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Standard Guide for Environmental Monitoring Plans for Decommissioning of Nuclear Facilities¹

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1. Scope

1.1 This guide covers the development or assessment of environmental monitoring plans for decommissioning nuclear facilities. This guide addresses: (1) development of an environmental baseline prior to commencement of decommissioning activities; (2) determination of release paths from site activities and their associated exposure pathways in the environment; and (3) selection of appropriate sampling locations and media to ensure that all exposure pathways in the environment are monitored appropriately. This guide also addresses the interfaces between the environmental monitoring plan and other planning documents for site decommissioning, such as radiation protection, site characterization, and waste management plans, and federal, state, and local environmental protection laws and guidance. This guide is applicable up to the point of completing D&D activities and the reuse of the facility or area for other purposes.

1.2 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

[E666 Practice for Calculating Absorbed Dose From Gamma or X Radiation](#)

[E668 Practice for Application of Thermoluminescence-Dosimetry \(TLD\) Systems for Determining Absorbed Dose in Radiation-Hardness Testing of Electronic Devices](#)

[E1167 Guide for Radiation Protection Program for Decommissioning Operations](#)

[E1281 Guide for Nuclear Facility Decommissioning Plans](#)

[E1892 Guide for Preparing Characterization Plans for Decommissioning Nuclear Facilities](#)

[ISO/ASTM 51707 Guide for Estimating Uncertainties in Dosimetry for Radiation Processing](#)

2.2 ANSI Standards:³

[ANSI N 545 Environmental Application of Thermoluminescent Dosimetry](#)

[ANSI N 13.1 Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities](#)

[ANSI N323AB Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments](#)

2.3 Nuclear Regulatory Commission Documents:⁴

[NUREG CR-2082 Monitoring for Compliance with Decommissioning Termination Survey Criteria](#)

[NUREG-1575 Multi-Agency Radiation Survey and Site Investigation Manual \(MARSSIM\), Revision 1, August 2000](#)

[NUREG-1576 Multi-Agency Radiological Laboratory Analytical Protocols \(MARLAP\)](#)

2.4 U.S. Government Documents:

[29 CFR Part 1910.120⁴](#)

2.5 U.S. EPA Documents:

[OSWER-9950.1 RCRA Ground-Water Monitoring Technical Enforcement Guidance Document⁵](#)

[SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods](#)

[40 CFR 302 Designation, Reportable Quantities, and Notifications](#)

[40 CFR 61 National Emission Standards for Hazardous Air Pollutants](#)

[40 CFR 58 Ambient Air Quality Surveillances](#)

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

⁴ Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

⁵ Available from U.S. Environmental Protection Agency, 401 M St. SW, Washington, DC 20460.

2.6 *American Public Health Association Document: Standard Methods for Examination of Water and Wastewater*⁶

3. Terminology

3.1 Definitions:

3.1.1 *active phase, n*—time during which physical decontamination/dismantling operations are performed.

3.1.2 *characterization, n*—a systematic identification of the types, quantities, forms, and locations of contamination on the site.

3.1.3 *Data Quality Objectives (DQOs), n*—quantitative and qualitative statements that specify the quality of data needed from a particular data collection activity.

3.1.4 *decommission, vt*—to remove safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of any applicable licenses.

3.1.5 *decontamination, n*—activities employed to reduce the levels of (radioactive or hazardous chemical) contamination in or on structures, equipment, materials, and personnel. Typical forms of decontamination may include: (1) decontamination to support decommissioning objectives; (2) decontamination to reduce radiation levels in support of as low as reasonably achievable (ALARA) objectives; (3) decontamination to limit the spread of radiological contamination; (4) decontamination to support the unrestricted release of material and equipment; and (5) decontamination of personnel.

3.1.6 *monitoring, vt*—observing or taking measurements systematically over time to determine the status of and to detect significant changes in conditions or performance of a system, facility, or area.

3.1.7 *passive phase, n*—time of surveillance and maintenance from the time plant operations cease until decontamination/dismantling operations begin, and from the end of active decontamination/dismantling operations until the site is released for unrestricted use.

