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June 8, 2018

Mr. Christopher Grossman
Nuclear Material Safety and Safeguards
Division of Decommissioning, Uranium Recovery, and Waste Programs
Materials Decommissioning Branch
U.S. Nuclear Regulatory Commission
11545 Rockville Pike, MS T8-F05
Rockville, MD 20852

SUBJECT: SCOPING SURVEY PLAN FOR THE FORMER WILLIAM L. GILBERT CLOCK COMPANY PROPERTY AT 13 WALLENS STREET IN WINSTED, CONNECTICUT
CONTRACT NO. NRC-HQ-50-17-A-0001; DCN 5307-PL-06-1

Dear Mr. Grossman:

Oak Ridge Associated Universities (ORAU) is pleased to provide the attached plan for the scoping survey of the former William L. Gilbert Clock Company property at 13 Wallens Street in Winsted, Connecticut. This survey plan follows a streamlined version of the outline given in the Temporary Instructions 2800/043, Appendix A.

Please feel free to contact me at 865.574.0685 or Erika Bailey at 865.576.6659 if you have any questions.

Sincerely,

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

JDL:DAK:lw

Attachment

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Group Manager/Technical Review	ENB

SCOPING SURVEY PLAN FOR THE FORMER WILLIAM L. GILBERT CLOCK COMPANY PROPERTY AT 13 WALLENS STREET, WINSTED, CONNECTICUT

Prepared by
David A. King
ORAU

JUNE 2018

FINAL PLAN

Prepared for the
U.S. Nuclear Regulatory Commission

This document was prepared for the U.S. Nuclear Regulatory Commission (NRC) by Oak Ridge Associated Universities under contract number NRC-HQ-50-17-O-0001.

Property:	Former William L. Gilbert Clock Company 13 Wallens Street Winsted, CT 06098
Docket Number:	03038939
Current Property Name(s):	Gilbert Clock Shop Apartments
Current Property Owner(s):	Gilbert Clock Properties, LLC
Inspection Dates:	June 26–27, 2018
Inspector(s):	NRC Inspectors TBD, U.S. Nuclear Regulatory Commission (NRC) Region I, Oak Ridge Associated Universities (ORAU) support staff TBD

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 NRC regulatory authority as byproduct material. The Gilbert Clock Shop Apartments at 13 Wallens Street in Winsted, Connecticut (CT) were identified as part of the former William L. Gilbert Clock Company property, where clocks were manufactured from 1866 to 1964. The clock factory employed 500 workers and produced two thousand clocks per day (ORNL 2015). One of Gilbert's products was "Night and Day Radium Dial Clocks" using "LUMA-nous" dials developed by the Gilbert engineering department (Funk and Wagnalls 1920). The original manufacturing buildings were gutted and remodeled, though the extent of Ra-226 contamination on original structural materials (exterior walls and heavy floor beams) remains unknown.

During a May 2018 site visit, inspectors performed surveys of land areas and inside various apartments within Buildings A, B, and C. Inspectors identified one area in Apartment A-17 and two areas in Apartment A-22 that produced gamma radiation above ambient background levels (ORAU 2018). Due to this finding, NRC determined that a follow-up scoping survey should be performed to more thoroughly investigate the property. The scope of this survey will be Buildings A and C apartments that were not surveyed during the May site visit. The objectives of the survey will be to determine if additional discrete sources of Ra-226 are present and, if so, if these sources could result in a dose above regulatory limits.

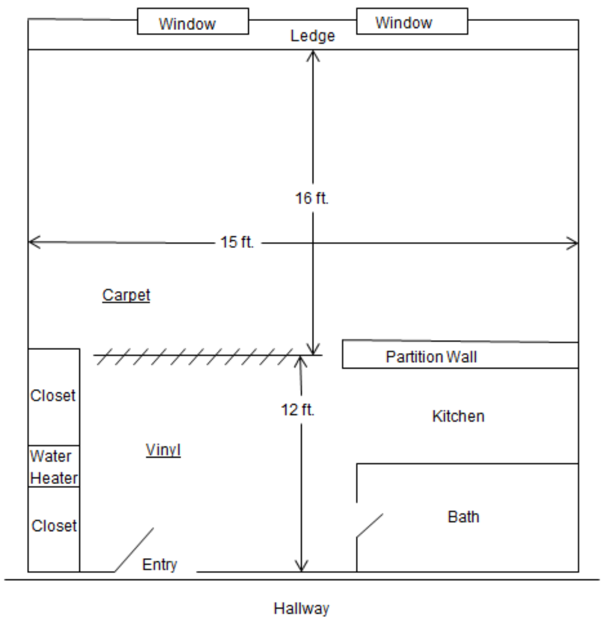
2.0 PROPERTY DESCRIPTION AND CONCEPTUAL MODEL

