ATTACHMENT 4.3-4D

August 8, 1960

DERBY FIRES AND ASSOCIATED AIR DUST LEVELS – PLANT 5

J. A. Quigley, M.D.

R. H. Starkey

Following is a compilation of air dust data collected in connection with the recent derby fires in Plant 5. The dates shown indicate when the samples were taken.

Type	Sample Description	No. of Samples	Concentration – d/m/M³ High	Low	Average	% MAC*
GA	Background – West side of derby storage area. No fires. (8/2/60)	5	263	48	149	2.1
GA	Same as above, except one derby on fire. (8/2/60)	2	60,000	4,127	32,063	458.0
GA	Same as above, except two derbies on fire. (8/2/60)	2	16,500	308	8,404	120.0
GA	Same as above, except skid of derbies on fire. (8/3/60)	4	35,400	300	17,525	250.0
GA	Same as above, except two or three derbies on fire. (8/3/60)	3	54,900	4,200	30,060	429.0
GA	Same as above, except skid of burning derbies 20' east of pumps. Smoke going north. (8/3/60)	2	354	277	281	4.0
GA	Background – Derby spray trough, 2nd floor. Smoke and fume still visible from previous fires. (8/2/60)	4	1,700	205	726	10.4

Finding 4.3-5: The list of facilities in which thorium-232 was processed, the time periods of thorium processing, and the thorium production data shown in the TBD have significant gaps. Entire periods of processing and plants in which the work was done have been missed. These gaps may affect the feasibility of dose reconstruction for workers during certain periods and in certain plants.

The TBD considers thorium-232 work to have been done mainly in the Pilot Plant and Plant 9. It also acknowledges work in Plant 8 and, for a short period, of production in Plant 4. The TBD does not mention Plant 6 in connection with thorium production; however, Attachment 4.3-5A clearly shows that thorium was processed in Plant 6 at least from 1960 to 1962.

Table 4.3-1 corresponds to thorium air dust data for Plant 6, as given in Attachment 4.3-5A. Furthermore, it is clear that production continued into 1963. The dust survey report from which the data in Table 4.3-1 are derived was written in March 1963. Despite the extremely dusty conditions in some operations (notably raking cold residue into the furnace at 1,260 Maximum Allowable Concentration (MAC)), production was continuing at the time the report was written. The report recommended that "this furnace should be shut down immediately after processing the thorium now on site."

Table 4.3-1: Plant 6 Air Dust Data, 1960 to 1962

Location	Sample Year	Type of Sample	Air conc, xMAC	Comments
Raking excessive cold residue into furnace	1962	BZ	**1,260**	Recommended for shut down July 1, 1963 for clean up
Unplugging furnace discharge line	1962	BZ	**417**	
Unplugging furnace discharge line	1961	BZ	**4.0**	Same location as 1962
Unplugging furnace discharge line	1960	BZ	**4.0**	Same location as 1962
Loading Th metal into 5-gal can from 55-gal drums	1962	BZ	**69**	
Raking drum residue into Rotex sifter	1962	BZ	**27**	
Raking drum residue into Rotex sifter	1961	BZ	**31**	Same location as 1962
Raking drum residue into Rotex sifter	1960	BZ	**33**	Same location as 1962
Changing drum at product canning station	1962	BZ	**19**	
Changing drum at product canning station	1961	BZ	**4.0**	Same location as 1962
Changing drum at product canning station	1960	BZ	**4.0**	Same location as 1962
Charging furnace with pieces of metal	1962	BZ	**7**	
Charging furnace with pieces of metal	1961	BZ	**3.0**	Same location as 1962
Charging furnace with pieces of metal	1960	BZ	**3.0**	Same location as 1962

Source: Starkey 1963
Note: 1 MAC = 70 dpm/m^3

A Fernald history of thorium residue processing indicates that burning of residues may have begun in Plant 6 in late 1959, when a furnace there was modified to burn residues accumulated from metal production during 1955 and 1956 in Plant 9 (Attachment 4.3-5B). There were 1500 drums (or 240,000 pounds) that were sent to the Plant 6 furnace for oxidation (Attachment 4.3-5C). Hence, there is documentary evidence for thorium residue burning from sometime in 1959 until at least July 1963 (see Attachment 4.3-5D). (It is unclear whether thorium operations took place in Plant 6 after that date.) A 1954 evaluation of dust levels at various plants involved in chemical and metallurgical work with thorium provided recommendations for the steps to be taken at Fernald in order to make Plant 6 “suitable for thorium rolling” (Klevin 1954, p. 19).

Neither Table 5-13 nor Table 5-14 in Vol. 5 of the TBD, which show production data by plant, chemical form, and time period, have any thorium production listed for 1960, 1961, 1962, or 1963. The Site Description (Vol. 2 of the TBD) also does not mention Plant 6 as a thorium production location. Finally, one of the main references that NOISH used in compiling the thorium production data (Dolan and Hill 1988) also does not list Plant 6 as a production location for thorium:

> *Thorium was processed at the FMPC throughout much of the thirty-five year history of the site. The demand for various thorium materials fluctuated greatly and the FMPC developed or modified processes to meet these varying requirements. During different periods, thorium was processed through Plants 2/3, 4, 8, 9, and the Pilot Plant.* [Dolan and Hill 1988, p. 57]

Thorium tetrafluoride was produced in a “short” campaign in Plant 4, but production data are not available:

