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Health and Safety Research Division

GENERIC RADIOLOGICAL CHARACTERIZATION PROTOCOL FOR SURVEYS CONDUCTED FOR DOE REMEDIAL ACTION PROGRAMS

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GENERIC RADIOLOGICAL CHARACTERIZATION PROTOCOL FOR SURVEYS CONDUCTED FOR DOE REMEDIAL ACTION PROGRAMS*

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ABSTRACT

This report describes goals and methodology that can be used by radiological survey contractors in surveys at properties associated with the Department of Energy's remedial action programs. The description includes (1) a general discussion of the history of the remedial action programs; (2) the types of surveys that may be employed by the Radiological Survey Activities (RASA) contractor; (3) generic survey methods that may be used during radiological surveys; and (4) a format for presenting information and data in a survey report.

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1. INTRODUCTION

During the early history of this country's atomic energy program, over 150 sites (primarily in the eastern United States) were involved in research, processing, and storage of radioactive ores and residues containing uranium, thorium, and their decay chain radionuclides. Work at these federally, privately, and institutionally owned facilities was performed under contract with the Manhattan Engineer District (MED) and later the Atomic Energy Commission (AEC). The urgency and magnitude of this program, as well as the limited knowledge of some industrial participants regarding radioactive characteristics of residual material, contributed to contamination of some sites.[1] Contracts for needed services were made and terminated as required. However, at termination, the sites were to have been decontaminated according to guidelines then in

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use. Most of these sites were decontaminated, but since that time many of the radiological records have been lost or destroyed, and the radiological criteria for the unrestricted release of these sites have changed. An AEC [now the Department of Energy (DOE)] program was initiated in 1974 to identify all formerly utilized sites, characterize their current radiological status, determine the extent of remedial action (if necessary), decontaminate the sites as necessary, and release the sites for unrestricted or limited use as required.[1] This program is called the Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP). Surveys to define the radiological conditions at many of the sites have been completed, and remedial actions have been initiated or completed for several of the sites.

In 1974, the AEC initiated a study of 22 inactive uranium mill sites in cooperation with the Environmental Protection Agency (EPA) and health authorities in the eight affected western states.[2,3] This study developed into the Uranium Mill Tailings Remedial Action Program (UMTRAP) under authority of the Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604). The objectives of this program were to conduct engineering assessments of existing conditions at these sites, determine the remedial action required, develop plans and specifications for implementing remedial action, perform the necessary remedial action, verify the results, and release the sites for unrestricted or limited use as required. The radiological surveys and assessments for these 22 inactive uranium mill sites have been completed.

Several facilities have operated under the auspices of the MED, AEC, and the Department of Defense, whose work has been partially or wholly related to radioactive materials. Currently, many of these sites are controlled by DOE under the Surplus Facility Program. These facilities require no historical documentation review or initial radiological characterization; however, DOE has responsibility for decontamination and decommissioning of these facilities. DOE's Surplus Facility Program has been established to develop plans for remedial action, to conduct the necessary remedial action, to verify the results, and to release these sites for unrestricted or limited use as required.

Within DOE, responsibility for various aspects of the remedial action programs has been assigned to the Assistant Secretary for Environmental Protection, Safety, and Emergency Preparedness (ASEP) and to the Assistant Secretary for Nuclear Energy (ASNE). The ASEP, through DOE, is responsible for initial radiological characterization and designation of sites for remedial action, health and safety overview, and certification of remedial action in compliance with appropriate standards. The ASNE is responsible for planning and conducting remedial actions. More complete descriptions of the activities assigned to each assistant secretary may be found elsewhere.[2] Within DOE, the Radiological Survey Activities (RASA) Program performs duties assigned by DOE in support of objectives of the ASEP.

Argonne National Laboratory, Oak Ridge Associated Universities, and Oak Ridge National Laboratory have been assigned major roles in the conduct of the DOE RASA program. These institutions (identified throughout this report as RASA contractors) are responsible for characterization of the radiological conditions at sites assigned by DOE and for technical support in determining the need and priority of any remedial action. Following remedial action, RASA contractors ensure that site conditions are within pertinent federal and state radiological guidelines. Other institutions supporting the DOE RASA program include Aerospace Corporation, which provides technical support to DOE; EG&G, which performs aerial radiological surveys; Battelle-Pacific Northwest Laboratories, which conducts vicinity properties risk assessment for property occupants; and Monsanto Research Corporation--Mound, which provides long-term radon and radon daughter measurements for DOE. The work is performed in close cooperation with and according to the specific needs of DOE.

All primary UMTRAP sites, surplus DOE sites, and most primary FUSRAP sites have undergone comprehensive radiological assessments.[1,2] Near many of these sites, however, public, residential, commercial, and industrial properties (collectively termed vicinity properties) have been secondarily contaminated as a result of the use of contaminated building materials or process residues for building construction or for fill in outdoor areas. In many cases, the use of process residues (such as mill tailings) to backfill foundations has produced elevated

radiation exposures in indoor areas. Experience gained to date indicates that the contaminating materials are present in various combinations and distributions and that unique survey procedures to identify the contaminating material or to verify its removal will normally be required for each property. The broad survey program, which was initiated to identify the contaminated vicinity properties, included other government agencies (notably the Department of Housing and Urban Development and EPA), direct public inquiries, aerial surveys, mobile gamma scanning, and historical records searches. Aerial surveys for most of the suspect areas have been completed and are being followed up by mobile gamma-scanning measurements. Current information indicates that a large number of properties may be involved. Radiological surveys for some of the properties have been completed, and remedial actions for some of these are under way or have been completed.

Final cleanup standards have been prepared by the EPA[4] for the inactive uranium mill sites and associated vicinity properties in the UMTRAP. Certain other federal radiological guidelines[5,6] and the ALARA (as low as reasonably achievable) philosophy are applicable to federal remedial action programs. Generic cleanup criteria have not been established for sites and vicinity properties included in the FUSRAP program; however, DOE has established criteria on a site-by-site basis in accordance with established federal guidelines[5,6] and ALARA philosophy. Appendix A summarizes the applicable radiation protection guidelines used in DOE's remedial action programs.

The purpose of this report is to document the generic survey plan used for radiological surveys by the RASA contractors. Individual RASA contractors have responsibility for preparing documents describing their specific instrumentation and survey methodology.

2. GENERAL SURVEY PROCESS

The tasks to be performed at each site have been organized by DOE into discrete steps to ensure an orderly progression of work and to minimize costs. At the completion of each step for each site, DOE implements a series of decision processes to proceed to the next step and to coordinate the next set of activities. Work performed by the RASA contractor to support the program has been organized to be directly compatible with the overall DOE remedial action program organization and to provide the documentation required by DOE to implement the decision and coordinating processes. The sequence of radiological survey activities for a site is illustrated in Fig. 1.

The first step consists of reviews of records and any other information relevant to the properties involved, the types of materials that might be involved, the intended use of the materials, and the type and levels of radioactive contamination that might be anticipated. The results of previous radiological survey activities (such as those performed by the EPA and by the local and state agencies and aerial gamma scanning of the indicated area, which may have been completed by DOE contractors) provide a primary basis for identifying properties that might be involved. Such data are used to define the specific requirements for additional property identification activities. These activities are followed by the appropriate radiological survey as described in the following sections. Upon completion of the radiological survey, a survey report is prepared and submitted to DOE documenting all pertinent information gathered during the radiological survey process. The reports may also include estimates of potential health risks or other conclusions drawn from radiological survey information.

