

Health Physics Society



An American National Standard

Performance and Documentation of Radiological Surveys

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American National Standard

Performance and Documentation of Radiological Surveys

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Performance and Documentation of Radiological Surveys

1.0 Purpose and Scope

1.1 Introduction

Radiological surveys are performed at many types of facilities for a variety of purposes. Survey objectives range from ensuring operational radiological control to demonstrating that a remediated facility may be safely released for unrestricted use. Radiological surveys comprise a set of discrete survey tasks, such as, ambient dose rate measurements, air monitoring, evaluating radiation levels from radiation producing equipment, assessing radioactive material concentrations in environmental media, and determining surface contamination levels. It is essential that these fundamental radiological survey tasks be properly performed and documented so that survey results are sufficient for their intended purposes. The data life cycle, which includes survey planning, implementation, and assessment, can be used to ensure that these survey data satisfy their stated objectives.

The data life cycle is an integral component of designing, assessing and documenting radiological surveys (ANSI/ASQC E4-1994). During the planning phase of the data life cycle, the Data Quality Objectives (DQO) Process is used to define quantitative and qualitative criteria for determining the number and type of survey measurements and samples needed for the identified survey purpose. Following the statement of survey DQOs, field and analytical procedures are selected, and appropriate quality assurance (QA) and quality control (QC) documents are developed. Survey data are then collected following the developed survey and QA/QC procedures documents. The data life cycle is completed with the Data Quality Assessment (DQA), which includes validation and verification of the data to ensure that the measurement and sampling protocols were properly followed. DQA then proceeds using the validated data set to determine if the quality of the data is sufficient to support the decision.

The data life cycle, along with standardized performance of radiological survey tasks, helps to ensure that reliable procedures are implemented, appropriate survey instruments are selected and used, and qualified personnel are responsible for conducting surveys and assessing survey results. Inconsistencies and non-uniformities in documentation of radiological surveys are reduced by promoting the use of consistent units on records and consistent reporting of survey data. These records are used in the evaluation of trends, demonstrating compliance with regulations, and providing documentation of area and work site conditions.

This standard provides both specific and general guidance for facilities using radioactive material or machines producing radiation fields that will make the performance and documentation of radiological surveys more uniform and complete. The information provided is integrated into the overall survey program, in the form of procedures, for the various radiological survey types. Training of personnel responsible for radiological surveys should, in some manner, encompass the information provided.

1.2 Purpose

This standard provides minimum requirements for the performance and documentation of radiological surveys. These requirements are incorporated into procedures for specific survey programs, thereby assuring that survey information is complete, uniform, and sufficient for its intended purposes. Radiological surveys in the workplace and environment include measurements of dose rates, exposure rates, radioactive material concentrations in air and other media, and surface contamination levels, among others. Records of survey results may be used to evaluate trends; to plan for other similar tasks; to plan for measures to reduce personnel exposure; to demonstrate compliance with appropriate regulations; and to improve facility conditions. Further, survey results

provide evidence regarding working conditions as the need arises—e.g., during the process of worker compensation claims or during a tort law proceeding in which a worker sues for compensatory or punitive damages.

1.3 Scope

Radiological surveys are performed by making *in situ* measurements of radiation and radioactivity and by collecting media samples for subsequent radiological analyses by a measurement system in the field or laboratory. This standard addresses the specific measurement and sampling tasks that compose a radiological survey, such as air sampling, surface activity measurements, dose and exposure rate measurements. The documentation of surveys includes the use of consistent nomenclature and units for records and a standardized methodology for calculating minimum detectable concentration levels. The standard is not intended to replace existing requirements for design or strategies for performing specific radiological surveys, e.g., final status or compliance demonstration surveys for remediated sites, and operational surveys to demonstrate radiological control. This standard identifies the survey tasks used in most radiological surveys, and provides details on how these survey tasks are performed and documented. The information provided in this standard is intended to be used in the development of procedures for the various radiological survey programs. This standard is not intended for external/internal dosimetry programs nor to replace requirements already established for environmental monitoring surveys or radioactivity determinations.

2.0 Definitions

The following terms are of a restricted nature for the purposes of this standard. Terms defined in N1.1-1976 (ANS-9) and in the *American National Standard Glossary of Terms in American Nuclear Society* (1986) are not defined in this standard. A word or term requiring a more precise definition is redefined in this section even though it was included in one of the aforementioned references.

2.1 Specific Word Usage

The word “shall” is used to denote a requirement; the word “should” is used to denote a recommendation; and the word “may” is used to denote permission, neither a requirement nor a recommendation. To conform to this standard, all survey activities and documentation shall be performed in accordance with its requirements, but not necessarily with its recommendations.

2.2 Specific Terms

As Low As Reasonably Achievable (ALARA):

An approach to radiological safety to manage and control exposures to levels that are as low as reasonable, considering social, technical, and economical factors.

Background radiation: Radiation from naturally occurring radioactive materials which have not been technologically enhanced (i.e., not increased by or as a result of past or present human practices above levels encountered in the natural state, such as that from oil and gas production pipe scale and phosphate industry wastes, cosmic and cosmogenic sources, global fallout, and consumer products containing nominal amounts of radioactive material.)