> *In 1954, Plant 4 was used for a short campaign to produce dry ThF_4 from the ThO_2 dried and calcined in Plant 9 in hydrofluorination Bank 7. The ThF_4 was returned to Plant 9 and used to produce thorium metal. This was a short-duration process due to mechanical difficulties in Bank 7. Production quantities are not available for ThF_4 production in Plant 4.* [TBD, Vol. 2, p. 24]

While the TBD does not provide a reference for these statements, it appears that they are based on Dolan and Hill (1988, p. 61). However, Dolan and Hill are not as definite that production did not occur at other times:

> *Production quantities are not available for ThF_4 in Plant 4. Because of the problems encountered, it is **believed** that this process was only operated for a short period and hence the potential for emissions was very slight.* [Dolan and Hill 1988, p. 61] [Emphasis added.]

Since thorium residues, including metal residues, were processed in a furnace in Plant 6 between 1960 and 1963 (inclusive), the question arises as to where the thorium processing was done to produce the metal in this period. Neither the TBD nor Dolan and Hill provide any production data for these years. It is plausible that chemical processing of thorium, including production of thorium tetrafluoride and reduction of the tetrafluoride to metal, occurred at Fernald during 1960 to 1963 (possibly only the first half of 1963). It may also have occurred in the late 1950s and in other periods.

Dolan and Hill (1988) concluded that thorium production in the Pilot Plant started in 1964. Vol. 2 of the TBD indicates that thorium tetrafluoride was produced in the Pilot Plant and then reduced to metal in the 1969–1971 period. Reduction of ThF_4 to metal occurred in Plant 9. Dolan and Hill (p. 59) also state that "[t]horium metal was produced in Plant 9 from 1954 through 1955." Machining was also done in Plant 9 during this period (p. 59).

It is possible that these facilities were used in the 1960–1963 period for ThF_4 production and reduction; however, this needs to be more carefully investigated. In that case, it is also possible that Plant 2/3 may have been used to produce the thorium nitrate feedstock that was the starting point of the ThF_4 production process.

SC&A has not located any positive documentation that Plant 5, where the UF_4 reduction to metal was done, was also used for ThF_4 reduction. However, a 1954 evaluation (Klevin 1954) of thorium health hazards recommends that consideration should be given to the use of the "'F' machine in charging thorium bombs, since these have proved to be effective in controlling airborne contamination and are operationally satisfactory at both MCW and FMPC Plant 5" (p. 11). It appears that at least at the time of the evaluation (March 1954), such a machine was not available in Plant 9, where the ThF_4 reduction was being carried out. Hence, it is possible that the charging of the bombs may have been done at Plant 5 for some time until a suitable machine was procured for Plant 9. It may also have been used in the later 1960–1963 period.

SC&A stresses that it is making the above statements about possible work in Plant 4 and Plant 5 (or additional undocumented work in Plant 9 and/or the Pilot Plant) as pointers for research into thorium production history, rather than as conclusions. Thorium data are likely to be one of the most critical parts of dose reconstruction for Fernald claimants who worked there from 1954 onwards. As NIOSH and ORAU acknowledged in the August 18, 2006, conference call, the TBD does not reflect a considerable amount of documentation that is available or becoming available (see Section 8.1.1).

The TBD lists Plant 2/3 as a location for thorium processing:

> *In 1968, Plant 2/3 was used to process thorium as a thorium production test for a short duration. Few details are available regarding this process. Thorium nitrate crystals were produced in a denitration pot in Plant 2/3. Interviews with long-time employees indicated that this was a short-term operation; probably one pot of crystals was produced. Other records discuss the production of thorium oxide in Plant 2/3 by a process of denitration, redigestion, and drying.* [TBD, Vol. 2, p. 20]

No plant-specific data enabling dose reconstruction are provided. Production data shown in Table 6 of Dolan and Hill do not contain any data for Plant 2/3 thorium production amounts or time periods (Dolan and Hill 1988, p. 20). Since Plant 2/3 was the refinery where uranium ores were processed, it may be presumed that thorium ores were also processed there. This has considerable significance for worker exposure. The TBD does mention the processing of thorium ores at Fernald, but lists them as being processed in the Pilot Plant as part of the thorium processing there between 1964 and 1980 (TBD, Vol. 2, p. 11); however, records show that thorium production at Fernald went back to 1954. This raises the question whether thorium processing took place in Plant 2/3 in connection with early thorium-related processes in Plant 9 and Plant 4. The information in Dolan and Hill on thorium was partly based on interviews, but NIOSH was unable to provide any interview records to SC&A.

According to the TBD, much of the thorium data was destroyed in the 1970s:

> *Much of the thorium production data has been lost, and the plant and bioassay monitoring data recovered to date has been sparse. A comprehensive effort to reconstruct the effluent of uranium and thorium from the Fernald plants in 1988 discovered that a large number of records and files were destroyed in the early 1970s during declassification efforts (Dolan and Hill 1988). Reviews of AEC records in Oak Ridge and Atlanta failed to uncover additional details.* [TBD, Vol. 5, p. 18]

There are other problems with the production data as well. For instance, Vol. 2 of the TBD states that thoria gel production for 1964 and 1965 was estimated based on a linear extrapolation of the quantity produced in 1966 through 1970:

> *Production records also indicate that 492 metric tons of thorium as thoria gel were produced from 1966 to 1970. Production for 1964 and 1965 was estimated based on a linear extrapolation of the quantity produced in 1966 through 1970. The estimated total production from this process is 686 metric tons assuming linear production from 1964 to 1970.* (TBD Vol. 2, p. 11).