The Gilbert Manufacturing Company was founded in 1866 at the corner of Wallens Street and N. Main in Winsted, CT and at one time was one of the largest clock-makers in the world, producing two thousand clocks per day (ORNL 2015). In 1871, a fire destroyed the original building; two new brick factory buildings were built and named the William L. Gilbert Clock Company. In 1934, the company's name changed to Gilbert Clock Corporation. In 1955, the buildings were damaged by flooding and gutted. General Computing Machines took ownership in 1957 and changed the name to General-Gilbert Corporation. Operations ceased in 1964, and the facility was sold. In 1975, most of the facility was destroyed by fire, leaving only two of the original Gilbert Clock Factory brick buildings. The buildings were again gutted and rebuilt, converted into apartments in 1997 after sitting empty for almost 20 years. All structural materials are presumed new from the 1997 re-build, except for the existing exterior walls and heavy floor beams (ORNL 2015).

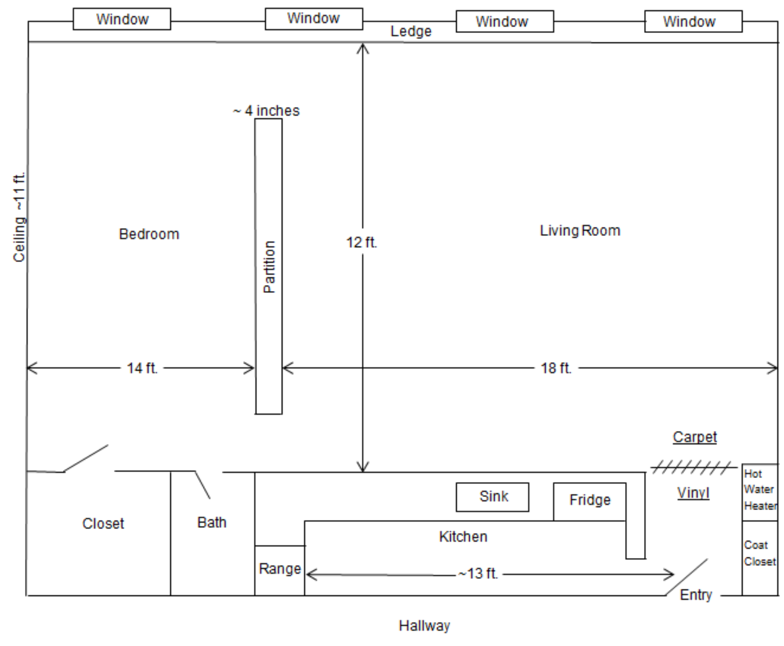
Figure 1 shows a current view of the over 8,900-m^2 (2.21-acre) Lot 009 property with the two brick apartment buildings, noting the property boundary outlined in blue. The square footage of the buildings is unknown. Each building contains four floors, and each floor contains seven or eight apartments. Building A is located along Wallens Street, and the long dimension of Building B/C runs along White Street. Figure 2 depicts both buildings. Rough drawings of floorplans that could be found in Building A are presented in Figure 3. The layout of Building B/C apartments are similar to Building A, though noting that the first and second floors are associated with Building B, and the third and fourth floors are associated with Building C (thus Building B/C).

Figure 1. Current View of 13 Wallens Street (Property Boundary Outlined in Blue)

Figure 2. Apartment Buildings A (Left) and B/C (Right) at 13 Wallens Street



Building A Apartment A-4 (Efficiency)



Building A Apartment A-12 (One Bedroom)

Figure 3. Building A Typical Apartment Floorplans

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.

