

ANSI/HPS N13.59-2008

American National Standard

**Characterization in Support of Decommissioning
Using the Data Quality Objectives Process**

Approved: July 3, 2008

American National Standards Institute, Inc.

Published by

**Health Physics Society
1313 Dolley Madison Blvd.
Suite 402
McLean, VA 22101**

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Printed in the United States of America

This standard was consensus-balloted and approved by the ANSI-accredited HPS N13 Committee on March 14, 2008. At the time of balloting, the HPS N13 Committee had the following membership:

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Foreword

(This foreword is not a part of American National Standard HPS N13.59-2008)

This American National Standard provides guidance for performing characterizations of land areas and structures in support of decommissioning. This standard recommends that the data quality objectives process be used in the design and implementation of characterization surveys. It is expected that when the ultimate objective of decommissioning is site release, characterization and final status survey design should be coordinated. The Multiagency Radiation Survey and Site Investigation Manual (MARSSIM) was published in December 1997. Since its release, MARSSIM users have sought guidance specifically geared to the design of characterization surveys. This standard addresses that need and provides a technical approach for designing characterization surveys in support of decommissioning using the DQO process.

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Characterization in Support of Decommissioning Using the Data Quality Objectives Process

1.0 Introduction

Characterization is a fundamental aspect of decommissioning projects. The radiation survey and site investigation process described in the Multiagency Radiation Survey and Site Investigation Manual (MARSSIM) describes the six steps of this process as site identification, historical site assessment, scoping survey, characterization survey, remedial action support survey, and final status survey (MARSSIM 2000). Characterization surveys are performed for a variety of purposes, such as providing information to estimate the extent of building surfaces and soil that exceeds the release criteria and therefore requires some amount of cleanup and to determine disposal options for materials that are removed from a facility. Characterization surveys are generally the most comprehensive of all survey types and generate the most data (NRC 2006). Thus, characterization data are essential for the proper planning of remedial activities.

Conversely, insufficient characterization data, often due to invalid assumptions in the initial planning, can result in unexpected and unplanned costs for a decontamination and decommissioning (D&D) project. To minimize the total costs of characterization surveys, planning and execution of a characterization survey should be thought of as a continuing process or iteration in which the data from the characterization effort are studied to confirm that assumptions are met. For example, the characterization effort is complete when the average, distribution, range, and/or the uncertainty in the estimate of surface and soil contamination that exceed the release criteria fall within acceptable uncertainties. Many characterization surveys fail to achieve their objectives because the initial assumptions that are made are invalid and remain untested, resulting in unquantified uncertainties. The uncertainties inherent in characterization surveys can be managed using the data quality objectives process.

1.1 Purpose

This standard serves as a guide to characterization by providing the technical

approach for designing a characterization survey for a specific use of the data (e.g., to make decommissioning decisions with known confidence). The decisions and confidence bounds are developed using the Data Quality Objectives (DQO) process. Using the DQO process to plan characterization focuses the user on the objective of characterization: clarifying the characterization data needs to satisfy the objective.

A common deficiency in characterization plans developed to date has been the lack of a structured process to identify all of the characterization objectives/decisions required to complete decommissioning. A phased approach to characterization has been used and will continue to be used in the future. However, in the past, continuing, or phased, characterization has often been required to satisfy emerging decision requirements that could have been addressed more efficiently during the initial characterization effort if a comprehensive effort to determine all characterization decisions had been undertaken. This standard does recommend a phased approach, when appropriate, but in a more prospective manner. For example, one objective may be to determine the radionuclide mixture in a building sump that is not accessible during initial characterization. The objective would be clearly described in the characterization plan through the DQO process and this future characterization work incorporated into the overall decommissioning project schedule.

Focusing on the decision rules, rather than “defining the nature and extent of contamination,” avoids the characterization phase’s becoming a “fishing expedition” with no end in sight. By focusing on the decisions that need to be made, it is possible to objectively stop the characterization phase once sufficient data have been collected to make the decisions that need to be made at the level of confidence required by the decision makers. The goal is not to know everything about the site; the goal is to have only those data necessary to select between alternative paths of future action. Decisions lay out those actions and the action levels (e.g., release criteria) for selection among alternative actions. This focuses the characterization, provides the quality criteria for the data collection, and defines when characterization may be stopped. Laying out the decisions and

specifying the action levels are done during planning, before any data are collected.