No justification for this assumption is provided in the TBD. Furthermore, the data shown in Table 5-13 of the TBD (Vol. 5, p. 20) show that NIOSH assumed that only thoria gel was produced in 1964 and 1965, even though there was other processing and at least one other chemical form (thorium oxalate) produced in the Pilot Plant in the 1966 to 1970 period. If the average of the total production in the Pilot Plant were extrapolated backwards, the estimated production of thorium in the Pilot Plant in 1964 and 1965 would be 238 metric tons in each year, or about 2.4 times the amount estimated by NIOSH (98 metric tons in each year). No explanation is provided for the more limited extrapolation.

Furthermore, if thoria gel was produced in 1964 and 1965, one would expect purified thorium nitrate solution also to have been produced. However, the text only discusses production from 1966 onward. Was there any such production in 1964 and 1965? In fact, though Table 5-14 shows that thorium nitrate was produced in the Pilot Plant, it is not explicitly mentioned in Table 5-13 where production estimates are provided. In this same context, it is confusing that some items of production have quantitative estimates (but without references) in Volume 2 of the TBD, but there is no counterpart tabulation in Volume 5 on internal dose reconstruction. For instance, thorium nitrate production is not shown in Table 5-13 of Volume 5; however, Volume 2 gives a rather precise value of 790.4 metric tons for the 1966–1973 period for the Pilot Plant (p. 11).

Finally, a 1988 thorium records search document (Bonfer 1988) also indicates that the TBD compilation of production at Fernald is incomplete. The starting date for thorium production of 1954 appears to be correct according to Bonfer 1988, which provides a date of January 26, 1954, with metal production operations starting on February 15, 1954—all in Plant 9. Bonfer 1988 also mentions "extraction studies" being started in the laboratory in April 1954. These studies continued well into 1955. Furthermore, while Tables 5-13 and 5-14 show Plant 9 production only in 1954 and 1955, there is clear evidence that Plant 9 production covered a longer time span. For instance, Bonfer states the following:

> *The final Plant 9 process of manufacturing massive thorium metal continues into 1956.* [Bonfer 1988, p. 2]

Similarly, while Tables 5-13 and 5-14 show Pilot Plant production only beginning in 1964, Bonfer 1988 states the following:

> *A project was initiated during July 1956 in the Pilot Plant to demonstrate the sylvania reduction process for calcium reduction of thorium oxide to thorium metal powder.* [Bonfer 1988, p. 2]

Attachment III in Bonfer 1988 is a catalog of orders for a variety of forms of thorium. It includes orders that were filled in 1957, 1958, and 1959—years that are not discussed for thorium production in the TBD. In this context, it is noteworthy that while the TBD does not mention thorium metal production in Plant 9 in 1956, the history of residue recovery does. The quantity of production must have been significant, because the residues from 1955 and 1956 amounted to 80 tons (Mead 1972, p. 86). Finally, Attachment II in Bonfer (1988) also shows three orders in 1985, but it is not clear whether these orders were filled with material that had already been produced prior to that time or whether there was post-1979 production at Fernald. The TBD does not discuss these orders or cite Bonfer (1988).

In conclusion, it is very likely that production estimates in the TBD are significant underestimates. It is clear that Tables 5-13 and 5-14 (TBD, Vol. 5, p. 20) do not capture a large amount of the processing that was done, even from readily available documentation. The locations and time periods of processing are also significantly incomplete. A thorough revision of the TBD is necessary to establish when the workers were at risk of exposure due to production, and in which plants they were at risk.

ATTACHMENT 4.3-5A

2260757

NATIONAL LEAD COMPANY OF OHIO

CINCINNATI 39, OHIO

March 26, 1963

SUBJECT : AIR DUST RE-EVALUATION OF THE THORIUM FURNACE - PLANT 6

TO C. R. Chapman

FROM R. H. Starkey

REFERENCE

On December 10 and 11, 1962 an air dust re-evaluation was conducted of the Thorium Furnace. Results of the air dust samples taken during this survey are shown below and they are compared with the results of samples collected during October, 1960 and January, 1961.

Operation or Location		X MAC* 1962	1961	1960
BZ	Raking excessive cold residue from edge of top hearth into furnace	1260	-	-
BZ	Unplugging furnace discharge line	417	4.0	4.0
BZ	Loading thorium metal into 5 gallon can from 55 gallon drums to be carried to furnace for charging	69	-	-
BZ	Raking thorium residue into Rotex sifter	27	31	33
BZ	Changing drum at product canning station	19	4.0	4.0
BZ	Charging furnace with pieces of metal	7	3.0	3.0
GA	Approximately 12 feet southeast of furnace	2.5	-	-
GA	1 foot west of furnace	1.8	-	-

* MAC - maximum allowable concentration (70 α d/m/M³)
- Denotes operation or area did not exist or was included in another classification at the time of sampling.

