MARSSIM Revision 2 Introduction

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Introduction

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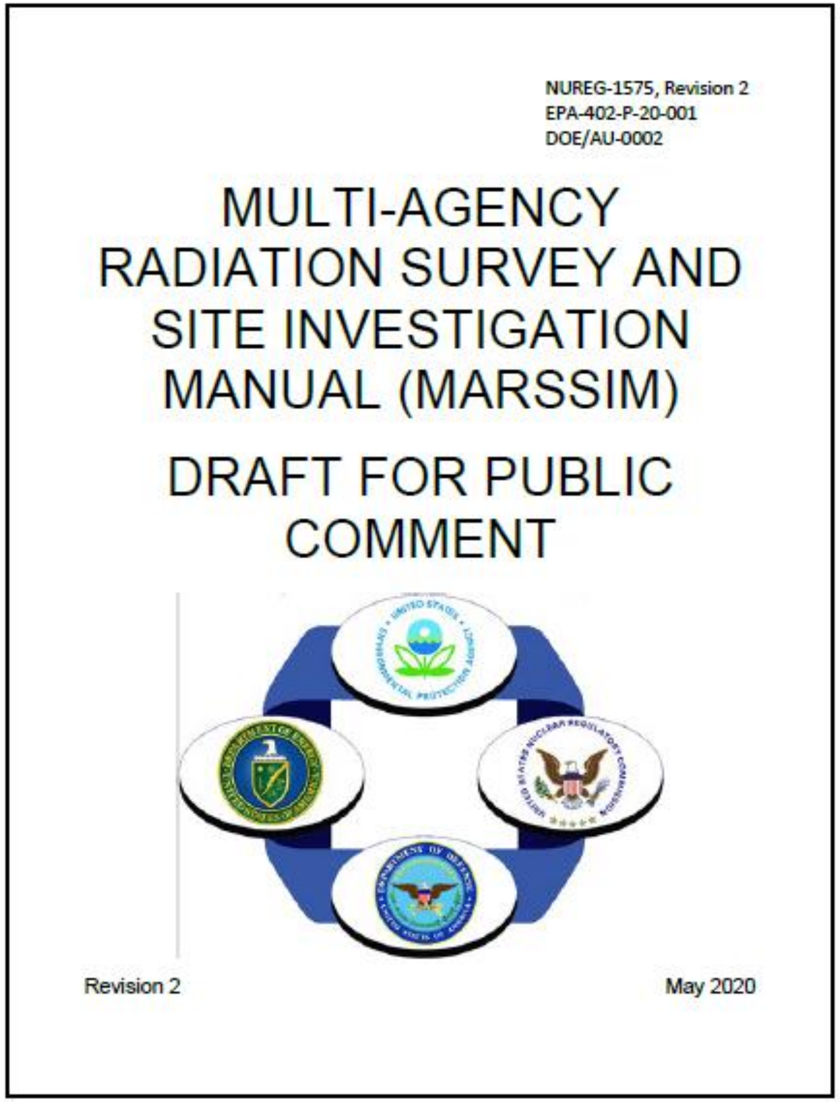
MARSSIM Document Overview

8 Chapters

15 Appendices

2 Volumes

720 Pages



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MULTI-AGENCY RADIATION SURVEY AND SITE INVESTIGATION MANUAL (MARSSIM)

DRAFT FOR PUBLIC COMMENT

Revision 2

May 2020

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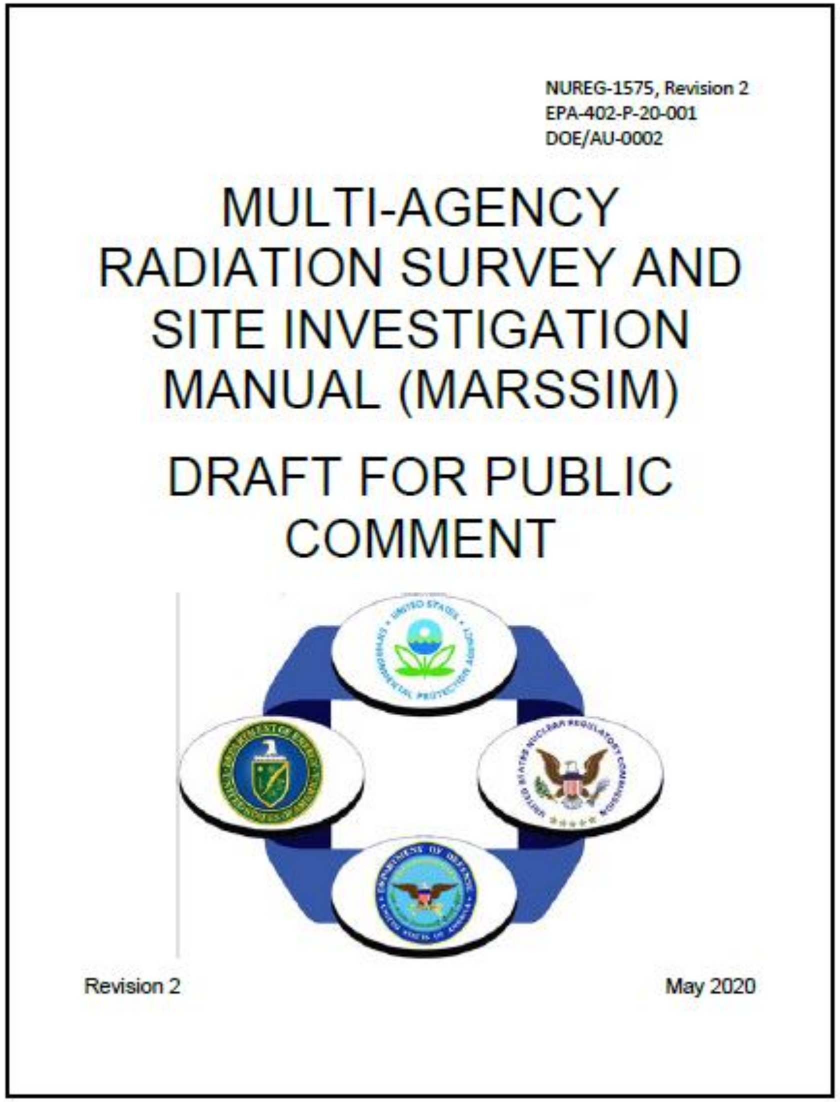

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ROADMAP

Introduction to MARSSIM

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulation. The MARSSIM guidance focuses on the demonstration of compliance during the final status survey following scoping, characterization, and any necessary remedial actions.

