HEALTH AND SAFETY RESEARCH DIVISION
Environmental Restoration and Waste Management Non-Defense Programs
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Radiological Survey Results at 14 Cliff Street,
Beverly, Massachusetts (VB011)

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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a team from Oak Ridge National Laboratory conducted a radiological survey at 14 Cliff Street, Beverly, Massachusetts. The survey was performed in May 1991. The purpose of the survey was to determine if uranium dust from work performed under government contract at the former Ventron facility had migrated off-site to neighboring areas. The survey included a surface gamma scan and the collection of soil samples for radionuclide analyses.

Results of the survey demonstrated no radionuclide concentrations or radiation measurements in excess of the DOE Formerly Utilized Sites Remedial Action Program guidelines.
Radiological Survey Results at 14 Cliff Street, Beverly, Massachusetts (VB011)*

INTRODUCTION

The Metal Hydrides Corporation facility in Beverly, Massachusetts (which became the Ventron Corporation in 1965), was one of many companies performing work during the 1940s associated with the development of nuclear energy for defense-related projects under contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC). Operations conducted under government contract at such sites included the procurement, storage, and processing of uranium oxides, salts, and metals, and the subsequent machining of these products. As a result of activities involving these materials, equipment, buildings, and land at some of the sites became radiologically contaminated with small amounts of the material resulting in low levels of contamination on the properties. At contract termination, release limits and decontamination operations were typically applied in conformance with standards currently deemed adequate for purposes of health and environmental protection. Subsequent to original assessments and the release of these facilities, new research and information have resulted in the development of more stringent guidelines for release of such facilities for unrestricted use. Furthermore, in some instances, documentation is limited or nonexistent, and conditions at a specific site may be unknown. It is the policy of the U.S. Department of Energy (DOE) to verify that radiological conditions at such facilities comply with existing guidelines.1 The Formerly Utilized Sites Remedial Action Program (FUSRAP) was established by DOE in 1974 to assist in assessment and cleanup activities at these sites.

The radiological survey detailed in this report was performed under the FUSRAP program and is one of several conducted in May 1991 on properties in the vicinity of the former Ventron facility by members of the Oak Ridge National Laboratory (ORNL) at the request of DOE. The city of Beverly lies on Massachusetts Bay approximately 15 miles northeast of the central Boston area. The former Ventron facility, now owned by Morton International, is located at the confluence of the Bass and Danvers rivers on Congress Street near the Beverly-Salem bridge (Fig. 1, p. 5).2

From 1942 through 1948, the Metal Hydrides Corporation converted uranium oxide to uranium metal powder at the facility under contract to the MED in support of the war effort. As better methods for production of uranium metal were developed, Metal Hydrides shifted

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*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.
its operations toward recovering uranium from scrap uranium and turnings from the slug fabrication plant at Hanford, Washington.\(^1\) Contracts between Metal Hydrides and the government were completed in 1954.

Following a radiological screening survey at the site in 1977, a comprehensive survey was performed in 1982 (ref. 2). In 1987, DOE contractors removed the uranium-contaminated roof from a Ventron building, which had begun to leak. Radioactive materials remaining on the site do not pose a health hazard under present use conditions but could cause radiation exposure to workers if excavation or major renovation took place on the property. DOE plans a complete characterization study of the site in 1992 and the initiation of remedial action soon thereafter.

The survey of the residential property reported in this document and surveys of other surrounding properties are part of DOE's continuing program to assess the former Ventron site and plan for remedial action. The objective of the surveys was to determine if uranium from plant operations had migrated off-site to neighboring areas including the Massachusetts Bay and, if so, to what degree. The relative location of this vicinity property to the former Ventron site is shown in Fig. 2 (p. 6). The radiological surveys consisted of measurements of radiation levels over the ground surface of the properties and analysis of soil, sediment, and other material samples for the presence of radionuclides.

SURVEY METHODS

A comprehensive description of the survey methods and instrumentation used in this survey is given in Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program, ORNL/TM-8600 (April 1987).\(^3\)

SURFACE RADIATION MEASUREMENTS

Gamma radiation levels were determined using a portable NaI gamma scintillation meter. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute (cpm) are normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates in $\mu$R/h. Using a Geiger-Mueller pancake detector, beta-gamma radiation levels in cpm were measured over selected paved and structural surfaces, and then converted to mrad/h.

SOIL SAMPLING AND ANALYSES

Surface and subsurface soil samples were systematically collected over the property in a pattern sufficient to obtain a characterization of the radionuclide content of the soil. All soil samples were analyzed to determine $^{238}\text{U}$, $^{232}\text{Th}$, and $^{226}\text{Ra}$ concentrations.
SURVEY RESULTS

Current DOE guidelines for sites included within the FUSRAP are summarized in Table 1 (p. 10). Typical background radiation levels for the Beverly, Massachusetts, area are presented in Table 2 (p. 11). These data are provided for comparison with the 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 in soil, debris, and other samples.

Photographs taken in May 1991 of the property at 14 Cliff Street, Beverly, Massachusetts are shown in Figs. 3 through 6 (pp. 7 and 8). Figure 7 is a diagram of the property.

SURFACE RADIATION MEASUREMENTS

Results of the surface gamma scan are shown in Fig. 7 (p. 9). Surface gamma exposure rates ranged from 6 to 13 μR/h. These values are comparable to the 6 to 9 μR/h typically found for background radiation levels in the Beverly, Massachusetts, area (Table 2, p. 11).

Beta-gamma dose rates ranging from 0.02 to 0.04 mrad/h were measured over selected hard surfaces on the property. All measurements were comparable to background levels measured in the vicinity.