Although the Thorium Furnace and Rotex sifter have ventilation, it is completely inadequate. In addition, a majority of the operations performed in conjunction with the furnace do not have local ventilation at all. It should be mentioned also that the plexiglass window in the product canning station is broken. This is reducing the ventilation efficiency of the station. The rabbeling arms in the top hearths of the furnace

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ATTACHMENT 4.3-5B

PROJECT PROPOSAL

A. PROPOSAL NUMBER

CP-59-79

B. TITLE OF PROJECT

Sludge Furnace Alterations for Oxidation of Thorium Residues - Plant 6

C. DATE

October 20, 1959

D. DISCUSSION AND JUSTIFICATION

1. Problem

The metal oxidation facilities at FMPC are not available, due to the lack of isolated dust removal systems, for the processing of pyrophoric thorium residues such as sludges, chips or turnings. There is a considerable inventory of such material now being stored here, and more is received from time to time from other sites. Stockpiling of these pyrophoric residues creates handling and storage problems due to their hazardous nature.

During the past four years there have been 30 known fires with these materials, some of which burned for several days. Clean up after these fires is a difficult job. In one case, the fire burned through a concrete storage pad. Storage of the drums on soil resulted in a worse situation, when a fire contaminated a considerable area, and much stone and dirt had to be removed. As long as these residues are in

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ATTACHMENT 4.3-5C

NATIONAL LEAD COMPANY
OF OHIO

September 28, 1961

ROUTE TO
NAME

22256

SUBJECT: FINAL SUMMARY AND INVENTORY OF THORIUM

TO: [illegible] McCreary

FROM: J. [illegible] Carritti

REF: [illegible] as of 10/1/61

During the past three years all of the thorium residue materials and the thorium products were inspected, segregated, redrummed, reweighed and recoded by the Project Labor Pool.

This program entailed a great deal of work due to the improperly coded items and at times the work was somewhat hazardous due to drums exploding, catching on fire or causing obnoxious fumes. A full drum (55 gallon) of calcium metal was also found among the drums and it had been coded as a thorium residue. At times the work on this project was at a standstill due to the radiation and there were no workers to rotate who were not exposed to the maximum agreeable monthly radiation dosage. The radiation dosages were checked monthly with Health and Safety Division.

It should be noted that much of the work performed by the Project Labor Pool could have been avoided if proper and greater care would have been taken in the drumming, coding, segregating or marking of the original drums. Many of the drums of metal residues were oxidized or corroded into sludges and were further oxidized at Plant 6 thorium furnace. It can be said that the thorium residues were in a worse condition than the depleted or normal residues and this was a major cause of the thorium contamination to the storm sewers. The thorium materials are now in good condition and the material probably will not require redrumming for several years. The housekeeping is now greatly improved and there should be no more thorium contamination going into the storm sewer system.

All drums or boxes of the good thorium products and potentially remelt metal are located in undercover storage and all the residues are on the outside pad. Approximately 6,000 drums of low grade thorium residues were discarded at some off site burial area and over 1,500 drums (240,000 pounds - net weight) have been sent to Plant 6 thorium furnace for oxidation.

The following summary describes each lot of material stating the new lot number, number of drums, the new weight and material description. By copy of this letter please change your October 1, 1961 inventory tab run accordingly. If you desire to take an actual part physical inventory on November 1, 1961, please advise Production Records and Plant 1 of this fact (note, I will gladly assist on any inventory).

Type 201: All of the product TNT was redrummed with no change in lot numbers. This TNT must be removed in the opposite order that it was stored, i.e. last in - first out.

ATTACHMENT 4.3-5D

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NATIONAL LEAD COMPANY OF OHIO

April 11, 1963

2117328

Mr. C. L. Karl, Area Manager
U. S. Atomic Energy Commission
P. O. Box 39188
Cincinnati, 39, Ohio

SUBJECT: THORIUM OPERATIONS AT NLO - PRESENT AND FUTURE

Reference: Letter, C. L. Karl to J. H. Noyes, subject "Thorium Turnings at Sylvania", dated 2-20-63.

Dear Mr. Karl:

In view of the recent request by Sylcor to ship a large quantity of thorium turnings to FMPC for oxidation in the Plant 8 facility, the entire thorium operation has been reviewed.

While developing the shipping information requested presents no major problem, continued operation of the thorium furnace in Plant 6 does. A basic problem exists and must be solved.

The solution decided upon with respect to the furnace can be used to determine just what should be done with the turnings at Sylcor. Summarized below are the principal considerations in this matter:

1. The current operation is unsatisfactory from both a hygiene and a fire and safety standpoint.

2. It is being continued only as terminal operation until July 1963. By that time the present inventory of thorium feed material is expected to be consumed.

3. Air dust levels in some operations now exceed 50 MAC; they range from 10-1400 MAC. Even the general air samples are 2-3 MAC. This stems from many deficiencies with the materials handling and ventilation systems.

4. To consume an additional 20,000 pounds of thorium turnings will add five months to the schedule. To continue an already unsatisfactory situation for an extended period, without major improvements, is intolerable.

5. Fire and safety hazards add to the problem. The roof over the furnace is not fire-proof, and should be.

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Finding 4.3-6: NIOSH Lacks the Necessary Data for Defining Thorium Exposure During Post-Production Periods

Table 5-13 of the FMPC TBD identifies discrete years during which thorium was processed at the Pilot Plant, Plant 8, and Plant 9. Because much of the thorium production data has been lost/destroyed, these dates, as well as locations can neither be assumed accurate nor complete, as discussed separately under Finding 4.3-5 above.

