

# U.S. NUCLEAR REGULATORY COMMISSION

## REGULATORY GUIDE 4.13, REVISION 2



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## ENVIRONMENTAL DOSIMETRY – PERFORMANCE SPECIFICATIONS, TESTING, AND DATA ANALYSIS

### A. INTRODUCTION

#### Purpose

This regulatory guide (RG) describes an approach that is acceptable to the staff of the U.S. Nuclear Regulatory Commission (NRC) to meet regulatory requirements for performing surveys and evaluations of public dose in the unrestricted area and the controlled area of a licensed facility from direct radiation using environmental dosimetry.

This RG provides environmental dosimeter performance specifications, testing criteria and data analysis methods for passive environmental dosimetry systems, such as thermoluminescence dosimeters (TLDs) and optically stimulated luminescence dosimeters (OSLs). It endorses the American National Standards Institute/Health Physics Society (ANSI/HPS) N13.37-2014, “Environmental Dosimetry—Criteria for System Design and Implementation” (Ref. 1), which contains information on environmental dosimetry that meets the NRC’s regulatory requirements.

#### Applicability

This RG applies to reactor and nonreactor licensees under the following regulations.

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities” (Ref. 2),
- 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 3),
- 10 CFR Part 70, “Part 70—Domestic Licensing of Special Nuclear Material” (Ref. 4), and
- 10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste” (Ref. 5).

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Electronic copies of this RG, previous versions of RGs, and other recently issued guides are available through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <https://www.nrc.gov/reading-rm/doc-collections/reg-guides/> under Document Collections, in Regulatory Guides. This RG is also available through the NRC’s Agencywide Documents Access and Management system (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html> under ADAMS Accession Number (No.). ML19044A595. The regulatory analysis may be found in ADAMS under Accession No. ML18087A167. The associated draft guide DG-4019 may be found under ADAMS Accession No. ML18087A169

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## Applicable Regulations

- 10 CFR Part 20, “Standards for Protection Against Radiation” (Ref. 6).
  - 10 CFR 20.1301, “Dose limits for individual members of the public,” establishes the dose limits for members of the public.
  - 10 CFR 20.1302, “Compliance with dose limits for individual members of the public,” requires, in part, licensees to make, or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas.
- 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.”
  - 10 CFR 50.36a, “Technical specifications on effluents from nuclear power reactors,” requires each licensee of a nuclear power plant to include technical specifications that require operating procedures for the control of effluents and annual reports of the quantity or principal radionuclides released to unrestricted areas in both gaseous and liquid effluents with the expectation that radioactive materials released to unrestricted areas meet the numerical limiting conditions for operation in Appendix I, to 10 CFR Part 50, “Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low as is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.”
  - 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” Criterion 64, “Monitoring Radioactivity Releases,” establishes design criteria for monitoring the plant environment for radioactivity that may be released from the plant.
  - 10 CFR Part 50, Appendix I, “Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion, “As Low As Is Reasonably Achievable, for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” Section IV.B, requires that an appropriate surveillance and monitoring program be established to provide data on measurable levels of radiation in the environment.
- 10 CFR Part 52
  - 10 CFR Part 52.0, “Scope; applicability of 10 CFR Chapter I, provisions,” states that the regulations referenced in 10 CFR Chapter I are applicable to 10 CFR Part 52 licensees (e.g., 10 CFR Part 20).
- 10 CFR Part 70
  - 10 CFR 70.59, “Effluent monitoring reporting requirements,” requires licensees authorized to possess and use special nuclear material for processing and fuel fabrication, scrap recovery, conversion of uranium hexafluoride, or in a uranium enrichment facility to submit a report on effluent monitoring information to estimate maximum potential annual radiation doses to the public resulting from effluent releases.
- 10 CFR Part 72
  - 10 CFR Part 72.104, “Criteria for radioactive materials in effluent and direct radiation from an [independent spent fuel storage installation] ISFSI or [Monitored Retrievable

Storage Installation] MRS,” includes dose limits and requirements that are consistent and compatible with the U.S. Environmental Protection Agency (EPA) standards in 40 CFR Part 191, “Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste” (Ref. 7).

- 40 CFR Part 190 (Ref. 8) (10 CFR 20.1301(e) requires that NRC licensees subject to the standards set forth in 40 CFR Part 190 shall comply with those standards)
  - 40 CFR 190.10, “Standards for normal operations,” establishes the EPA standards for the annual dose equivalent not to exceed 25 millirem (mrem) (0.25 millisievert (mSv)) to the whole body, 75 mrem (0.75 mSv) to the thyroid, and 25 mrem (0.25 mSv) to any other organ.