The process of planning the survey, implementing the survey plan, and assessing the survey results prior to making a decision is called the Data Life Cycle. MARSSIM Chapter 2 and Appendix D provide detailed guidance on developing appropriate survey designs using the Data Quality Objectives (DQO) Process to ensure that the survey results are of sufficient quality and quantity to support the final decision. The survey design process is described in MARSSIM Chapters 3, 4, and 5. Guidance on selecting appropriate measurement methods (*i.e.*, scan surveys, direct measurements, samples) and measurement systems (*i.e.*, detectors, instruments, analytical methods) is provided in MARSSIM Chapters 6 and 7 and Appendix H. Data Quality Assessment (DQA) is the process of assessing the survey results, determining that the quality of the data satisfies the objectives of the survey, and interpreting the survey results as they apply to the decision being made. The DQA process is described in MARSSIM Chapter 2 and Appendix E and is applied in MARSSIM Chapter 8. Quality Assurance and Quality Control (QA/QC) procedures are developed and recorded in survey planning documents, such as a Quality Assurance Project Plan (QAPP) which is described in MARSSIM Chapter 9.

MARSSIM does not provide guidance for translating the release criterion into derived concentration guideline levels (DCGLs). MARSSIM discusses contamination of surface soil and building surfaces in detail. If other media (*e.g.*, ground water, surface water, subsurface soil, equipment, vicinity properties) are potentially contaminated at the time of the final status survey, modifications to the MARSSIM survey design guidance and examples may be required.

The Goal of the Roadmap

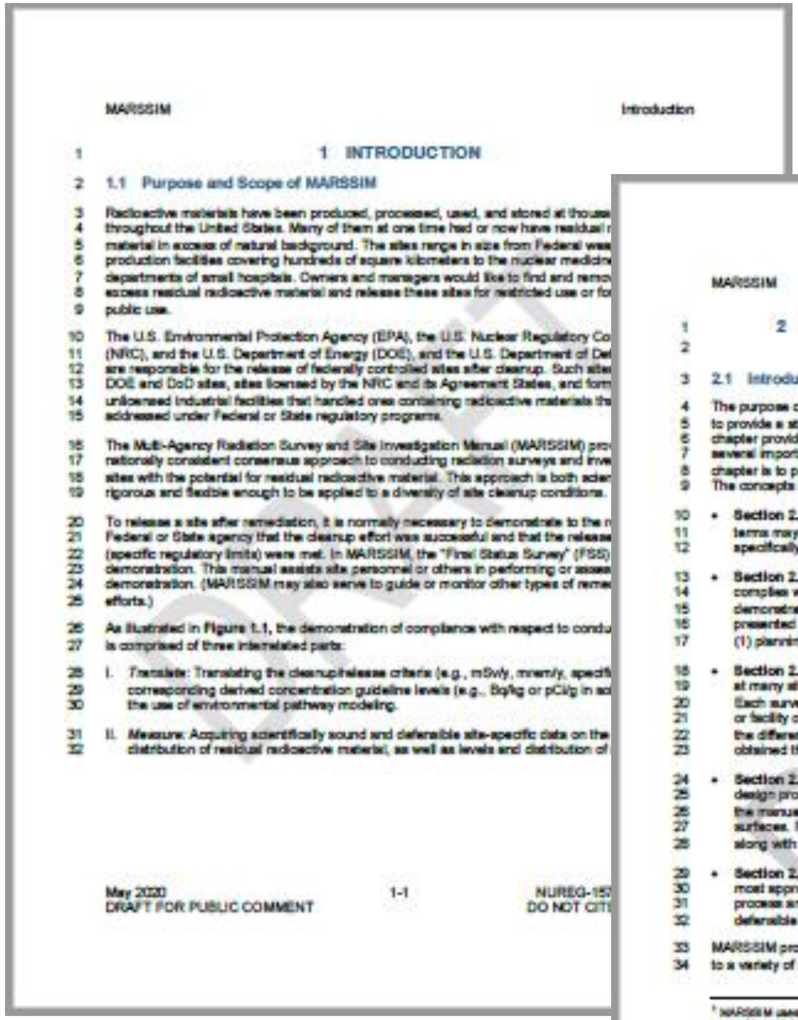
The goal of the roadmap is to present a summary of the major steps in the design, implementation, and assessment of a final status survey and to identify where guidance on these steps is located in MARSSIM. A brief description of each step is included in the roadmap along with references to the sections of MARSSIM that provide more detailed guidance.

This roadmap provides the user with basic guidance from MARSSIM combined with "rules of thumb" (indicated by ➡) for performing compliance demonstration surveys. The roadmap is not designed to be a stand-alone document, but to be used as a quick reference to MARSSIM for

Chapters 1 & 2

Introduction

Overview of the Radiation Survey and Site Investigation Process


MARSSIM Introduction

1 INTRODUCTION

1.1 Purpose and Scope of MARSSIM

Radioactive materials have been produced, processed, used, and stored at thous
throughout the United States. Many of them at one time had or now have residual r
material in excess of natural background. The sites range in size from Federal wea
production facilities covering hundreds of square kilometers to the nuclear medicin
departments of small hospitals. Owners and managers would like to find and remo
excess residual radioactive material and release these sites for restricted use or fo
public use.

The U.S. Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Co
(NRC), and the U.S. Department of Energy (DOE), and the U.S. Department of De
are responsible for the release of federally controlled sites after cleanup. Such site
DOE and DoD sites, sites licensed by the NRC and its Agreement States, and form
unlicensed industrial facilities that handled ores containing radioactive materials th
addressed under Federal or State regulatory programs.