However, independent of these uncertainties, thorium exposures at any process facility must be assumed to have continued well after thorium processing ceased due to residual contamination that may have co-mingled with newly-created uranium contamination.

In this context, it is important to note that even 1 MAC exposure to thorium for certain organs yields a committed dose much higher than exposure to uranium, the main material processed and produced at Fernald for certain organs. (At the time, 1 MAC for thorium and uranium was defined as being the same number—70 dpm/m^3 until 1970 and 100 dpm/m^3 thereafter.) SC&A has pointed out the critical importance of this fact for dose reconstruction in other reports (see SC&A 2006, for instance). For convenience, we have reproduced Table 4.3-2 from SC&A 2006 herein.

Table 4.3-2: 50-Year Organ Dose Conversion Factors for U-234 and Th-232 – Inhalation
(in sieverts per becquerel and ratios)

Organ	U-234 Type M, Sv/Bq	U-234 Type S, Sv/Bq	Th-232 Type S, Sv/Bq	Ratio Th S/U M	Ratio Th S/ U S
Bone Surface	3.90E-06	5.03E-07	2.86E-04	7.33E+01	5.69E+02
Breast	1.37E-07	1.63E-08	8.29E-07	6.05E+00	5.09E+01
Liver	5.34E-07	6.93E-08	5.05E-06	9.46E+00	7.29E+01
Red Marrow	4.03E-07	5.21E-08	1.00E-05	2.48E+01	1.92E+02
Testes	1.37E-07	1.63E-08	2.62E-06	1.91E+01	1.61E+02

Source: Federal Guidance Report 13, U.S. EPA, published on CD in 2002.
Reproduction of Table 4 from SC&A 2006.
Note: DCFs are based on AMAD = 1 μm

These data show that a 1-MAC level of air contamination with Type S thorium-232 is equivalent to 569 MAC of Type S uranium-234 for bone surface dose. Thus even ~0.1% Th-232 dust in the air (in terms of dpm/m^3) mixed in with uranium can make a significant contribution to bone surface dose. The dose conversion factors (DCFs) show that a few tenths of 1% can make a significant contribution of dose of the testes and red bone marrow. When assessed against these facts, the TBD/ER are particularly deficient in regard to residual thorium air concentration during times when personnel were monitored for uranium (via urinalysis) and/or by air sampling that blindly assessed for alpha activity.

Finding 4.3-7: The Guidance in the TBD Regarding Exposures from Redrumming Thorium is not Well Founded and is Not Claimant Favorable.

There were extensive thorium redrumming, packaging, and shipping operations in the 1980–1986 period. Such operations were also carried out during the period of thorium processing. For instance, a 1965 "Request for Engineering Services" began as follows (see Attachment 4.3-7):

> *The thorium residue drums are disintegrating.* [Name] *started redrumming these residues but was stopped by the IH&R Department due to high dust levels of contamination arising from dust generated by the redrumming operation. Prior to the IH&R shutdown of the redrumming operation, the sump cake had been redrummed in 900 drums and 100 drums of floor sweepings had been redrummed.*
>
> *…About 30% of the drums are so corroded that they cannot be lifted off their pallets without falling apart.* ***This is the fourth time this material has been redrummed. There are approximately 2000 drums of this material.*** [DeFazio 1965, emphasis added]

The inference from the engineering request for ventilation system design is that the prior redrumming operations were carried out at least three times without such ventilation and that half the job in question (redrumming of 1,000 out of 2,000 drums) was also similarly carried out without ventilation. SC&A has not found BZ air dust data corresponding to the discrete redrumming operations.

SC&A concludes that air concentrations during periodic redrumming efforts were high as implied in a 1968 memorandum, which stated:

> *As you well know, most of our air dust at FMPC over the years have resulted from drumming and dumping dry materials. Any time that we can eliminate either of these operations our air dust problems become greatly reduced.* [Starkey 1968]

However, needed data for assessing intakes to workers engaged in redrumming efforts are lacking at two levels: (1) it is unlikely that the identity of the workers engaged in redrumming can be obtained, and (2) it is equally unlikely that BZ air sampling data for redrumming efforts exist.

ATTACHMENT 4.3-7

file 1-91

NATIONAL LEAD COMPANY OF OHIO
Cincinnati, Ohio 45239

November 17, 1965

2223507

DEFENDANT'S EXHIBIT 3668

SUBJECT: VENTILATION FOR REDRUMMING OF THORIUM RESIDUES

TO: S. F. Audia

FROM: P. G. DePazio

REFERENCE: Request for Engineering Services dated October 20, 1965
Engineering Project 1-91

The thorium residue drums are disintegrating. [redacted] started redrumming these residues but was stopped by the IH&R Department due to high levels of contamination arising from dust generated by the redrumming operation. Prior to the IH&R shutdown of the redrumming operation, the sump cake had been redrummed in 900 drums and 100 drums of floor sweepings had been redrummed.

Upon the stoppage of the work, an Engineering Request was issued requesting design of ventilation to enable the redrumming to continue. A preliminary investigation of the problem revealed a number of facets involving IH&R, Technical, and Production in several areas of the project. Accordingly, a meeting was called to gather all of the outstanding information on the problem of handling, storing and eventual disposal of the thorium residues.

