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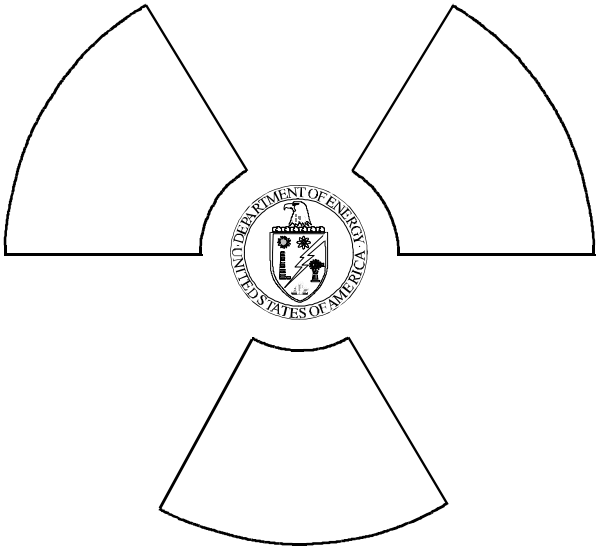
PORTABLE MONITORING INSTRUMENT CALIBRATION GUIDE

for use with

Title 10, Code of Federal Regulations, Part 835,
Occupational Radiation Protection



Assistant Secretary for Environment,
Safety and Health

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ACRONYMS

AEC	Atomic Energy Commission
ALARA	as low as is reasonably achievable
ANSI	American National Standards Institute
DOE	U.S. Department of Energy
DOE G	DOE Guide
DOE O	DOE Order
DOE-STD	DOE Standard
NCSL	National Conference of Standards Laboratories
NIST	National Institute of Standards and Technologies
RCS	RADIOLOGICAL CONTROL, DOE-STD-1098-99
RPP	radiation protection program

PORTABLE MONITORING INSTRUMENT CALIBRATION

1. PURPOSE AND APPLICABILITY

This Guide provides an acceptable methodology for establishing and operating a program for selecting, calibrating, testing, and maintaining portable radiation monitoring instruments that will comply with U.S. Department of Energy (DOE) requirements specified in Title 10 of the Code of Federal Regulations (CFR), Part 835, Occupational Radiation Protection (DOE 1998a); hereinafter referred to as 10 CFR 835. In particular, this Guide provides guidance for achieving compliance with the instrument calibration requirements of paragraph 401(b) of 10 CFR 835. For completeness, this Guide also identifies applicable guidance provided in DOE-STD-1098-99, RADIOLOGICAL CONTROL (DOE 1999a), hereinafter referred to as the RCS, and recommendations contained in secondary documents (American National Standards Institute (ANSI) Standards, etc.) concerning instrument calibration.

This Guide amplifies the regulatory requirements of 10 CFR 835, which are enforceable under the provisions of Sections 223(c) and 234A of the Atomic Energy Act of 1954, as amended (AEC 1954).

Except for requirements established by regulation, contract, or administrative means, the provisions in this Guide are DOE's views on acceptable methods of program implementation and are not mandatory. Conformance with this Guide will, however, create an inference of compliance with the related regulatory requirements. Alternate methods that are demonstrated to provide an equivalent or better level of protection are acceptable. DOE encourages its contractors to go beyond the minimum requirements and to pursue excellence in their programs.

The word "shall" is used in this Guide to designate requirements from 10 CFR 835. Compliance with 10 CFR 835 is mandatory except to the extent an exemption has been granted pursuant to 10 CFR 820, Procedural Rules for DOE Nuclear Activities (DOE 1997a). The words “should” and “may” are used to denote optional program recommendations and permissible alternatives, respectively.

This Guide is applicable to all DOE activities that are subject to the requirements of 10 CFR 835.

2. DEFINITIONS

Terms defined in 10 CFR 835 are used in this Guide consistent with their regulatory definitions.

Acceptance testing: Evaluation or measurement of performance characteristics to verify that certain stated specifications and contractual requirements are met.

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

Detector: A device or component designed to produce a quantifiable response to ionizing radiation, normally measured electronically.

Functional tests: Tests (often qualitative) to determine that an instrument is operational and capable of performing its intended function. Such tests may include, for example, battery check, zero setting, or source response checks.

Geotropism: A change in an instrument's reading as its orientation changes, due to gravitational effects.

Instrument (radiation detection): A complete system consisting of one or more subassemblies (e.g., detector, readout, etc.) designed to quantify one or more characteristics of ionizing radiation or radioactive material.