### **Related Guidance**

- RG 4.1, “Radiological Environment Monitoring for Nuclear Power Plants” (Ref. 9), provides guidance on establishing and conducting a comprehensive environmental monitoring program at nuclear power plants.
- NUREG-1301, “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No. 1” (Ref. 10), provides guidance on standard radiological effluent controls for pressurized water reactors.
- NUREG-1302, “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors, Generic Letter 89-01, Supplement No. 1” (Ref. 11), provides guidance on standard radiological effluent controls for boiling water reactors.
- RG 1.21, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste” (Ref. 12), provides guidance on (1) measuring, evaluating, and reporting plant-related radioactivity (excluding background radiation) in effluents and solid radioactive waste shipments from NRC licensed facilities, (2) assessing and reporting the public dose from facility operations, and (3) complying with 40 CFR 190 in accordance with the requirements of 10 CFR 20.1301(e).

### **Purpose of Regulatory Guides**

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency’s regulations, to explain techniques that the staff uses in evaluating specific problems or postulated events, and to provide guidance to applicants. RGs are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

### **Paperwork Reduction Act**

This RG provides voluntary guidance for implementing the mandatory information collections in 10 CFR Parts 50, 52, 70 and 72 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et. seq.). These information collections were approved by the Office of Management and Budget (OMB), under control numbers 3150-0011, 3150-0151, 3150-0009 and 3150-0132. Send comments regarding this

information collection to the Information Services Branch (T6-A10M), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to [Infocollects.Resource@nrc.gov](mailto:Infocollects.Resource@nrc.gov), and to the OMB reviewer at: OMB Office of Information and Regulatory Affairs (3150-0011, 3150-0151, 3150-0009 and 3150-0132), Attn: Desk Officer for the Nuclear Regulatory Commission, 725 17th Street, NW Washington, DC 20503; e-mail: [oir\\_submission@omb.eop.gov](mailto:oir_submission@omb.eop.gov).

### **Public Protection Notification**

The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless the document requesting or requiring the collection displays a currently valid OMB control number.

## B. DISCUSSION

### Reason for Revision

This revision of the guide (Revision 2) provides updated NRC guidance on an acceptable environmental dosimetry program by endorsing ANSI/HPS N13.37-2014. The ANSI/HPS N13.37-2014 standard provides up-to-date environmental dosimetry system design criteria and dosimeter laboratory test protocols and data-analysis methods suitable to assess potential facility-related radiation doses.

The NRC modified the title of Revision 2 to RG 4.13 from the title used for Revision 1. The modified title more clearly indicates the content of the RG, which includes data-analysis methods suitable to assess potential facility-related radiation doses, and to broaden the scope beyond thermoluminescence dosimetry to include other types of dosimetry.

### Background

RG 4.1, “Radiological Environmental Monitoring for Nuclear Power Plants,” provides an overall description of a method for establishing an environmental monitoring program for nuclear power plants. It includes qualitative but not quantitative guidance for evaluating direct radiation measurements to determine the dose contribution from plant operation to members of the public in the general environment.

Revision 1 to RG 4.13, “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications,” issued in July 1977 (Ref. 13), endorsed the ANSI N545-1975 (withdrawn June 18, 2004), “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications),” standard (Ref. 14) as a generally acceptable method of performing direct radiation surveys in the environment of NRC-licensed facilities, subject to additional dosimeter performance specifications listed in Revision 1.

ANSI N545-1975, Appendix C, “Interpretation of Field Exposures to Isolate Contributions Attributable to Man-Made Radiation Sources (Such as Nuclear Power Plant),” provided a conceptual description of two methods for analyzing environmental data, but it did not provide quantitative data analysis techniques for either method. The two methods were:

- (1) Background radiation levels are the same at any location but may vary from year to year.

The background radiation levels are assumed to be the same, regardless of the monitoring location. Therefore, dosimetry measurements can be made at control locations (i.e., at a site remote from a nuclear facility) and compared to the dose rate at indicator locations near the monitored facility.

- (2) Background radiation levels are constant at each monitored location but may vary between locations.

The background dose rate at each location is constant (i.e., from preoperational time periods to operational time periods). Dosimetry measurements can be made at a monitoring location and compared to previous (e.g., preoperational) measurements at the same location.