About 30% of the drums are so corroded that they cannot be lifted off their pallets without falling apart. This is the fourth time that this material has been redrummed. There are approximately 2800 drums of this material. Originally, it was drummed separately under the following headings as: ThF_4, Metal Scrap, Sump Cake, ThO_2, Floor Sweepings, ThF_4 and Scrap, Miscellaneous Scrap, Material held for historical purposes and General Scrap. These drums were marked and stored on the outdoor pad. Due to the corrosive nature of the material and exposure to the elements, the drums corroded and disintegrated on the pad with a resulting loss of marking on individual drums. Even though the general area of storage for separate lots is known there has been mixing of the drummed materials. The degree of mixture was increased as each redrumming of the material was accomplished. As a result, we have an increasing amount of general scrap and miscellaneous residues and scrap.

On November 10, 1965, a meeting was held to discuss this problem. In attendance were: [redacted]. An attempt was made to delineate this problem of redrumming thorium residues. The following possible courses of action were established in the meeting:

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P-582

Finding 4.3-8: Thorium intakes due to fugitive emissions and resuspension in non-production areas may have been significant in some locations and during some periods. The TBD does not address the issue of fugitive emissions from production areas into non-production areas. Furthermore, the TBD does not provide a method to estimate exposure/intakes for those workers without lapel air sampling.

If NIOSH intends to estimate thorium exposure/intakes based on BZ air sampling data for thorium processing locations and time periods, exposures from fugitive releases will not be included. There is clear evidence of significant problems with fugitive emissions of thorium from production areas. These problems were not confined to early production. A 1970 memorandum on "Thorium Metal Production Housekeeping" is worth quoting at length in this regard (see Attachment 4.3-8):

> 1. *Probably the worst housekeeping problem in the facility is the Ball Mill. This equipment leaks excessively at practically every joint. All horizontal surfaces have a thick covering of dust. In operation, this dust becomes airborne and adds to the dust coming from the leaks. Since the ventilation is inadequate and there is no proper enclosure, a bucket was placed under the largest leak to help contain the spilled dust. This is not adequate. It is recommended that Engineering Division be requested to inspect the Ball Mill and associated equipment and recommend methods of improving both the dust problem and the housekeeping problem.*
>
> 2. *During the operation of removing the calcined ThF_4 and CaF_2 from the retorts, the stack of trays is left standing on a skid near the south annex door. The door is left open to aid in cooling the trays. The wind coming through the door blows the loose powder from the trays and spreads it generously through the annex. Removing the trays from the support requires heavy effort and this dislodges more powder to be spread by the wind. It is recommended that this stack of trays be put inside the enclosure used for grinding, weighing, and blending their contents.* [Ross 1970]

Quantitative data for the problem of high fugitive dust over time does not exist, but the document indicates that the levels of thorium dust were high both indoors and outdoors, and that industrial hygiene measures were poor. Moreover, the same memorandum makes it clear that significant residual contamination from the poorly controlled processes was present in many locations. They included the following:

> *…the drying oven area, the bottom of the blending enclosure, the saws and the saw area, the entrance to the furnace room when used to remove dezinced derbies from their holders, the top deck of the furnace room, the ThF_4 enclosure and the area surrounding it, and others.* [Ross 1970]

These circumstances indicate that both thorium production workers as well as those who did not directly work with thorium may have experienced significant thorium intakes due to faulty equipment, lack of adequate ventilation, and poor location of the equipment. Maintenance workers who repaired the equipment may also have had large exposures due to resuspension of dust from the heavily contaminated surfaces. In view of the high DCFs of thorium relative to uranium for several organs, it is essential that dose reconstruction must account for all worker exposures to thorium.

ATTACHMENT 4.3-8

6/10

June 8, 1970

2117287

THORIUM METAL PRODUCTION HOUSEKEEPING

J. E. Beckelheimer

K. N. Ross

Inspection of the thorium metal production facilities during the past several weeks has pointed out some housekeeping problems that I wish to call to your attention.

1. Probably the worst housekeeping problem in the facility is the Ball Mill. This equipment leaks excessively at practically every joint. All horizontal surfaces have a thick covering of dust. In operation, this dust becomes airborne and adds to the dust coming from the leaks. Since the ventilation is inadequate and there is no proper enclosure, a bucket was placed under the largest leak to help contain the spilled dust. This is not adequate. It is recommended that Engineering Division be requested to inspect the Ball Mill and associated equipment and recommend methods of improving both the dust problem and the housekeeping problem.

2. During the operation of removing the calcined ThF_4 and CaF_2 from the retorts, the stack of trays is left standing on a skid near the south annex door. The door is left open to aid in cooling the trays. The wind coming through the door blows the loose powder from the trays and spreads it generously through the annex. Removing the trays from the support requires heavy effort and this dislodges more powder to be spread by the wind. It is recommended that this stack of trays be put inside the enclosure used for grinding, weighing, and blending their contents. If faster cooling is necessary, a ventilated enclosure could be built there. It is suggested that a method of removing the central pipe from the trays would use much less effort and cause less airborne dust.

General

Prompt cleanup of all soills is the keystone of good housekeeping. In every inspection, it has been noticed that thorium

037425

Attachment 4.3-8 (Continued)

Thorium Metal Production Housekeeping　　　　Page 2
J. E. Beckelheimer
June 8, 1970

containing material was spilled in many locations. Some of these repeated spill locations are the drying pan unloading station, the drying pan carts, the drying oven area, the bottom of the blending enclosure, the saws and saw area, the entrance to the furnace room when used to remove dezinced derbies from their holders, the top deck of the furnace room, the ThF_4 grinding enclosure and area surrounding it, and others. These spills are caused by human frailties and would be of no consequence if they were promptly and properly cleaned up. Vacuum cleaning and/or washdown with water is recommended.