3.1.8 *radiological release criteria, n*—levels of residual radioactivity present at the completion of a decommissioning activity below which the site may be released to the general public for unrestricted use.

3.1.9 *hazardous material clean-up criteria, n*—the reduction of hazardous contaminants needed to reduce the risk identified in the baseline health-based risk assessment to a level consistent with Applicable and Relevant or Appropriate Requirement (ARAR) values.

3.1.10 *hazardous substance, n*—any material identified by the Environmental Protection Agency (EPA) in 40 CFR 262.

3.1.11 *restricted use, n*—organizational control is maintained over a property through physical barricades, signs and notices, or deed covenants that limit the full use of the property by an owner or prospective owner.

3.1.12 *unrestricted use, n*—control over the property is fully released for any use desired by the owner.

4. Summary of Guide

4.1 Nuclear facilities must have established plans for monitoring the environment surrounding the site as part of their license or technical specifications. These plans are designed to identify any release of radioactive or hazardous material and to assess the resulting impacts. Similar plans are required during surveillance and maintenance, decommissioning or site remediation to continue environmental monitoring, although the types of discharges and the affected pathways may be different from those monitored during facility operations.

4.2 In addition, limited environmental surveillance may have been performed since the facility operated. The existing environmental monitoring plans should be modified for decommissioning and reflect the current environment, potential release points, and affected pathways. If no environmental monitoring plan exists, one must be developed.

4.3 The decommissioning environmental monitoring plan must be consistent and complete to ensure the detection and mitigation of off-site impacts caused by radioactive or hazardous materials released from decommissioning activities at nuclear facilities.

5. Significance and Use

5.1 Use of this guide will ensure that the potential impact on the surrounding environment from planned decommissioning activities has been properly assessed.

5.2 Use of this guide will ensure that the adequacy of environmental sampling has been assessed for location, frequency, analytical techniques, and media type to monitor the environment and to detect site-related releases and their impact.

6. Organizational Interfaces

6.1 The environmental monitoring plan should coordinate with other decommissioning documents. Guide E1281 recommends that certain planning documents and implementation plans will be prepared prior to commencement of dismantlement actions. This guide ensures that the basic environmental monitoring planning elements and requirements are identified, examined, and addressed to accomplish the decommissioning activities. Other project plans and reports guide the operations and organization for the decommissioning project.

6.1.1 Planning and implementation documents define the activities around which the site environmental monitoring program will be developed. Documents that should be reviewed include the following:

- 6.1.1.1 Site Description and Operating History Reports,
- 6.1.1.2 Site Characterization Report,
- 6.1.1.3 Health Based Baseline Risk Assessment,
- 6.1.1.4 Planned Decommissioning Activities Document,
- 6.1.1.5 Licensing and Regulatory Issues Document,
- 6.1.1.6 Quality Assurance Document, and
- 6.1.1.7 Radiation Protection Document.

6.1.1.8 **Appendix X1** contains brief overviews of these documents, as they contribute to the environmental plan.

⁶ Available from American Public Health Association, 1015 15th St. NW, Washington, DC 20005.

7. Elements of an Environmental Monitoring Plan

7.1 Site environmental monitoring shall comply with a written plan. This plan must both direct the performance of monitoring and inform concerned individuals as to the intent and methodologies used in monitoring the environment. The plan must clearly define the scope of work activities, that is, describe the site, area, or room to be decommissioned. Guidance on the content and structure of the plan is outlined in **7.2 – 7.10.12**. Additional guidance relative to the requirements for monitoring of environmental pollutants at facilities being decommissioned can be found in such references as , 40 CFR 61, and 40 CFR 58. These cover such topics as notification of the release of hazardous materials, emission standards for air pollutants, and air monitoring of these materials.

7.2 *Introduction and Objectives*—The introduction should address the history of actions leading to decommissioning, identify the organizations involved, describe the decommissioning process and required documentation, define the objective or purpose of the environmental monitoring program, and describe the intended use of the monitoring data.