Performance tests: Tests performed periodically over the life of an instrument to verify that it continues to meet operational requirements. Examples of performance tests are response time and geotropism.

Portable monitoring instrument: An instrument intended to be operated while being carried by an individual.

Source response check: A functional test that includes the observation of the response of an instrument to a check source.

Test: A procedure whereby an instrument, component, or circuit is evaluated against certain criteria for satisfactory operation.

Traceability: The ability to show, through documentation, that a particular instrument or radiation source has been calibrated using either the national standard or a transfer standard in a chain or echelon of calibrations, ultimately leading to a comparison with the national standard.

Type test: An initial test of one or more production instruments made to a specific design to show that the design meets certain specifications.

3. DISCUSSION

A comprehensive radiation protection program (RPP) requires reliable means of monitoring radiological conditions. Such monitoring requires the use of properly functioning radiation monitoring instruments.

10 CFR 835.401(b) requires that instruments and equipment used for monitoring radiological conditions shall be appropriate for the radiation(s) encountered and the environmental conditions and be routinely maintained, calibrated, and tested. American National Standards Institute (ANSI) Standard N323A, *Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments* (ANSI 1997) provides comprehensive guidance for implementing a portable monitoring instrument calibration program. The recommendations contained therein are mandatory for DOE sites that are subject to DOE Order 5480.4, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION STANDARDS (DOE 1993).

This Guide provides guidance for a portable monitoring instrument calibration program that addresses selection (acceptance testing), calibration, tests for operability (functional tests and performance tests), maintenance, calibration equipment, calibration quality, laboratory documentation, facilities, and staff. Note that, while 10 CFR 835.401(b) applies to all radiation monitoring instruments and equipment, the guidance provided in this Guide applies specifically to portable monitoring instruments only. This Guide does not provide specific guidance for:

- installed or stationary monitors such as air monitors, portal monitors, and other non-portable monitoring instrumentation;

- laboratory equipment such as liquid scintillation counters and complex laboratory multi-channel analyzers;

- low exposure rate instruments (even if they are portable) with ranges extending below 0.1mrad/h;

- personal monitoring devices, such as thermoluminescent dosimeters and radio-sensitive film. These devices are addressed by DOE-STD-1111-98, DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM ADMINISTRATION (DOE 1998b);

- pocket ionization chambers. These devices are addressed by ANSI N13.5, *Performance Specifications for Direct Reading and Indirect Reading Pocket Dosimeters* (ANSI 1989a); and

- electronic dosimeters. Appropriate guidance regarding selection, calibration, testing and maintenance of electronic dosimeters is provided in ANSI N13.27, *Performance Specifications for Pocket-sized Alarming Dosimeter/Ratemeters* (ANSI 1981).

While this Guide does not apply directly to the above listed devices, many of the concepts and practices discussed in this Guide, and in the referenced consensus standards, may be applicable to these devices. These concepts and practices should be considered when establishing calibration and maintenance programs for these devices.

4. IMPLEMENTATION GUIDANCE

This section provides guidance for selecting, calibrating, testing, and maintaining portable radiation monitoring instruments and equipment. The portable monitoring instrument maintenance and calibration program should be developed and conducted consistent with ANSI N323A.

The essential elements of an acceptable portable instrument calibration program are shown below with reference to 10 CFR 835, with additional elements provided in ANSI N323A:

- a system that ensures calibration shall be performed periodically on each instrument (10 CFR 835.401(b)(1)). ANSI N323A (4.9) recommends that calibration be performed at least annually;

- an internal audit program shall be conducted no less frequently than every 36 months (10 CFR 835.102); and

- a records program shall be established that documents results of maintenance and calibration performed on instruments and equipment used for area monitoring and contamination control (10 CFR 835.703(d)), includes the maintenance of training records (10 CFR 835.704(a)), documents changes in equipment, techniques, and procedures used for monitoring, (10 CFR 835.704(e)), and documents the results of internal audits (10 CFR 835.704(c)).

Further, the following elements should be in place for those activities that perform their own instrument calibrations:

- procedures addressing the calibration of reference sources, support instruments, and field instruments;

- a method to determine when instruments have been returned out-of-calibration and a method to notify users of out-of-calibration instruments;

- adequate technical staff with appropriate training in instrument calibration; and

- a dedicated facility that permits calibrations without outside physical interference.

For those activities that rely on contracted organizations to perform calibration services, the RPP should include or make reference to a Memoranda of Agreement with the calibration contractor(s) that assures compliance with applicable DOE requirements.

