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**RESULTS OF THE RADIOLOGICAL
SURVEY AT 136 WEST CENTRAL AVENUE (MJ030),
MAYWOOD, NEW JERSEY**

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RESULTS OF THE RADIOLOGICAL SURVEY AT 136 WEST CENTRAL AVENUE (MJ030), MAYWOOD, NEW JERSEY*

INTRODUCTION

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated with residues from the former MCW were included as a decontamination research and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from the MCW. The principal radionuclide of concern is thorium-232. The radiological survey discussed in this report is part of that effort and was conducted, at the request of DOE, by members of the Measurement Applications and Development Group of Oak Ridge National Laboratory.

A radiological survey of the private, residential property at 136 West Central Avenue, Maywood, New Jersey, was conducted during 1987. The survey and sampling of the ground surface and subsurface were carried out on April 29, 1987.

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

SURVEY METHODS

The radiological survey of the property included (1) a gamma scan at the surface of the entire property outdoors; (2) collection of surface and subsurface soil samples; (3) gamma exposure rate measurements at the floor surface and at 1 m above the surface indoors; (4) the determination of indoor radon and radon daughter concentrations; and (5) measurements to determine possible alpha and/or beta-gamma activity on surfaces. The survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation is presented in another report.²

Using a portable gamma scintillation meter, ranges of measurements were recorded indoors on the surfaces of floors as well as at 1 m above the floor surfaces in each room of the house. In areas of elevated exposure rates, airborne radon and radon progeny concentrations were determined by filtration and subsequent alpha spectrometric analysis of air samples. To determine the presence of extant beta activity in contaminated regions, measurements were also taken on floor and wall surfaces with a side-window Geiger-Mueller (G-M) meter. At the same locations, surface alpha levels were assessed by taking measurements with an alpha scintillation survey meter.

Outdoors, gamma exposure rates were recorded for areas of the property surface. Systematic soil samples were then obtained at randomly selected locations irrespective of gamma exposure rates. In addition, biased soil samples were collected in areas of elevated gamma levels.

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.³ The normal background radiation levels for the northern New Jersey area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

Indoor Survey Results

Gamma Radiation Levels

Gamma exposure rates at the floor surfaces throughout the first level of the house ranged from 12 to 16 $\mu\text{R/h}$ while measurements at 1 m above the floor surfaces were 10 to 11 $\mu\text{R/h}$. Gamma levels in most of the basement ranged from 10 to 16 $\mu\text{R/h}$ at the surface but were 62 $\mu\text{R/h}$ in a small area in the southwest corner of the structure. Measurements taken at 1 m above the floor surface were generally 10 to 11 $\mu\text{R/h}$; however, an exposure rate of 25 $\mu\text{R/h}$ was found at the location of the maximum surface level measured. Indoor exposure rates were above the typical background average of 8 $\mu\text{R/h}$ (Table 2), with measurements in the

south end of the basement generally near or above the DOE guideline of 20 $\mu\text{R/h}$ above background for indoor areas (Table 1).

Airborne Radon Progeny Concentrations

The results for ^{222}Rn decay products, converted to number of working levels (WL), show concentrations ranging from 0.008 to 0.0092 WL for the garage, the first-floor living room, and a second-floor bedroom. These values are well below the DOE guideline of 0.02 WL. However, concentrations of ^{222}Rn progeny were 0.048 and 0.058 WL for the south and north ends of the basement, respectively. These values exceed the DOE criterion for habitable structures (Table 1).

Alpha and Beta-Gamma Activity Levels

No beta activity was detected when measurements were taken with a G-M meter on the floor surface in the basement, and alpha activity levels were indistinguishable from background. Thus, surfaces in the basement are not contaminated.

Outdoor Survey Results

Surface Gamma Radiation Levels

Gamma radiation levels measured during a scan of the surface of the property are given in Fig. 1. Gamma exposure rates over the property ranged from 10 to 30 $\mu\text{R/h}$, with the 30 $\mu\text{R/h}$ occurring at the rear of the property. Although the Maywood Interim Storage Site pile was not in direct line of sight at this location, it was evident that the elevated gamma was emanating from that source. Under certain conditions, extraneous radiation ("shine") emanating from a source outside the area of concern will affect measurements in that area. The source of the scattered radiation at this site is the large, heavily contaminated storage pile. To ensure that no contamination was present near the rear property line where surface measurements were affected by "shine," extensive soil sampling was performed (see Fig. 2).

Systematic and Biased Soil Samples

Eighteen systematic soil samples (S1A-S9B) and twenty-six biased soil samples (B1A-B2M) were taken for radionuclide analyses. The samples were taken at 15-cm increments from depths of 0 to 30 cm for the systematic samples and at varying increments from depths of 0 to 215 cm for the biased samples. Locations of the samples are shown in Fig. 2, with results of laboratory analyses provided in Table 3. Concentrations of ^{226}Ra and ^{232}Th in the systematic samples ranged from 0.76 to 2.9 pCi/g and from 1.1 to 3.6 pCi/g, respectively. In the biased samples, concentrations ranged from 0.73 to 1.4 pCi/g for ^{226}Ra and from 0.94 to 47 pCi/g for ^{232}Th . The DOE guideline for ^{232}Th concentration in subsurface soil is exceeded in three biased samples (B1I, B1J, and B2L). Radium-226 concentrations in both systematic and

biased samples were slightly elevated above background for the northern New Jersey area (Table 2) but are well below DOE guidelines.