3.0 DATA QUALITY OBJECTIVES

The Data Quality Objectives (DQOs) described herein are consistent with the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575 (NRC 2000) and provide a formalized method for planning radiation surveys, improving survey efficiency and effectiveness, and ensuring that the type, quality, and quantity of data collected are adequate for the intended decision applications. The seven steps in the DQO process are outlined below:

1. State the problem
2. Identify the decision
3. Identify inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimize the design for obtaining data

3.1 Step 1 – State the Problem

The first step in the DQO process defines the problem that necessitates the study, identifies the planning team, and examines the budget and schedule. The NRC is evaluating former manufacturing facilities and other identified locations where Ra-226 was historically used or stored to determine if residual Ra-226 sources and associated decay products are present and at concentrations above 10 Code of Federal Regulations (CFR) Part 20, *Standards for Protection Against Radiation,* Section 1301, “Radiological criteria for restricted use” or 10 CFR Part 20, Section 20.1402, “Radiological criteria for un-restricted use” limits.

Based on this background information, the problem statement is as follows:

> Surveys are required in Buildings A and C apartments that were not previously surveyed to determine if additional sources of Ra-226 are present and if the concentrations could contribute to a dose that exceeds the 25 mrem/yr and/or 100 mrem/yr radiological dose limits.

Project Organization and Responsibilities. Table 1 presents the project organization across programs and departments, including key personnel, roles, and contact information.

Table 1. Key Personnel Contact Information

Name	Organization	Role	Phone	E-mail
Jeffery Whited	NRC, HQ	Project Manager	301-415-4090	Jeffrey.Whited@nrc.gov
Christopher Grossman	NRC, HQ	Back-up Project Manager	301-415-0140	Christopher.Grossman@nrc.gov
Raymond Powell	NRC, RI	Branch Chief	610-337-6967	Raymond.Powell@nrc.gov
David King	ORAU	Project Manager	865-574-0685	David.King@orau.org

HQ = Headquarters RI = Region I

The NRC inspector will coordinate with the Office of Nuclear Material Safety and Safeguards (NMSS) and the property owner to gain site access. NRC project managers will coordinate with the property owner for access agreements and scheduling. The inspector will coordinate with the NMSS project manager for site coordination, state coordination, outreach, and internal NRC coordination.

Project Budget and Schedule. The project is funded by the NRC, and the survey is tentatively scheduled for June 26–27, 2018. Fieldwork is anticipated to last two days.

3.2 Step 2 – Identify the Decision

The second step in the DQO process identifies the Principal Study Questions (PSQs) and Alternate Actions (AAs); develops a decision statement; and organizes multiple decisions, as appropriate. This is done by specifying AAs that could result from a “yes” response to the PSQs and combining the PSQs and AAs into a decision statement. Table 2 presents the PSQs and AAs combined into a decision statement.

Table 2. Ra-226 PSQs, AAs and Decision Statement

Principal Study Questions	Alternative Actions
PSQ1: Has the survey identified elevated Ra-226 concentrations that could contribute to a dose greater than 100 mrem/yr?	**No**: The data will be used to determine if concentrations could contribute to a dose greater than 25 mrem/yr. **Yes**: The data will be used by the NRC to recommend future actions to control and mitigate risk from exposure to discrete sources of Ra-226.
PSQ2: Has the survey identified elevated Ra-226 concentrations that could contribute to a dose greater than 25 mrem/yr?	**No:** The data will be used to support the conclusion that no additional action is required to protect current or future receptors from exposure to discrete sources of Ra-226. **Yes:** The data will be used by the NRC to recommend future actions to control and mitigate risks from exposure to discrete sources of Ra-226.
Decision Statements	
Discrete sources of Ra-226 are (or are not) present at levels that could contribute to a dose greater than 25 mrem/yr and/or 100 mrem/yr total dose; therefore, NRC does (or does not) recommend additional action at the property to control and mitigate risks from exposure to discrete sources of Ra-226.	