SOIL SAMPLING AND ANALYSES

Soil sample locations are shown in Fig. 7 (p. 9) and results of analyses are listed in Table 3 (p.12). Maximum concentrations of $^{226}$Ra and $^{232}$Th in surface soil (0–15 cm) were 1.5 and 2.8 pCi/g; maximum values in subsurface soil were 0.97 pCi/g and 0.95 pCi/g, respectively. Results are comparable to typical background levels in the Beverly area (Table 2, p. 11), and below DOE guidelines (Table 1, p. 10). Uranium-238 concentrations in surface soil ranged from 0.84 to 24 pCi/g, and in subsurface soil were 0.89 to 2.8 pCi/g. Concentrations of all three radionuclides were highest in samples S1 and S2 taken from the cliff (Figs. 6 and 7, pp. 8 and 9). Uranium-238 concentrations in most of the samples from 14 Cliff Street were above typical background soil levels in the Beverly area (Table 2, p. 11); however, all values are well below guidelines of 35 to 40 pCi/g that have been applied at other FUSRAP sites (Table 1, p. 10).

SIGNIFICANCE OF FINDINGS

The results of the radiological survey at 14 Cliff Street, Beverly, Massachusetts, demonstrated no radionuclide concentrations or radiation measurements above established DOE guidelines.
REFERENCES


Fig. 1. Diagram showing general location of the former Vention site.
Fig. 2. Diagram showing location of 14 Cliff Street, Beverly, Massachusetts, in relation to the former Ventrion site.
Fig. 3. View looking south at the house at 14 Cliff Street, Massachusetts.

Fig. 4. View looking north at the house at 14 Cliff Street, Massachusetts.
Fig. 5. View of 14 Cliff Street, Beverly, looking northwest (house at far right). The Danvers in the left side of the photograph.

Fig. 6. Photograph showing survey team gathering at the cliff behind 14 Cliff Street, Beverly, Massachusetts, second from left side of photograph.
Fig. 7. Surface gamma exposure rates and soil sample locations at 14 Cliff Street, Beverly, Massachusetts.
Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

<table>
<thead>
<tr>
<th>Modes of exposure</th>
<th>Exposure conditions</th>
<th>Guideline value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma radiation</td>
<td>Indoor gamma radiation level (above background)</td>
<td>20 μR/h&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
| Radionuclide concentrations in soil (generic) | Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m² area  

\[
\begin{align*}
226\text{Ra} \\
232\text{Th} \\
230\text{Th}
\end{align*}
\]
| Derived concentrations            | 238U                                                                                 | Site specific<sup>b</sup>                             |
| Guideline for non-homogeneous contamination (used in addition to the 100-m² guideline)<sup>c</sup> | Applicable to locations with an area ≤25 m², with significantly elevated concentrations of radionuclides (“hot spots”) | \[G_A = G_i (100/A)^{1/2}\]  

where \[G_A = \text{guideline for “hot spot” of area (A)}\]  

\[G_i = \text{guideline averaged over a 100-m² area}\] |

<sup>a</sup>The 20 μR/h shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.


<sup>c</sup>DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (Adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Table 2. Background radiation levels and concentrations of selected radionuclides in soil in the Beverly, Massachusetts, area

<table>
<thead>
<tr>
<th>Type of radiation measurement or sample</th>
<th>Radiation level or radionuclide concentration</th>
<th>Range</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma exposure rate at 1 m above ground surface ($\mu$R/h)$^a$</td>
<td></td>
<td>6-9</td>
<td>7</td>
</tr>
<tr>
<td>Concentration of radionuclides in soil (pCi/g)$^a$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$^{232}$Th</td>
<td>0.8 - 0.9</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>$^{226}$Ra</td>
<td>0.7 - 0.9</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>$^{238}$U</td>
<td>0.7 - 1.0</td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

$^a$Values obtained from three locations in the Beverly area.
Table 3. Concentrations of radionuclides in soil samples from 14 Cliff Street, Beverly, Massachusetts

<table>
<thead>
<tr>
<th>Sample&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Depth (cm)</th>
<th>Radionuclide concentrations (pCi/g)&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>226Ra</td>
</tr>
<tr>
<td>S1</td>
<td>0–8</td>
<td>1.0 ± 0.05</td>
</tr>
<tr>
<td>S2</td>
<td>0–8</td>
<td>1.5 ± 0.06</td>
</tr>
<tr>
<td>S3A</td>
<td>0–15</td>
<td>0.92 ± 0.02</td>
</tr>
<tr>
<td>S3B</td>
<td>15–30</td>
<td>0.91 ± 0.02</td>
</tr>
<tr>
<td>S4A</td>
<td>0–15</td>
<td>0.68 ± 0.01</td>
</tr>
<tr>
<td>S4B</td>
<td>15–30</td>
<td>0.59 ± 0.02</td>
</tr>
<tr>
<td>S5A</td>
<td>0–15</td>
<td>0.85 ± 0.02</td>
</tr>
<tr>
<td>S5B</td>
<td>15–30</td>
<td>0.97 ± 0.02</td>
</tr>
<tr>
<td>S6A</td>
<td>0–15</td>
<td>0.81 ± 0.02</td>
</tr>
<tr>
<td>S6B</td>
<td>15–30</td>
<td>0.67 ± 0.02</td>
</tr>
<tr>
<td>S7A</td>
<td>0–15</td>
<td>0.52 ± 0.02</td>
</tr>
<tr>
<td>S7B</td>
<td>15–30</td>
<td>0.65 ± 0.02</td>
</tr>
</tbody>
</table>

<sup>a</sup>Sample locations are shown on Fig. 7 (p. 9).

<sup>b</sup>Indicated counting error is at the 95% confidence level (± 2σ).

<sup>c</sup>Systematic samples are taken at locations irrespective of gamma exposure rates.
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