranium Urinalysis	Specify location: 13 samples (~22%) 1955, 1957 No Location: ~45 samples (~78%)		
			Periodic Physical Exam	9 reports (1957, 1959–1967)		
17	Machine Tool Operator*	1953–1967	Uranium Urinalysis	Specify location: 36 samples (~32%) 1955 No location: ~75 (~68%)	37	CATI interview indicates 2 main plants.
			Personnel and Clothing Monitoring	1 report (1955)		
18	[redacted]*	1953–1967	Uranium Urinalysis	Specify location: 3 samples (4%) 1956–1958 No location: 65 samples (96%)	3	CATI interview indicates 2 main plants and also describes thorium operations.
19	[redacted]*	1953–1967	Uranium Urinalysis	Specify location: 6 samples (~12%) 1957–1958 No location: 45 samples (~88%)	6	CATI interview indicates 3 main plants.
20	Chemical Operator	1954–1967	Uranium Urinalysis	Specify location: 3 samples (~6%) No location: 45 samples (~94%)	3	CATI interview unsure of work locations (CATI given by survivor).

*Indicates claimant was also included in the 1967 list identifying "thorium workers" for the purpose of in-vivo counting.

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4.2 REVIEW OF HIS_20 DATABASE FOR LOCATION-BASED INFORMATION (1953–1967)

To gain a better understanding of the site-wide practice of recording work location data, SC&A analyzed the HIS_20 database to identify workers whose urine bioassay samples also specified the individual plant where the sample was taken. Plant locations are denoted in the urinalysis database in the "sample type" column, where sample types 1–9 refer to Plants 1–9, respectively (samples for the pilot plant are marked "PP"). It should be noted that, when the database was originally compiled from hardcopy records, the plant designation was replaced with some other sample code, such as "routine." These changes were sometimes noted in the "comments" column, which stated, "OLD SAMPLE WAS [insert plant number]." It is not clear to what extent this practice occurred and whether other "sample type" codes were changed without the corresponding comment that indicated the plant area. Nevertheless, this review attempted to identify the samples whose codes were changed and associate them with the correct plant areas.

Table 2 summarizes the number of uranium urinalysis results by plant and year. As Table 2 indicates, the practice of labeling urinalysis samples with the worker location is mainly restricted to the 1955–1957 timeframe and applies to approximately two thirds of the available samples for those years. This is consistent with the spread of urinalysis samples identified in the claimant sampling shown in Figure 2. No other location-based information was found in the HIS_20 database for the period of interest.

Table 2. Number of Urinalysis Results that Identify Location Compared to Total Urinalysis Results by Year

Year	Pilot Plant	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Sum of Urinalysis Results by Location (% Total)	Total Uranium Urinalyses by Year
1953	-	-	-	-	-	50	39	-	-	-	89 (3.7%)	2,430
1954	-	-	-	-	35	88	89	-	-	-	212 (2.4%)	8,725
1955	245	238	447	414	173	1,315	683	3,669	258	40	7,482 (70.1%)	10,669
1956	914	500	453	205	450	727	1,900	994	924	-	7,067 (62.5%)	11,314
1957	268	191	327	216	595	1,356	4,202	-	1,586	215	8,956 (65.9%)	13,581
1958	-	-	3	2	19	73	32	-	13	-	142 (1.4%)	9,995
1959	-	-	-	-	-	-	-	-	-	-	-	14,556
1960	-	-	-	-	-	-	-	-	-	-	-	19,410
1961	-	-	-	85	-	2	-	-	-	-	87 (0.9%)	9,513
1962	-	-	-	-	-	-	-	-	-	-	-	8,490
1963	-	-	-	-	-	-	-	-	-	-	-	9,678
1964	-	-	-	-	-	-	-	-	-	-	-	6,753
1965	-	-	-	-	-	-	-	-	-	-	-	6,566
1966	-	-	-	-	-	-	-	-	-	-	-	6,383
1967	-	-	-	-	-	-	-	-	-	-	-	5,363

(Dashes indicate no data are available)

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5.0 CONCLUSION

It is apparent from the 20 sampled claimant files and analysis of the HIS_20 database that only limited information is available to associate workers with specific areas on a consistent basis. Given that NIOSH's proposed methodology in Morris (2010) is predicated on reliable information about temporal and spatial worker placement, NIOSH needs to address the paucity of such information and modify its approach in order to assure that assigned thorium intakes are bounding to the workers who were potentially exposed to thorium in the 1953–1967 timeframe.

