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Mr. David Misenhimer, P.E.  
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Materials Decommissioning Branch  
U.S. Nuclear Regulatory Commission  
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**SUBJECT: DOE CONTRACT NO. DE-SC0014664  
SITE STATUS REPORT FOR THE EVANSVILLE RADIUM  
INSTITUTE IN EVANSVILLE, INDIANA  
NRC RFTA 16-008; DCN 5289-SR-09-1**

Dear Mr. Misenhimer:

The Oak Ridge Institute for Science and Education (ORISE) is pleased to provide the attached site status report for the site visit to the former Evansville Radium Institute facility in Evansville, Indiana. This report follows the outline given in the Temporary Instructions 2800/043, Appendix C.

Please feel free to contact me at 865.574.7008 or David King at 865.574.0685 if you have any questions.

Sincerely,

David A. King, CHP, PMP  
Sr. Health Physicist/Project Manager  
ORAU

DK:lw

Attachment

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This document was prepared for the U.S. Nuclear Regulatory Commission (NRC) by the Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement (NRC FIN No. F-1244) between the NRC and the U.S. Department of Energy (DOE). ORISE is managed by Oak Ridge Associated Universities under DOE contract number DE-SC0014664.

## EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) requested that the Oak Ridge Institute for Science and Education (ORISE) perform a radiation survey of the property at 400 SE 4th Street in Evansville, Indiana. This property covers the footprint once occupied by the Evansville Radium Institute, which used radium sources to treat cancers and other skin diseases in the early 1900s. The original buildings were demolished in 1957, and the land has been redeveloped. The objective of this survey was to determine whether discrete sources of radium, if any, that would be associated with the former Evansville Radium Institute operations are still present.

ORISE performed the radiation survey on November 29, 2016, and did not identify elevated levels of radiation indicative of discrete sources of radium. Because no elevated levels of radiation were identified, ORISE concludes that discrete sources of radium are likely not present in the building or surrounding surface or subsurface soils. Based on these results, it is recommended that the NRC not pursue additional action at the 400 SE 4th Street property.

## SITE STATUS REPORT

Property: Evansville Radium Institute  
400 SE 4<sup>th</sup> Street  
Evansville, IN 47713

Docket Number: 03038954

Current Property Name: Select Specialty Hospital

Current Property Owner: Select Medical

Inspection Date: November 29, 2016

Inspectors: Mike Kunowski/ NRC and Daniel Strohmeyer/ NRC, supported by Kaitlin Engel/  
Oak Ridge Associated Universities (ORAU)

Project Managers: Jeffrey Whited/NRC and Christopher Grossman/NRC

### 1.0 INTRODUCTION

The Energy Policy Act of 2005 amended section 11e.(3) of the Atomic Energy Act of 1954 to place discrete sources of radium-226 (Ra-226) under U.S. Nuclear Regulatory Commission (NRC) regulatory authority as byproduct material. The NRC is evaluating properties where Oak Ridge National Laboratory's (ORNL) review of historical information has identified Ra-226 use. The property at 400 SE 4<sup>th</sup> Street in Evansville, Indiana (IN), was identified as the location of the former Evansville Radium Institute that operated in the early 1900s (ORNL 2015). The objectives of the initial site visit were to determine if discrete sources of Ra-226 are present, to identify the areas of highest contamination, to determine if there are any current health and safety concerns, and to determine if a more in-depth scoping survey is needed to better reach a conclusion on whether site cleanup is necessary. Surveys were performed as described within NRC's procedure, Temporary Instruction (TI) 2800/043 "Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources" (NRC 2016).

Data from the November 29, 2016 initial site visit, which includes gamma radiation scans and exposure rate measurements, are used to plan future actions that may be needed to reduce the exposure to Ra-226 to current or future site occupants to levels that do not exceed the applicable regulatory requirement. It is important to note that destructive testing is not generally performed as described within TI 2800/043.

### 2.0 PROPERTY DESCRIPTION AND INITIAL SITE VISIT CONSIDERATIONS

#### 2.1 Property Description and History

The site summary included in the "Historical Non-Military Radium Sites Research Effort Addendum" report (ORNL 2015) provides known site details about the type, form, history, potential locations and other information related to discrete sources of Ra-226 used at the site. The Evansville Radium Institute was assumed to be part of the Evansville Sanitarium, which was located near the Institute. The sanitarium was founded in 1894 and expanded over the years, becoming the Walker Hospital in 1917 and the Walker-Welborn Hospital in 1933. The original sanitarium facility was demolished in 1957 to make room for additions to the hospital.

