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NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

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MEMORANDUM FOR: Region III Files

THRU: T. H. Essig, Chief, Environmental and Special Projects Section

FROM: W. B. Grant, Radiation Specialist

SUBJECT: WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

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

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Radiation Specialist

Attachment: as stated

cc w/attachment:
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WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

Introduction

Small deposits of thorium-bearing residues have been found in many parts of the city of West Chicago[1]. These deposits were found along obvious truck routes and were also apparently used during construction and for landfill. The radiaiton dose rate (μrem/hr at 3 feet) of the deposits varied from 900 to 4 with an average of 70 μR/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 or skin contamination were produced.

Experiment No. 1

In January 1979, a soil sample of approximately one cubic foot was taken from Area No. 6 (900 μrem/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[2]. 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 flow rates of 20 and 25 CFM, respectively.

Part I 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) and a low volume (2.8 liter/min.) lapel breathing zone air sample (NRC 2101) were collected. All samples were collected for ten minutes. The operator wore anti-C clothing and a full face respirator. Dust was observed during even slight movements 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 2101) were collected.

Part IV 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 Tables 1 and 2.

1/ Thorium Residules in West Chicago, Illinois, N. A. Frigerio, T. J. Larson and R. S. Stowe, NUREG/CR-0413, September 1978.

2/ Conversations with Barbara Lewis, Environmental Impact Studies, Argonne National Laboratory, Many, 1979.

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 μrem/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 5-21%. Normal moisture content of soil will vary from 1-2% to as much as 20% depending on the sand/clay content.

Experiment No. 2 consisted of the operator troweling or cultivating the soil for 20 minutes. A low volume lapel (2.8 liters per min.) 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 11% rather than 0%.

Moisture data are shown in Table 3. The percent moisture data were calculated by dividing the difference in sample weights before and after drying by the weight after drying[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 for gross alpha and beta activity, the samples did, in fact, contain thorium and its daughters. 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 its daughters had been mixed. The analyses showed that the West Chicago samples ranged from 15-1762 pCi/gram. Specific analyses are shown in Table 4.

Experiment No. 3

In August 1979, soil samples containing thorium residuals taken in June 1979 were reopened and spread out to a depth of approximately two to three inches and allowed to dry for 96 hours indoors. The moisture content at the time of the experiment was determined to be between 0.2 to 8%. Moisture data are shown in Figure 3.

The experiment consisted of the operator troweling or cultivating the soil for 20 minutes. A low volume (2.8 liters per minute) lapel breathing zone air sample was collected during this operation. As in previous experiments, the operator wore anti-C clothing and a half face respirator. The procedure used in Experiment No. 2 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 3% rather than 0%.

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.

3/ Ibid.

Conclusion

Experiment No. 1 utilized soil that was artifically dried to a total absence of moisture. According to soil scientists[4] this condition could not be achieved in nature, was extremely conservative and therefore not considered as a possible event in the risk analysis.

Table 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 0.3 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.

Based on the data generated by Experiment Nos. 2 and 3, it is concluded that if a West Chicago resident were to inadvertently dig up or cultivate any of the areas containing thorium residuals listed in Table 1 of NUREG/CR-0413:

1. The risk of inhalation of airborne activity was insignificant, since no detectable aerosol was generated by actions during the experiments which were intended to produce an aerosol.

2. The exposure due to ingestion of surface contamination was well within prescribed limits, in spite of the very conservative assumptions used in the dose calculation.

4/ Ibid.

WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

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

1. NRC-2093, 20 CFM, BKGD. @ 1 foot elevation
2. NRC-2094, 25 CFM, BKGD. @ 6 foot elevation

3. NRC-2095, 25 CFM, Part I @ 6 foot elevation
4. NRC-2096, 20 CFM, Part I @ 1 foot elevation

5. NRC-2097, 25 CFM, Part III @ 6 foot elevation
6. NRC-2098, 20 CFM, Part III @ 1 foot elevation

7. NRC-2099, 25 CFM, Part IV @ 6 foot elevation
8. NRC-2100, 20 CFM, Part IV @ 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.

WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

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.

WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

SOIL SAMPLES - EXPERIMENT NO. 2

Area No.	Location	Samples, wt., grams Before	After	% Moisture
53	Blair and Sherman	358.6g	297.4	21
68	675 Factory	379.4g	335	13
31	Pearl at George	327.7g	286.1	15
32	461 Ann	340.5g	311.0	9
7	625 Factory	414.0g	392.8	5
6	Factory and Blair	373.3g	337.0	11
47	213 Main	490.3g	432.8	13

SOIL SAMPLES - EXPERIMENT NO. 3

Area No.	Location	Samples, wt., grams Before	After	% Moisture
53	Blair and Sherman	408.6	378.8	8
68	675 Factory	375.5	374.7	0.2
31	Pearl at George	351.0	327.1	7
32	461 Ann	411.4	382.0	8
7	625 Factory	386.3	385.1	0.3
6	Factory and Blair	344.0	383.4	3
47	213 Main	355.2	349.2	3

WEST CHICAGO, AIRBORNE THORIUM RISK EXPERIMENT

LAPEL AIR SAMPLE - SAMPLE

Area No.	Location	% Moisture	Gross Alpha pCi/Filter	Gross Beta pCi/Filter	Thorium-232 pCi/g
EXPERIMENT NO. 1					
6 (NRC-2101)	Factory and Blair	0 (est.)	159	108	NA
6 (NRC-2102	Factory and Blair	0 (est.)	<1	3.3	NA
EXPERIMENT NO. 2					
53	Blair and Sherman	21	0	0	1024
68	675 Factory	13	0	0	47
31	Pearl and George	15	0	0	217
32	461 Ann	9	0	0	15
7	625 Factory	5	0	0	359
6	Factory and Blair	11	0	0	1762
47	213 Main	13	0	0	137
EXPERIMENT NO. 3					
53	Blair and Sherman	8	0	0	1024
68	675 Factory	0.2	0	0	47
31	Pearl and George	7	0	0	217
32	461 Ann	8	0	0	15
7	625 Factory	0.3	0	0	359
6	Factory and Blair	3	0	0	1762
47	213 Main	3	0	0	137

1594 056

NA - Not Analyzed