Potential health risks are determined by gathering appropriate data regarding on-site conditions and usage, as well as by sufficient radiological measurements to determine average and maximum radiation levels such that the potential for radiation exposure to site occupants can be determined. By knowing the various radiation exposure pathways from specific radionuclides, the assumed occupancy factors and the average and maximum radiation levels to which occupants could be exposed, long-term radiation doses to these occupants can be estimated. Estimated

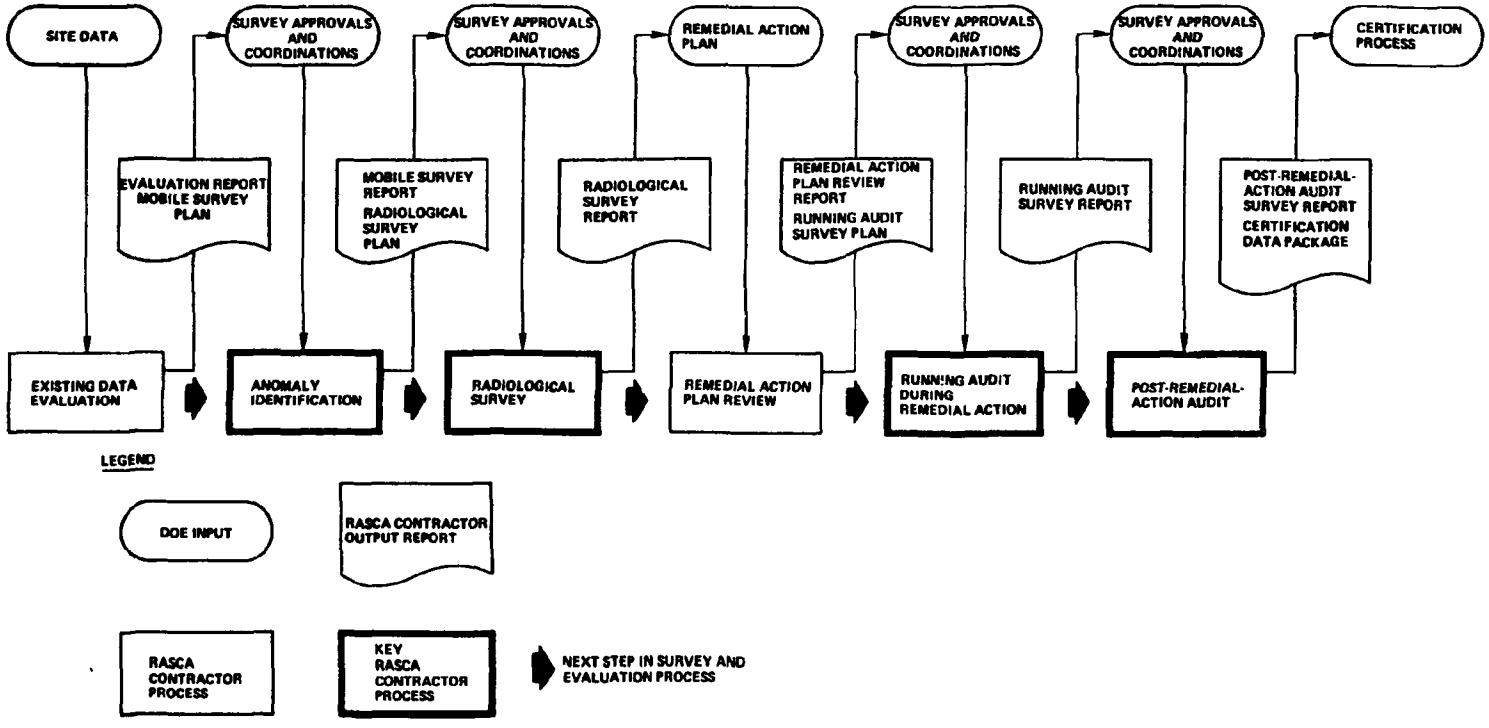

Fig. 1. Site survey planning, coordinating, and reporting sequence for RASA contractors.

doses for an individual occupant can then be converted to the potential for adverse health effects by using health-risk estimators such as those found in the BEIR report.[7] Estimates of the relative degree of potential health effects at a site may assist DOE in prioritizing the need and urgency for remedial action.

The following sections describe generic types of radiological surveys that may be employed by the RASA contractor, including the radiological survey methodology that might be used for the radiological measurements, and the procedures for obtaining environmental samples required for each type of survey. These are adapted to the specific requirements for each site and are implemented according to the specific characteristics of the site and specific procedures and instrumentation used by the individual RASA contractor. Any combination of these surveys may be employed at a given site. Although each site may have particular requirements to satisfy the radiological survey objectives, each type of radiological survey procedure shares common elements. Among these elements are the radiation detection devices that are used to measure or analyze radiation levels or radionuclide concentrations within a sample taken from a site. These detection devices must be able to detect radiation levels or radionuclide concentrations that are a fraction of the applicable Nuclear Regulatory Commission (NRC), EPA, and/or DOE criteria, guidelines, or regulations. Specific guidance for each of these applicable measurements or analyses is presented in the following sections.

2.1 AERIAL RADIOLOGICAL SURVEY

An aerial radiological survey consists of gamma spectral analysis performed from an aircraft flying over a defined area of land at a specified altitude (usually approximately 45 m) in parallel traverses at a specific spacing between traverses (usually approximately 76 m). An NaI(Tl) gamma detection system on the aircraft averages the radiation levels produced by gamma-emitting radionuclides. The result of the survey is a map with superimposed isopleths of gamma exposure rates. This type of survey is used for locating general areas of radiation anomalies over a specified tract of land. This detection system is also able to discern the specific radionuclides causing the radiological anomalies.

2.2 MOBILE GAMMA-SCAN RADIOLOGICAL SURVEY

This type of radiological survey consists of a methodical ground-level gamma-scanning of a property or series of properties by a vehicle equipped with NaI(Tl) detectors and associated analyzers and recorders. A mobile gamma-scanning vehicle has the capability to detect radiation levels statistically different from background levels measured from vehicle-accessible areas. The purpose of a mobile gamma-scanning survey is to accomplish one or more of the following: (1) verify aerial radiological survey results; (2) identify a specific location of radioactivity on the ground as indicated by the aerial radiological survey; and/or (3) identify the location of other radiation anomalies that did not appear on an aerial scan. A mobile gamma scan requires input of pertinent information such as site history, maps, and photographs, and it requires a radiological survey plan prior to initiation of the survey. Section 3.2.2 describes the methodology for the mobile gamma-scanning survey.

2.3 PRELIMINARY RADIOLOGICAL SURVEY

The preliminary radiological survey normally consists of a visit to the candidate site by a RASA contractor. During a preliminary survey, sufficient information should be gathered so that the contractor may recommend that the site be released for unrestricted use or that a comprehensive radiological survey be performed. Occasionally, little information about the radiological condition of a site may be known; in such cases, the function of the preliminary survey is to determine if any contamination exists on the site and, if so, to determine the effort that will be required to perform a comprehensive radiological survey. Once contamination is known to exist on site, or sufficient evidence suggests that contamination probably exists on site, the preliminary radiological survey's purpose is to

1. gather pertinent information such as historical data, maps, diagrams, and photographs;

2. prepare for a comprehensive radiological survey by contacting appropriate local, state, and federal authorities and site owners and/or managers (initial contact with these individuals is made by DOE);

3. gather background measurements and samples if needed; and

4. perform appropriate initial outdoor and/or indoor measurements and sample collection for purposes of planning a comprehensive radiological survey.

2.4 COMPREHENSIVE RADIOLOGICAL SURVEY

The comprehensive radiological survey consists of a visit to the candidate site by RASA contractor personnel. At this time, enough measurements and samples are obtained to fully characterize the radiological condition of that site, including the boundaries of contamination, to support the determination of need for remedial actions. In addition, the comprehensive radiological surveys provide enough information that no further radiological survey work is required before conducting engineering and environmental assessments of possible remedial action options. The specific objectives of a comprehensive radiological survey are to establish if radioactive contamination exists on site and, if so, to determine

1. the radionuclide identity of the contamination;

2. the location of the contamination;

3. the areal and vertical extent of the contamination;

4. an estimate of the volume of contaminated material;

5. the degree of contamination relative to background radiation levels and appropriate regulatory guidelines;

6. the potential for off-site migration of contamination; and

7. data to support estimates of the potential for health effects to residents, employees, and/or the general public.

The survey methodology employed to achieve these specific objectives is described in the following paragraphs.

The process by which a comprehensive radiological survey is conducted is shown in Fig. 2. The comprehensive radiological survey will follow the radiological survey plan prepared for that specific site. Pertinent ancillary information is gathered prior to preparing the survey plan so that historical data, maps, and photographs may be used in planning the survey. To prepare for the comprehensive radiological survey, a preliminary radiological survey may be necessary for viewing the site, making preliminary measurements, and contacting appropriate people. These tasks aid in determining the scope of the survey, selecting the most appropriate instrumentation, and preparing necessary subcontracts. Prior to the radiological survey, it may be necessary to prepare the site by clearing it of debris and vegetation, performing a land survey to determine property boundaries, and/or contracting necessary services (e.g., drillers, ground radar, etc.). Before or during the comprehensive radiological survey, it is necessary to determine background radiation levels to provide a context for comparison of on-site radiation levels. The general methodology of the comprehensive radiological survey is described in the following paragraphs, and the specific methodology is described in Sect. 3.2.