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ATTACHMENT 1: DETAILED REVIEW OF 20 CLAIMANT FILES

(CONTAINS PRIVACY ACT INFORMATION)

Reference Claim # 1
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/63
Job Title(s): [redacted]
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
3006, Inspection Department	Film badge investigation	7/[redact]/52	Lost film badge for the week
Plant 6	Urinalysis result	4/[redact]/1956	Claimant had over 20 other urinalysis samples that did not specify a work location.
Inspection	Urinalysis result	3/[redact]/57	
Plant 6	Urinalysis result	5/[redact]/57	
Plant 6	Urinalysis result	6/[redact]/57	
Plant 6	CATI report and claim application	Not specified	CATI and claim were filed by worker's daughter.

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Reference Claim #2
Claim ID: [redacted]
Worker Employment Period: [redacted]/53–[redacted]/68
Job Title(s): Chemical Operator
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5, A & B Areas	CATI report	1953–1966	
Plant 5, Bldg. 3005	Film badge investigation	11/[redact]/53–11//[redact]/53	Job duties: [redacted]
Plant 5, Bldg. 3005	Film badge investigation	11/[redact]/53–11/[redact]/53	Job duties: [redacted]
Plant 5	Film badge investigation	9/[redact]/54–9/[redact]/54	Job duties: [redacted]
Plant 5	Film badge investigation	10/[redact]/54–10/[redact]/54	Job duties: [redacted]
Plant 5	Film badge investigation	10/[redact]/54–11/[redact]/54	Job duties: [redacted]
Plant 5	Film badge investigation	12/[redact]/54–12/[redact]/54	Job duties: [redacted]
Plant 5	Urinalysis result	5//[redact]/55	Claimant had over 100 other urinalysis samples that did not specify a work location.
Plant 5	Urinalysis result	5/[redact]/55	
Plant 5	Urinalysis result	5/[redact]/55	
Plant 5	Urinalysis result	5/[redact]/55	
Plant 5	Urinalysis result	5/[redact]/55	
Plant 5	Urinalysis result	7//[redact]/55	
Plant 5	Urinalysis result	7/[redact]/55	
Plant 5	Urinalysis result	7/[redact]/55	
Plant 5	Urinalysis result	8//[redact]/55	
Plant 5	Urinalysis result	8/[redact]/55	
Plant 5	Urinalysis result	4/[redact]/56	
Plant 8	Urinalysis result	5/[redact]/57	
Plant 8	Urinalysis result	6/[redact]/57	
Plant 8	Urinalysis result	6/[redact]/57	
Plant 8	Urinalysis result	7/[redact]/57	
Plant 1	Urinalysis result	12/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/58	
Plant 8	CATI report	Unspecified	*"Worked on the* [redacted] *which putting* [sic] *out fires in uranium containing drums"*

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Reference Claim #3
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/82
Job Title(s): Millwright
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
In all buildings and areas	CATI report (/[redact]/)	[redact]/52–[redact]/82	Claimant was [redacted]of the union, which required him to go to all areas of the site.
Plant 5 and others	CATI report (/[redact]/)	[redact]/52–[redact]/82	
Various buildings	CATI report (/[redact]/)	[redact]/52–[redact]/82	Used a [redacted]to get from building to building.
14, 7, maybe others	CATI report (/[redact]/)	[redact]/52–[redact]/82	
Plant 2-3	Urinalysis result	1/[redact]/56	Claimant had over 80 other urinalysis samples during the period of interest that did not specify a work location.
Plant 7	Urinalysis result	8/[redact]/56	
Plant 7	Urinalysis result	8/[redact]/56	
Plant 7	Urinalysis result	8/[redact]/56	
Plant 3	Urinalysis result	9/[redact]/56	
Plant 3	Urinalysis result	9/[redact]/56	
Plant 3	Urinalysis result	9/[redact]/56	
Pilot Plant	Urinalysis result	9/[redact]/56	
Plant 3	Urinalysis result	9/[redact]/56	
Pilot Plant	Urinalysis result	10/[redact]/56	
Pilot Plant	Urinalysis result	10/[redact]/56	
Plant 1	Urinalysis result	5/[redact]/57	
Plant 1	Urinalysis result	5/[redact]/57	
Plant 1	Urinalysis result	5/[redact]/57	
Pilot Plant	Urinalysis result	8/[redact]/57	
Production, Bldg. 3005	Film badge investigation	7/[redact]/53–7/[redact]/53	Work location: recasting area