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) pro
nationally consistent consensus approach to conducting radiation surveys and inve
sites with the potential for residual radioactive material. This approach is both scie
rigorous and flexible enough to be applied to a diversity of site cleanup conditions.

To release a site after remediation, it is normally necessary to demonstrate to the r
Federal or State agency that the cleanup effort was successful and that the release
(specific regulatory limits) were met. In MARSSIM, the "Final Status Survey" (FSS)
demonstration. This manual assists site personnel or others in performing or asses
demonstration. (MARSSIM may also serve to guide or monitor other types of reme
efforts.)

As illustrated in **Figure 1.1**, the demonstration of compliance with respect to condu
is comprised of three interrelated parts:

I. *Translate*: Translating the cleanup/release criteria (e.g., mSv/y, mrem/y, specif
corresponding derived concentration guideline levels (e.g., Bq/kg or pCi/g in so
the use of environmental pathway modeling.

II. *Measure*: Acquiring scientifically sound and defensible site-specific data on the
distribution of residual radioactive material, as well as levels and distribution of

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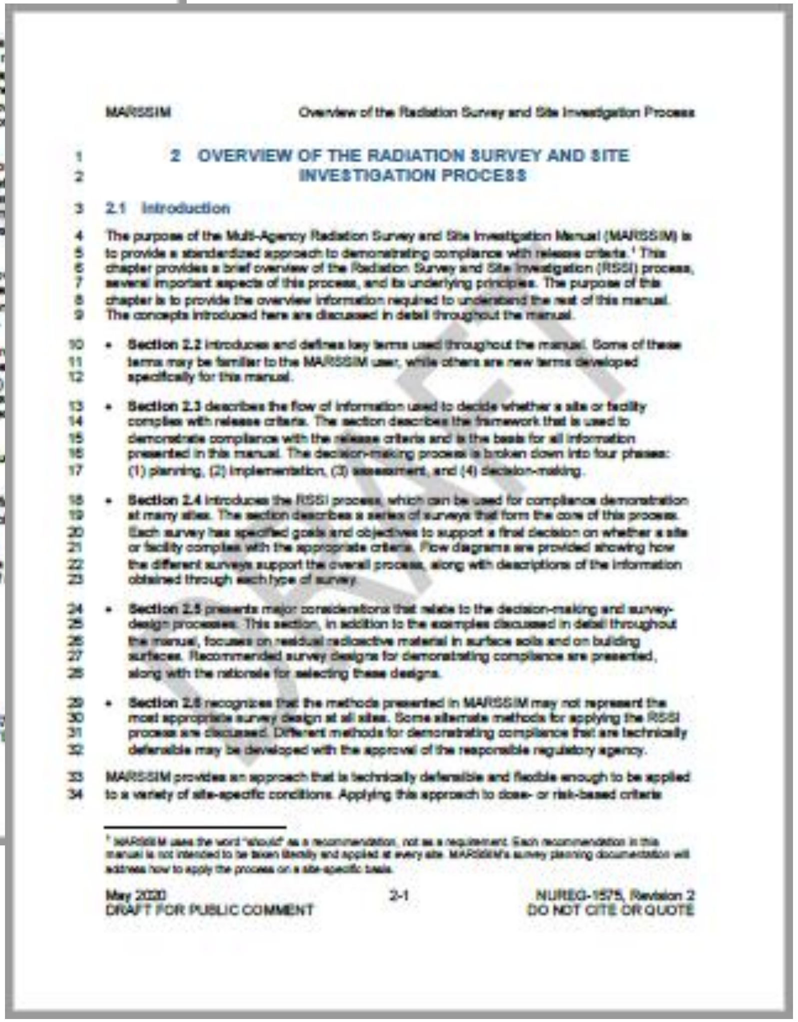
MARSSIM Overview of the Radiation Survey and Site Investigation Process

2 OVERVIEW OF THE RADIATION SURVEY AND SITE INVESTIGATION PROCESS

2.1 Introduction

The purpose of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) is to provide a standardized approach to demonstrating compliance with release criteria.[1] This chapter provides a brief overview of the Radiation Survey and Site Investigation (RSSI) process, several important aspects of this process, and its underlying principles. The purpose of this chapter is to provide the overview information required to understand the rest of this manual. The concepts introduced here are discussed in detail throughout the manual.

- **Section 2.2** introduces and defines key terms used throughout the manual. Some of these terms may be familiar to the MARSSIM user, while others are new terms developed specifically for this manual.
- **Section 2.3** describes the flow of information used to decide whether a site or facility complies with release criteria. The section describes the framework that is used to demonstrate compliance with the release criteria and is the basis for all information presented in this manual. The decision-making process is broken down into four phases: (1) planning, (2) implementation, (3) assessment, and (4) decision-making.
- **Section 2.4** introduces the RSSI process, which can be used for compliance demonstration at many sites. The section describes a series of surveys that form the core of this process. Each survey has specified goals and objectives to support a final decision on whether a site or facility complies with the appropriate criteria. Flow diagrams are provided showing how the different surveys support the overall process, along with descriptions of the information obtained through each type of survey.
- **Section 2.5** presents major considerations that relate to the decision-making and survey-design processes. This section, in addition to the examples discussed in detail throughout the manual, focuses on residual radioactive material in surface soils and on building surfaces. Recommended survey designs for demonstrating compliance are presented, along with the rationale for selecting these designs.
- **Section 2.6** recognizes that the methods presented in MARSSIM may not represent the most appropriate survey design at all sites. Some alternate methods for applying the RSSI process are discussed. Different methods for demonstrating compliance that are technically defensible may be developed with the approval of the responsible regulatory agency.

MARSSIM provides an approach that is technically defensible and flexible enough to be applied to a variety of site-specific conditions. Applying this approach to dose- or risk-based criteria

[1] MARSSIM uses the word "should" as a recommendation, not as a requirement. Each recommendation in this manual is not intended to be taken literally and applied at every site. MARSSIM's survey planning documentation will address how to apply the process on a site-specific basis.