The comprehensive radiological survey is initiated by preparing or adapting a map or diagram of the site. This figure is used for locating all essential features of the site (structures, streams, etc.), visual documentation of radiation levels on site (including contaminated areas), locating samples (water, soil, sediment, etc.), and/or marking

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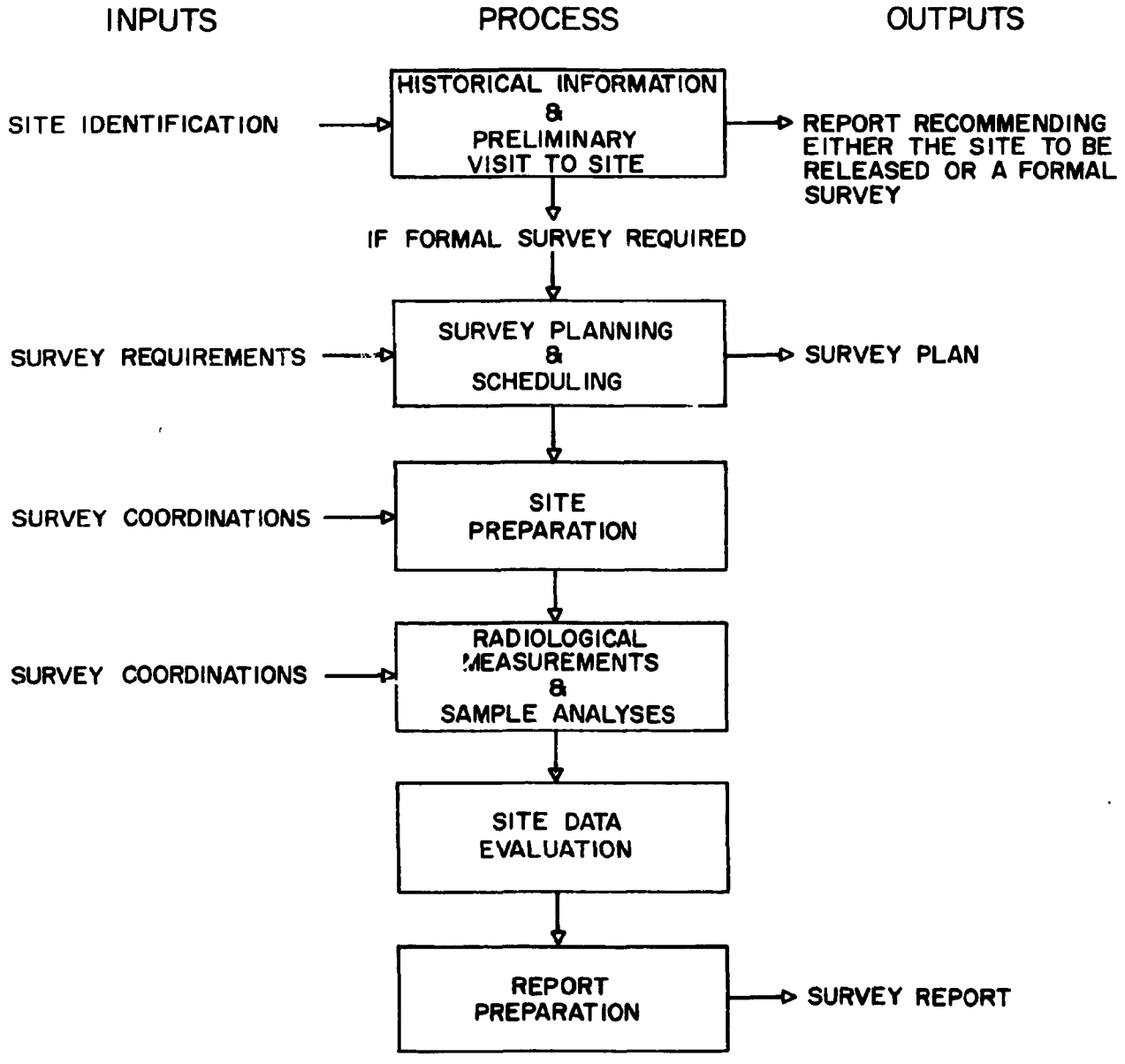

Fig. 2. Process involved in a comprehensive radiological survey.

the progression of the survey. Many of these figures are formalized and presented in the survey report. A grid system may be established for the site and included in the figure to aid in denoting locations of samples, measurements, or areas of contamination.

The survey usually consists of

1. scanning to locate and define areas of anomalous radiation levels (potentially contaminated areas);

2. systematic radiation measurements and samples taken (usually at grid points) to determine average radiation levels on site, so that long-term radiation doses to site occupants can be calculated to estimate potential health effects;

3. biased samples and measurements ("biased" means that samples or measurements are not systematically determined but are influenced by information concerning contamination levels) taken where anomalous radiation levels were observed during scanning to determine the identity of the contamination, to further define the areal extent and magnitude of contamination, and to determine if radiation levels exceed appropriate criteria;

4. subsurface investigations, including drilling, logging, ground-penetration radar, and sampling, to determine the vertical extent of contamination; and

5. taking other measurements or samples (such as radon and radon daughters, vegetation, sediment, etc.) on and off site to meet site- or survey-specific objectives and to determine the potential for off-site migration of radionuclides.

Guideline sensitivities and errors associated with measurements and sample analyses for a comprehensive radiological survey have been established by DOE for the RASA contractor. These levels are listed in Table 1. Specific descriptions of instrumentation, instrument calibration, and instrument operation are provided by the individual RASA contractor.

Table 1. Acceptable sensitivity and error associated with measurements and sample analyses taken for a comprehensive radiological survey

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
External gamma radiation	≤10 μR/h	±25% at 2 σ	Area to be surveyed will be gridded as per procedures described in Sect. 3.2.4. Average and maximum values for each grid block will be determined and reported for 1 m above the surface and at the surface
Beta-gamma[a]			Area to be surveyed will be divided into grid blocks no larger than 1 m^2 (indoors). Average and maximum values will be determined for each grid block and equipment as recommended in ref. 6. Methodology for measurements is described in Sect. 3.2.4
Surface dose rate	≤0.1 mrad/h	±25% at 1 σ	
Surface contamination	<1000 dpm/100 cm^2	±25% at 1 σ	
Removable surface contamination	<1000 dpm/100 cm^2	±20% at 1 σ	
Alpha[a]			Area to be surveyed will be divided into grid blocks no larger than 1 m^2 (indoor measurements). Average and maximum values will be determined for each grid block and equipment as recommended in ref. 6. Methodology for measurements is described in Sect. 3.2.4
Surface contamination	<50 dpm/100 cm^2 for fixed activity	±25% at 1 σ	
Removable surface contamination	<1000 dpm/100 cm^2 for U-nat,[b] U-238, U-235, and decay products	±25% at 1 σ	
	<20 dpm/100 cm^2 for transuranics, Ra-226 and -228, Th-230 and -228, Pa-231, Ac-227, and I-125 and -129	±25% at 1 σ	
	<500 dpm/100 cm^2 for Th-nat and -232, Sr-90, Ra-224 and -223, U-232, and I-126, -131, and -133	±20% at 1 σ	

Table 1. (Continued)

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
Radionuclides in soil	Ideally sensitivity should be such that the detectable limit for a radionuclide is not greater than twice the background concentrations	±50% at 1 σ	Surface and subsurface soil samples will be collected based on a predetermined grid according to procedures described in Sects. 3.2.4 and 3.2.5. Biased samples will be collected in areas where high contamination levels are expected
	If these sensitivities are cost restrictive, detectable limits can be raised with DOE approval to levels no greater than interim or proposed soil limits for a given nuclide:	±50% at 2 σ	
	- for nuclides in the U-238 or Th-232 series, 2 pCi/g	±20% at 2 σ	
	- for plutonium and transuranics, 10 pCi/g	±50% at 2 σ	
	- for Cs-137 and Sr-90, 100 pCi/g	±50% at 2 σ	

[a]This is an NRC guideline for allowable surface contamination. The American National Standards Institute (ANSI) has proposed similar surface contamination guidelines (ANSI N13.12). Although N13.12 (ref. 8) contains information that will be useful to the survey teams, all comparisons of surface contamination to standards will be made to NRC guidelines given in ref. 6 (the surface contamination standard used for the DOE Survey Program).

[b]Natural uranium is defined as uranium found in nature (having natural or normal concentrations of its isotopes). One gram of natural uranium is 0.677 μCi of activity (0.331 μCi of U-238, 0.331 μCi of U-234, and 0.015 μCi of U-235).

[c]Practicality depends on availability of the sample and on time and cost constraints.

