TEENAGE EXPERIMENTS CONTAMINATE SUBURBAN PROPERTY

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Abstract

In August 1994, 18-year-old David Hahn (David) was detained by police in Clinton Township, Michigan. When the police searched his car, they discovered a locked tool box and other containers that David said contained radioactive materials resulting from experiments he had conducted with the radioactive materials from, primarily, consumer products. From the ages 14 to 18, David spent his spare time at his Union Lake, Michigan, home attempting to concentrate, burn, chemically alter, and experiment with: the thorium from hundreds of lantern mantles, radium from various luminescent sources and clock dials, americium from smoke detector sources, and radioactive materials from natural ores. In the process, he had contaminated a wooden shed in his backyard and his bedroom, and exposed himself. In 1995, EPA, their emergency response contractor, and the Michigan Department of Public Health (MDPH) performed an emergency assessment and removal at the property. The response and removal were conducted cost-effectively and generated approximately 10 cubic yards of radioactive waste.

Introduction

On August 30, 1994, 18-year-old David, who resided at the home of his father and stepmother in Clinton Township, Michigan, was detained by Clinton Township police. While searching the car, police discovered material stored in a locked, aluminum foil-covered tool box that David reported to be radioactive. Clinton Township police contacted MDPH to verify the information provided to them by David. After MDPH verified the items to be radioactive, the police locked the items in a small storage building detached from the police station building. Among the items removed from the car by police were numerous foil cubes containing a radioactive gray powder, a package of small discs, cylindrical metallic objects, mercury switches, and small packages wrapped in duct tape and aluminum foil. Gamma spectroscopy analysis performed by the MDPH on the gray powder showed Thorium, estimated at 5 to 8% by weight, resulting from chemical processing. These materials are regulated by the Atomic

Energy Act. Since Michigan is not an Nuclear Regulatory Commission (NRC) agreement state, MDPH notified the NRC, Region 3.

During subsequent interviews with David, MDPH learned that David had been conducting chemical experiments with radioactive materials in a wooden shed at the home of his mother in Union Lake, Michigan. The experiments included burning of and attempted concentration of radioisotopes of thorium from lantern mantles, recovery of radium from various luminescent sources (including clock dials), recovery and concentration of americium from smoke detector sources and miscellaneous other materials, including natural ores containing radionuclides. The home in Union Lake is situated in a residential subdivision. The shed was located in the backyard. On November 29, 1994, MDPH conducted a radiological survey at the Union Lake home. The findings concluded that the wooden shed at the Union Lake site and the items stored in the shed were contaminated with radioactive materials. The U.S. Environmental Protection Agency (U.S. EPA) was contacted by MDPH to assist with further investigation and possible disposal of contaminated articles and the shed.

Table 1 summarizes results of measurements by MDPH in picocuries. To obtain the activity in becquerels, divide by 27.03.

TABLE 1

Sample Number	**Description**	**Am-241, pCi/each**	**Ra-228 pCi/each**
SS-94-134	Silver/gray cylinder	500,000 ± 100,000	
SS-94-135	Gray rocks		40,000 ± 5,000
SS-94-136	Black/white granular material		28,000 ± 4,000
SS-94-137	Flat 7mm object in aluminum foil	500,000 ± 100,000	

Ra-228 is reported as a daughter of Th-232. Inferred Thorium-232 concentration in two samples, based upon Ra-228 activity, assuring Th-232 in equilibrium at same activity, can be calculated as follows:

SS-94-135 estimated sample mass = 4.4 grams
SS-94-136 estimated sample mass = 4.8 grams

Th-232 concentration in

SS-94-135 -- $\frac{40{,}000 \text{ pCi}}{4.4 \text{ grm}}$ = 9,100 pCi/g (8.3% by weight)

SS-94-136 -- $\frac{28{,}000 \text{ pci}}{4.8 \text{ grm}}$ = 5,800 pCi/g (5.4% by weight)

Am-241 sources at 500,000 pCi each appear to be smoke detector sources with a nominal activity of 0.5 *u*Ci each.