Claimant Reference #4
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/68
Job Title(s): Machinist
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 2-3, Pilot Plant, Plants 4 through 7, Plant 9, all over the plant	CATI report	[redact]/52–[redact]/68	Report indicates claimant worked with thorium in Plant 9.
Unknown	Urinalysis result	[redact]/53–[redact]/68	Claimant had over 50 urinalysis samples during the period of interest that did not specify a work location.

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Reference Claim #5
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/69
Job Title(s): Millwright
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
All over the plant	CATI report	[redact]/52–[redact]/69	
Plant 7	Urinalysis result	8/[redact]/54	Claimant had over 85 other urinalysis samples during the period of interest that did not specify a work location.
Plant 7	Urinalysis result	9/[redact]/54	
Plant 7	Urinalysis result	9/[redact]/54	
Plant 7	Urinalysis result	9/[redact]/54	
Plant 7	Urinalysis result	9/[redact]/54	
Plant 7	Urinalysis result	9/[redact]/54	
Plant 7	Urinalysis result	10/[redact]/54	
Plant 7	Urinalysis result	10/[redact]/54	
Plant 4	Urinalysis result	2/[redact]/57	
Plant 4	Urinalysis result	2/[redact]/58	
Plant 1	Urinalysis result	3/[redact]/58	
Plant 8	Urinalysis result	3/[redact]/58	
Plant 1	Urinalysis result	3/[redact]/58	
Plant 1	Urinalysis result	3/[redact]/58	
Production, Bldg. 3012 and 3006	Film badge investigation	3/[redact]/53–3/[redact]/53	

Reference Claim #6
Claim ID: [redacted]
Worker Employment Period: [redacted]/53–[redacted]/70
Job Title(s): Technician
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
All locations, as required	CATI report	[redact]/53–[redact]/70	
Unknown	Urinalysis result	[redact]/56–[redact]/70	Claimant had over 35 urinalysis samples during the period of interest that did not specify a work location.

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Reference Claim #7
Claim ID: [redacted]
Worker Employment Period: [redacted]/53–[redacted]/71
Job Title(s): Chemical Operator
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	CATI report	[redact]/53–[redact]/71	Interviewee was not sure.
K-65	Film badge investigation	[redact]/53–[redact]/53	Job description: [redact] K-65 material
K-65	Film badge investigation	6/[redact]/53–6/[redact]/53	Job description: [redact] K-65 material
K-65	Film badge investigation	[redact]/53–[redact]/53	Job description: [redact] K-65 material
Plant 1	Urinalysis result	9/[redact]/55	Claimant had over 155 other urinalysis samples during the period of interest that did not specify a work location.
Plant 2	Urinalysis result	4/[redact]/56	
Plant 2	Urinalysis result	6/[redact]/56	
Plant 1	Urinalysis result	7/[redact]/56	
Plant 1	Urinalysis result	7/[redact]/56	
Plant 2	Urinalysis result	10/[redact]/56	
Plant 2	Urinalysis result	5/[redact]/57	
Plant 5	Radiation exposure investigation	3/[redact]/63–3/[redact]/63	Job description: [redact]

Reference Claim #8
Claim ID: [redacted]
Worker Employment Period: [redacted]/53–[redacted]/61
Job Title(s): Maintenance Man
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	Urinalysis result	3/[redact]/55	CATI report does not specify work location (CATI given by survivor). Claimant had over 30 other urinalysis samples during the period of interest that did not specify a work location.
Plant 8	Urinalysis result	10/[redact]/56	
Plant 8	Urinalysis result	3/[redact]/57	
Plant 8	Urinalysis result	3//[redact]/57	
Plant 8	Urinalysis result	3/[redact]/57	
Plant 8	Urinalysis result	3/[redact]/57	
Plant 8	Urinalysis result	3/[redact]/57	
Plant 8	Urinalysis result	3/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/57	
Plant 8	Urinalysis result	4/[redact]/57	
Plant 8	Urinalysis result	8/[redact]/57	
Plant 8	Urinalysis result	3/[redact]/58	