3.3 Step 3 – Identify Inputs to the Decision

The third step in the DQO process identifies both the information needed and the sources for this information; determines the basis for action levels; and identifies sampling and analytical methods that will meet data requirements. For this effort, information inputs include the following:

- Energy Policy Act of 2005 amended section 11e.(3) of the Atomic Energy Act of 1954, as amended

- 10 CFR Part 20, Standards for Protection Against Radiation, Sections 20.1402 and 1301
- *Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources*, Temporary Instruction 2800/043, Revision 2, (NRC 2018)
- Site Status Report for William L. Gilbert Clock Company at 13 Wallens Street in Winsted, Connecticut (ORAU 2018)
- Site summary documentation (ORNL 2015)
- Site access agreements and associated limitations, if any
- NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), for estimating detector-specific minimum detectable concentrations (MDCs)
- Applicable field instrumentation and survey procedures, method procedures, data/sample management procedures, and survey results
- Applicable analytical laboratory procedures, method procedures, data/sample management procedures, and analytical results
- Dose modeling data, inputs, and dose consequence outputs (SNL 1999 and ORISE 2017)

3.4 Step 4 – Define the Study Boundaries

The fourth step in the DQO process defines target populations and spatial boundaries; determines the timeframe for collecting data and making decisions; addresses practical constraints; and determines the smallest subpopulations, area, volume, and time for which separate decisions must be made.

Boundary conditions include physical, temporal, and practical factors that may limit an inspector's access to the property. More specifically:

- Physical boundary
    - The subject property consists of two multi-story brick buildings that have been renovated into an apartment complex, and most areas of interest should be physically accessible. Survey boundaries are limited to apartments and common areas selected by the site and NRC. Apartments and common areas surveyed during the May 2018 site visit will not be targeted in this survey effort.
- Temporal boundary
    - Inspectors may have limited time to survey all apartments and areas requested by the NRC, and access to each target apartment may only be available during small windows of time; also, survey activities will be limited to 2 days.
- Practical boundary
    - Inspectors may have limited property access based on the access agreement with the property owner and/or tenants' disposition for entry into their apartments.

Volumetric/destructive sampling is unlikely for this survey, though it will be considered if necessary.

To address these boundary conditions, this survey plan is based on a survey approach to targeting accessible locations with the highest potential for containing Ra-226 contamination. In general, the inspection team will collect as much data as possible from accessible areas with the highest potential of containing Ra-226 contamination in the time allotted to perform the survey. Inaccessible areas will not be surveyed unless there is a clear indication that the inaccessible areas may have levels of contamination critical to the PSQs. In such cases, the path forward will be discussed with the NRC management.

Decisions may be made based on any single confirmed discrete source (the smallest subpopulation) that could produce a radiological dose greater than either 100 or 25 mrem/yr, assuming plausible current-use or reasonably expected future-use scenarios. If suspected Ra-226 is encountered, the inspection team will gather sufficient data from the area to delineate and quantify contamination levels. These data will support the dose analysis and programmatic decisions.

3.5 Step 5 – Develop a Decision Rule

The fifth step in the DQO process specifies appropriate population parameters (e.g., mean, median); confirms action levels (ALs) are above detection limits; and develops an "if…then…" decision rule statement. The objective of the survey is to locate discrete sources of Ra-226 and, if located, determine if the sources (either individually or in combination) could result in an unacceptable dose based on current or reasonably expected future use. Inspectors are required, via implementation of this plan, to locate and collect necessary data to delineate Ra-226 contamination. This data will then be used to calculate the site-specific dose for comparison to the 100 and 25 mrem/yr limits. Specific ALs, therefore, are thresholds that will be used to prompt more extensive data collection in a particular area, as follows:

1. Positive identification, by visual inspection or other means, of discrete sources of Ra-226.

2. A gamma radiation measurement that is clearly above ambient background conditions. A 2-inch by 2-inch (2×2) sodium iodide detector (Ludlum Model 44-10) will be used to identify locations with elevated gamma radiation levels, if present. Dose rate measurements will be made using a sodium iodide, tissue-equivalent scintillator exposure ratemeter (Ludlum Model 192) that is calibrated for the measurement of Ra-226.