In 1980, the NRC provided guidance on an acceptable method for light-water reactors (LWRs) to comply with the EPA 40 CFR 190 requirements. The agency described the method in NUREG-0543, “Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard (40 CFR Part 190),” issued February 1980 (Ref. 15). NUREG-0543 states conditions under which conformance with 10 CFR Part 50, Appendix I, provide reasonable assurance of conformance with 40 CFR Part 190. NUREG-0543 states that, in comparing 10 CFR Part 50, Appendix I, to 40 CFR Part 190, the only potentially significant exposure pathway for LWRs that is not addressed is the direct radiation pathway.

NUREG-0543 indicated that, for most facilities with offsite direct radiation doses exceeding 5 mrem (0.05 mSv) per year, it is necessary to determine the magnitude and distribution of offsite direct radiation doses. Under these conditions, NUREG-0543 assumed that a reasonable assurance exists that no individual would receive a significant dose (i.e., greater than 1 mrem (0.01 mSv) per year per reactor) from radioactive liquid effluent release pathways. Therefore, only doses to individuals via airborne gaseous effluent pathways and doses resulting from direct radiation need consideration in determining compliance with EPA’s regulations in 40 CFR Part 190. After the direct radiation dose fields were characterized, the dose resulting from direct radiation was added to the doses resulting from liquid and gaseous effluents to demonstrate compliance with 40 CFR Part 190.

Since the publication of NUREG-0543 in 1980, some licensees have constructed independent spent fuel storage installations (ISFSIs) and low-level radioactive waste facilities for storage of replaced steam generators and reactor heads. The additional storage of this waste has the potential for increasing the direct radiation levels and dose to members of the public in the unrestricted area and the controlled area of a licensed facility. The environmental monitoring program for direct radiation provides one method that can be used, in part, to meet the requirements in 10 CFR 20.1302(a) to make, or cause to be made, surveys of radiation levels in unrestricted and controlled areas. Further, new regulations governing the storage of spent nuclear fuel in ISFSIs (10 CFR Part 72) have also been issued since 1980, for which the environmental monitoring program provides a method that can be used, or may be required, to meet, in part, the requirements in those regulations.

In 1991, the NRC revised 10 CFR Part 20 to include a new requirement in 10 CFR 20.1302 stating that licensees shall perform, as appropriate, surveys of radiation levels in the unrestricted area and the controlled area of a licensed facility to demonstrate compliance with the dose limits for individual members of the public.

Subsequently, ANSI N545-1975 was withdrawn and replaced with ANSI/HPS N13.37-2014, “Environmental Dosimetry—Criteria for System Design and Implementation.” ANSI/HPS N13.37-2014 provides revised environmental dosimetry performance specifications and data analysis methods based on the premise that the background radiation at each location is constant.

ANSI/HPS N13.37-2014 introduced four important terms which are:

- (1) The “minimum quantifiable dose” (MQD) rate is the smallest amount of dose rate that can be accurately measured with less than or equal to a 7 percent coefficient of variation. The MQD is used to evaluate the adequacy of a dosimeter system design.
- (2) The “minimum differential dose” (MDD) rate is the smallest amount of dose rate that can be detected and attributed to a facility’s operation (e.g., the incremental dose rate above background). The MDD is a nominal 5 to 6 mrem (0.05 to 0.06 mSv) per quarter or 10 to 12 mrem (0.01 to 0.12 mSv) per year. However, there is no minimum performance requirement for an MDD; rather it is a characteristic of the environmental dosimetry system.

- (3) The “facility related dose” (FRD) is the actual amount of dose detected in a monitoring period (above natural background) attributed to the facility. If the FRD is less than the MDD, the FRD is “not detected.”
- (4) The “extraneous dose” is the extra dose accumulated on a dosimeter before and after field deployment. Extraneous dose is due to radiation sources other than those at the field monitoring location, such as natural background (when the dosimeter is not deployed), and dose received from manmade sources in transit such as medical isotopes or facility sources such as nitrogen-16 (N-16) shine when the dosimeter is not deployed. To determine the field dose, the extraneous dose is subtracted from the gross (total) dose on the field dosimeter.

In determining the radiation dose from direct radiation, it should be recognized that passive environmental dosimeters such as TLDs and OSLs may not be able to measure very low doses below the dosimeter’s MDD. If the total public dose from gaseous and liquid effluents plus the MDD could exceed the public dose limits in 10 CFR 20.1301, licensees must perform additional calculations or measurements using other methods sufficient to demonstrate that the public dose limits are not exceeded.

### **Harmonization with International Standards**

The NRC staff reviewed guidance developed by the International Atomic Energy Agency, the International Commission of Radiological Protection, and the International Electrotechnical Commission (IEC). The International Commission on Radiological Protection and the International Atomic Energy Agency have issued a significant number of standards, guidance, technical documents, and recommendations that address good practices in most aspects of radiation protection.