Background reference area: A geographical soil area or structure surface area (i.e., building construction material) from which background radiation levels and radionuclide concentrations in soil can be obtained and used for comparison to the radiation and radioactivity measurements performed in areas being surveyed. The distribution and concentration of radiation levels and radionuclide concentrations in the background reference area should be the same as that for the surveyed area (site) if that site had never been contaminated.

Calibration source: Radioactive material that has been characterized by, and is traceable to, a recognized standards or testing laboratory, such as the National Institute of Standards and Technology (NIST), for its radiological properties (e.g., particle emission rate). The calibration source is used for calibration of survey instruments and measurement systems.

Check source: A radioactive source, not necessarily calibrated, which is used to confirm the continuing satisfactory operation of a survey instrument.

Continuous air monitor (CAM): An instrument that continuously samples and measures the levels of airborne radioactivity on a “real-time” basis. These instruments typically have alarm capabilities at preset levels.

Critical level (L_C): The net count, or final instrument measurement result after appropriate calibration and/or correction factors have been applied, at or above which a decision is made that activity is present in a sample. That is, if the observed net count is less than the critical level, the surveyor correctly concludes that no net activity is present in the sample. When the net count exceeds L_C , the surveyor falsely concludes that net activity is present in the blank sample (Type I decision error).

Data Quality Objectives (DQO) Process: A planning tool that promotes the effective use of resources and increases the likelihood of efficiently collecting appropriate and useful survey data. DQOs are qualitative and quantitative statements derived from the outputs of the DQO Process that: 1) clarify the objective; 2) define the most appropriate types of data to collect; 3) determine the most appropriate conditions from which to collect the data; and 4) specify tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision. DQOs assure that the type, quantity and quality of the survey data used in decision making is appropriate for its intended use, at the same time promoting efficient use of resources by eliminating unnecessary, duplicative, or overly precise survey data.

Detection limit (L_D): The smallest number of net counts, or final instrument measurement result after appropriate calibration and/or correction factors have been applied, that will be detected with a probability (β) of non-detection (Type II decision error), while accepting a probability α of incorrectly deciding that activity is present in a sample (Type I decision error).

Energy dependence: A change in instrument response with respect to varying radiation energies, with other conditions, such as incident radiation fluence, held constant. Energy dependence is evident for many instruments that measure surface activity, in that the instrument efficiency varies as a function of particle energy.

Graded approach: The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results.

Guideline unit: Unit of measure for measurement and sampling data that is consistent with the unit used for the applicable guideline, limit or release criterion. Guideline units include dpm/100 cm² (or Bq/cm²) for surface activity and pCi/g (or Bq/g) for radionuclide concentrations in soil.

Instrument efficiency: Ratio between the instrument net count rate and the surface emission rate of a source under specified geometric conditions. For a given instrument, the instrument efficiency depends on the radiation energy emitted by the source and the geometry between the detector and the source. Instrument efficiency is a 2" (5.08 cm) value (i.e., based on surface emission rate, not activity) and shall only be used in surface activity determinations when multiplied by a surface efficiency to yield a 4" (10.16 cm) value of total efficiency.

Minimum detectable concentration (MDC)
The smallest activity concentration that can be detected with specific confidence for a given instrument and specific measurement procedure. The MDC is usually specified as the smallest activity concentration that can be detected with 95% confidence (i.e., 95% of the time a given instrument and measurement procedure will detect activity at the MDC). Note that the term MDC applies to both activity present on a surface (which may be referred to as “MDA”), as well as activity within a volume of a material.

Quality assurance (QA): An integrated system of management activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that radiological survey data meet defined standards of quality with a stated level of confidence.

Quality control (QC): The overall system of technical and procedural activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established, such as those established by the regulator.

Quality system: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability and implementation plan of an organization for ensuring quality in its work processes, products and services. The quality system provides the framework for planning, implementing, documenting, and assessing work performed by the organization and for carrying out required quality assurance and quality control activities.

Radiation producing equipment: Any equipment or device that produces ionizing radiation by virtue of the application of high voltage, including diagnostic and therapeutic x-ray machines, electron microscopes, etc.

Radiologically controlled area (RCA): An area that requires physical or administrative controls for purposes of protecting individuals from exposure to radiation and radioactive materials.

Radiological work permit: Permit that identifies radiological conditions, establishes worker protective clothing, dosimetry and monitoring requirements, and contains specific approvals for radiological work activities.

Removable surface contamination: Radioactive material that can be removed from surfaces by nondestructive means, including casual contact, wiping, or washing. Does not include radioactive material that is fixed and that requires physical abrasion of the surface by scabbling or other physical means to remove the radioactive material.

Surface efficiency: Ratio between the number of particles of a given type emerging from the surface per unit time (surface emission rate) and the number of particles of the same type released within the source per unit time. The surface efficiency is nominally 0.5, but may be increased by backscattered radiation and reduced by self-absorption.

Surface emission rate: The number of particles of a given type (i.e., alpha, beta or gamma) emerging from the face of a source (or surface) per unit time.