Table 1. (Continued)

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
Radionuclides in air			Air monitoring will be conducted at all indoor facilities where there is potential for the presence of airborne radioactivity and outdoors where necessary. Monitors will be selected, tested, calibrated, and placed, and samples will be analyzed in accordance with the general guidance contained in DOE Order 5480.1. Sampling procedures are discussed in Sect. 3.2.8
Radon	1 pCi/L	±50% at 2 σ	
Radon daughters	≤0.005 WL	±50% at 2 σ	
Transuranics	≤40 fCi/m^3	±50% at 2 σ	
All others	≤50% CG_w for uncontrolled areas (Column 1, Table 2, Attachment XI-1 of DOE Order 5480.1 or Column 1, Table II, Appendix B of 10 CFR 20) and as near to background concentrations as practical[c]		
Radionuclides in water			Surface or ground water samples will be obtained at locations where there is potential for waterborne contamination. The number and location of sampling points will depend on site-specific factors. Sampling procedures are discussed in Sect. 3.2.8
Gross alpha	≤15 pCi/L (excluding radon and uranium)	±50% at 2 σ	
Radium	≤3 pCi/L	±50% at 2 σ	
Other radionuclides	≤50% CG_w for uncontrolled areas (Column 2, Table 2, Attachment XI-1 of DOE Order 5480.1 or Column 1, Table II, Appendix B of 10 CFR 20) and as near to background concentrations as practical[c]	±50% at 1 σ	

Once the comprehensive radiological survey is completed, the site is restored to the condition in which it was found prior to the survey (i.e., fill all holes, remove grid markers, etc.). Following the survey and analyses of samples, a complete report, including measurement and sample analytical results, estimates of volume of contaminated material, and potential health effects, will be submitted to DOE for review in a reasonable period of time. After the review comments are incorporated, a final report of the comprehensive radiological survey will be submitted to DOE by the RASA contractor.

2.5 REMEDIAL ACTION RADIOLOGICAL SURVEY

The purpose of the remedial action radiological survey is to gather enough radiological information to confirm the success of the remedial action in reducing radiation exposure to levels within the appropriate regulatory criteria. The RASA contractor may use any level of effort necessary to achieve this goal. It may be sufficient merely to perform an audit of the remedial action radiological contractor records, or a process as extensive as a comprehensive radiological survey may be required during and after remedial action. The level of effort required will be decided on a site-by-site basis by DOE. However, the radiological contractor supporting the remedial action should perform a radiological survey equivalent to the one described below. As a general rule, the more comprehensive the survey performed by the remedial action contractor, the less on site work will be required for the RASA contractor. If remedial action is performed at a site, DOE determines whether or not a remedial action survey is required. If required, the remedial action survey has two phases. A running audit of the results of cleanup activities may or may not be conducted during remedial action, prior to site restoration, to verify the effectiveness of the remedial action and to provide a basis for site certification. Following restoration, a post-remedial action audit may or may not be performed to verify that the radiological contamination has been reduced to the level specified by the remedial action plan and to the appropriate radiological guidelines. Data from these surveys and other records are then given to DOE to support a determination of proper disposition of the site. During

the running audit, the radiological measurements and analyses of the environmental samples are performed in conjunction with activities of the radiological contractor directly associated with cleanup of the property. The work is performed to verify (or refute) the conclusion by the radiological contractor that the contamination has been adequately reduced to meet criteria. After completion of remedial actions at the site, additional radiological measurements and, perhaps, environmental samples may be obtained and evaluated to ensure that the remedial action objectives have been achieved. These data, together with those obtained during the running audit, are used to provide the necessary reports to DOE. The running audit and the post-remedial action audit will be conducted in accordance with elements of the generic plans for the two types of survey activities.

Figure 3 shows the process by which a remedial action radiological survey is conducted. Before on-site work is initiated during the remedial action activities, the remedial action plan and criteria to be used to release the site are reviewed, and a plan to perform the survey is prepared. The survey plan will normally include provisions to conduct the radiological measurements and sample analysis program in concert with the designated radiological contractor for the property. Before or during the radiological survey, appropriate background radiation levels will be determined. When all necessary plans and schedules have been finalized, a radiological survey may be conducted as required. This survey will be performed after decontamination operations are complete but before restoration. The methodology for conducting the survey concurrent with remedial action (running audit) is described in the following paragraphs.

The radiological measurements and samples will be collected relative to a grid system, which has been prepared for the area. A grid system consists of mutually perpendicular lines spaced at equal intervals. The intersections of these grid lines are

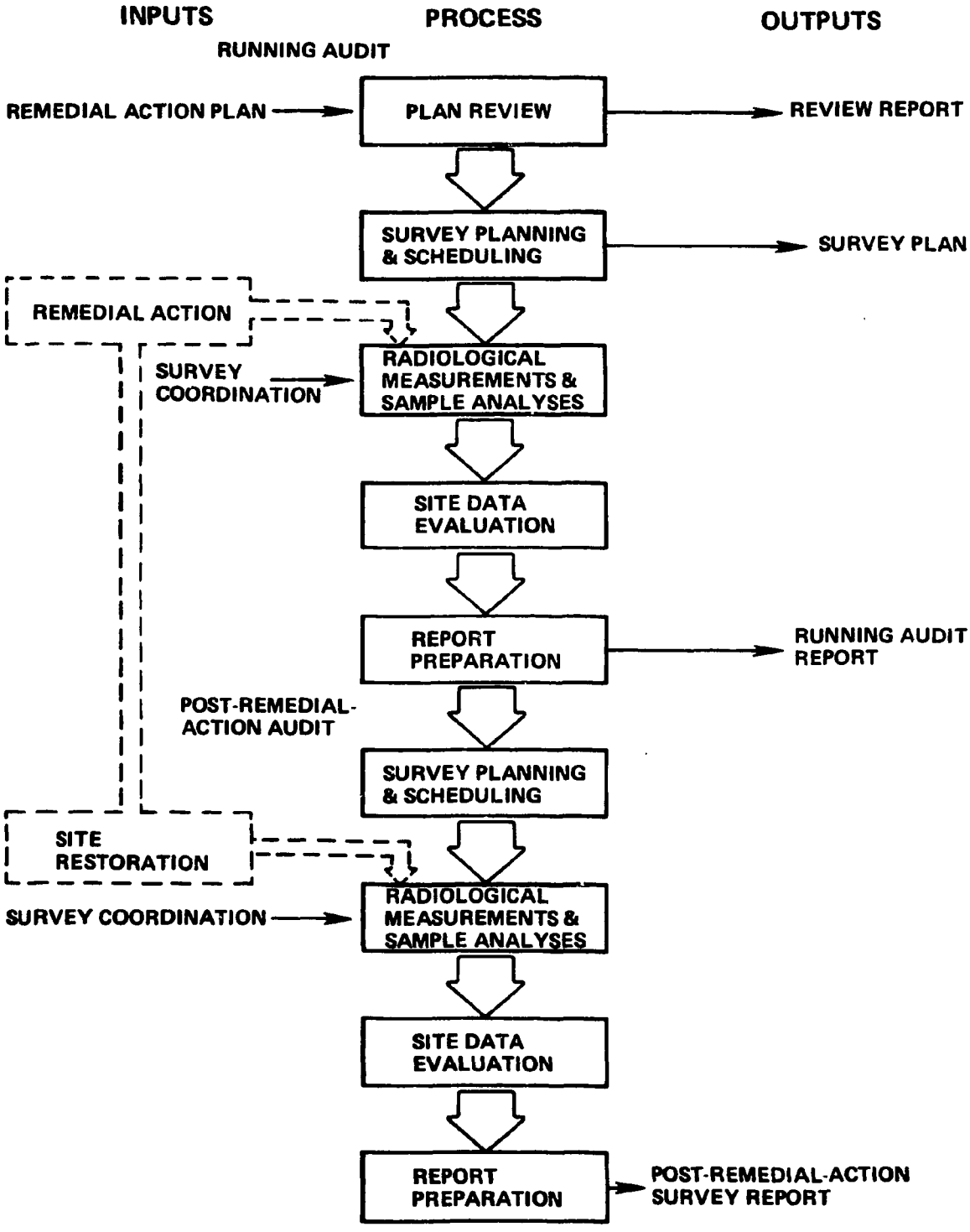

Fig. 3. Process by which a remedial action radiological survey is conducted.

referred to as grid points. The smallest squares enclosed by the grid lines are called grid blocks.