The Walker-Welborn Hospital closed in the 1990s. The current facility is the Select Specialty Hospital, a subsidiary of Select Medical (ORNL 2015). The multi-story building provides specialty inpatient acute care services. The main floor of the facility is used for offices, while the lower floor is used mainly for storage. The outside area to the east of the front entrance is primarily asphalt or concrete sidewalks with small areas of grass and trees. Adjacent to the building are flower beds that contain landscaping rocks (lava rocks). The site summary report determined the previous location of the Evansville Radium Institute was near the front entrance on SE 4<sup>th</sup> Street.

## 2.2 Initial Site Visit Considerations

It is unknown if any radium testing took place after the original buildings were demolished (ORNL 2015). Based on the above history of the property and its redevelopment, NRC staff considers the likelihood of discrete sources of Ra-226 existing in current property structures to be negligible. Rather, were discrete sources of Ra-226 present, they would likely be identified in surface soils, and if so this could be indicative of potential subsurface contamination. The structures, pavement, and other obstructions on the property limited the area in which initial surveys were performed. Therefore, the initial site visit focused on the accessible land areas and the lower level of the building to try to identify any discrete Ra-226 sources. Surveys covered approximately 35 percent of the historical site area.

## 3.0 SITE OBSERVATIONS AND FINDING

### 3.1 Summary of Activities

The inspection team conducted an initial site visit with radiological surveys at the former Evansville Radium Institute property on November 29, 2016. A pre-inspection meeting was held with David Garman and Glen Winekauf from the site, Mike Kunowski, Daniel Strohmeyer, Christopher Grossman, and Jeffrey Whited from NRC, Mary Stikley from the State of Indiana, Department of Homeland Security, and Kaitlin Engel from ORAU. The inspection team was granted access to all portions of the facility that were requested.

Radiological surveys consisted of gamma radiation scans using a Ludlum model 44-10 2-inch by 2-inch sodium iodide detector (2x2) connected to a Ludlum model 2221 ratemeter/scaler, and exposure rate measurements using a Ludlum model 192 sodium iodide based microRoentgen ( $\mu\text{R}$ ) ratemeter.<sup>1</sup> As a rule-of-thumb, sodium iodide detectors can respond to gamma-emitting radionuclides located in the top 15 to 30 centimeters (6 to 12 inches) of soil. A Ludlum model 44-142 plastic scintillator connected to a Ludlum model 2221 ratemeter/scaler was available for direct surface activity measurements, if required. Table 1 presents the specific instruments used during the initial site visit.

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<sup>1</sup> Roentgen is a unit of exposure (energy absorbed in air), whereas a rem is a unit of dose delivered to a person (resulting from the radiation energy absorbed in that person). While Roentgen and rem are related, these are different units. Because they are similar for gamma ray energies from Ra-226, NRC makes the simplifying assumption in this case that these units are equivalent (1 Roentgen = 1 rem).

<b>Radiation Type (units)</b>	<b>Detector Type</b>	<b>Detector Model (Number)</b>	<b>Ratemeter (Number)</b>
Alpha-plus-beta (cpm)	Plastic Scintillator <sup>a</sup>	44-142 (1030)	2221 (693)
Gross gamma (cpm)	Sodium Iodide	44-10 (663)	2221 (602)
Gross gamma exposure meter (µR/h)	Sodium Iodide	192 (1129)	N/A

N/A = not applicable; ratemeter is not required.

Number = ORAU equipment barcode

cpm = counts per minute

µR/h = microRoentgen per hour

<sup>a</sup>Though traditionally used for beta radiation detection, ORAU has calibrated the detector for quantifying the detector response to both alpha and beta radiation.

Surveys of the outside of the building, including the small lawn areas near 4<sup>th</sup> Street, the flower beds, sidewalks, and the driveway to the facility were performed using the 2x2 sodium iodide detector and exposure rate meter. Materials encountered included: asphalt, concrete sidewalks, flower beds with landscaping lava rocks, grassy areas, and a fill-dirt pile located to the south of the building.