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Reference Claim #9
Claim ID: [redacted]
Worker Employment Period: [redacted]/53 – [redacted]/69
Job Title(s): [redacted]
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
K-65, Plants 2–5, Pilot Plant, Water Treatment	CATI report	[redact]/53–[redact]/69	Claimant does not know if he was exposed to thorium. Work in K-65 may have been during the first 3 months of employment.
Plant 1	Urinalysis result	9/[redact]/55	Claimant had approximately 20 other urinalysis samples during the period of interest that did not specify a work location.
Plant 1	Urinalysis result	7/[redact]/56	
Plant 1	Urinalysis result	7/[redact]/56	
Plant 2	Urinalysis result	8/[redact]/56	
Plant 2	Urinalysis result	8/[redact]/56	
Plant 2	Urinalysis result	8/[redact]/56	
Plant 2	Urinalysis result	8/[redact]/56	
Plant 2	Urinalysis result	8/[redact]/56	
Plant 2	Urinalysis result	10/[redact]/56	
Plant 2	Urinalysis result	10/[redact]/56	
Plant 2	Urinalysis result	10/[redact]/56	
Plant 2	Urinalysis result	2/[redact]/57	
Plant 2	Urinalysis result	3/[redact]/58	

Reference Claim #10
Claim ID: [redacted]
Worker Employment Period: [redacted]/54 – [redacted]/71
Job Title(s): Forklift Operator
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plants 1, 5, 6, 9. All other buildings	CATI report	[redact]/54–[redact]/71	"[redact]."
Unknown	Urinalysis result	NA	Claimant had over 50 other urinalysis samples during the period of interest that did not specify a work location.

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Reference Claim #11
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/2001
Job Title(s): Operator – [redacted] Worker
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Bldg. 3005, MF-5, 4/8, 2, B Plant, PP 3013, PP 3037, Plants 2, 2-3, 5, 8, 9 – West Pilot Plant, Bldg. 13-A	CATI report	[redact]/52–[redact]/2001	
Plant 5	Employment record from claimant	[redact]/52–[redact]/54	Claimant loaned to Pilot Plant on [redact]/52 and again on [redact]/53; it is not clear how long he worked there.
Plant 9	Employment record from claimant	[redact]/54–End of Period	Note: According to thorium timeline, processing of thorium stopped in Plant 9 in 1956.
Bldg. 3006	Film badge investigation	4/[redact]/53	
Plant 5	Urinalysis result	10/[redact]/53	
Plant 5	Urinalysis result	10/[redact]/53	
Plant 5	Film badge investigation	1/[redact]/54–1/[redact]/54	
Plant 5	Radiation exposure investigation	2/[redact]/55–2/[redact]/55	Conflicts with claimant-supplied employment records.
Plant 9	Urinalysis result	6/[redact]/56	Claimant had over 50 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	8/[redact]/56	
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/58	
Plant 9	Radiation exposure investigation	[redact]/63–[redact]/63	

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Reference Claim #12
Claim ID: [redacted]
Worker Employment Period[redacted]/52–[redacted]/76
Job Title(s): Chemical Operator – [redacted] Worker
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Pilot Plant, moved to Plant 9 (until 8/68), Plant 5	CATI report ([redact])	[redact]/52–[redact]/76	"[name redacted] [redact])"
Pilot Plant, Plant 9 (1952–1968), and Plant 5 (1968–1976)	CATI report ([redact])	See location	
Plant 5	Film badge investigation	7/[redact]/53–/[redact]/53	
Plant 5	Film badge investigation	8/[redact]/53–8//[redact]/53	
Plant 5	Film badge investigation	[redact]/53–[redact]/53	
Plant 5	Film badge investigation	8/[redact]/53–8/[redact]/53	
Plant 5	Film badge investigation	10/[redact]/53–10/[redact]/53	
Plant 5	Film badge investigation	11/[redact]/53–11/[redact]/53	
Plant 5	Film badge investigation	11/[redact]/53–11/[redact]/53	
Plant 5	Film badge investigation	5/[redact]/54–5/[redact]/54	
Plant 9	Urinalysis result	6/[redact]/56	Claimant had over 50 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	1/[redact]/57	
Plant 9	Urinalysis result	9/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/58	