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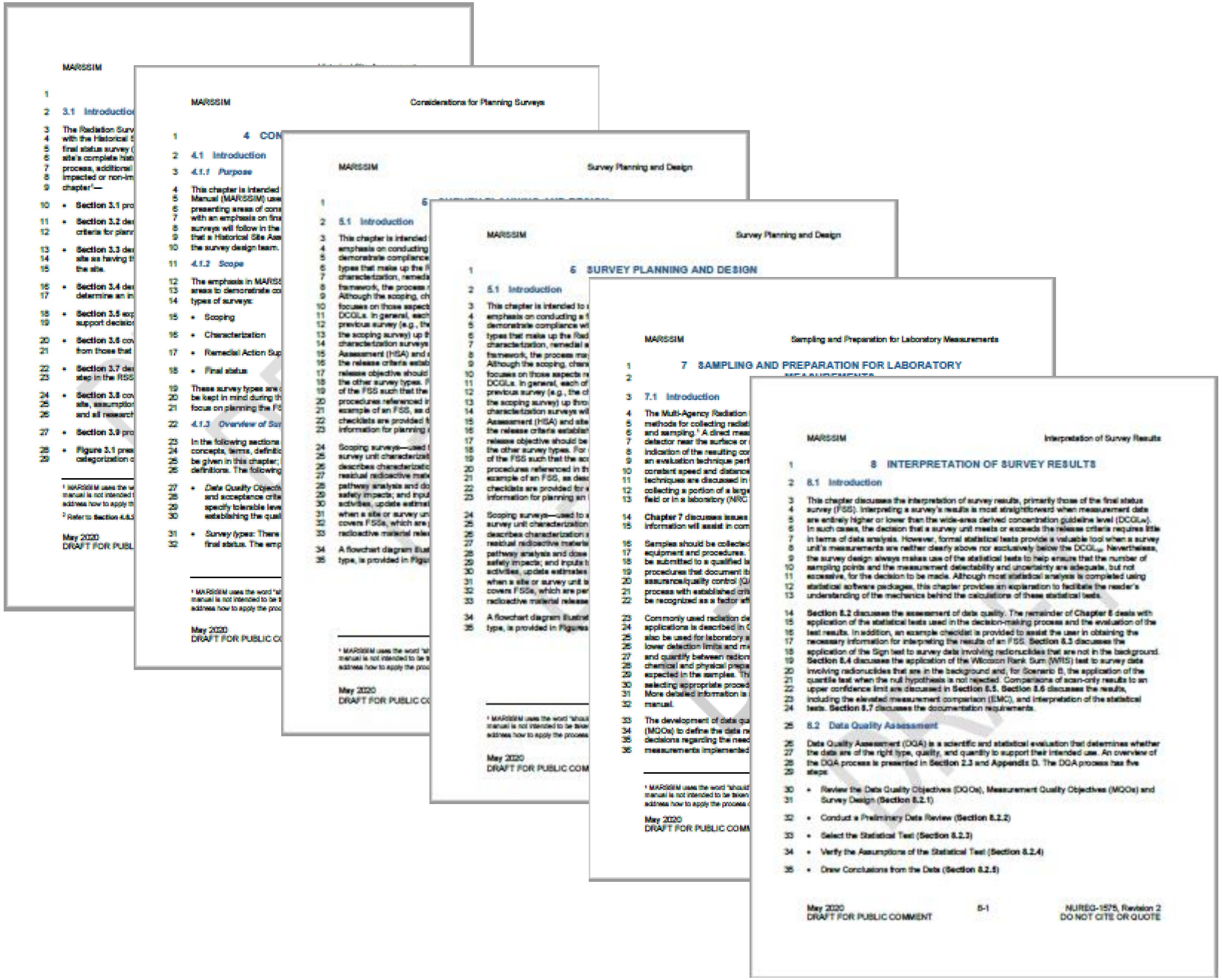
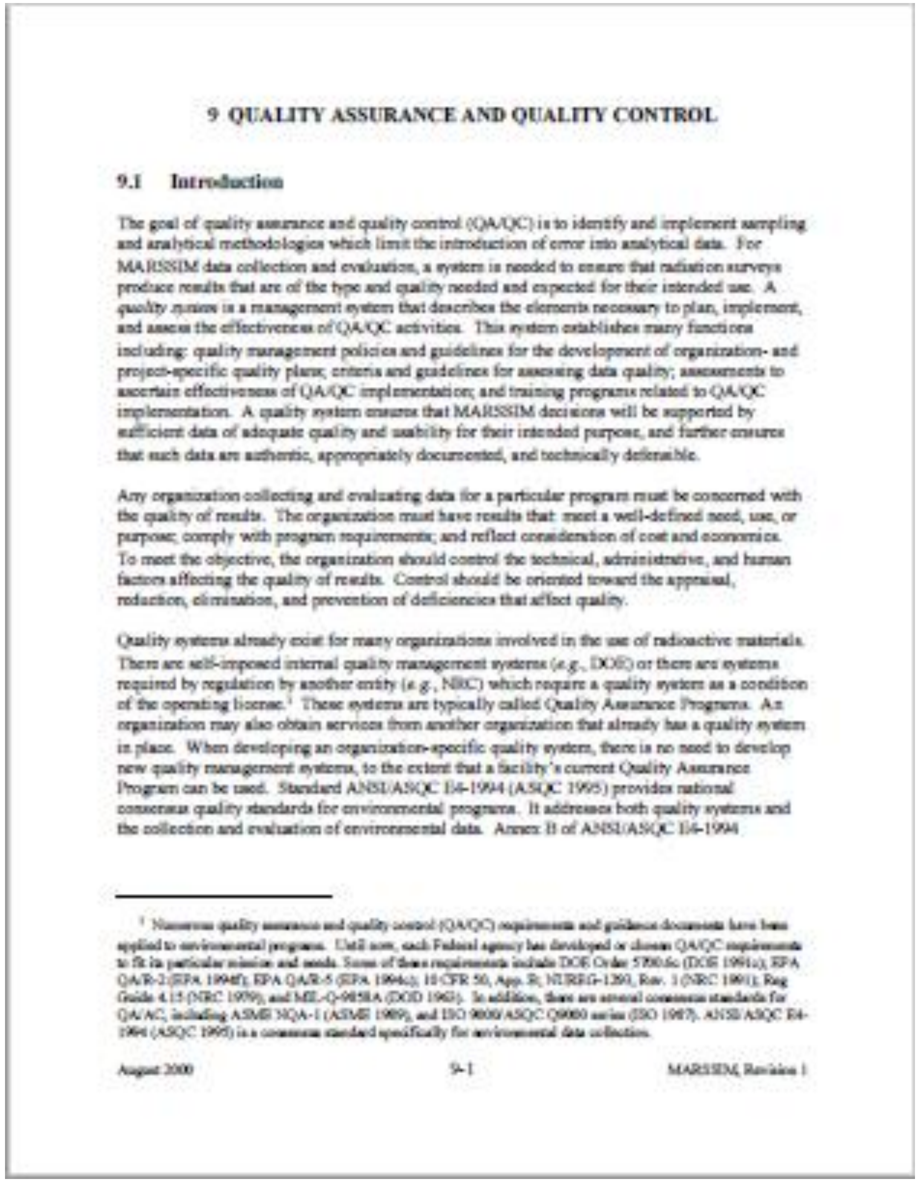