A contiguous collection of grid blocks comprises a grid area. The grid area is the functional unit used to assess the adequacy of remedial action. The grid area considered appropriate for a remedial action survey is 100 m^2. For decontaminated areas of 100 m^2 or larger, a 2.5-m grid system may be used (e.g., the grid lines will be 2.5 m apart). For areas less than 25 m^2, a 1-m grid system may be used. For intermediate areas (25 to 100 m^2), the grid system can be adjusted to provide at least 25 grid blocks for the area. The grid system will include the surface area, the walls where contaminated materials have been removed, and the foundation walls of any building within the grid.

Each grid block within a grid area will be scanned (see Sect. 3.2.3) by the appropriate scanning instrument (e.g., gamma scintillator). The maximum measurement found within each grid block will be recorded. If samples are appropriate, such as required over an excavated soil surface, then the gamma scan measurements will be evaluated in the following manner. One sample will be obtained from the location of the highest reading from the gamma scan measurements (or in some prespecified manner if measurement results are uniform). That sample will be analyzed for radionuclide concentration. If the radionuclide concentration meets appropriate criteria, no further sampling is necessary from that area. Justification for this conclusion is that if the soil with the maximum concentration of radionuclide meets the criteria, then the average for the area will meet the criteria. It is assumed that any remedial action has removed the contaminated material from the area down to the noncontaminated surface interface and that any contaminated material is on the surface of the area scanned. The uncertainty inherent in this method arises from the uncertainty in the strength of association of ^{226}Ra surface contamination (e.g., soil) and gamma radiation levels near the surface. Generally, a high correlation exists between these two quantities, but this correlation should be tested at each site by frequent comparison of sample content and radiation level.

If the radionuclide content of the sample taken at the maximum gamma level exceeds criteria, or if the correlation between gamma levels and ^{226}Ra levels is found to be low, one sample should be taken from

each grid point in the area. Each sample will be aliquoted if necessary, the aliquots composited and uniformly mixed. The composite sample will be analyzed for radionuclide concentration. If the radionuclide concentration meets appropriate criteria, no further action is necessary for that area. If the radionuclide content of the sample exceeds criteria, further remedial actions for that area are necessary. This procedure will be repeated as necessary following completion of the removal of contaminated materials.

The sampling procedure will be conducted in concert with the radiological contractor responsible for conducting the remedial action for a site. The RASA contractor will collect duplicate samples at locations near samples collected by the remedial action radiological contractor for independent analysis. The number of duplicate samples will be determined by the RASA field team leader. A number of split samples (aliquots from the same sample) will also be obtained and will undergo detailed laboratory analysis to compare the analytical sample results with those of the remedial action radiological contractor.

The remedial action audit for decontaminated areas is scheduled to be performed following the completion of site restoration activities. The radiological measurements and samples outdoors and in large indoor rooms will be referenced to a grid system for the decontaminated area. The grid size will be adjusted to provide 30 grid blocks for the sampling area, but the distance between grid lines should not be more than 10 m or less than 1 m. The RASA contractor will select the appropriate measurements and samples using the methodology described in Sect. 3.2.

Guideline sensitivities and errors associated with measurements and sample analyses for a remedial action radiological survey have been established by DOE for the RASA contractor. These levels are shown in Table 2. Specific descriptions of instrumentation, instrument calibration, and instrument operation are supplied by the individual RASA contractor.

Table 2. Acceptable sensitivity and error associated with measurements and sample analyses taken for a remedial action survey

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
External gamma radiation	$\leq$10 μR/h or the most restrictive applicable standard	$\pm$10% at 2 σ	Area to be surveyed will be gridded as per procedures described in Sect. 3.2.4. The range of values for each grid block will be determined and reported for 1 m above the surface and at the surface
Beta-gamma			Area to be surveyed will be divided into grid blocks no larger than 1 m^2 (indoors). The range of values will be determined for each grid block and equipment as recommended in ref. 6. Methodology for measurements is described in Sect. 3.2.4
Surface dose rate	$\leq$0.1 mrad/h	$\pm$20% at 1 σ	
Removable surface contamination	<1000 dpm/100 cm^2	$\pm$20% at 2 σ	
Alpha			Area to be surveyed will be divided into grid blocks no larger than 1 m^2 (indoor measurements). The range of values will be determined for each grid block and equipment as recommended in ref. 6
	Instruments should be capable of measuring within 80% of the levels stated in ref. 6[b] and/or levels defined in EPA's proposed guidelines for transuranics (EPA 520/4-77-016) for fixed and removable surface contamination	$\pm$20% at 2 σ	

Table 2. (Continued)

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
Radionuclides in air			Air monitoring will be conducted at all indoor facilities where there is potential for the presence of airborne radioactivity and outdoors as required. Monitors will be selected, tested, calibrated, and placed, and samples will be analyzed in accordance with the general guidance contained in DOE Order 5480.1. Sampling procedures are discussed in Sect. 3.2.8
Radon	1 pCi/L	±50% at 2 σ	
Radon daughters	<0.005 WL (indoors)	±50% at 2 σ	
Transuranics	<40 fCi/m^3	±20% at 2 σ	
Other nuclides	≤80% CG_w for uncontrolled areas (Column 1, Table 2, Attachment XI-1 of DOE Order 5480.1 or Column 1, Table II, Appendix B of 10 CFR 20)	±20% at 2 σ	
Radionuclides in water			Surface or ground water samples will be obtained at locations where there is potential for waterborne contamination. The number and location of sampling points will depend on site-specific factors. Sampling procedures are discussed in Sect 3.2.8
Gross alpha (excluding radon and uranium)	<15 pCi/L	±20% at 2 σ	
Radium	≤3 pCi/L	±50% at 2 σ	
Other radionuclides	≤80% CG_w for uncontrolled areas (Column 2, Table 2, Attachment XI-1 of DOE Order 5480.1 or Column 1, Table II, Appendix B of 10 CFR 20)	±20% at 2 σ	

Table 2. (Continued)

Measurement or sample	Sensitivity	Error and confidence level	Procedure or methodology
Radionuclides in soil	≤50% of the concentration of radionuclides as defined in the site-specific remedial action criteria	±20% at 2 σ	Surface and subsurface soil samples will be collected based on a predetermined grid according to procedures described in Sect. 2.4.1. Biased samples will be collected in areas where high contamination levels are expected
Analysis of split samples from the remedial action contractor	≤50% of the defined remedial action criteria concentrations	±20% at 2 σ	Analyses will be performed utilizing the same techniques and procedures used on samples collected by the DOE radiological survey contractor. Results will be compared to the remedial action contractor results as well as to the criteria to verify their results

[a]The detail of measurements required for a remedial action survey will depend on the adequacy of the remedial action contractor's survey for certification.

[b]This is an NRC guideline for allowable surface contamination. The American National Standards Institute (ANSI) has proposed similar surface contamination guidelines (ANSI N13.12) (ref. 8). Although N13.12 contains information that will be useful to the survey teams, all comparisons of surface contamination to standards will be made to NRC guidelines given in ref. 6 (the surface contamination standard used for the DOE Survey Program).

Following the survey and analyses of samples, a complete report of all measurement and sample analytical results and a discussion of the significance relative to remedial action criteria will be submitted to DOE for review in a timely manner. Review comments will be included in a final report of the remedial action radiological survey to be submitted to DOE by the RASA contractor.

3. GENERIC RADIOLOGICAL SURVEY METHODOLOGY

This section describes the radiological survey methodology employed during the various types of surveys discussed in the previous section. These descriptions are generic; specific descriptions of instrumentation and survey procedures are supplied by the individual RASA contractor.

3.1 PREPARATION PRIOR TO RADIOLOGICAL SURVEY

It may be necessary for the RASA contractor to perform a number of activities prior to the radiological survey of a site. This section describes the scope and objective of these activities.

3.1.1 Information Relevant to Survey

Before planning survey activities at a site, the RASA contractor must assemble and review any documents, maps, diagrams, or photographs that may be relevant to performing the radiological survey. The purpose in gathering this information is to

1. limit the extent of the survey by selecting those survey methodologies most appropriate to past, present, or future radiological activities conducted at a site;

2. prevent redundancy in measurements or locations to be surveyed; and

3. provide information to facilitate or supplement the radiological survey.

This process may require gathering of information or review of a document (such as required during the review of the remedial action plan prior to performing a remedial action survey). Examples of pertinent information that might be required are

1. relevant historical documents of radiological activities at a site;

2. previous aerial or ground-level radiological surveys;

3. documents of ownership;

4. maps, diagrams and photographs;

5. geological, hydrological, topographical, or meteorological data; and

6. relevant local, state, or federal activities that are planned for the site.