Total surface contamination: Radioactive material present on a surface that includes both removable and non-removable components.

3.0 Survey Types and Objectives

The purpose of this section is to present the tasks that are incorporated into the design of the various survey types (e.g., operational control, equipment and material release, decommissioning), so that the basic elements of each survey are apparent. The discussion of selected survey types are expected to be representative of the many surveys that are performed during the receipt, possession, use, transfer, and disposal of radioactive material and radiation-generating equipment, and the ultimate decommissioning of a facility.

3.1 Purpose of Survey Types

As a broad overview, operational surveys to ensure radiological control are used to evaluate exposures and to determine what protective measures and restrictions are necessary for the workers to safely perform tasks and to demonstrate regulatory compliance, while effluent monitoring is performed to demonstrate that off-site releases are within acceptable standards. Surveys in support of decommissioning are used to document that residual radioactivity satisfy the applicable release criteria. Special surveys include pre-operational surveys, leak testing radiation sources, measurements for shipping radioactive materials, and material release surveys. The following sections describe in further detail the survey tasks that comprise each radiological survey type.

3.1.1 Operational Surveys for Radiological Control Monitoring of radiation levels, surface contamination, and airborne radioactivity is performed to assess and demonstrate radiological control. Operational surveys are conducted to characterize workplace conditions, to identify areas requiring radiological posting, to detect changes in radiological conditions, to assess acceptability of off-site releases, to detect the gradual buildup of radioactive material over time, to verify the effectiveness of engineering and administrative controls, and to assess radiological conditions during the performance of work. Radiological monitoring should be performed under a radiation protection plan and quality system.

Assessment of radiological conditions usually includes a sufficient number of survey locations to characterize the radiation levels and

radioactive material/radioactivity present and to verify radiological posting boundaries. Operational surveys are performed before, during, and at the completion of work that has the potential for causing significant changes in levels of radiation, radioactive material, or radioactivity present.

3.1.1.1 Radiation Level Surveys A successful radiological control program at any facility or operation contains several key elements that are used to monitor the workplace and to reduce radiation exposure. The purpose of radiation level (or dose rate) surveys is to characterize workplace conditions, identify areas and materials that require radiological posting or labeling, support activities specified in radiological work permits (job coverage), and provide information about external radiation sources, including radiation producing equipment. These surveys are also performed to identify areas that require additional shielding or application of other dose reduction techniques. Workplace radiation level surveys include measurements of both the general area and at contact with potential sources of radiation.

3.1.1.2 Surface Contamination Surveys The detection and control of surface contamination is an integral part of a radiological control program and provides an indication of the effectiveness of engineering controls and proper work practices in preventing the release of radioactive materials. Radioactive contamination, if undetected or not properly controlled, can result in contamination of personnel, facilities and equipment. It may also spread to other parts of a facility and interfere with proper facility operations, it may result in inhalation, ingestion, or other personnel internal exposure to radioactivity, and it may spread into the environment.

Surface contamination surveys incorporate techniques to assess both total and removable surface contamination levels. Surface scans identify areas of elevated direct radiation levels that may be indicative of surface contamination. Direct measurements of surface activity are performed to quantify surface contamination levels at systematic and biased locations—e.g., at locations of elevated direct radiation levels as identified by surface scans. Smear surveys are performed to provide a semi-quantitative assessment of removable contamination, and typically cover an area of 100 cm². Large area

smears (up to 1000 cm² and greater) may be performed to qualitatively assess the level of removable contamination on building surfaces and equipment.

3.1.1.3 Airborne Radioactivity Monitoring

Airborne radioactivity monitoring is performed to detect and quantify airborne radioactive material concentrations to limit and prevent internal exposure, to provide an indication of the effectiveness of engineering controls and proper work practices in preventing the spread of contamination, and to support the selection of appropriate protective equipment.

Air monitoring equipment is used in situations where airborne radioactivity levels can fluctuate and early detection of airborne radioactivity is necessary to prevent or minimize inhalation of radioactivity or off-site releases. Selection of air monitoring equipment by the radiation protection organization is based on the specific job being monitored. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors (CAMs).

3.1.2 Equipment and Material Release Surveys

Equipment and material release (clearance) surveys are performed for materials, items and equipment being released from radiologically controlled areas (RCAs)—e.g., airborne radioactivity areas, surface contamination areas or areas exposed to a neutron flux or particle activation—to uncontrolled areas and intended for unconditional release. This process is part of a radiological control program intended to prevent the spread of contamination and maintain exposures of workers, the public, and the environment to ionizing radiation below regulatory limits and ALARA. Equipment and material release surveys include surface scanning, surface activity measurements, and miscellaneous sample collection, and may require disassembly of equipment and items if inaccessible surface contamination or activation is suspected. Hermetically sealed items and containers under positive pressure may be considered to be free of internal contamination, unless they were known to be exposed to a neutron flux or particle activation.

3.1.3 Decommissioning Surveys

Decommissioning survey types include scoping, characterization, remedial action support, and final status surveys—with the primary emphasis