7.2.1 *Monitoring Objectives*—Basic objectives should include the following, as a minimum:

7.2.1.1 Assess the actual or potential doses to man from contaminants released to the environment as a result of decontamination efforts,

7.2.1.2 Demonstrate compliance with applicable environmental regulations during decommissioning and with established release criteria. Chapter 4 of *The Decommissioning Handbook*⁷ provides an excellent summary of the various environmental regulations that apply to decommissioning work,

7.2.1.3 Evaluate the adequacy and effectiveness of the containment and effluent control system during decontamination.

7.2.2 *Calibration and Measurement System Performance:*

7.2.2.1 Provisions must be made when planning environmental monitoring activities at decommissioning sites to ensure that all data are obtained using instruments and instrumentation systems capable of producing accurate and valid data. This requires the use of instruments and equipment having valid and current calibration certificates. ANSI N323AB describes the protocols for portable instrument calibration. It also means that careful consideration should be given to the appropriate use of spiked samples, blanks, and split samples as quality assurance principles are incorporated into the environmental monitoring program. The MARLAP manual provides guidance for this.

7.2.3 *Data Quality Objectives*—The DQOs impact statistical sampling design, sampling techniques, analytical procedures, and documentation procedures. The elements for a decommissioning monitoring plan will be prepared with concern for the DQO process. Technical monitoring objectives will be established to support the data quality objectives in the monitoring plan. The objectives will be specified in terms of

precision, accuracy, representativeness, completeness, comparability, and detection limit. For further information on DQOs, see Ref (1).⁸

7.3 *Background Information:*

7.3.1 *Location*—The plan should specify the location and describe the site and surrounding area.

7.3.2 *Source of Contaminants and Transport Pathways*—The source term from the site characterization data should be complete enough to identify the types of radionuclides and hazardous materials on site, their quantities, and the physical conditions in which they are found. The plan should specify the chemical composition and condition of the material, extent of contamination, and whether the material is in soil or groundwater, or on buildings and equipment surfaces. Implementation of a site characterization plan, developed using guidance provided in Guide E1892, will provide this data.

7.3.3 *Information Sources*—Sources of information on the site should be identified, searched for pertinent information, and summarized, including previous sampling, facility waste plans, environmental characterizations, radiation surveys, and local sampling problems.

7.3.4 *Impact Data*—Available environmental impact data should be summarized.

7.3.5 *Background Evaluation Requirements:*

7.3.5.1 Requirements governing the decommissioning activities and release of the site may be based on levels above background; therefore, careful evaluation of background conditions at the decommissioning site should be considered when planning the environmental monitoring program.

7.4 *Evaluation of Existing Data:*

7.4.1 *Source Term Examination*—Once all contaminants present at the site are identified, those contaminants that potentially could be released to the environment during decommissioning should be identified specifically and included in the transport model, as discussed in **7.4.2**.

7.4.2 *Pathways Modeling for Monitoring System Design*—The decommissioning activities specified in the decommissioning plan should be reviewed to identify activities that could release hazardous materials to the off-site environment. The environmental transport pathways will then be identified, including critical environmental components and receptors. Using the strength of the source and the model, the most significant pathways and receptors will be identified for each contaminant.

7.4.2.1 The pathways model (conceptual or mathematical) for transport of material to the environment should establish the critical population and the most probable locations for accumulation of radioactivity or hazardous material. Pathways with potentially high accumulation rates should be selected for sampling to provide a means of detecting releases at the earliest opportunity. Likewise, exposure pathways to humans defined in the site release criteria (that is, milk, fish, and groundwater consumption, and dust ingestion and inhalation) should be specifically considered for sampling. These pathways to humans provide a means of comparing site releases and resultant

⁷Taboas, A. L., Moghissi, A. A., and LaGuardia, T. S., Eds., *The Decommissioning Handbook*, Chapter 4, Environmental and Related Requirements, ASME, Three Park Ave., New York, NY, 2004.

⁸The boldface numbers in parentheses refer to a list of references at the end of this guide.