3. Direct measurements on a surface medium clearly above ambient background conditions. Using the methods described in NUREG-1507, the Ludlum Model 44-142 plastic scintillator detector has an estimated static MDC of 60 dpm/100 cm^2 (alpha-plus-beta). A detector response above the static MDC will prompt the inspector to collect additional data/information in the immediate area.

4. Removable surface contamination will confirm the presence of dispersible, potentially airborne, Ra-226 contamination. Smear samples will be collected and measured for gross alpha and gross beta activity to quantify the removable fraction, or more specifically, to determine if removable Ra-226 is present.

Gross gamma, exposure rates, and/or alpha-plus-beta measurements will be collected from locations of highest gamma response to optimize detection potential. Ra-226 and some associated decay products are alpha emitters. The alpha radiation may be easily attenuated by thin layers of dust, paint, moisture, etc. Gamma and alpha-plus-beta emissions will often provide a more accurate quantification of the total activity. In all cases, it is presumed that the resulting dose to a current or potential future receptor could reasonably exceed 25 mrem/yr if measured concentrations exceed action levels. A site-specific dose analysis may result from the confirmation of any of these items. The decision rule is, therefore:

> If Ra-226 is found to contribute to a radiation dose above a dose limit, then the NRC may recommend actions to control access to the area; else the data may be used to support a no-further-action decision.

3.6 Step 6 – Specify Limits on Decision Errors

The sixth step in the DQO process specifies the decision maker's limits on decision errors, which are then used to establish performance goals for the survey. The identification of only one discrete source of Ra-226 would result in future NRC action. Therefore, decision errors here are associated with a measurement goal of no more than 10 to 50 percent of quantifiable ALs, though MDCs are set at the 95 percent confidence interval, where applicable.

1. The positive identification of Ra-226, through visual inspection or other means, is not associated with a quantifiable AL and is simply a presence/absence determination. Thus, false positive/false negative decisions are a function of area accessibility.

2. The exposure ratemeter produces a stable response at ambient levels, on the order of 10 µR/h. The TI specifies rule-of-thumb ALs of 15 µR/h above background for residential properties and 40 µR/h above background for industrial (or non-residential) properties. The apartment complex is a residential property, so the 15 µR/h AL applies. The typical ambient background of approximately 10 µR/h is less than 50 percent of the anticipated gross action level of approximately 25 µR/h. These rule-of-thumb ALs would suggest the presence of unacceptable Ra-226 based on the external gamma pathway alone, though a more detailed dose analysis may be required to support final decisions.

3. Direct measurement MDCs at the 95 percent confidence interval using a plastic scintillator detector are dependent on background/medium-specific and instrument-specific inputs. However, some direct measurements for alpha-plus-beta activity may be used to support site-specific dose analysis when required. The alpha-plus-beta static MDCs are less than 50 percent of the 630 dpm/100 cm^2 total AL (ORISE 2017), assuring that both false positive and false negative errors are minimized.

4. The MDC for smears, also based on the 95 percent confidence interval, is less than 10 dpm/smear for gross alpha and less than 15 dpm/smear for gross beta (100 cm^2 per smear is presumed for standard smears). A project-specific AL of 63 dpm/100 cm^2 is presumed to represent the 10 percent removable fraction as defined in the derivation of the 630 dpm/100 cm^2 total AL (ORISE 2017).

Hand-held instruments will be used to locate and delineate contamination associated with Ra-226. Table 3 presents example MDCs for a Ludlum Model 44-142 plastic scintillator detector, assuming an alpha-plus-beta background response of 350 cpm. A 2×2 sodium iodide detector may also be used to locate and delineate Ra-226 contamination. Using the default methods described in NUREG-1507, the scan MDC for Ra-226 is estimated at 2.8 pCi/g, as presented in Table 3, though this concentration is derived for volumetric contamination and not surfaces. For this effort, the 2×2 sodium iodide detector will be used qualitatively to locate and delineate gross radium contamination, if present. Property-specific MDCs will be established based on site-specific background conditions and instrumentation.