1.2 Scope

This standard provides guidance for performing characterizations of land areas and structures in support of decommissioning. In this context, *land areas* generally refers to environmental media such as soils, surface and ground water, and vegetation; *structures* typically refers to building construction materials. It is expected that when the ultimate objective of decommissioning is site release, characterization and final status survey design should be coordinated. Therefore, users of the MARSSIM or other final status survey protocols can use this standard for its technical approach to designing a characterization survey for a specific objective.

The scope of this standard is geared toward radiological characterization. However, if non-radiological contaminants (e.g., asbestos, polychlorinated biphenyls (PCBs), lead, mercury, arsenic) are potentially present, it is beneficial to integrate radiological and non-radiological characterization activities. A useful reference for non-radiological characterization activities is ASTM E 1527-05.

It is outside the scope of this standard to discuss all of the instruments, tools, and procedures currently available to support characterization activities. This standard does not apply to the release of materials and equipment. Similarly, it is outside the scope to address emerging characterization technologies. Rather, this standard endorses any and all instruments, tools, and procedures that effectively achieve the particular characterization objective. In this regard, the standard serves to focus the user on preparing a characterization survey plan based on the DQO process, drawing on specific instruments, tools, and procedures as needed.

2.0 Definitions

The definitions and terms contained in this standard, or in other American National Standards referred to in this document, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard.

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 economic factors.

Background radiation: Radiation from naturally occurring radioactive materials that have not been technologically enhanced (i.e., not increased by or as a result of past or present human practices, e.g., oil and gas production pipe scale and phosphate industry wastes), cosmic and cosmogenic sources, and global fallout.

Background reference area: A geographical soil area or structure surface area (i.e., building construction material) from which background radiation levels and radionuclide concentrations 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, as well as physiochemical properties, in the background reference area should be similar to those in the surveyed area (site) had the surveyed site 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, that is used to confirm the continuing satisfactory operation of a survey or measurement instrument.

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 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 spatial boundaries and practical constraints on collecting the data, and 4) specify tolerable limits on decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision. DQOs ensure that the type, quantity, and quality of the survey data used in decision making are appropriate for its intended use, at the same time promoting efficient use of resources by eliminating unnecessary, duplicative, or overly precise survey data.

DCGL: Acronym for *derived concentration guideline level*, a radionuclide-specific surface or volume residual radioactivity level that equates to the decommissioning release criterion and is derived through various exposure pathway scenarios.

Energy dependence: A change in instrument response with respect to varying radiation energy. The efficiency of many survey and measurement instruments varies as a function of photon or particle energies.

Graded approach: The process of ensuring that the level of detail or magnitude of resources applied to an item or work is commensurate with the intended use of the results and the degree of confidence needed in the quality of the results.

Guideline: Level of radioactivity or radiation presented in terms of ambient radiation, surface activity, and radionuclide concentration in soil that represents the decommissioning release criterion.

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 Bq/cm² (or dpm/100 cm²) for surface activity and Bq/g (or pCi/g) for radionuclide concentrations in soil.

Hot spot: A general term that refers to an area of elevated contamination or radiation that 1)

exceeds the average guideline level or 2) is markedly greater than the general contamination or radiation level.

Instrument efficiency, ϵ_i : Ratio of 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 2π 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 4π value of total efficiency.

Minimum detectable concentration (MDC): The lowest activity concentration that can be detected with specific confidence for a given instrument and specific measurement procedure. The MDC is usually specified as the lowest 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 and to 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 or measurement 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, 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.

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

Radiological work permit: A work control document that identifies radiological conditions, establishes guidelines for workers' protective clothing and 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. It does not include radioactive material that is fixed and requires physical abrasion of the surface by scabbling or other physical means to remove the radioactive material.

Surface efficiency, ϵ_s : Ratio between the number of particles of a given type emerging from a given 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 back-scattered 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 a given 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 Data Quality Objectives for Characterization

3.1 DQO Process

The U. S. Environmental Protection Agency (EPA) has developed a systematic planning process for data collection. This process focuses on the decision that would be supported by the data—so that only those data required for previously identified decisions would be

collected, ensuring that the right quality and quantity of data are collected to make a specific decision. This systematic planning process is called the Data Quality Objectives (DQO) process.

The DQO process, and the EPA orders and federal regulations that mandate a Quality System, are described in EPA's guidance document *Guidance for the Data Quality Objectives Process* (EPA 2000a). The document addresses all environmental data operations, from initial characterization to final cleanup and release.