4.1 INSTRUMENT SELECTION

Instruments shall be selected that are appropriate to measure the type(s), levels, and energies of radiation(s) encountered and for the existing environmental conditions (10 CFR 835.401(b)(2) & (b)(3)). To ensure these requirements are met, the initial instrument selection process should include knowledge of facility radiation types, energies, anticipated or known ranges, and results of available instrument performance and testing data (vendor or independent) The selection process should include type testing and acceptance testing.

4.1.1 Type Testing

DOE encourages implementation of a formal instrument qualification (type testing) process in accordance with the relevant portions of ANSI N323A, ANSI N42.17A, *Performance Specifications for Health Physics Instrumentation - Portable Instruments for Use In Normal Environmental Conditions* (ANSI 1989b), and ANSI

N42.17C, *Performance Specifications for Health Physics Instrumentation - Portable Instruments for Use In Extreme Environmental Conditions* (ANSI 1989c).

4.1.2 Acceptance Testing

Prior to use, new instruments should be subjected to acceptance testing as detailed in ANSI N323A. Instruments that do not meet the selected specifications should not be accepted or used by the facility.

4.2 INSTRUMENT CALIBRATION

ANSI N323A sets forth criteria for proper portable monitoring instrument calibration. An instrument calibration hall be performed on each instrument periodically at an established frequency (10 CFR835.401(b)(1)). ANSI N323A establishes an annual calibration frequency for portable monitoring instruments. The calibration frequency should be determined and the calibration should be performed according the details presented in the above referenced consensus standards. If routine checks (e.g., routine operability tests and as-found tests) indicate that the response of an instrument (or type of instrument) remains stable over a long period of time, then the calibration frequency may be extended. Conversely, if routine checks indicate that an instrument (or type of instrument) fails to provide a stable response over the prescribed calibration interval, then the calibration interval should be shortened. The reliability of an instrument (or type of instrument) and appropriate calibration frequency should be determined by collecting and analyzing data in accordance with National Conference of Standards Laboratories Recommended Practice RP-1, *Establishment and Adjustment of Calibration Intervals* (NCSL 1989).

4.3 OPERABILITY TESTS

Functional tests should be performed prior to initial use of an instrument in the field. Functional tests should be detailed in the instrument-use procedures and should include, as a minimum: general condition; battery condition; verification of current calibration (i.e., check to see that the date due for calibration has not passed); background readings; and other tests (high voltage, zero setting, alarm functions, etc.) as applicable to the instrument. Functional tests should also include a source response check (i.e., observing the instrument response to a check source) before initial operation. During use in the field, instruments should be tested with a check source to ensure that the readings remain within prescribed limits. This should be done as prescribed in ANSI N323A. The performance of functional tests during use in the field should be appropriately documented. This may be as simple as a check-list on the survey sheet.

Performance tests should be performed periodically and after maintenance to ensure that the instruments continue to meet performance requirements for field measurements. Examples of performance tests are tests for geotropism and response time. Performance requirements should be met as specified in the applicable sections of ANSI N323A, ANSI N42.17A, and ANSI N42.17 C. These tests may be conducted as part of the calibration procedure.

4.4 MAINTENANCE

Maintenance shall be performed periodically on an established frequency (10 CFR 835.401(b)(1)). Maintenance activities should be directed toward ensuring that the instruments continue to meet the required accuracy for field measurements.

All preventive and corrective maintenance should be performed using components and procedural recommendations at least as stringent as those specified by the instrument manufacturer. If the manufacturer does not provide routine maintenance procedures, a procedure should be written and approved by staff and management in the organization performing the maintenance.

4.5 CALIBRATION EQUIPMENT/CALIBRATION QUALITY

The calibration laboratory should possess and maintain appropriate radiation and non-radiation standards to achieve reliable operation.

Instruments should be calibrated with appropriate standards that are traceable to the National Institute of Standards and Technology (NIST) or its international equivalents. Calibrations of reference radiation fields or sources, calibration assemblies, maintenance of standards, and check sources should be in accordance with ANSI N323A. For information on acceptable reference sources for calibration for various radiation types, refer to Table 2 of ANSI N323A. Calibration quality including calibration field accuracies and quantities should be in accordance with ANSI N323A.

For non-radiation quantities (e.g., temperature, humidity, pressure, voltage, current, etc.), the facility may use standards based on traceability to NIST.