The IEC, an international organization focused on developing standards for electrical, electronic, and related technologies, issued international standard IEC 62387:2012, “Radiation Protection Instrumentation—Passive Integrating Dosimetry Systems for Personal and Environmental Monitoring of Photon and Beta Radiation” (Ref. 16). ANSI/HPS N13.37-2014 and RG 4.13, Revision 2, are generally consistent with the IEC standard for dosimetry system performance specifications and complement and supplement the technical guidance in IEC 62387. However, although the performance criteria are generally comparable, by focusing specifically on passive environmental monitoring dosimetry systems, the ANSI/HPS N13.37-2014 testing approach may be a simpler approach than the one described in IEC 62387. Additionally, ANSI/HPS N13.37-2014 extends beyond IEC 62387:2012 in providing guidance for deployment and data analysis of environmental monitoring dosimetry systems.

Generally, it should be noted that some of the recommendations issued by these international organizations do not correspond to the requirements specified in the NRC’s regulations. In such cases, the NRC’s requirements take precedence.

### **Documents Discussed in Staff Regulatory Guidance**

This RG endorses the use of one or more codes or standards developed by external organizations, and other third-party guidance documents. These codes, standards and third-party guidance documents may contain references to other codes, standards or third-party guidance documents (“secondary references”). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then licensees and applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in a RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in a RG, then the secondary reference is

neither a legally-binding requirement nor a “generic” NRC approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

## **C. STAFF REGULATORY GUIDANCE**

This section describes an approach that is acceptable for performing surveys and evaluations of public dose in the unrestricted area and the controlled area of a licensed facility from direct radiation using environmental dosimetry.

The NRC endorses the guidance in ANSI/HPS N13.37-2014 without exception for meeting the NRC's requirements in the applicable regulations.

## D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees subject to 10 CFR Part 20 may use this guide and information to meet applicable regulatory requirements.

### Use by Applicants and Licensees

Applicants and licensees may voluntarily<sup>1</sup> use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described or referenced in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations.

Licensees may use the information in this RG for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59, “Changes, Tests, and Experiments.” Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues.

### Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this RG. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this RG, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this RG to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action that would require the use of this RG. Examples of such unplanned NRC regulatory actions include issuance of an order requiring use of this RG, generic communication, or promulgation of a rule requiring the use of this RG without further backfit consideration.

During regulatory discussions on plant specific operational issues, the NRC staff may discuss with licensees various actions consistent with staff positions in this RG, as one acceptable means of meeting the underlying NRC regulatory requirements. Such discussions would not ordinarily be considered backfitting even if prior versions of this RG are part of the licensing basis of the facility. However, unless this RG is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee’s failure to comply with the positions in this RG constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff’s consideration of the request involves a regulatory issue directly relevant to this revised RG, and (2) the specific subject matter of this RG is an essential consideration in the staff’s determination of the acceptability of the licensee’s request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements.

If a licensee believes that the NRC is either using this RG or requesting or requiring the licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, “Backfitting Guidelines,” (Ref. 17) and the NRC Management Directive 8.4, “Management of Facility-Specific Backfitting and Information Collection” (Ref. 18).

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<sup>1</sup> In this section, “voluntary” and “voluntarily” means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

## REFERENCES<sup>2</sup>

1. American Nuclear Standards Institute/Health Physics Society N13.37-2014, “Environmental Dosimetry—Criteria for System Design and Implementation.”<sup>3</sup>
2. *U.S. Code of Federal Regulations* (CFR), Part 50, “Domestic Licensing of Production and Utilization Facilities,” Chapter I, Title 10, “Energy.”
3. CFR, Part 52, “Licenses, Certifications, and Approvals For Nuclear Power Plants,” Chapter I, Title 10, “Energy.”
4. CFR, Part 70, “Domestic Licensing of Special Nuclear Material,” Chapter I, Title 10, “Energy.”
5. CFR, Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-level Radioactive Waste, and Reactor-related Greater Than Class C Waste,” Chapter I, Title 10, “Energy.”
6. CFR, Part 20, “Standards for Protection against Radiation,” Chapter I, Title 10, “Energy.”
7. EPA, CFR Part 191, “Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-level and Transuranic Radioactive Wastes,” Chapter I, Title 40, “Protection of Environment.”
8. Environmental Protection Agency (EPA), CFR, Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations,” Chapter I, Title 40, “Protection of Environment.”<sup>4</sup>
9. U.S. Nuclear Regulatory Commission (NRC), Regulatory Guide (RG) 4.1, “Radiological Environmental Monitoring for Nuclear Power Plants,” Washington DC.
10. NRC, NUREG-1301, (1991) “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, Generic Letter 89-01, Supplement No. 1,” Washington DC.
11. NRC, NUREG-1302, (1991), “Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Boiling Water Reactors, Generic Letter 89-01, Supplement No. 1,” Washington DC.