The application of the DQO process ranges from a formal quantitative approach to an informal qualitative approach. Either way, it provides a good method for formally determining characterization objectives, analyzing data requirements, presenting and discussing these requirements with decision makers and/or other stakeholders, and documenting the final decision criteria. This standard supports a flexible approach to the application of the DQO process.

The seven-step DQO process is described as follows (EPA 2000a).

Step 1: State the Problem. In this step, the planning team is assembled and they develop a concise description of the problem. For instance, the team may develop a site conceptual model of the environmental hazard or issue to be investigated.

Step 2: State the Decision(s) that need to be made. The goal of this step is to define the questions that the study will attempt to resolve. For example, study questions might be "Are contaminants present in soil and sediment at the site that exceed appropriate release criteria?" and "What is the volume of soil that requires disposal as low-level waste?" Decision statements are then developed, and multiple decisions are organized into a decision logic diagram where each branch terminates in an action statement or set of actions that must be undertaken to resolve the problem.

Step 3: State the Inputs to the Decision(s). The purpose of this step is to identify the information inputs that are required to address each decision statement. In this step, sources of information in addition to the data that will be collected are identified. Often during this step,

the type of data originally planned for collection is shown not to be the type of data that will resolve the decisions in the decision logic from Step 2. During this step, the Action Level (i.e., the cut-off value for taking one action versus another, e.g., the release criteria) is identified. Often, the Action Level is a result of negotiation, a consensus among technical experts and regulators, and requires outside information.

Step 4: State the Boundaries for the Decision(s). In this step, spatial, temporal, and practical boundaries to the problem are set. This helps narrow the problem and better define exactly what data are required. What is the size of the area to be surveyed? What grid sizes should be used for the survey? In statistical terms, the target population is defined, along with any subpopulations about which separate decisions must be made.

Step 5: State the Decision Rule(s). This is the point at which the discussion switches from the qualitative issues discussed in Steps 1 to 4 and moves to a more quantitative level. A statement is made on how the data that will be collected will be used to decide between alternative actions. The form of the decision rule is: *If* (condition X were shown to exist), *then* (action Y should be taken). As part of the condition, the parameter of interest is specified (e.g., the mean, median, range, minimum, maximum, a proportion, etc.), along with the value(s) at which action will be taken (e.g., the release criteria). The decision rule must be very specific.

Step 6: State the Acceptable Error Tolerances. In this step, the basis for saying “how good” the decisions (and hence the data) need to be is negotiated and decided upon by the stakeholders involved in the DQO process. Is it sufficient to be within ± 5 pCi of the true mean except for a 5% chance? Or is it sufficient to be within ± 100 pCi and have a 30% chance of being outside the upper or lower bounds on the estimate? In some cases the acceptable errors may be prescribed by the regulator, and in other cases it may be a judgment call by the DQO participants—but in either case, it is at the essence of the DQO process. Given the uncertain nature of sampling data, the actual error is never known, or even whether an error had been made. However, a sampling plan can be designed that limits errors to stated limits, provided assumptions are correct. If no level of error is acceptable, then the sampling plan will

necessarily require collection of a 100% sample and use of equipment that is accurate essentially 100% of the time.

Step 7: Optimize the Sampling Design. Whereas Steps 1 to 6 are input steps to the DQO process, Step 7 is the output step. Once all the inputs are provided, a team knowledgeable in statistical sampling designs and statistical tests can use all the information provided in Steps 1 to 6 to come up with a sampling design. This design specifies the number of samples, location and timing of samples, type of samples, type of measurement and collection equipment, and scanning versus sampling, among others.

3.2 Characterization Data Needs

Traditionally, data needs for characterization are stated in terms of objectives. The DQO process requires thinking of data needed to *make decisions* versus data needed to meet objectives. This paradigm shift makes it possible to put quality requirements on the data. To design a sampling plan to meet objectives requires criteria for when objectives are met. Criteria for meeting objectives are comparable to a decision rule. However, the decision rule goes one step further and identifies the actions to be taken. The DQO process goes one step further and asks the consequences of making incorrect decisions, which forces the decision maker to think about how different errors in data can arise and how these data errors can lead to decision errors.

Since characterization planning comes at the beginning of a decommissioning project, it is easy to group several objectives together and not be rigorous in thinking about how decisions will be made based on the data that are collected. Any effort that can be made during the planning stage to identify separate data needs and potential decision errors will make working through the DQO steps easier. When potential data errors are identified, the final sampling plan must specify the quality of instruments or number of samples required to eliminate those data errors that lead to unacceptable decision errors.

Some examples of characterization decisions and the processes that the data support include 1) deciding whether the extent of contamination