Chapter 9

Quality Assurance and Quality Control



9 QUALITY ASSURANCE AND QUALITY CONTROL

9.1 Introduction

The goal of quality assurance and quality control (QA/QC) is to identify and implement sampling and analytical methodologies which limit the introduction of error into analytical data. For MARSSIM data collection and evaluation, a system is needed to ensure that radiation surveys produce results that are of the type and quality needed and expected for their intended use. A *quality system* is a management system that describes the elements necessary to plan, implement, and assess the effectiveness of QA/QC activities. This system establishes many functions including: quality management policies and guidelines for the development of organization- and project-specific quality plans; criteria and guidelines for assessing data quality; assessments to ascertain effectiveness of QA/QC implementation; and training programs related to QA/QC implementation. A quality system ensures that MARSSIM decisions will be supported by sufficient data of adequate quality and usability for their intended purpose, and further ensures that such data are authentic, appropriately documented, and technically defensible.

Any organization collecting and evaluating data for a particular program must be concerned with the quality of results. The organization must have results that: meet a well-defined need, use, or purpose; comply with program requirements; and reflect consideration of cost and economics. To meet the objective, the organization should control the technical, administrative, and human factors affecting the quality of results. Control should be oriented toward the appraisal, reduction, elimination, and prevention of deficiencies that affect quality.

Quality systems already exist for many organizations involved in the use of radioactive materials. There are self-imposed internal quality management systems (*e.g.*, DOE) or there are systems required by regulation by another entity (*e.g.*, NRC) which require a quality system as a condition of the operating license.[1] These systems are typically called Quality Assurance Programs. An organization may also obtain services from another organization that already has a quality system in place. When developing an organization-specific quality system, there is no need to develop new quality management systems, to the extent that a facility's current Quality Assurance Program can be used. Standard ANSI/ASQC E4-1994 (ASQC 1995) provides national consensus quality standards for environmental programs. It addresses both quality systems and the collection and evaluation of environmental data. Annex B of ANSI/ASQC E4-1994

[1] Numerous quality assurance and quality control (QA/QC) requirements and guidance documents have been applied to environmental programs. Until now, each Federal agency has developed or chosen QA/QC requirements to fit its particular mission and needs. Some of these requirements include DOE Order 5700.6c (DOE 1991c); EPA QA/R-2 (EPA 1994f); EPA QA/R-5 (EPA 1994c); 10 CFR 50, App. B; NUREG-1293, Rev. 1 (NRC 1991); Reg Guide 4.15 (NRC 1979); and MIL-Q-9858A (DOD 1963). In addition, there are several consensus standards for QA/AC, including ASME NQA-1 (ASME 1989), and ISO 9000/ASQC Q9000 series (ISO 1987). ANSI/ASQC E4-1994 (ASQC 1995) is a consensus standard specifically for environmental data collection.

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End of Volume 1

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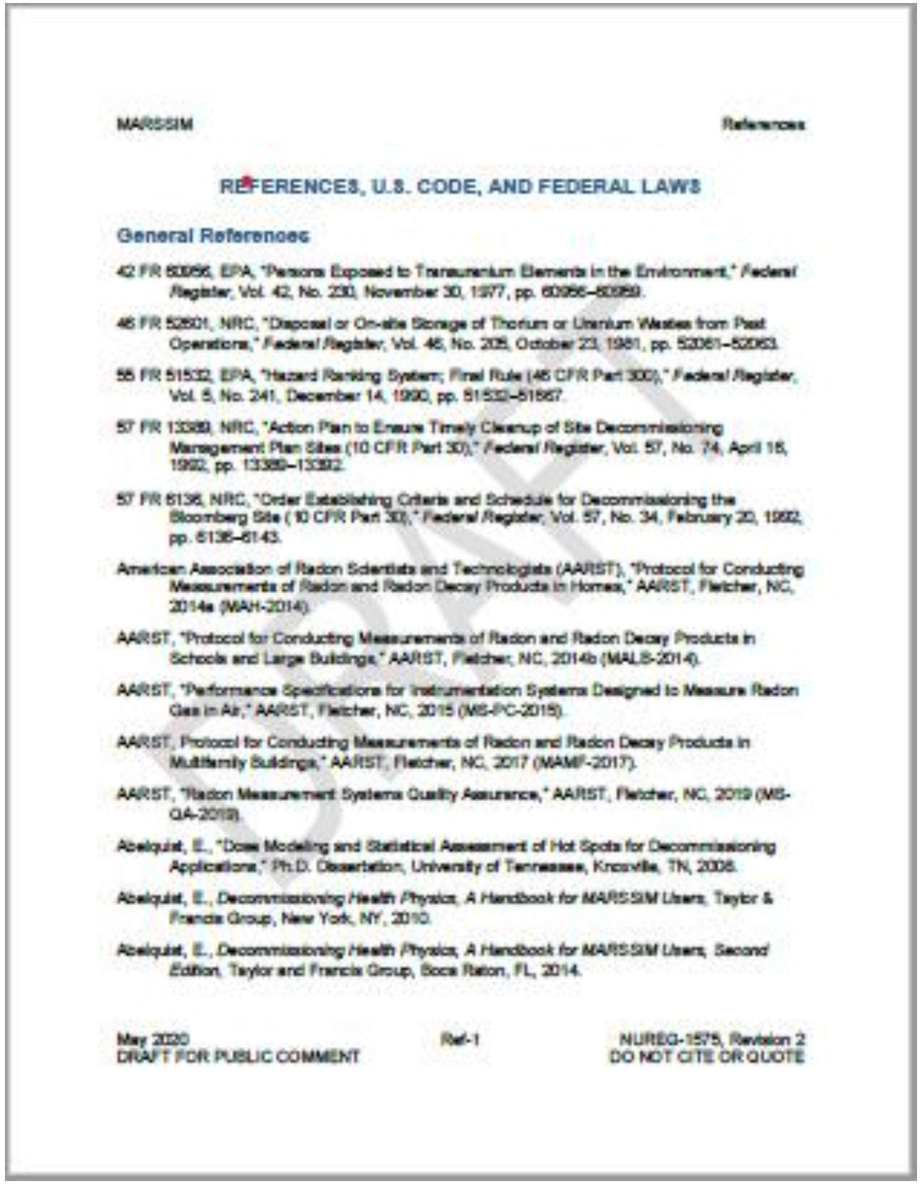