Table 3. Example Minimum Detectable Concentrations					
Gross Activity	**Instrument**	**Typical Bkg. (cpm)**	**Typical Total Eff.**[a]	**Detector Area (cm^2)**	**Static MDC**
Alpha-plus-beta	Plastic Scintillator	350	1.6	100	60 dpm/100 cm^2
Gamma	2×2 sodium iodide	10,000	N/A	N/A	2.8 pCi/g[b]

[a]Assumes equilibrium with progeny
[b]Default scan MDC from NUREG-1507 for soil or soil-like (bulk) materials

3.7 Step 7 – Optimize the Design for Obtaining Data

The seventh step in the DQO process is used to review DQO outputs; develop data collection design alternatives; formulate mathematical expressions for each design; select the sample size to satisfy DQOs; decide on the most resource-effective design of agreed alternatives; and document requisite details. The overall approach is to collect as much data as possible given the boundary conditions identified in Section 3.4. The survey approach is divided into several general steps, starting with property reconnaissance and the division of accessible areas into logical Survey Units (SUs). The inspector should clearly specify which areas are accessible and which are not (and for what reasons).

It is presumed that Ra-226 will generate a detectable gamma radiation signal and is most easily located in the field using gamma radiation instrumentation. Therefore, inspectors will initially screen the property using hand-held 2×2 sodium iodide detectors. Locations with a maximum gamma radiation signature, potentially containing Ra-226, may then be prioritized for further evaluation using dose-rate and alpha/beta instruments, and/or may be sampled as deemed necessary.

Within each apartment building SU, and considering Figure 4, the inspectors shall:

- Perform a survey using a 2×2 sodium iodide detector and exposure ratemeter to locate areas of elevated gamma radiation. Scans will be continuous over all accessible areas. In each room, one to five 1-meter general area exposure rate measurements will be collected to estimate the average exposure rate. Measurement locations will target the center of each quadrant of the room plus the middle of the room (locations may be moved to avoid large obstacles). The number of measurements will be scaled to the size of the room (i.e., small rooms such as bathrooms may have only one measurement location).

- In addition to the background measurements, based on professional judgment, collect measurements at the locations with the highest gamma radiation levels or if a potential Ra-226 source is identified:

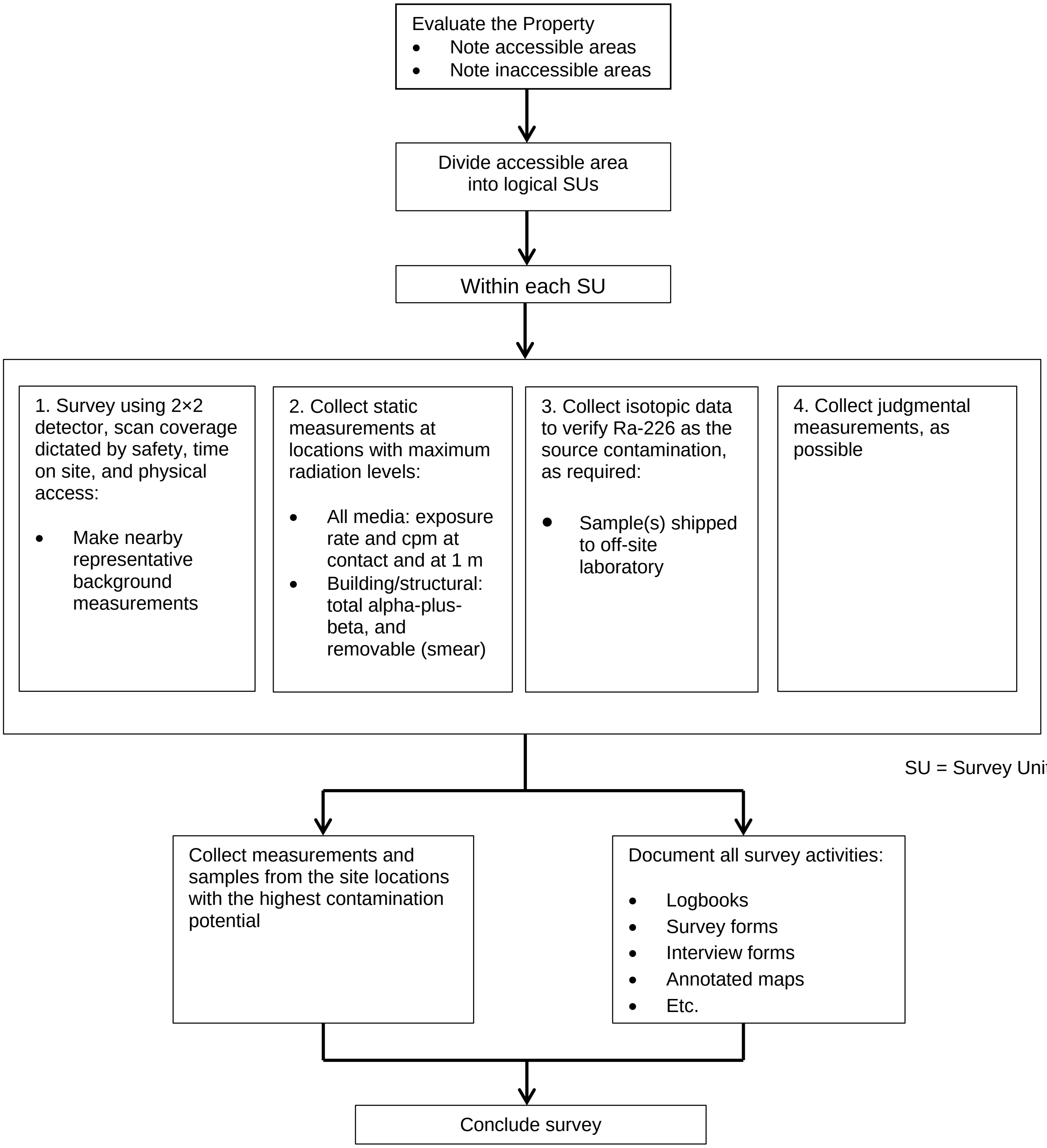


Figure 4. Survey Overview

- Delineate the contaminated area via surface scans and static alpha-plus-beta or gamma measurements and specify location, including whether structural surface or system/equipment, boundaries, and magnitude of contamination including "hot spots." Illustrate this information in a logbook or annotate a map for future reference—note approximate or actual floor/ceiling coordinates to the southwest corner of the room or lower left corner of a wall.

- Collect a 2×2 sodium iodide direct measurement and an exposure rate measurement on contact and at one meter from the surface.

- Collect alpha-plus-beta direct measurements (static measurements).

- Collect sufficient smear samples to estimate the removable activity fraction in the area.

- Note, if possible, the proximity of the contaminant relative to habitable spaces and the hours of occupancy for those spaces.

- Collect a volumetric sample (i.e., paint scrapings), if possible, for off-site laboratory analysis. However, sample collection must be non-destructive and not cause damage to the area of collection.

In general, no surveys or sampling requiring destruction of property should be performed. If destruction of property is necessary to obtain critical measurements, then the inspector shall consult with NRC regional management for guidance.

A detailed logbook will be maintained, which will provide a comprehensive description of field activities. Inspectors, at a minimum, will clearly document the following:

- Dates, times, and individuals performing the survey
- Instrumentation type and identification numbers
- Site and environmental conditions and instrument background measurement data
- 2×2 sodium iodide screening results by room, area, or other logical property division
- Exposure measurement results
- Direct measurement results
- Sample (smear and volumetric) identification numbers and proposed analyses
- Detailed maps or drawings documenting measurement and sample location information
- Detailed description of the location, physical characteristics, radiation levels, and occupants (adult/minor) noting the estimated time in the area associated with confirmed discrete sources, if identified and if possible
- Relevant discussions or interactions with non-project personnel/stakeholders
- Details regarding any deviation from the plan

Survey forms and annotated maps may also be used to record radiation measurement and location information.

4.0 HEALTH AND SAFETY

Because the level of contamination, if any, is unknown, inspectors will need to be flexible and prepared to upgrade personal protective equipment (PPE), if needed. Initial PPE will be minimal and will be adjusted as necessary.