SIGNIFICANCE OF FINDINGS

Measurements taken at 136 West Central Avenue indicate that the property contained radioactive contamination primarily from the ^{232}Th decay chain, with some contamination from ^{226}Ra . These radionuclide distributions are typical of the type of material originating from the processing operations at MCW. The concentration and extent of ^{232}Th on this property are in excess of the applicable DOE criteria (Table 1). This material was found in the location shown in Fig. 2 at sample locations B1 and B2. Furthermore, concentrations of radon decay products in the basement were determined to be excessive. Based on the results of this radiological assessment, it is recommended that this site be considered for inclusion in the DOE remedial action program.

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Fig. 1. Gamma radiation levels ($\mu\text{R/h}$) measured on the surface at 136 West Central Avenue, Maywood, New Jersey (MJ030).

Fig. 2. Diagram showing locations of soil samples taken at 136 West Central Avenue, Maywood, New Jersey (MJ030).

Table 1. Applicable guidelines for protection against radiation^a

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μ R/h
Exposure to ^{222}Rn progeny	Average annual radon progeny concentration (including background)	0.02 WL
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m ² area ^{232}Th ^{230}Th ^{228}Ra ^{226}Ra	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm thick soil layers more than 15 cm below the surface

^aReference 3.**Table 2. Background radiation levels for the northern New Jersey area**

Type of radiation measurement or sample	Radionuclide level or radionuclide concentration
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9 ^a
^{238}U	0.9 ^a
^{226}Ra	0.9 ^a

^aReference 4.

Table 3. Concentrations of radionuclides in soil at 136 West Central Avenue, Maywood, New Jersey (MJ030)

Sample ^a	Depth (cm)	Radionuclide concentration (pCi/g)	
		²²⁶ Ra ^b	²³² Th ^b
<i>Systematic samples^c</i>			
S1A	0-15	0.96 ± 0.06	1.4 ± 0.3
S1B	15-30	0.85 ± 0.1	1.3 ± 0.3
S2A	0-15	0.86 ± 0.07	1.3 ± 0.3
S2B	15-30	0.76 ± 0.2	1.2 ± 0.2
S3A	0-15	2.4 ± 0.1	2.9 ± 0.3
S3B	15-30	1.7 ± 0.08	2.0 ± 0.08
S4A	0-15	2.5 ± 0.1	3.1 ± 0.4
S4B	15-30	1.9 ± 0.04	2.0 ± 0.5
S5A	0-15	2.0 ± 0.2	2.4 ± 0.1
S5B	15-30	1.4 ± 0.2	1.7 ± 0.1
S6A	0-15	1.5 ± 0.06	2.1 ± 0.2
S6B	15-30	0.98 ± 0.05	1.5 ± 0.2
S7A	0-15	1.4 ± 0.2	2.0 ± 0.4
S7B	15-30	0.94 ± 0.1	1.1 ± 0.2
S8A	0-15	1.5 ± 0.1	3.4 ± 0.6
S8B	15-30	0.97 ± 0.1	1.7 ± 0.05
S9A	0-15	2.4 ± 0.2	3.3 ± 0.6
S9B	15-30	2.9 ± 0.1	3.6 ± 0.6
<i>Biased samples^d</i>			
B1A	0-15	0.73 ± 0.08	1.1 ± 0.2
B1B	15-30	0.74 ± 0.05	0.94 ± 0.06
B1C	30-45	0.78 ± 0.1	1.2 ± 0.1
B1D	45-75	0.78 ± 0.1	1.0 ± 0.3
B1E	75-90	0.81 ± 0.07	1.1 ± 0.3
B1F	90-105	0.95 ± 0.02	1.1 ± 0.04
B1G	105-120	1.2 ± 0.07	2.0 ± 0.09
B1H	120-135	1.1 ± 0.2	4.6 ± 0.3
B1I	135-150	1.4 ± 0.2	17 ± 0.4
B1J	150-165	1.0 ± 0.3	14 ± 1
B1K	165-185	0.81 ± 0.2	4.3 ± 0.2
B1L	185-195	0.75 ± 0.05	2.1 ± 0.08
B1M	195-215	0.89 ± 0.1	1.5 ± 0.3
B2A	0-15	0.84 ± 0.03	1.1 ± 0.09
B2B	15-30	0.88 ± 0.06	1.1 ± 0.2
B2C	30-45	0.81 ± 0.2	1.0 ± 0.3
B2D	45-60	0.84 ± 0.1	1.1 ± 0.3

Table 3 (continued)

Sample ^a	Depth (cm)	Radionuclide concentration (pCi/g)	
		²²⁶ Ra ^b	²³² Th ^b
<i>Biased samples^d</i>			
B2E	60–75	1.1 ±0.08	1.8 ±0.2
B2F	75–90	1.2 ±0.2	8.1 ±0.6
B2G	90–105	1.3 ±0.2	10 ±0.3
B2H	105–120	0.91±0.1	12 ±1
B2I	115–135	0.80±0.1	4.2 ±0.2
B2J	135–150	1.1 ±0.4	4.9 ±1
B2K	150–165	0.90±0.2	4.2 ±0.3
B2L	165–185	1.2 ±0.2	47 ±4
B2M	185–195	0.94±0.6	9.4 ±0.3

^aLocations of soil samples are shown on Fig. 2.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cSystematic samples are taken at grid locations irrespective of gamma exposure.

^dBiased samples are taken from areas shown to have elevated gamma exposure rates.

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