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<sup>2</sup> Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public Web site at <http://www.nrc.gov/reading-rm/doc-collections/> and through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>. The documents can also be viewed online or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. For problems with ADAMS, contact the PDR staff at 301-415-4737 or (800) 397-4209; fax (301) 415-3548; or e-mail [pdr.resource@nrc.gov](mailto:pdr.resource@nrc.gov).

<sup>3</sup> Copies of American National Standards Institute (ANSI) standards may be purchased from ANSI, 1819 L Street, NW, Washington, DC 20036, on their Web site at <http://webstore.ansi.org/>; telephone (202) 293-8020; fax (202) 293-9287; or e-mail [storemanager@ansi.org](mailto:storemanager@ansi.org). Copies of the Health Physics Society (HPS) products may be purchased from HPS, 1313 Dolley Madison Boulevard, Suite 402 McLean, Virginia 22101 Phone: 703-790-1745.

<sup>4</sup> Copies of EPA Library may be obtained through their Web site: <https://www.epa.gov/libraries/library-services.html>.

12. NRC, RG 1.21, “Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste,” Washington, DC.
13. NRC, RG 4.13, Revision 1 (1977), “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications,” Washington, DC.
14. American National Standards Institute (ANSI) N545-1975, withdrawn June 18, 2004, “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications).”
15. NRC, NUREG-0543 (1980), “Methods for Demonstrating LWR Compliance with the EPA Uranium Fuel Cycle Standard (40 CFR Part 190),” Washington DC.
16. International Standard of the International Electrotechnical Commission (IEC) 62387:2012 “Radiation Protection Instrumentation – Passive integrating dosimetry systems for personal and Environmental Monitoring of Photon and Beta Radiation.”<sup>5</sup>
17. NRC, NUREG-1409, “Backfitting Guidelines,” Washington, DC.
18. NRC, Management Directive (MD) 8.4, “Management of Facility-Specific Backfitting and Information Collection,” Washington, DC.

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<sup>5</sup> Copies of International Electrical Commission (IEC) documents may be obtained through their Web site: <http://www.iec.ch/> or by writing the IEC Central Office at P.O. Box 131, 3 Rue de Varembe, 1211 Geneva, Switzerland, Telephone +41 22 919 02 11.

# Bibliography

## **Regulatory Guides**

RG 4.8, “Environmental Technical Specifications for Nuclear Power Plants,” December 1975 (ADAMS Accession No. ML003739900) (Withdrawn; see [74 FR 21017; May 6, 2009](#)).

## **NUREG-Series Reports**

NUREG-0133, “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants: A Guidance Manual for Users of Standard Technical Specifications,” October 1978 (ADAMS Accession No. ML091050057).

NUREG/CR-3775, “Quality Assurance for Measurements of Ionizing Radiation,” June 1984 (ADAMS Accession No. ML101390303).

## **Generic Letters (GLs)**

GL 79-41, “Compliance with 40 CFR [Part] 190, EPA Uranium Fuel Cycle Standard,” September 17, 1979 (available at <https://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/1979/gl79041.html>).

GL 79-70, “Environmental Monitoring for Direct Radiation,” December 21, 1979 (available at <https://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/1979/gl79070.html>).

## **Branch Technical Positions**

Branch Technical Position on Environmental Monitoring, “An Acceptable Radiological Environmental Monitoring Program,” Revision 0, March, 1978 (ADAMS Accession No. ML093380781).

Branch Technical Position on Environmental Monitoring, “An Acceptable Radiological Environmental Monitoring Program,” Revision 1, November 1979 (ADAMS Accession No. ML12187A692).

## **National Standards**

ANSI N545-1975, “Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry (Environmental Applications)” (<http://webstore.ansi.org/>).

ANSI/HPS N13.11-2009, “Personnel Dosimetry Performance – Criteria for Testing” (<http://webstore.ansi.org/>).

## **Associated Documents**

Darois, E.L., and Rashidifard, N.S. (Radiation Safety & Control Services, Inc.), “Characterization of Neutron and Gamma Fields and Dosimetry Response from Spent Fuel in Transit and Stored at ISFSI Facilities,” Radiological Effluents and Workshop, San Diego, CA, June 23–25, 2015 (ADAMS Accession No. ML15362A644).