This information may be obtained from previous or current site owners, official documents, or reputable sources. Often much of this information is provided directly by DOE.

3.1.2 Radiological Survey Plan

The radiological survey plan, a document written by the RASA contractor, summarizes pertinent ancillary information about a site to be surveyed and presents a detailed description of the application of those specific survey methodologies anticipated to be used during the radiological survey.

Before any activities are conducted on a property, the property's owner or controlling agency is contacted by a representative of DOE. The appropriate individual is informed by the DOE representative of the

potential for radioactive contamination on the property and the nature of the work to be performed to determine the presence and/or location and extent of radioactive contamination. The DOE representative will obtain formal consent from the property owner or controlling agency before any survey activity on the property.

A number of activities may be required to be performed on or near the site in preparation for a radiological survey. The functions of these preparations are specific to the task, and the activity required is dictated by the survey plan (i.e., if the survey plan requires subsurface investigations, it may be necessary to secure the services of a local subcontractor to auger holes on the site during the radiological survey). The following preparatory activities may be performed by the RASA contractor or a local subcontractor, either before or concurrent with the radiological survey, depending on the activity and survey plan. Preparation activities for a radiological survey could include

1. clearing of vegetation and rubble prior to an outdoor survey;

2. cleaning and clearing a building prior to an indoor survey;

3. a land survey to establish a measurement grid system and property boundaries and to prepare maps;

4. securing drilling and auger contractors for subsurface investigations or placement of water monitor wells;

5. securing a ground-penetrating radar contractor for locating subsurface features and potential hazards during subsurface investigations;

6. securing technical support personnel to supplement the RASA contractor personnel;

7. sample preparation support for preparation of soil, water, or other samples that require analyses;

8. contacting local utilities to locate potential gas, water, sewer, telephone, and power lines on site;

9. contacting local, state, and/or federal health officials;

10. contacting local political representatives (i.e., mayor, councilman, etc.) if deemed necessary to DOE; and

11. contacting appropriate site owners, managers, residents, or employees to coordinate survey scheduling.

3.2 SURVEY METHODOLOGY

This section describes various types and functions of activities that might be performed during a radiological survey.

3.2.1 Background Measurements and Samples

Background measurements and samples are collected to provide baseline data to compare with measurements and data collected at a site. Background measurements and samples should be site- or area-specific, and for each type of measurement or sample taken on a survey, a comparable reference background radiation level should be known. These background radiation levels may be determined by consulting an appropriate, reputable document, or the RASA contractor may take readings either before or during the radiological survey of the site. A measurement or sample would be considered to be at background only if it were taken from an area not affected (or as nearly so as possible) by anthropogenic sources of radioactivity, excluding fallout. Although no minimum number of background measurements and samples of each type is specified, the number should be large enough to be representative. These background radiation levels should be presented in the radiological survey report and should be contained in the discussion of the radiological survey results.

3.2.2 Mobile Gamma-Scanning Measurements

The RASA contractor uses mobile gamma scanning to identify properties containing anomalous radiation levels without going on site. Mobile scanning is typically accomplished using large-volume, collimated NaI(Tl) gamma scintillators in conjunction with data handling systems capable of correlating the count rate data obtained with appropriate location information. The instrumentation is housed in a standard over-the-road vehicle that can be driven through city streets, alleys, highways, and other public means of access.

The mobile system identifies radiation anomalies by comparing the instantaneous count rate information with a background level established for the area being scanned. Various methods of data analysis are used to discriminate for the radionuclide contaminants of concern; these include multichannel analysis capabilities and statistical analysis of the input data. Documentation of scanning survey results is typically in the form of strip charts or computer-generated data summaries.

Mobile scanning from roadways requires that vehicle travel speed and source-to-detector distance be kept to a minimum for optimum results. This is accomplished by driving the vehicle next to the street curb and maintaining scanning speeds of less than 5 mph. In areas to be scanned, all accessible roads would be traversed, and properties would be scanned from as many views as possible (e.g., front, alley, and side streets). When access to properties can be gained from other public areas (e.g., parking lots), additional scans are taken.

3.2.3 Scanning Measurements

Scanning is the process by which the RASA contractor uses portable radiation detection instrumentation to methodically measure the radiation levels of a surface (i.e., ground, wall, floor, equipment, etc.). The purpose of scanning is to locate and define the areal extent of radiation anomalies. Scanning may be performed for alpha, beta, beta-gamma, low-energy X, and gamma radiations. The type of measurement, suitable portable instrumentation, and the specific methodology to perform the measurement are selected by the individual RASA contractor as dictated by the type of radioactive contamination present, the

instrumentation available, and the degree of surface coverage needed to meet the objectives of the survey plan. Scanning is performed by moving the survey probe slowly over a surface until the entire surface has been covered. It should be noted that the detector response is directly dependent on the scanning rate. Contaminated material may be overlooked if the rate of scanning is too rapid for the detector output. Thus, the survey methodology must be carefully selected for specific conditions. During surface scanning, the probe should be kept as close to the surface as possible. Any significant changes in radiation levels above background, either by visual changes in the instrument ratemeter or, more typically, in the pitch of audio response in the instrument headphones, are noted. These radiation anomalies are further investigated by the use of locationally biased measurements and sampling, which further define the extent and magnitude of contamination.

3.2.4 Systematic Measurements and Samples

If a grid system has been established over an area, discrete radiological measurements or samples may be taken at the grid points. The purpose of these measurements or samples is to provide definitive radiation levels at precisely defined locations. Furthermore, these measurements permit the calculation of average radiation levels within a given area (by averaging the individual measurements or sample analytical results) for purposes of comparison with other areas or to estimate potential health effects to people occupying that area. Grid point measurements may include alpha, beta, beta-gamma, low-energy X, or gamma radiation, and samples typically include soil and routine surface smears. The type of measurement, suitable portable instrumentation, and specific methodology to perform the measurement are again selected by the individual RASA contractor as dictated by the type of contamination present, the instrumentation available, and the objectives of the radiological survey. The grid point measurement is taken by placing the instrument at the appropriate distance above the surface, taking a discrete measurement for some time interval (i.e., instantaneous, 10 s, 60 s, etc.), and recording the measurement. The desired type of sample is obtained as near to the grid point as reasonably possible; then it is labeled and removed for the appropriate analyses.

3.2.5 Biased Measurements and Samples

At locations where anomalous radiation levels are observed or suspected, biased radiological measurements and samples may be taken ("biased" indicates that the locations are not chosen on a random or systematic basis). The purposes of these measurements and samples are to further define the areal extent of potential contamination and to determine maximum radiation levels within an area. Biased measurements may include alpha, beta, beta-gamma, low-energy X, or gamma radiations; however, at these locations these measurements may also be supplemented with other types of atypical measurements such as radon flux or gamma spectrographic measurements. Air, water, soil, and smear samples may typically be taken at these locations; samples of vegetation, radon flux measurements, or sediment samples may be appropriate. Biased measurements and samples are obtained in the manner specific to the individual RASA contractor's methodology; the locations are selected to best define the areal limits of the anomalous radiation levels. All sample and measurement locations and results are recorded. The type of biased measurements and samples taken and the methodology used to perform those activities will be selected by the individual RASA contractor within the limitations of instrumentation, site conditions, and survey objectives.

3.2.6 Subsurface Measurements and Samples

Subsurface investigations consist of measurements and samples taken beneath the ground or floor surface. The purpose of these investigations is to locate subsurface contamination and define the vertical extent of the contamination. These investigations are conducted by excavating the floor or ground surface (by trenching, augering, coring, shoveling, or other means) to depths that are either below a contaminated soil layer or to a natural formation (beneath anthropogenic filling activities). The subsurface investigations may include logging or scanning of the vertical surfaces with alpha, beta, beta-gamma, low-energy X, and shielded or unshielded gamma radiation detection instrumentation.

Excavated material or material from the sides of the vertical walls may be sampled for radionuclide analyses, and water or air in the excavated hole may be sampled for radionuclide content. The number of excavations and the type of measurements or samples to be obtained with appropriate specific methodology to be used will be selected by the individual RASA contractors based on the type of contamination present, limitations in field conditions, type of instrumentation available, and objectives of the survey plan.

3.2.7 Radon and Radon Daughter Measurements

At sites contaminated with materials of the naturally occurring uranium, thorium, and/or actinium decay chains, it may be necessary to sample for radon and radon daughter concentrations in air. The purpose of these measurements is to determine instantaneous or short-term concentrations inside structures on a site to determine the need for long-term radon and radon daughter monitoring.