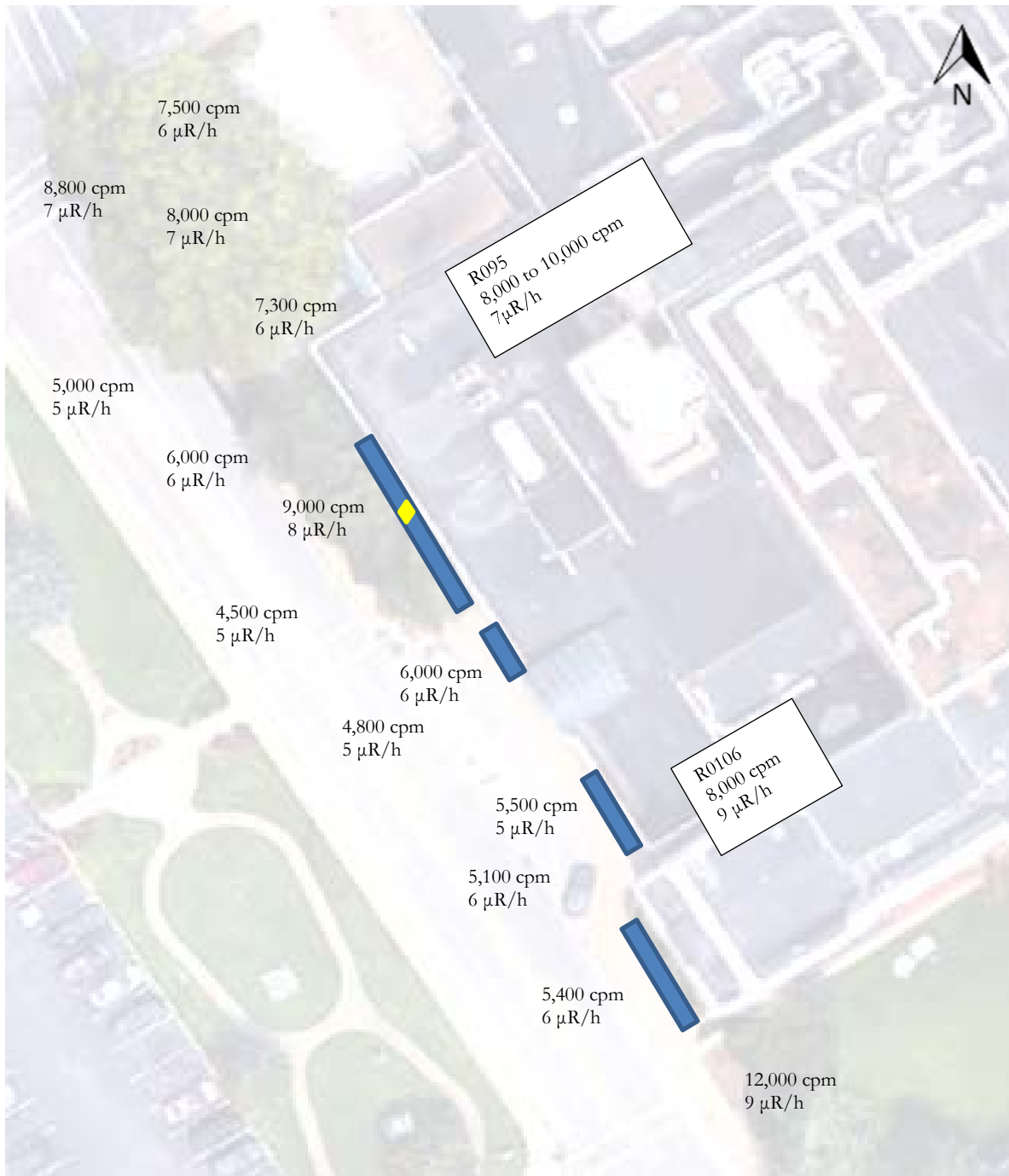
Several areas inside the building on the lower level were surveyed as well. These selected areas were assumed to be near the location of the former Radium Institute. The areas investigated included rooms R0106, R095, and the entry to a crawl space located near Cherry Street. Room R0106 is to the south and R095 is to the north of the former institute location. Room R0106 is currently unoccupied and Room R095 is currently used for storage and is mostly occupied by equipment. The crawl space is considered a confined space; therefore, entry into that area was not possible at the time of the site visit. Materials inside the building included concrete floors, concrete blocks, drywall, and red bricks.

### 3.2 Summary of Results

Figure 1 presents a summary of the results from the initial site visit. The inspection team estimates that 30 percent of the former Evansville Radium Institute facility footprint is now an outdoor area (sidewalks, landscaping, etc.), and the remaining 70 percent is covered by the Select Specialty Hospital. The inspection team had access to and scanned 100 percent of the outdoor area. Inside the hospital, however, only approximately 10 percent of the area was surveyed because much of the lower level is used for equipment storage or presents a physical or safety-related obstacle (e.g., a confined space). Based on these estimates, the inspection team surveyed approximately 35 percent of the historical site area. Results from the gamma radiation scans with the 2x2 sodium iodide detector are reported in counts per minute (cpm) and the results from the exposure rate meter are reported in microRoentgens per hour (µR/h), both measurements include background. Exposure rate measurements were compared to the 40 µR/h threshold established in the NRC's Temporary Instruction 2800/043 (NRC 2016) to implement controls. Inspectors identified no anomalous gamma radiation measurements, with the exception of the lava rocks described in more detail below. Nor did they identify any discrete Ra-226 materials in surface soil at the accessed portions of the site. In addition, no records were identified that suggest discrete sources of radium existed onsite after the property's redevelopment.