- Appropriate PPE for this survey consists of sturdy work shoes. Consult the *Health and Safety and Waste Management Work Instructions for Scoping Surveys at Sites Potentially Contaminated by Discrete Sources of Radium* (ORAU 2017).

- If an exposure rate is encountered greater than 2 mrem/hr at one meter, or if the area is suspected of containing airborne contamination, then:

  - Coordinate/plan with regional management should significant contamination be encountered, as well as coordination with the property owners.

  - Consider how best to delineate and control the area, and, if appropriate, clearly post the area to limit public access during and after sampling activities.

  - Inspectors may be required to upgrade the level of PPE while sampling.

  - Any waste (e.g., PPE and sampling equipment) will be managed according to the waste management plan (see Section 5.0).

Note that a state representative may request to accompany the inspectors during the survey. It should be clearly communicated that these individuals are responsible for their own health and safety.

5.0 WASTE MANAGEMENT

Survey activities have the potential for generating waste containing non-trivial levels of Ra-226 activity. Types of waste include PPE, sampling equipment (e.g., scrapers), and the sampled media (e.g., smears or soil). In the event that investigation derived waste become contaminated by Ra-226, the item or items will be packaged and labeled for laboratory analysis to quantify Ra-226 concentrations. All dry activated waste will be stored in a clearly labeled and segregated drum (e.g., 30-gallon) at the ORAU site in Oak Ridge, Tennessee, until NRC approves of disposal. At that time, ORAU will dispose of radioactive waste in accordance with regulatory requirements and will maintain appropriate records of waste disposal (ORAU 2015).

6.0 ANALYTICAL REQUIREMENTS

All samples, including smears, will be assigned a unique sample identification number and will be maintained under chain-of-custody for transfer to the contract analytical laboratory. The analytical laboratory will perform analyses in accordance with:

- U.S. NRC, *Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards*;

- ASME-NQA-1, *Quality Assurance Program Requirements for Nuclear Facilities*; and

- U.S. NRC, *Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)*, NUREG-1576.

Example sample and analytical parameters are listed in Table 4.

Table 4. Example Sample and Analytical Parameters

Analyte	Matrix	Container	Preserv.	Hold Time	Method
Ra-226	Surface	Smear	None	180 d	Gross α/β
Ra-226	Solids	Plastic Bag	None	180 d	Gamma or Alpha Spectroscopy

7.0 REFERENCES

Funk and Wagnalls 1920. *The Literary Digest Volume LXIV*, Funk & Wagnalls Company, New York, digitized by Google, pp. 383, 944, and 1463 of 1909, January—March.

NRC 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507, U.S. Nuclear Regulatory Commission, Washington, D.C., December.

NRC 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. NUREG-1575, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, D.C., August.

NRC 2018. Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources, Temporary Instruction 2800/043, Revision 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, D.C., May. (ADAMS Accession No. ML17297B921).

ORAU 2015. *ORAU Radiation Protection Program*, Oak Ridge Associated Universities, Oak Ridge, Tennessee, April.

ORAU 2017. *Health and Safety and Waste Management Work Instructions for Scoping Surveys at Sites Potentially Contaminated by Discrete Sources of Radium*, DCN 5307-PL-02-1, Oak Ridge Associated Universities, Oak Ridge, Tennessee, August.

ORAU 2018. Site Status Report for William L. Gilbert Clock Company at 13 Wallens Street in Winsted, Connecticut, DCN 5307-SR-24-0, Oak Ridge Associated Universities, Oak Ridge, Tennessee, May

ORISE 2017. Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination. DCN 5289-TR-01-2, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee, May 30. (ADAMS Accession No. ML17072A414).

ORNL 2015. *Historical Non-Military Radium Sites Research Effort Addendum*, "William L. Gilbert Clock Company: Site Summary," pp. 161-165, Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 24. (ADAMS Accession No. ML16291A488).

SNL 1999. *Residual Radioactive Contamination from Decommissioning Parameter Analysis.* NUREG/CR-5512, Vol. 3, U.S. Nuclear Regulatory Commission, Washington, D.C., October.