### July 19, 1979

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MEMORANDUM FOR:	A. B. Davis, Chief, Fuel Facility and Materials Safety Branch
THRU:	T. H. Essig, Chief, Environmental and Special Projects Section
FROM:	W. B. Grant, Radiation Specialist
SUB.JECT :	WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

Attached is the experiment conducted, on West Chicago soil samples, in January and June 1979.

W. B. Grant Radiation Specialist

Attachment: as stated

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#### Introduction

Small deposits of thorium-bearing residues have been found in many parts of the city of West Chicagol. These deposits were found along obvious truck routes and were also apparently used during construction and for landfill. The radiation dose rate ( $\mu$ Rem/hr at 3 feet ) of the deposits varied from 900 to 4 with an average of 70  $\mu$ R/hr for 77 areas. Since some of these areas could possibly be disturbed by unsuspecting residents during construction or gardening, the experiments sought to determine what risk, if any, would result if any aerosol were produced.

#### Experiment No. 1

In January 1979, a soil sample of approximately one cubic foot was taken from Area No. 6 (900  $\mu$ Rem/hr). This area was chosen because it represented the highest dose rate and because of its availability on city property. The sample was dried under a heat lamp in a filtered open faced fume hood for approximately 48 hours which resulted in a soil moisture content of essentially zero. This is lower than could be achieved in soil in nature<sup>27</sup>. The sample was then spread out to a depth of about two to three inches on plastic sheeting inside a large empty building at Argonne National Laboratory. No ventilation systems were in operation during the experiments. The soil was allowed to settle and preoperational air samples were collected using High Volume Samplers at one foot and six foot elevations above the soil. Samples (NRC 2093 and NRC 2094) were collected for ten minutes at a flow rate of 20 and 25 CFM respectively.

Part 1 of the experiment consisted of an operator troweling and breaking clumps of soil to simulate garden work. High volume air samples (NRC 2095 and 2096) were collected as during preoperation, and, in addition, a low volume (2.8 liter/min.) lapel breathing zone air sample (NRC 2101) was collected. All samples were collected for ten minutes. The operator wore anti-C clothing and a full face respirator. Dust was observed during any movement of the soil.

Part II of the experiment simply allowed the dust to settle for ten minutes.

Part III of the experiment consisted of the operator standing on, or walking over, the plot of soil while ten minute high volume air samples at one and six feet (NRC 2097 and 2098) and a ten minute low volume lapel air sample (NRC 2102) were collected.

- 1/ Thorium Residuals in West Chicago, Illinois, N. A. Frigeric, T. J. Larson and R. S. Stowe, NUREG/CR-0413, September 1978.
- 2/ Conversations with Barbara Lewis, Environmental Impact Studies, Argonne National Laboratory, May, 1979.

Part 1V consisted of high volume air samples being collected at the same locations (NRC 2099 and 2100) with no work being done and after a 20 minute settling time.

Sampling parameters and results of these air samples are found in Figures 1 and 2.

#### Experiment No. 2

In June 1979, soil samples containing thorium residuals were taken from each of seven areas in West Chicago. The areas were chosen for their relatively high dose rates,  $900 - 45 \mu \text{Rem/hr}$  and their availability on city property.

The samples were spread out to a depth of approximately two to three inches and allowed to air dry for 24 hours indoors. The moisture content at the time of the experiment was determined to be between 5-16%. Normal moisture content of soil will vary from 1-2% to as much as 20% depending on the sand/clay content. According to Lewis<sup>3</sup> an average moisture content of 10% is reasonable.

Experiment No. 2 consisted of the operator troweling or cultivating the soil for 20 minutes. A low volume lapel breathing zone air sample was collected during this operation. The operator wore a full set of anti-C clothing, and a half face respirator. The experiment was repeated for all seven soil samples. It should be noted that Sample No. 6 was a repeat of Experiment No. 1 with a soil moisture content of 9% rather than 0%.

Moisture data are shown in Figure 3.

The air sample results from all seven samples showed levels less than the detection limit of one dpm/sample for gross alpha and gross beta.

An analysis of these samples was made to show that, although the air sample results were less than the detection limit, the samples contained thorium and daughter products. The analysis was made using a gamma spectroscopy system and by comparing these samples to a soil sample into which a known quantity of thorium and daughter products had been mixed. The analyses showed that the West Chicago samples ranged from 15-1762 pCi/gram.

#### Conclusions

Experiment No. 1 utilized soil that was artifically dried to a total absence of moisture. According to soil scientists 2/3/ this condition could not be achieved in nature, was extremely conservative and therefore not considered as a possible event in the risk analysis.

3/ Ibid.

Figure 2 shows that the highest quantity of activity detected was on the gloves used during this experiment. If this entire quantity of activity were ingested by a human, the resultant dose to the G.I. tract would be G.3 mRem. This worst case condition is 0.02% of this ICRP recommended dose limit. Even if one were to ingest this quantity 5000 times in one year, the recommended dose limit would not be exceeded.

The conslusion reached by Experiment No. 2 is that it represents the risk that would be representative for a resident of West Chicago who inadvertently dug up/or cultivated any of the areas containing thorium residuals listed in Table 1 of NUREG/CR-0413. This risk is concluded to be extremely minimal since no radioactive aersol resulted from this small scale experiment.

Air samples taken on January 12, 1979, at Argonne National Laboratory, Building 40.

NRC-2093, 20CFM, BKGD. @ 1 foot elevation
NRC-2094, 25CFM, BKGD. @ 6 foot elevation
NRC-2095, 25 CFM, Part I @ 6 foot elevation
NRC-2096, 20 CFM, Part I @ 1 foot elevation
NRC-2097, 25 CFM, Part II @ 6 foot elevation
NRC-2098, 20 CFM, Part II @ 1 foot elevation
NRC-2098, 20 CFM, Part II @ 1 foot elevation
NRC-2099, 25 CFM, Part III @ 6 foot elevation
NRC-2100, 20 CFM, Part III @ 1 foot elevation

Lapel No. 1, NRC-2101, 2.8 LPM, Part I Lapel No. 2, NRC-2102, 2.8 LPM, Part II

All air samples collected for ten minutes.

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AIR SAMPLE RESULTS - JANUARY 12, 1979

Sample Number	Alpha pCi/filter	Beta pCi/filter	Actinium-228 pCi/filter	Thorium-228 pCi/filter
NRC-2093	<1	2.6	NA	NA
NRC-2094	1.4	3.7	NA	NA
NRC-2095	553	330	74	69
NRC-2096	2350	1420	295	263
NRC-2097	79.4	52.3	NA	NA
NRC-2098	437	281	63	58
NRC-2099	2.8	5.4	NA	NA
NRC-2100	8.4	6.6	NA	NA
NRC-2101	159	108	NA	NA
NRC 2102	<1	3.3	<10	<10
			pCi/pair of gloves	pCi/pair of gloves
NRC-2103 (Gloves)	NA	NA	5620	5400

NA = Not Analyzed.

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## SOIL SAMPLES - EXPERIMENT NO. 2

		WT Samples		
Area No.	Location	Before	After	
53	Blair and Sherman	358.6g	300g	
68	675 Factory	379.4g	341.0g	
31	Pearl at George	327.7g	287.9g	
32	461 Ann	340.5g	311.9g	
7	625 Factory	414.0g	393.2g	
6	Factory and Blair	373.3g	338.5g	
47	213 Main	490.3g	435.6g	