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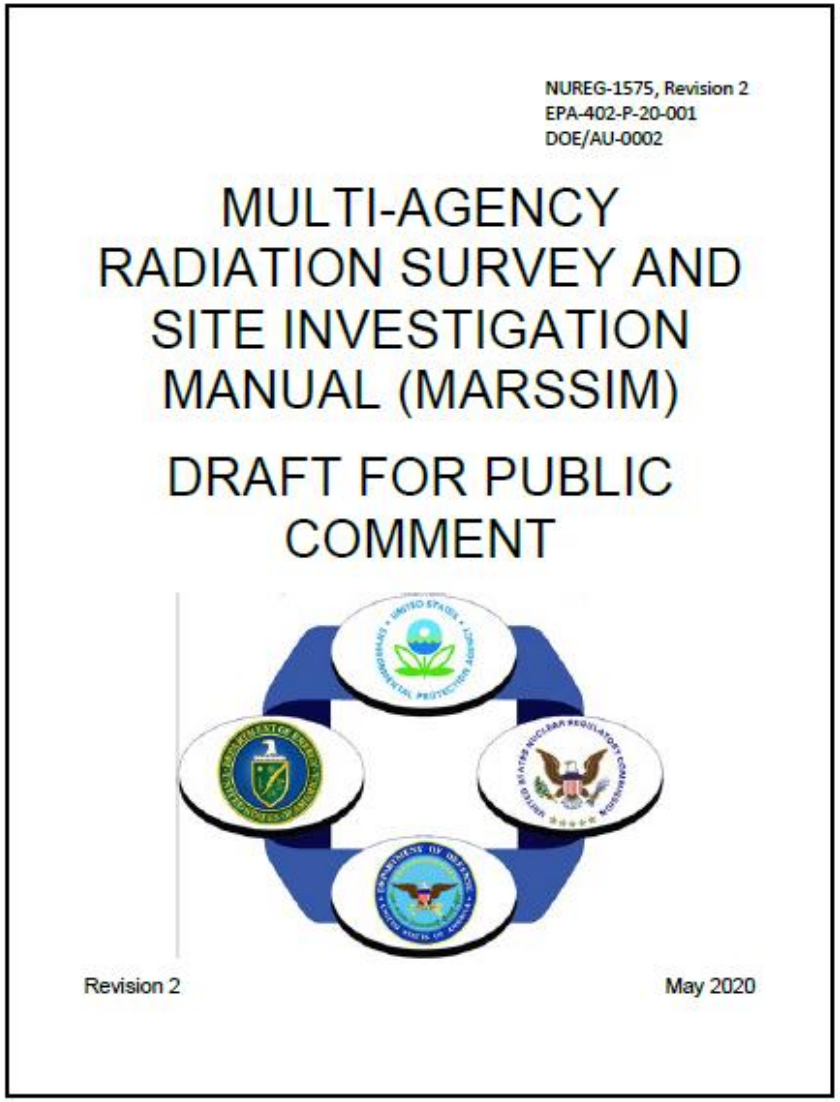
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Original Appendix N – Data Validation using Data Descriptors

Appendix D

MARSSIM Project-Level Quality System Components

D MARSSIM PROJECT-LEVEL QUALITY SYSTEM COMPONENTS

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) provides detailed guidance for planning, implementing, and evaluating environmental and facility radiological surveys conducted to demonstrate compliance with a dose- or risk-based regulation.[1] The MARSSIM guidance focuses on demonstration of compliance during the final status survey (FSS) following scoping, characterization, and any necessary remedial actions.

MARSSIM requires that all environmental data collection and use take place in accordance with a site-specific systematic planning process that incorporates industry-established quality assurance/quality control (QA/QC). The goal of a QA/QC program is to identify and implement sampling and analytical methodologies that limit the introduction of error into analytical data. For MARSSIM data collection and evaluation, a quality system is needed to ensure that radiation surveys produce results that are of the type and quality needed and expected for their intended use. A quality system is a management system that describes the elements necessary to plan, implement, and assess the effectiveness of QA/QC activities. This system establishes many functions, including quality management policies and guidelines for the development of organization- and project-specific quality plans, criteria and guidelines for assessing data quality, assessments to ascertain effectiveness of QA/QC implementation, and training programs related to QA/QC implementation. A quality system ensures that MARSSIM decisions will be supported by sufficient data of adequate quality and usability for their intended purpose and it further ensures that such data are authentic, appropriately documented, and technically defensible. MARSSIM uses the project-level components of a Quality System as a framework for planning, implementing, and assessing environmental data collection activities.