Site Assessment

Initial screening for beta/gamma contamination was conducted using Ludlum Model 3 rate meter equipped with a Ludlum Model 44-40 shielded Geiger-Mueller (G-M) pancake probe. This was followed by screening of the interior surfaces of the shed for alpha contamination using a Ludlum Model 43-63 gas proportional detector with an Eberline Model ESP-2 rate meter, calibrated at a 24 percent efficiency. Calibration procedures and survey methodologies were taken from *NUREG/CR-5849 Manual for Conducting Radiological Surveys in Support of License Termination*, June 1992.

Readings taken from the floors, walls, and shelves in the shed ranged from background levels of 2 counts per 20 seconds per 100 square centimeters (c/20s/100 cm square) to 431 c/20s/100cm square. Individual items in the shed depicted readings of up to 50,000 counts per minute. The shed measured 16 feet long by 5 feet wide by 8 feet in height. Table II lists the results of the survey in disintegration per minute. The SI unit for activity is the becquerel (Bq). 1 Bq = 1 disintegration per second.

A radiation survey was also conducted at the Clinton Township residence. All the surfaces and structures in the house recorded background readings. A pair of pliers and

TABLE II Selected Field Measurements of the Shed and its Contents

	Pancake GM		**Gas Proportional, Alpha**	
Item/Area and Location on Sketch	**(cpm)**	**(dpm/100 cm^2)**	**(cpm)**	**(dpm/100 cm^2)**
Background	40 to 50		--	--
Top of air conditioner	--	--	1,500	5,100
Metal on air conditioner	1,500	35,000	14,000	48,000
Shelf	--	--	2,000	6,800
Lead sheeting	250	--	--	--
Roof-shingle floor	1,600	--	4,000	14,000
Copper bowl	6,000	--	5,000	17,000
Metal vegetable can	50,000	--	--	--
Paper scraps	3,000	--	--	--
Black residue on rocks/concrete	3,000	69,000	--	--

a spoon from David's desk recorded 1,200 c/20s/100 cm square using a gas proportional detector, and were found to be the only contaminated items at the Clinton Township residence.

The contaminated items from the Clinton Township residence, as well as all the items confiscated by the police during the initial incidence, were brought to the shed in Union Lake for packaging and disposal. Following items were retrieved from the police station:

- Over 50 foil cubes containing gray powder determined to be Th-232 and its daughters, Ra-228 at 9,100 pCi/g
- Several small disks and cylindrical metallic objects, confirmed to be smoke detector sources of 0.5 *u*Ci Am-241 each
- Lantern mantles, a clock face
- Rocks, ores, and refined products
- Miscellaneous foil-wrapped and duct-taped packages containing Th-232 and its daughters, Ra-228 at 5,800 pCi/g
- Lead chunks
- 100 mercury switches, batteries, vacuum tubes, fireworks, wire, activated charcoal, acids, and other chemicals

TABLE III

Composite Waste Sample Content	
Radio Nuclide	**Range of Values (pCi/g)**
Actinium-228	0.92 - 360
Americium-241	3.8 - 1,700
Bismuth 212 and Lead-212	0 - 410
Lead-214	0 - 4.5
Potassium-40	8.5 - 31
Radium-224	0.39 - 370
Radium-228	0 - 0.73
Thorium-230	2.1 - 160
Thorium-232	0.3 - 58
Cesium-137	0.0042 - 0.38
Uranium-235	0 - 0.29

The Clean-up

PHASE I

Composite samples were collected for waste profile and preshipment analyses for eventual waste disposal at Envirocare of Utah. Composite waste sample content is presented in Table III.

PHASE II

Ingestion and inhalation were determined to be primary hazards. Appropriate dermal and respiratory protection was used. The shed was dismantled and sized. The shed and its contents were packaged in 36 drums (~10 cubic yards). One drum contained contaminated lead sheeting macro encapsulated in concrete. The drums were disposed at Envirocare of Utah. Shipment total activities were measured in millicuries as follows:

No. Of Containers	Volume-cu ft	Am-241	Th-232	Th-230
36	266.4	0.014	0.005	0.013

The post-removal radiation survey confirmed that the cleanup was complete. All post-removal instrument readings were at the background levels.

References

[1] Removal Action Plan for the Union Lake Radiation Site, Ecology and Environment. Inc;, March 21, 1995.

[2] Removal Response to Radiation Sites Guidance Document, U.S.EPA, August 1994.

[3] NUREG/CR 5849 Manual for Conducting Radiological Surveys in Support of License Termination, June 1992.