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Reference Claim #13
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/83
Job Title(s): Chemical Operator – [redacted] Worker
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	Film badge investigation	[redact]/53–[redact]/53	Job description: [redact]
Plant 5	Film badge investigation	8/[redact]/53–8/[redact]/53	Job description: [redact]
Plant 5	Film badge investigation	8/[redact]/53–8//[redact]/53	Job description: [redact]
Plant 5	Film badge investigation	8/[redact]/53–8/[redact]/53	Job description: [redact]
Plant 5	Film badge investigation	9/[redact]/53–9/[redact]/53	Job description: [redact]
Plant 5	Film badge investigation	9/[redact]/53–9/[redact]/53	
Plant 5	Film badge investigation	1/[redact]/54–1/[redact]/54	Job description: [redact]
Plant 9	Urinalysis result	11/[redact]/55	Claimant had over 50 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/58	
Plant 9	H&S information report	10/60	

Reference Claim #14
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/88
Job Title(s): Chemical Operator – [redacted] Worker
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plants 5 and 9	CATI report	[redact]/52–[redact]/88	Claimant was involved in a thorium blender explosion at the startup of Plant 9.
Plant 9	Urinalysis result	7/[redact]/55	Claimant had over 65 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	7/[redact]/55	
Plant 9	Urinalysis result	7/[redact]/55	
Plant 9	Urinalysis result	7/[redact]/55	
Pilot Plant	Urinalysis result	12/[redact]/56	
Pilot Plant	Urinalysis result	12/[redact]/56	
Plant 9	Urinalysis result	3/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/58	
Plant 9	Urinalysis result	4/[redact]/58	
Plant 9	Radiation exposure investigation	[redact]/57–[redact]/57	Job description: [redact] operator
Plant 5	Film badge investigation	4/[redact]/54–4/[redact]/54	Job description: [redact] operator
Plant 5	Film badge investigation	5/[redact]/54–5/[redact]/54	Job description: [redact] operator

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Reference Claim #15
Claim ID: [redacted]
Worker Employment Period: [redacted]/54–[redacted]/69
Job Title(s): Chemical Operator – [redacted] Worker (Plant 8)
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
All over the site, most time spent in Plants 4 and 8	CATI report	[redact]/54–[redact]/69	
Plant 4	Urinalysis result	10/[redact]/54	Claimant had over 80 other urinalysis samples during the period of interest that did not specify a work location.
Plant 4	Urinalysis result	10/[redact]/54	
Plant 4	Urinalysis result	10/[redact]/54	
Plant 4	Urinalysis result	5/[redact]/56	
Plant 4	Urinalysis result	2/[redact]/57	
Plant 4	Urinalysis result	3//[redact]/57	
Plant 4	Urinalysis result	3/[redact]/57	
Plant 4	Urinalysis result	3/[redact]/57	
Plant 4	Urinalysis result	7/[redact]/57	
Plant 4	Urinalysis result	7/[redact]/57	
Plant 4	Urinalysis result	7/[redact]/57	
Plant 4	Urinalysis result	2/[redact]/58	
Plant 4	Radiation exposure investigation	[redact]/58–[redact]/58	Job description: reactor operator

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Reference Claim #16
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/77
Job Title(s): Machine Tool Operator – [redacted] Worker (Plant 6)
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	Film badge investigation	9/[redact]/52	Job description: [redact] operations
Plant 5	Film badge investigation	2/[redact]/53–2/[redact]/53	Job description: [redact] operations
Plant 6	Urinalysis result	1/[redact]/55	Claimant had over 45 other urinalysis samples during the period of interest that did not specify a work location.
Plant 6	Urinalysis result	6/[redact]/55	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	12/[redact]/57	
Plant 6	Urinalysis result	6/[redact]/55	
Plant 5	Urinalysis result	10/[redact]/55	
Plant 9	Urinalysis result	1/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/57	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	12/[redact]/57	
Plant 9	Periodic physical examination	12/[redact]/57	
Plant 9	Periodic physical examination	2/[redact]/59	
Plant 6	Periodic physical examination	2/[redact]/60	
Plant 6	Periodic physical examination	5/[redact]/61	
Plant 6	Periodic physical examination	5/[redact]/62	
Plant 6	Periodic physical examination	7/[redact]/63	
Plant 6	Periodic physical examination	8/[redact]/64	
Plant 6	Periodic physical examination	10/[redact]/65	
Plant 6	Periodic physical examination	1/[redact]/67	