4.6 LABORATORY DOCUMENTATION

The calibration laboratory should maintain the following sets of documentation: (1) the laboratory protocol; (2) the laboratory records; and (3) the calibration records. Historical records should be maintained to detail any changes or revisions in procedures or protocols. The laboratory protocol describes the laboratory operations, i.e., what the laboratory is expected to do and how it is expected to do it. This documentation should also include the detailed calibration procedures for each instrument routinely calibrated. The laboratory records, on the other hand, are those records that document the activities of the laboratory. Finally, the calibration records are those records that document the maintenance, calibration, and testing of each instrument and source used.

4.6.1 Laboratory Protocol

Each DOE laboratory should have a written protocol for operations. Components that should be included in the protocol are listed in ANSI/NCSL Z540-1-1994, *American National Standard for Calibration - Calibration Laboratories and Measuring and Test Equipment - General Requirements* (ANSI/NCSL 1994).

4.6.2 Laboratory Records

Guidance for record-keeping can be found in ANSI N323A and ANSI N13.6, *American National Standard Radiation Protection Practice for Occupational Radiation Exposure Records Systems* (ANSI 1989d). DOE G 441.1-11, OCCUPATIONAL RADIATION PROTECTION RECORD-KEEPING AND REPORTING GUIDE (DOE 1999b), provides additional guidance for maintaining records consistent with the requirements of 10 CFR 835.

4.6.3 Instrument Calibration Records

A record shall be maintained for results of calibration and maintenance performed for each instrument (10 CFR 835.703(d)). Refer to DOE G 441.1-11 and ANSI N323A for specific items that should be included.

4.6.4 Instrument Location

A system for tracking the location of portable survey instruments and for recalling those instruments for recalibration should be established. The location of portable survey instruments should be known by the calibration staff or by some identifiable group assigned with that responsibility. Because instruments may incorporate or be accompanied by an accountable sealed radioactive source, instrument tracking may be required as part of the

sealed radioactive source control program. See DOE G 441.1-13, SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND CONTROL GUIDE (DOE 1999c) to determine if this is the case.

4.7 LABORATORY AND STAFF

The location, design, and use of the calibration laboratory should ensure that conditions within the laboratory will not affect calibration quality. In addition, the laboratory shall be designed to keep worker exposures ALARA in compliance with 10 CFR 835.1001 - 1003. The laboratory should also have an appropriate selection of calibration equipment and should be operated with a properly organized and trained staff. Additional guidance may be found in DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE (DOE 1999d), and Chapter 3 of the RCS.

4.7.1 Laboratory

The effect of external conditions on the internal environment of the calibration laboratory should be considered in selecting the facility site. The laboratory should be sited away from, or otherwise isolated from, sources of mechanical vibration and shock, sources of electrical and electromagnetic interference, and other potential sources of interference with the proper calibration of instrumentation. If such potential sources exist, the laboratory should have documentation that demonstrates an absence of adverse effects on calibration accuracy.

The electrical power should be appropriate for the equipment used, suitably stable, and free of switching surges and significant line noise. When necessary, local auxiliary voltage stabilizers, filters, and uninterruptable power supplies should be provided.

The laboratory environment should be controlled to ensure that environmental conditions do not affect the calibration quality. The conditions described in ANSI N323A, Table 1, should be considered and implemented, to the extent practicable and appropriate.

Calibration areas should not be used for storage of instruments, equipment, or sources. Such storage may lead to variable scatter or abnormal ambient radiation conditions.

4.7.2 Calibration Staff Qualifications

The calibration laboratory manager and the individual in charge of the day-to-day operation of the calibration laboratory should have the authority to conduct operations free from any influence that could adversely affect the quality or impartiality of the services offered. Refer to DOE STD-1107-97, KNOWLEDGE, SKILLS, AND ABILITIES FOR KEY RADIATION PROTECTION POSITIONS AT DOE FACILITIES (DOE 1997b) and DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE (DOE 1999e) for guidance on the recommended education, training, and skills for these two positions. The laboratory manager should understand the laboratory protocol, ensure it is followed, and should, at least annually, evaluate staff competence and the need for training. In smaller operations, the manager may also be in charge of day-to-day operations.

4.7.3 Calibration Staff Training

All staff employed in calibration work shall be trained in radiation safety prior to receiving occupational exposure (10 CFR 835.901(a)). DOE G 441.1-12, RADIATION SAFETY TRAINING GUIDE (DOE 1999f) provides additional guidance.