When contaminated material has been located within, beneath, or near a structure on a survey site, the RASA survey contractor will make instantaneous or short-term radon and radon daughter measurements inside the basement and/or ground level of the structure. Based on the results of these measurements and the proximity and magnitude of contamination, the RASA survey contractor will prepare a list of locations that are suspected of harboring radon/radon daughter concentrations at levels in excess of background (attributable to the presence of contaminated material) and will submit those identified sites to DOE. At that point, DOE will assess the need for long-term radon and radon daughter measurements and assign a RASA contractor to these sites. Data gathered by the RASA contractor will be used for estimates of potential health effects to site occupants. This will replace short-term radon/radon daughter measurement data used by the RASA survey contractor for immediate estimates of potential health effects.

Radon and radon daughter measurements may be taken by a variety of methods, over various time intervals, using instrumentation specific to the RASA contractor's radiological survey objectives and limitations. To typify radon and radon daughter concentrations, measurements are usually taken indoors in high-occupancy areas when the structure has not

been deliberately vented or closed. Although individual measurement results are reported (in a table or appendix in the survey report), indoor air concentration values are generally averaged for the radiological survey report.

3.2.8 Other Measurements and Samples

Other (atypical) measurements, samples, and/or methodologies may be required to fulfill the design objectives of the radiological survey. Many of the measurements and samples considered in this section are essential for determining long-term health effects to the public from environmental pathways. The measurement or sample type selected is specific for the site, for the radionuclide, and for the long-term health effect of concern. These activities are selected by the RASA contractor either during the preparation for the radiological survey or as extraordinary conditions arise during the survey. Often these samples or measurements are collected to indicate potential migration of contaminated material from a site. Atypical measurements may include

1. measurement of radon flux rates;

2. alpha or gamma spectrographs of surfaces, air, or liquids to identify the type of contamination;

3. measurement of alpha, beta, or gamma activity in drains, pipes, or equipment; and

4. measurement of chemical, hydrological, or meteorological conditions on or near a site.

Atypical samples may include

1. long-lived radionuclide content in air or air particulate samples;

2. alpha, beta, or gamma activity or radionuclide content in water or water particulate samples;

3. alpha, beta, or gamma activity or radionuclide content in building equipment or construction materials or process products;

4. radionuclide content of off-site water and sediment samples from sources of standing or running surface water; and

5. radionuclide content of samples from the food chain, such as vegetation, dairy or poultry products, fruits, and meats.

Purposes, methods, and results of these atypical samples and measurements will be reported or referenced in the survey report.

4. SURVEY REPORT

Upon completion of the radiological survey, the RASA contractor prepares and submits to DOE a preliminary report, which summarizes significant findings of the survey. The RASA contractor also prepares a complete radiological survey report to present, in an understandable format, the complete survey results and all information and data relevant to past and present radiological conditions of a site. The report is intended for use by DOE, engineering contractors, property owners, and/or appropriate public bodies (e.g., congressional staffs, health agencies, etc.).

These reports, which are produced in a timely manner following completion of all measurements and sample analyses, are submitted to DOE in draft form. DOE returns comments to the RASA contractor, who addresses them by revising the report or by responding in writing to DOE. After the radiological survey report is revised, the RASA contractor submits the final report to DOE.

Formats for the various types of radiological Appendix B. The report formats are generic and are adapted to site- and survey-specific conditions by the RASA contractor.

REFERENCES

1. U.S. Department of Energy, A Background Report for the Formerly Utilized Manhattan Engineer District/Atomic Energy Commission Sites Program, DOE/EV-0097A (September 1980).

2. U.S. Department of Energy, Background Report for the Uranium Mill Tailings Sites Remedial Action Program, DOE/EP-0011 (April 1981).

3. U.S. Atomic Energy Commission, Summary Report Phase I Study of Inactive Uranium Mill Sites and Tailings Piles (October 1974).

4. U.S. Environmental Protection Agency, "Final Cleanup Standards for Inactive-Uranium Processing Sites," 40 CFR 192, Fed. Regist. 48, No. 3 (January 5, 1983).

5. U.S. Nuclear Regulatory Commission, "Standards for Protection Against Radiation," 10 CFR 20, Fed. Regist. Vol. 47, 41337 (Sept. 20, 1982).

6. U.S. Nuclear Regulatory Commission, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material (November 1976).

7. National Academy of Sciences, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: 1980, (BEIR III) (1980).

8. American National Standards Institute, Draft National Standard Control of Radiation Surface Contamination on Materials, Equipment, and Facilities to be Released for Uncontrolled Use, N13.12 (1978).

9. U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," 40 CFR 141, Fed. Regist. 41, No. 133 (July 6, 1976).

APPENDIX A

APPLICABLE GUIDELINES FOR

PROTECTION AGAINST RADIATION

Table A.1. Applicable guidelines for protection against radiation

Mode of exposure	Exposure conditions	Guideline value	Guideline sources
External gamma radiation	Continuous exposure to individual in general population (whole body)	60 μR/h	Nuclear Regulatory Commission (NRC)--Standards for Protection Against Radiation (10 CFR 20.105)[a]
	Indoor gamma radiation level (above background)	20 μR/h	Environmental Protection Agency (EPA)--Environmental Protection Standards for Uranium Mill Tailings (40 CFR 192.12)[b]
Surface alpha contamination	^{226}Ra contamination fixed on surfaces	100 dpm/100 cm^2	NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material[c]
	Removable ^{226}Ra contamination	20 dpm/100 cm^2	
Surface beta contamination	Removable beta-gamma emitters	1000 dpm/100 cm^2	NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Terminaton of Licenses for Byproduct, Source, or Special Nuclear Material[c]
Beta-gamma dose rates	Surface dose rate averaged over not more than 1 m^2	0.20 mrad/h	NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material[c]
	Maximum dose rate in any 100-cm^2 area	1.0 mrad/h	
Exposure to radon	Maximum permissible concentration of ^{226}Rn in air in unrestricted areas	3.0 pCi/L	NRC, 10 CFR20.103, Appendix B, Table II[a]
	Average annual radon daughter concentration (including background)	0.03 WL	EPA, 40 CFR 192.12[b]

Table A.1. (Continued)

Mode of exposure	Exposure conditions	Guideline value	Guideline sources
Radionuclides in water	Maximum permissible concentration of the following radionuclides in water for unrestricted areas:		NRC, 10 CFR 20.103, Appendix B, Table II[a]
	^{226}Ra	30 pCi/L	
	^{238}U	4 x 10^4 pCi/L	
	^{230}Th	2 x 10^3 pCi/L	
	^{210}Pb	100 pCi/L	
	Maximum contaminant level of combined ^{226}Ra and ^{228}Ra in drinking water	5 pCi/L	EPA--National Interim Primary Drinking Water Regulations (40 CFR 141)[d]
Radium concentration in soil	Average concentration of ^{226}Ra (above background)	5 pCi/g in top 15 cm	EPA, 40 CFR 192.12[b]
		15 pCi/g in any 15 cm below top 15 cm	

[a] ref. 5.
[b] ref. 4.
[c] ref. 6.
[d] ref. 9.

APPENDIX B

RADIOLOGICAL SURVEY REPORT FORMATS

Aerial Radiological Survey Report Format

AERIAL RADIOLOGICAL SURVEY REPORT FORMAT

I. Summary of Results

The aerial radiological survey and a concise summary of the results describe the area surveyed and the date of the survey. Results of the survey are described and compared with natural background radiation levels for that same area.

II. Introduction

This section contains background information for the aerial radiological survey. It describes where and when the survey was conducted, the survey methodology (i.e., how high the aircraft flew, the width of the traverses across the area, etc.), and how the survey results are reported.

III. Background Radiation

This section briefly discusses the natural radiation environment. The discussion includes sources of natural radiation and typical radiation levels observed throughout the United States and the area of interest.

IV. Survey Boundaries

This section contains an exact description of the confines of the area surveyed and any unusual geographical features affecting the survey.

V. Survey Results

The specific survey results in this section are given in figures showing isoradiation contours overlaid on an aerial photograph. This section describes the significant results of the aerial survey. If any anomalous radiation levels were observed during the survey, they are located and compared with background radiation level and the radioisotopes causing the anomalous radiation level are identified.

PRELIMINARY SURVEY RESULTS REPORT FORMAT

I. Introduction

This section includes

A. the purpose of the survey;

B. when the survey was conducted and by whom;

C. what site was surveyed; and

D. a brief history of the site or, if it is a vicinity property, a history of the associated candidate site (include process history if appropriate).