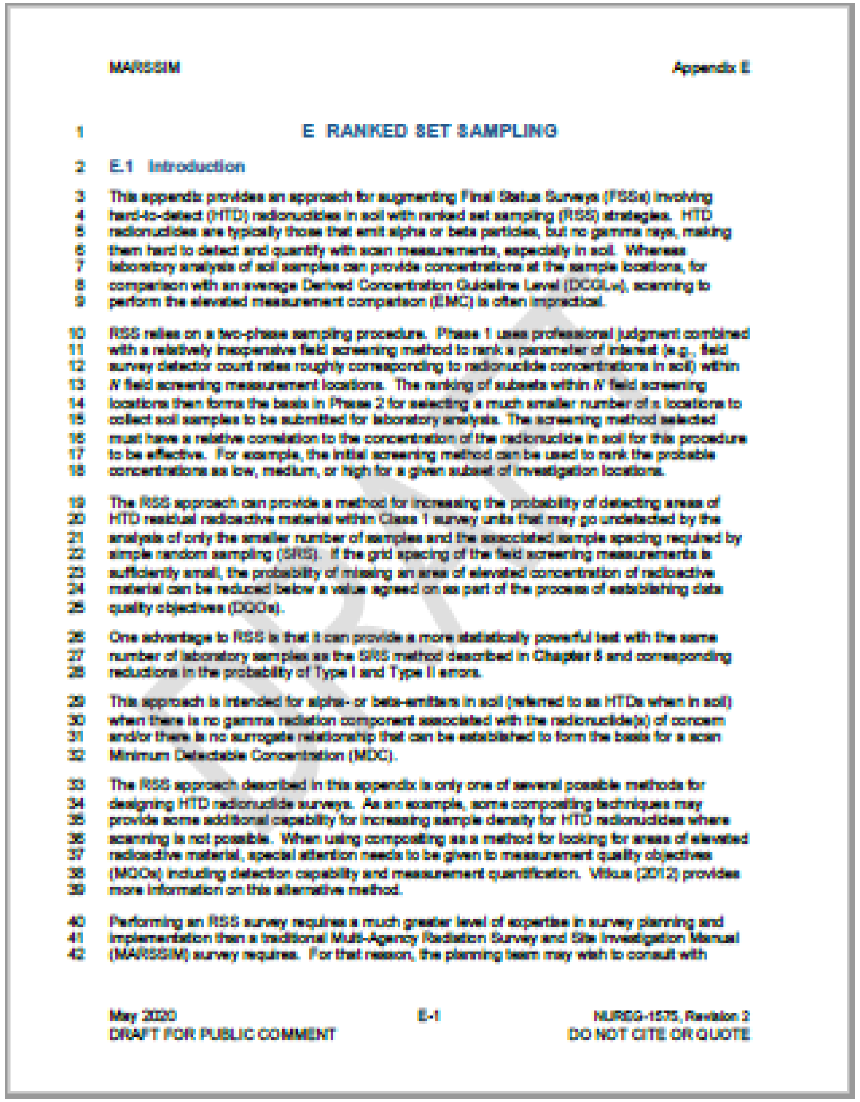
Appendix D includes the following elements of the Quality System process:

- Planning is carried out through the implementation of the Data Quality Objectives (DQO) process, in which planning steps for establishing a survey design are identified and MARSSIM-specific aspects of the planning process are established. The DQO process is a series of planning steps based on the scientific method for establishing criteria for data quality and developing survey designs (EPA 2006c, 1987a, 1987b) (Section D.1).
- The end result of the DQO process is a scientifically justifiable survey design. Based on the established design, a Quality Assurance Project Plan (QAPP) is established in the framework of an Environmental Quality System, the elements of which are outlined in the Uniform Federal Policy for Implementing Environmental Quality Systems (UFP-QS) (EPA 2005a). A QAPP that integrates all technical and quality aspects and defines in detail how specific QA and QC activities will be implemented during the survey project will be

[1] MARSSIM uses the word "should" as a recommendation, not as a requirement. Each recommendation in this manual is not intended to be taken literally and applied at every site. MARSSIM's survey planning documentation will address how to apply the process on a site-specific basis.

Appendix E

Ranked Set Sampling



E RANKED SET SAMPLING

E.1 Introduction

This appendix provides an approach for augmenting Final Status Surveys (FSSs) involving hard-to-detect (HTD) radionuclides in soil with ranked set sampling (RSS) strategies. HTD radionuclides are typically those that emit alpha or beta particles, but no gamma rays, making them hard to detect and quantify with scan measurements, especially in soil. Whereas laboratory analysis of soil samples can provide concentrations at the sample locations, for comparison with an average Derived Concentration Guideline Level ($DCGL_W$), scanning to perform the elevated measurement comparison (EMC) is often impractical.

RSS relies on a two-phase sampling procedure. Phase 1 uses professional judgment combined with a relatively inexpensive field screening method to rank a parameter of interest (e.g., field survey detector count rates roughly corresponding to radionuclide concentrations in soil) within *N* field screening measurement locations. The ranking of subsets within *N* field screening locations then forms the basis in Phase 2 for selecting a much smaller number of *n* locations to collect soil samples to be submitted for laboratory analysis. The screening method selected must have a relative correlation to the concentration of the radionuclide in soil for this procedure to be effective. For example, the initial screening method can be used to rank the probable concentrations as low, medium, or high for a given subset of investigation locations.

The RSS approach can provide a method for increasing the probability of detecting areas of HTD residual radioactive material within Class 1 survey units that may go undetected by the analysis of only the smaller number of samples and the associated sample spacing required by simple random sampling (SRS). If the grid spacing of the field screening measurements is sufficiently small, the probability of missing an area of elevated concentration of radioactive material can be reduced below a value agreed on as part of the process of establishing data quality objectives (DQOs).

One advantage to RSS is that it can provide a more statistically powerful test with the same number of laboratory samples as the SRS method described in Chapter 5 and corresponding reductions in the probability of Type I and Type II errors.

This approach is intended for alpha- or beta-emitters in soil (referred to as HTDs when in soil) when there is no gamma radiation component associated with the radionuclide(s) of concern and/or there is no surrogate relationship that can be established to form the basis for a scan Minimum Detectable Concentration (MDC).