<b>SITE:</b> Evansville	<b>AREA:</b> Bldg and land to the East	<b>DATE:</b> 11/29/2016	<b>TIME:</b> 0915/1110
<b>SURVEYOR(S):</b> KME		<b>PURPOSE:</b> Site Visit	

<b>TYPE</b>	<b>INSTRUMENT</b>	<b>DETECTOR</b>	<b>BACKGROUND</b>
Gamma	2221 #602	44-10 #663	*
Gamma	192 #1192	NA	*



Blue boxes indicate areas of landscaping “lava” rocks. Gamma scanning results ranged from 5,500 to 9,000 cpm and exposure rate measurements ranged from 5 to 8 µR/h in those areas.

The yellow dot indicates approximate location of where the volumetric sample was collected.

Room locations are approximate. The entry to the crawl space is located near R095.

\* Background varied based on proximity to naturally occurring radioactive material.

**Figure 1. Survey Results for the Former Evansville Radium Institute**

Outside the building, the 2x2 sodium iodide detector responses ranged from 4,500 to 12,000 cpm depending on proximity to lava rocks, sidewalks, asphalt, and grassy areas. The highest responses were encountered to the south of the building on a dirt pile that appeared to be used as filler to build up the area. The dirt was bound by blocks on one side and covered with mulch and various plants. Gamma radiation levels increased above the nominal background in the flower beds, near the building where landscaping lava rocks were located. The team concluded this was due to the presence of the lava rocks rather than the presence of a discrete source of radium. Exposure rates varied similarly depending on the proximity to naturally occurring radioactive materials (NORM), with a range from 5-10  $\mu$ R/h.

At NRC's request, a volumetric sample of the lava rocks was collected for gamma spectroscopy analysis. It is assumed that, the lava rocks are not associated with the discrete uses of Ra-226 that may have occurred on the site and were brought to the site for landscaping purposes. The lava rocks were collected with the permission of the site owner and did not unduly impact business operations. The sample of lava rocks was analyzed by gamma spectroscopy for Ra-226 and found to contain less than 2 pCi/g of Ra-226, which is consistent with naturally occurring levels of Ra-226 in soil. It was noted that another naturally occurring gamma emitting radionuclide, potassium-40 (K-40), was identified at a concentration of 38 pCi/g, which is likely the source of the elevated gamma readings due to NORM. There was no evidence that the lava rocks were in any way associated with discrete sources of Ra-226.

Inside the building, the 2x2 sodium iodide detector responses ranged from 8,000 to 10,000 cpm depending on proximity to NORM-containing construction materials (i.e. red bricks, cement blocks). Exposure rates varied as well and ranged from 7-9  $\mu$ R/h. No discrete areas of elevated direct gamma radiation were encountered. Therefore, no direct surface activity measurements were collected inside the building.

### 3.3 Summary of Dose Assessment Results

Because no radiation levels were detected above background and no discrete sources of radium were encountered, a dose attributed to discrete radium sources could not be calculated.

## 4.0 OBSERVATIONS AND RECOMMENDATIONS

There was no indication from the areas surveyed that surface soil at the Select Specialty Hospital (400 SE 4<sup>th</sup> Street Evansville, IN), located on the former Evansville Radium Institute site, contains discrete sources of Ra-226, as determined by the following observations:

- Gamma radiation levels were consistent with background, as discussed below.
- The absence of gamma radiation anomalies, with the exception of those associated with the NORM in both the lava rocks and various building materials, suggests that there are no sources of Ra-226 present in surface soils.
- There was no historical evidence that discrete sources of Ra-226 are present following the 1957 demolition and the property's subsequent redevelopment.
- Risk of potential contamination on the site is low and, if present, would most likely be found at a significant depth in the subsurface soil.



Therefore, the recommendation to the NRC staff is that a more detailed scoping survey is not necessary at this time, and NRC staff should not pursue additional action at the 400 SE 4<sup>th</sup> Street property.

## 5.0 REFERENCES

NRC 2016. *Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources*, Temporary Instruction 2800/043, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, D.C., October. (Agencywide Documents Access and Management System [ADAMS] Accession No. ML16035A053)

ORNL 2015. *Historical Non-Military Radium Sites Research Effort Addendum*, "Evansville Radium Institute: Site Summary," Pgs. 50-55. Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 24. (ADAMS Package Accession No. ML16287A522)