Apart from radiation safety training, the staff should receive training on the theory of radiation detectors, interaction of radiation with matter, basic statistics, maintenance of records, quality assurance, and other topics related to the safe and efficient operation of calibration equipment.

4.8 ASSESSMENTS

Internal audits of the radiation protection program shall be conducted such that, over a three year period, all functional elements are assessed, including program content and implementation (10 CFR 835.102). DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE provides guidance on the required internal audits.

5. REFERENCES

AEC (Atomic Energy Commission) 1954. Atomic Energy Act of 1954, as amended. Public Law 83-703 (68 Stat. 919), Title 42 U.S.C. sec. 2011.

ANSI (American National Standards Institute) 1981. *Performance Specifications for Pocket-sized Alarming Dosimeter/Ratemeters*. ANSI N13.27. New York, New York.

ANSI 1989a. *American National Standard Performance Specifications for Direct Reading and Indirect Reading Pocket Dosimeters*. ANSI N13.5-R1989. New York, New York.

ANSI 1989b. *Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Normal Environmental Conditions*. ANSI N42.17A-1989. New York, New York.

ANSI 1989c. *Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for Use in Extreme Environmental Conditions*. ANSI N42.17C-1989. New York, New York.

ANSI 1989d. *American National Standard Radiation Practice for Occupational Radiation Exposure Records Systems*. ANSI N13.6-R1989. New York, New York.

ANSI 1997. *American National Standard Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments*. ANSI N323A-1997. New York, New York.

ANSI/NCSL (American National Standards Institute/National Conference of Standards Laboratories) 1994. *American National Standard for Calibration - Calibration Laboratories and Measuring and Test Equipment - General Requirements*. ANSI/NCSL Z540-1-1994. Boulder, Colorado.

DOE (U.S. Department of Energy) 1993. DOE Order 5480.4, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION STANDARDS, dated 1-93. Washington, D.C.

DOE 1997a. 10 CFR 820, U. S. Deparment of Energy, Procedural Rules for DOE Nuclear Activities, 58 FR 43680, *Federal Register*, Vol. 58, No. 157, dated 10-8-97. Washington, D.C.

DOE 1997b. DOE-STD-1107-97, KNOWLEDGE, SKILLS, AND ABILITIES FOR KEY RADIATION PROTECTION POSITIONS AT DOE FACILITIES, dated 1-97. Washington, D.C.

DOE 1998a. 10 CFR 835, U. S. Department of Energy, Occupational Radiation Protection, 63 FR 59662, *Federal Register*, Vol. 63, No. 213, dated 11-4-98. Washington, D.C.

DOE 1998b. DOE-STD-1111-98, DEPARTMENT OF ENERGY LABORATORY ACCREDITATION PROGRAM ADMINISTRATION. Washington, D.C.

DOE 1999a. DOE-STD-1098-99, RADIOLOGICAL CONTROL, under development at time of publication. Washington, D.C.

DOE 1999b. DOE G 441.1-11, OCCUPATIONAL RECORD-KEEPING AND REPORTING GUIDE, under development at time of publication. Washington, D.C.

DOE 1999c. DOE G 441.1-13, SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND CONTROL GUIDE, dated 4-15-99. Washington, D.C.

DOE 1999d. DOE G 441.1-2, OCCUPATIONAL ALARA PROGRAM GUIDE, dated 3-17-99. Washington, D.C.

DOE 1999e. DOE G 441.1-1, MANAGEMENT AND ADMINISTRATION OF RADIATION PROTECTION PROGRAMS GUIDE, dated 3-17-99. Washington, D.C.

DOE 1999f. DOE G 441.1-12, RADIATION SAFETY TRAINING GUIDE, dated 3-17-99. Washington, D.C.

NCSL (National Conference of Standards Laboratories) 1989. *Recommended Practice RP-1, Establishment and Adjustment of Calibration Intervals*. Boulder, Colorado.

6. SUPPORTING DOCUMENTS

Heaton, II, H. T., and G. T. Lalos. 1983. *Calibration Handbook: Ionizing Radiation Measuring Instruments. Naval Surface Weapons Center*. White Oak, Maryland.

International Atomic Energy Agency. 1971. *Handbook on Calibration of Radiation Protection Monitoring Instruments*. IAEA Technical Report 133. Vienna, Austria.

U.S. National Bureau of Standards. 1981. *Requirements for an Effective National Ionizing Radiation Measurements Program*. NBS Special Publication 603. U.S. Department of Commerce. Washington, D.C.

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