All work stations should be cleaned before the operator moves to his next job. This method, when rigorously enforced, has been found to decrease the number of spills since more care is used to prevent a long tedious cleanup. Where the operator works at one station all shift, he is responsible for that area's cleanliness. Supervision must be alert and insist that each area be clean before the next operator or shift moves in.

Original Signed By

K. N. Ross

KNR/jm

cc: W. J. Adams
M. W. Boback
J. A. Quigley, M.L.

037426

Finding 4.3-9: The Inability to Assess Internal Exposures from the Ingestion of Thorium

When estimates of internal exposure to thorium are restricted to air sampling, there is no accountability of internal exposure that resulted from the ingestion of thorium.

At FMPC, substantial internal exposure resulting from the ingestion of both soluble and insoluble thorium compounds must be assumed for the following reasons (also see Attachments 4.3-9A through 4.3-9C):

(1) Large source terms of thorium compounds existed that were readily introduced into air and ubiquitously dispersed throughout the workplace.

(2) In combination, the absence of worker training, poor housekeeping, and poor work practices allowed workers to come into close contact with materials and contamination in the workplace.

(3) These problems were compounded by the failure to employ adequate engineering controls in the workplace (e.g., ventilation systems, automation of manual processes, etc.) and the failure to supply and/or enforce the use of anti-Cs, respirators, and other measures that would mitigate internal exposure.

(4) Workers were not monitored for skin and clothing contamination.

(5) Even for the post-1968 period when a limited number of workers were assessed by in vivo measurements/lung counting (i.e., MIVRML), these data are of limited value for quantifying the ingestion of thorium compounds – in particular, insoluble thorium compounds, which would have transiently exposed only epithelial cells of the gastrointestinal tract.

SC&A concludes that ingestion of thorium compounds at FMPC was inevitable; and ingestion may have contributed to significant internal exposures that were not monitored and are, therefore, unaccountable.

ATTACHMENT 4.3-9A

Jeter
Kell-6/10

June 8, 1970

2117287

THORIUM METAL PRODUCTION HOUSEKEEPING

J. E. Beckelheimer

K. N. Ross

Inspection of the thorium metal production facilities during the past several weeks has pointed out some housekeeping problems that I wish to call to your attention.

? Pilot Plant

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037425

Attachment 4.3-9A (Continued)

Thorium Metal Production Housekeeping Page 2
J. E. Beckelheimer
June 8, 1970

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Original Signed By

K. N. Ross

KNR/jm

cc: W. J. Adams
M. W. Boback
J. A. Quigley, M.D.

037426

ATTACHMENT 4.3-9B

Office Memorandum • UNITED STATES GOVERNMENT

TO : W. B. Harris

DATE: August 5, 1953

FROM : A. J. Breslin

SUBJECT: COMMENTS ON THE ATTITUDE OF FMPC PLANT #5 PERSONNEL TOWARD AIR HYGIENE

SYMBOL: HSH:AJB

In the course of the recent occupational exposure study conducted at Plant #5, many operating practices were observed which were of a nature to promote rather than to suppress dust dissemination and exposure. Typical of these aberrations, prevalent in nearly all production steps, were: (1) frequent entry of hoods without respiratory protection, (2) misuse of hoods, i.e., leaving doors open indefinitely or doing work outside of the hood provided, (3) performing dusty jobs without any ventilation, (4) careless handling of contaminated material.

Supervisory personnel admitted that these practices were undesirable but excused them on the basis that the large number of mechanical difficulties being met render the proper use of dust control facilities impossible. This excuse is invalid. It is true that the legendary "normal plant operation" in which all mechanical apparatus functions correctly is unattainable in the first few months after new plant start up. But this doesn't bestow an automatic blanket excuse for sloppy work habits. If employees are allowed to acquire an impudent attitude toward the handling of radioactive materials, it will be difficult later on to convince them that health rules must be heeded. Further, the concept of permissible limits of exposure does not allow for the temporary suspension of health standards due to operational failures. It has been our experience that if violations are permitted under these circumstances, a chronic disregard for safe operation can easily develop.

In the report on the Pilot Plant (FMPC-1) these same improper work habits were noted and it was predicted that these habits, if not corrected, would be carried into the production plants. The problem now exists in Plant #5.

It is essential that corrective action be initiated at the supervisory level. The present negligent attitude is a liability to clean operation.

Supervisory personnel must be made to understand that health is of equal importance to production and that overexposures to airborne dust, even if only of a transient, are to be avoided. They should personally enforce these rules: (1) In the event of equipment failure, available dust control equipment should be used to the best advantage. If the permanent

H&S
reslin/gmt
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ATTACHMENT 4.3-9C

62400

F-2-1

2126829

March 6, 1953

Health Conditions in the Various Plants

J. A. Quigley, M.D.

R. C. Heatherton

CENTRAL FILES

In line with our conversation of this morning regarding the conditions in the various plants, I would like to make some suggestions.