II. Survey Methods

This section includes and/or references appendices or documents that give

A. details of the survey plan for the site and

B. details of the survey instrumentation and sample analysis methods employed.

III. Survey Results

A brief summary of the significant findings of the radiological survey is included in this section. It should give following information:

A. a description of the area surveyed including the size of the area surveyed, the size and description of any structures located on the site, and the size of any grid system established over the property for survey purposes;

B. a written summary of radiation measurements on site including average onsite radiation levels and location and magnitude of maximum radiation levels encountered on a site for both outdoors and inside structures (if any);

C. a table summarizing range and average of radiation measurements (this table may include estimates of the area, depth, and volume of suspected contamination);

D. a figure showing radiation levels at grid points (if appropriate);

E. a figure showing location of suspected onsite contamination; and

F. a brief narrative discussing any significant increase in potential health effects to site occupants related to onsite radioactive contamination and recommendations for the need and type of additional survey activities (if any).

IV. References

Any documents referenced should be listed.

Preliminary Survey Results Report Format

Mobile Gamma Scan Radiological

Survey Report Format

MOBILE GAMMA SCAN RADIOLOGICAL SURVEY REPORT FORMAT

I. Introduction

This section includes

A. a brief description of the candidate site and the surrounding area,

B. a review of pertinent historical survey information as it applies to the scanning activities, and

C. a brief statement outlining the scope of mobile scanning in the area.

II. Survey Methods

This section briefly describes the instrumentation, data analysis techniques, and scanning methods used for the survey.

III. Survey Results

This section includes

A. a detailed description of the scope of the survey including listings or figures showing areas of town and/or streets surveyed and details of any correlations performed with previous survey results, and

B. a discussion of the results of scanning efforts in terms of the background levels established, range of data observed, and any data highlights that require special attention. The scan results are presented in tabular form in terms of the specific locations of radiation anomalies found.

IV. Significance of Findings

This section will summarize the results of the scanning effort and suggest a prioritized listing of all properties suggested for future survey consideration. Priorities are established based on (1) mobile scanning results, (2) historical radiological survey results (where available), and (3) the current or planned land use conditions. Vicinity properties that exhibit gamma exposure rates significantly above background and are occupied or have the potential for human occupancy are listed as high priority. Properties where public exposure is expected to be minimal are recommended for medium or low priority, depending on the land use and/or property location.

PRELIMINARY RADIOLOGICAL SURVEY REPORT FORMAT

The size of the preliminary survey report is flexible, but it should contain three to six pages of text, a minimum of two figures (one showing the general location of the site and another more detailed diagram showing buildings, locations of measurements taken, solid and water samples collected, etc.), and any pictures of the facility that support the findings of the report. Pertinent historical data, such as previous surveys or certifications, should be referenced or appended to the report.

The report should be divided into four basic sections (Introduction, Site Description, Description of Survey Procedures and Results, and Conclusions and Recommendations) and the appendices.

I. Introduction

This section of the report should explain the purpose of the survey and when and by whom it was conducted. A brief discussion of the MED and/or AEC contract work conducted at the site or associated with the site contamination should be included. Ideally, the material processed at the site, its sources, and its destinations should be included as well as any records of previous surveys or decontamination efforts. The location of any equipment or decontamination and/or process residues should be reported.

All reports should contain a map with enough detail that the facility can be located on a published street map. Any pictures or diagrams relating to the former MED and/or AEC operations may be included here or, if they are too voluminous, appended to the report and referenced here.

II. Site Description

This section contains a brief description of the site in its present condition and information on the use of the grounds, buildings, and any equipment used for the MED/AEC operations. In addition, information regarding occupancy of the buildings and grounds (especially for

any contaminated areas) should be presented. Any known planned changes or anticipated future uses of the site should be outlined. It would also be desirable to describe the environs of the site (i.e., neighboring properties) in this section.

A diagram of the facility could be included if it would aid in the description of the site. Owners and/or company contacts and those assisting the contractor in the survey effort should be mentioned here as well.

III. Description of Survey Procedures and Results

A very brief description of the survey equipment and methodology should be presented; however, this section should emphasize results rather than procedures. The text should summarize radiation levels found at the site and background levels found nearby. Diagrams showing areas of the buildings or ground surveyed are to be included in this portion of the report. Detailed measurements should be placed on the diagram of the facility or in a table referenced to the diagram. Similar reporting procedures should be followed for soil and water samples, including the comparison to background concentrations.

IV. Conclusions and Recommendations

This section should summarize the findings and recommendations of the survey contractor. The following questions should be answered here.

A. Was any contamination found; if so, how does it compare to standards?

B. Is there any foreseeable present or potential health hazard?

C. Are any additional surveys required; if so, why?

D. Do any conditions at this site require special consideration on the part of DOE?

Preliminary Radiological Survey Report Format

For the most part, sites surveyed should fall into two categories, those requiring comprehensive surveys (contaminated or possibly contaminated) and those requiring no additional surveys [radiologically clean sites or controlled (i.e., licensed) sites]. However, it is anticipated that situations will arise where the preliminary survey identifies a very isolated spot of contamination, such as in a drain or on a lab bench. If this occurs, the contractor should carefully assess the need for additional survey work. He should evaluate the benefits of a comprehensive survey, determine if the history is suggestive of hidden contamination, and based on these findings determine if any additional useful data would be obtained through the comprehensive survey effort. If the contractor believes that a comprehensive survey would not produce useful information, but that the isolated contamination found in the preliminary survey should be removed, he should indicate this in the report. He should make a recommendation that no additional surveys be conducted but that a remedial action be prepared for the designation package so it can be used by DOE in planning the remedial action.

COMPREHENSIVE AND POST-REMEDIAL ACTION RADIOLOGICAL SURVEY REPORT FORMAT

I. Summary

This section should be a brief, executive-type summary of survey results, including overall summary tables for indoor and outdoor results. It should include a brief statement about exposure evaluation results.

II. Introduction

This section should include:

A. purpose of the survey;

B. when the survey was conducted and by whom;

C. a brief history of the site, or if it is a vicinity property, a history of the associated candidate site (include process history if appropriate--use only published or documented information); and

D. a description of property [include area maps, site-scaled drawings and photographs (using care not to divulge site location or ownership if appropriate--use codes for all references to site location as needed)].

III. Survey Methods

This section should include and/or reference appendices or documents that give

A. details of the survey plan for the site and

B. details of the survey instrumentation and sample analysis methods employed.

IV. Survey Results

Subsections should discuss results for each measurement type. Text should summarize data in terms of range average and maximum levels observed. Appropriate figures and detailed data tables should be referenced. For on-site measurement results, comparisons to normal background levels should be mentioned in these sections. In addition,

specific requirements for each section are provided as follows.

A. Background Radiation Levels
   1. Reference or present a brief description of areas and results included in background determinations. If background levels were found on site, state what these values were.

B. Indoor Survey Results
   1. Measurements of external radiation levels
   2. Sampling results
   3. Radon and radon daughter measurements
   4. Subsurface investigations
      a. Reference to appended hole-logging graphs
   5. Other samples
      a. Tap water (if on a private well), drain residues, wood, etc.

C. Outdoor Survey Results
   1. Measurements of external radiation levels
   2. Surface sampling results
   3. Subsurface investigations
      a. Reference to appended hole-logging graphs
   4. Other samples
      a. Core-hole water, vegetation, etc.

V. Applicable Radiation Guidelines

This section should summarize the guidelines attributed to the governing regulatory bodies as well as the primary regulations applying to the site. It should reference a summary table of guidelines and an appendix, giving complete citations. Results of the radiological survey should be compared with appropriate criteria.

VI. Significance of Findings

The introductory paragraph of this section should state that, based on the results of the survey, the following information can be derived.

A. Extent of Contamination - Discuss and show by graphic displays the areal extent of contamination indoors and outdoors. A table of contaminated areas (referenced to the figure) should give a

Comprehensive and Post-Remedial Action

Radiological Survey Report Format

breakdown of the estimated area involved, depth of contamination in each area, and total volume of material present above the applicable guidelines.

B. Evaluation of Radiation Exposures - Summarize the bases for evaluation, assumptions used, and preliminary calculated estimate of the increased risk to individuals on site. Reference the detailed exposure evaluation appendix.

VII. References

VIII. Appendices

A. Definitions and units of measurement.
B. Survey plan (reference if appropriate).
C. Instrumentation/analysis methods (reference if appropriate).
D. Applicable radiation guidelines.
E. Auger-hole logging graphs.
F. Evaluation of radiation exposures.
G. Any pertinent data and/or results of other investigators.

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