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Reference Claim #17
Claim ID: [redacted]
Worker Employment Period: [redacted]/52 – [redacted]/88
Job Title(s): Machine Tool Operator – [redacted] Worker (Plant 9)
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plants 6 and 9	CATI report	[redact]/52– [redact]/88	
Plant 5, Bldg. 3006	Film Badge Investigation	9/[redact]/52	Job description: [redact]
Plant 6	Urinalysis result	1//[redact]/55	
Plant 6	Urinalysis result	1/[redact]/55	
Plant 6	Urinalysis result	2/[redact]/55	
Plant 9	Personnel and clothing monitoring report	4/[redact]/55	
Plant 6	Urinalysis result	12/[redact]/55	Claimant had over 75 other urinalysis samples during the period of interest that did not specify a work location.
Plant 6	Urinalysis result	6/[redact]/56	
Plant 6	Urinalysis result	6/[redact]/56	
Plant 6	Urinalysis result	6/[redact]/56	
Plant 6	Urinalysis result	6/[redact]/56	
Plant 6	Urinalysis result	7/[redact]/56	
Plant 6	Urinalysis result	7/[redact]/56	
Plant 6	Urinalysis result	8/[redact]/56	
Plant 6	Urinalysis result	8/[redact]/56	
Plant 6	Urinalysis result	8/[redact]/56	
Plant 6	Urinalysis result	9/[redact]/56	
Plant 6	Urinalysis result	9/[redact]/56	
Plant 6	Urinalysis result	9/[redact]/56	
Plant 6	Urinalysis result	9/[redact]/56	
Plant 6	Urinalysis result	10/[redact]/56	
Plant 6	Urinalysis result	10/[redact]/56	
Plant 6	Urinalysis result	10/[redact]/56	
Plant 6	Urinalysis result	10/[redact]/56	
Plant 6	Urinalysis result	11/[redact]/56	
Plant 6	Urinalysis result	11/[redact]/56	
Plant 9	Urinalysis result	7//[redact]/57	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	7/[redact]/57	
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	9/[redact]/57	
Plant 9	Urinalysis result	9/[redact]/57	
Plant 9	Urinalysis result	10/[redact]/57	
Plant 9	Urinalysis result	10/[redact]/57	
Plant 9	Urinalysis result	11/[redact]/57	
Plant 9	Urinalysis result	11/[redact]/57	
Plant 9	Urinalysis result	2/[redact]/58	

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Reference Claim #18
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/79
Job Title(s): [redacted] – [redacted] Worker (Plant 5)
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	CATI Report	[redact]/52–[redact]/54	
Plant 9	CATI Report	[redact]/54–[redact]	"[redact]…"
Plant 9	Urinalysis result	10/[redact]/56	Claimant had over 65 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	8/[redact]/57	
Plant 9	Urinalysis result	2//[redact]/58	

Claim Reference #19
Claim ID: [redacted]
Worker Employment Period: [redacted]/52–[redacted]/80
Job Title(s): [redacted] Operator – [redacted] Worker (Plant 2)
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plants 5, 6, and 9	CATI report	[redact]/52–[redact]/80	
Plant 5	Urinalysis result	3/[redact]/57	Claimant had over 45 other urinalysis samples during the period of interest that did not specify a work location.
Plant 5	Urinalysis result	8/[redact]/57	
Plant 5	Urinalysis result	9/[redact]/57	
Plant 5	Urinalysis result	1/[redact]/58	
Plant 5	Urinalysis result	3/[redact]/58	
Plant 5	Urinalysis result	4/[redact]/58	

Reference Claim #20
Claim ID: [redacted]
Worker Employment Period: [redacted]/54–[redacted]/3/69
Job Title(s): Chemical Operator
Available work location info:

Work Location	Source	Date/Time Period	Any Additional Comments
Plant 5	Urinalysis result	3/[redact]/56	Claimant had over 45 other urinalysis samples during the period of interest that did not specify a work location.
Plant 9	Urinalysis result	9/[redact]/57	
Pilot Plant	Urinalysis result	11/[redact]/57	

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