At the meeting the other night [redacted] and [redacted] all were taking a serious attitude regarding operating outside of specified permissible levels for radiation and radioactive materials. I think our permitting certain operations to continue at this site when it was known that we were well above the established permissible levels has been interpreted as permission to continue to operate in this fashion as long as there are pressing production and technical requirements to be fulfilled. A close look at the health status at the present time in the plants indicate that in most buildings that conditions have gone from bad to worse. We feel that we should not permit these to continue any longer, but should take definite steps at this time to correct all conditions which do not meet the specified requirements, if necessary alloting certain time before operations are discontinued for health reasons. In other words, I feel that any operation which cannot show a steady improvement toward operating within the prescribed maximum levels should be shut down immediately. As long as there is improvement and a definite sign that every effort is being made to correct the conditions along with the production and technical requirements, it is possible that continued operation would be permitted.

If such a recommendation were to be followed, I think that we would have to shut down most of the Pilot Plant operations and the chip furnace at a very early date. In my opinion the supervision in these areas has shown no inclination toward improving health and safety conditions but are concentrating chiefly on production requirements.

Yours truly,

R. C. Heatherton

RCH:bg

cc: E. F. Blase
A. Stefanec

PLAINTIFF'S EXHIBIT 108A

Finding 4.3-10: The Unanswered Question of Data Integrity for Air Monitoring

Concerns about the integrity of air sampling data for FMPC must be raised due to sworn statements made in 1993 in the form of an affidavit (see Attachment 4.3-10).

The affidavit in Attachment 4.3-10 is that of a former FMPC employee who served as an industrial hygienist during a period covering the 1950s–1970s. Among the most relevant statements in the affidavit are statements #4, #5, #7, and #13, which are partially reproduced below:

Statement #4 (Excerpts):

> *I did air dust surveys in all the plants at Fernald. I used a* ***homemade sampler*** *which consisted of a small vacuum with a Whatman filter where air was drawn….* [Emphasis added.]

Statement #5:

> *When I did air dust surveys, I could get a higher reading if I stood in the direction that the dust was blowing from the employee that I was sampling. Conversely, I would get a lower reading if I stood in the opposite direction from the way that the dust was blowing. Where I stood could make* ***100%*** *difference in the results that I* ***recorded*** *depending on how dirty the operation was. For example, if I stood on one side, the reading might be zero while on the other side, the reading might be 50 times Maximum Allowable Concentration ("MAC").* [Emphasis added.]

Statement #7 (Excerpts):

> *On several occasions during the term of my employment, when I got air dust survey results that were above the MAC. I was told by my supervisors that the results were in error and I was told to go back and resample. . . I think that my results were correct the first time that I sampled because they were similar to the results that I had obtained before the modifications and the modifications were not effective. . . I was sent back by my supervisors five or six times. Finally, I stood in the opposite direction from the employee from the way that the dust was blowing and I obtained a result that was below the MAC. When I returned the result that was below the MAC to the Health & Safety Division it was an acceptable result.*

Statement #13:

> *In the 1950s* ***no industrial hygienists worked on the second shift, third shift or on weekends****. It is my understanding that many operations that would not be condoned by the Health & Safety Division would be done on the second shift,*

> *third shift and on weekends when no industrial hygienists were present.*
> [Emphasis added.]

SC&A concludes that (1) the use of a "homemade" air sampling device, (2) air sampling that was limited to the first shift on Mondays through Fridays, and (3) management pressure to select favorable air sampling data raise justifiable concerns about the credibility of air monitoring data that NIOSH considers key to the reconstruction of thorium exposure/intakes.

ATTACHMENT 4.3-10

AFFIDAVIT

State of Ohio:
County of Hamilton: SS

I, being duly cautioned and sworn, state as follows:

1. I live at

2. I worked at the Feed Materials Production Center ("Fernald") at Fernald, Ohio from 195[redacted] until 19[redacted]. For the entire time that I worked at Fernald I worked in the Industrial Hygiene Section of the Health & Safety Division. My supervisors were Richard Heatherton, Robert Starkey and Michael Boback. Dr. Joseph Quigley was the Director of Health & Safety during my employment at Fernald.

3. I was an industrial hygienist for the entire time that I worked at Fernald. My job responsibilities consisted of conducting surveys in the various plant areas and making recommendations on such items as air dust sampling, toxic gases, and ventilation surveys; measuring dust collector exhaust systems and establishing sampling rate for particulate emissions; preparing monthly reports to management for material being exhausted to the atmosphere via dust collectors, as well as plant effluent to the river; investigating fume releases, dermititis cases as to possible cause, high film badge exposure, and higher than normal urinalysis results; performing ground contamination surveys and plant safety and housekeeping inspections; and monitoring shipments. The duties of this position also included issuing radiation work permits; collecting water samples from the river; performing miscellaneous special studies; representing the Company on off-site trips; and helping conduct heat, noise, and lighting surveys with other industrial hygienists.

4. I did air dust surveys in all the plants at Fernald. I used a homemade sampler which consisted of a small vacuum with a Whatman filter where air was drawn through at a given flow rate. The samples were all collected open face which means that the filter paper was not protected on the front of the sampler so, for example, that it was possible to lose some of the dust if you were bumped. You could also lose dust when transferring the filter paper into an envelope.

5. When I did air dust surveys, I could get a higher reading if I stood in the direction that the dust was blowing from the employee that I was sampling. Conversely, I would get a lower reading if I stood in the opposite direction from the way that the dust was blowing. Where I stood could make 100% difference in the results that I recorded depending on how dirty the operation was. For