The RSS approach described in this appendix is only one of several possible methods for designing HTD radionuclide surveys. As an example, some compositing techniques may provide some additional capability for increasing sample density for HTD radionuclides where scanning is not possible. When using compositing as a method for looking for areas of elevated radioactive material, special attention needs to be given to measurement quality objectives (MQOs) including detection capability and measurement quantification. Vitkus (2012) provides more information on this alternative method.

Performing an RSS survey requires a much greater level of expertise in survey planning and implementation than a traditional Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) survey requires. For that reason, the planning team may wish to consult with

Appendices – Split Up

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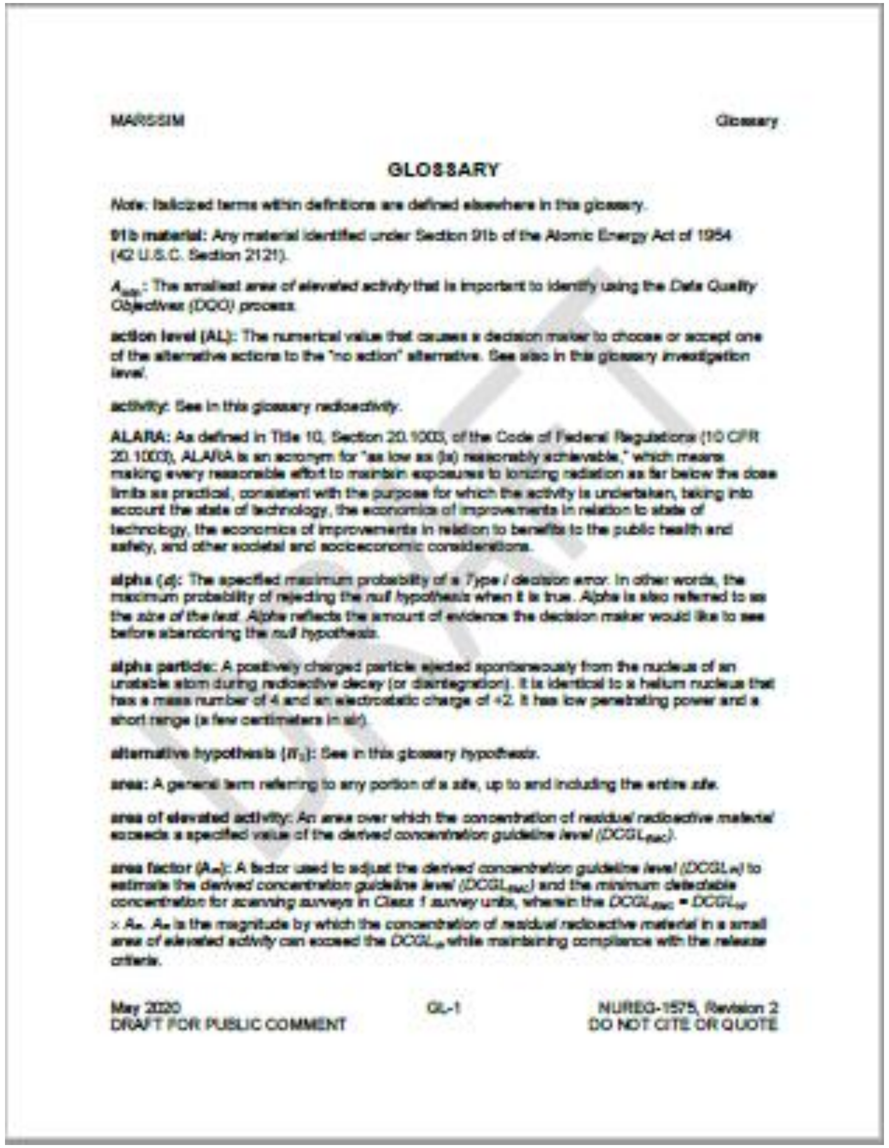
End of Volume 2

Glossary



MARSSIM Glossary

GLOSSARY

Note: Italicized terms within definitions are defined elsewhere in this glossary.

91b material: Any material identified under Section 91b of the Atomic Energy Act of 1954 (42 U.S.C. Section 2121).

A_{min}: The smallest *area of elevated activity* that is important to identify using the *Data Quality Objectives (DQO) process*.

action level (AL): The numerical value that causes a decision maker to choose or accept one of the alternative actions to the "no action" alternative. See also in this glossary *investigation level*.

activity: See in this glossary *radioactivity*.

ALARA: As defined in Title 10, Section 20.1003, of the Code of Federal Regulations (10 CFR 20.1003), ALARA is an acronym for "as low as (is) reasonably achievable," which means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations.

alpha (α): The specified maximum probability of a *Type I decision error*. In other words, the maximum probability of rejecting the *null hypothesis* when it is true. Alpha is also referred to as the *size of the test*. Alpha reflects the amount of evidence the decision maker would like to see before abandoning the *null hypothesis*.

alpha particle: A positively charged particle ejected spontaneously from the nucleus of an unstable atom during radioactive decay (or disintegration). It is identical to a helium nucleus that has a mass number of 4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air).

alternative hypothesis (H_1): See in this glossary *hypothesis*.

area: A general term referring to any portion of a *site*, up to and including the entire *site*.

area of elevated activity: An area over which the concentration of *residual radioactive material* exceeds a specified value of the *derived concentration guideline level ($DCGL_{EMC}$)*.

area factor (A_m): A factor used to adjust the *derived concentration guideline level ($DCGL_W$)* to estimate the *derived concentration guideline level ($DCGL_{EMC}$)* and the *minimum detectable concentration* for *scanning surveys* in *Class 1 survey units*, wherein the $DCGL_{EMC} = DCGL_W \times A_m$. A_m is the magnitude by which the concentration of *residual radioactive material* in a small *area of elevated activity* can exceed the $DCGL_W$ while maintaining compliance with the *release criteria*.

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Review of MARSSIM (Revision 0)

Reviews of MARLAP and MARSAME

Consultation on MARSSIM, Revision 2

Questions