

# REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

## REGULATORY GUIDE 4.13

### PERFORMANCE, TESTING, AND PROCEDURAL SPECIFICATIONS FOR THERMOLUMINESCENCE DOSIMETRY: ENVIRONMENTAL APPLICATIONS

#### A. INTRODUCTION

Section 20.105, "Permissible levels of radiation in unrestricted areas," of 10 CFR Part 20, "Standards for Protection Against Radiation," provides limits on levels of radiation in unrestricted areas resulting from possession, use, or transfer of NRC-licensed radioactive material. Section 20.106, "Radioactivity in effluents to unrestricted areas," of 10 CFR Part 20 prohibits a licensee from releasing to an unrestricted area radioactive materials in concentrations that exceed limits specified in 10 CFR Part 20 except as otherwise authorized in a license issued by the Commission. Section 20.201, "Surveys," of 10 CFR Part 20 further requires that a licensee conduct surveys as may be necessary to comply with the regulations of 10 CFR Part 20 including, when appropriate, the measurement of levels of radiation.

Section IV.B of 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," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that licensees establish appropriate surveillance and monitoring programs to provide data on measurable levels of radiation and radioactive materials in the environment.

General Design Criterion 64, "Monitoring radioactivity releases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 requires that nuclear power plant designs provide means for monitoring the plant environs for radioactivity that may be released as the

result of normal operations, including anticipated operational occurrences, and as the result of postulated accidents.

Thermoluminescence dosimetry (TLD) is widely used to measure levels of X and gamma radiation in the environs of NRC-licensed nuclear facilities. This guide provides minimum acceptable performance criteria for TLD systems used for this purpose. It also provides procedures for calibration, field application, and reporting.

#### B. DISCUSSION

Working Group 9 of the Health Physics Society Standards Committee for American National Standards Main Committee (ANSI) N13 on Radiation Protection has prepared a standard that specifies minimum acceptable performance of TLDs used for environmental measurements; outlines methods to test for compliance; and provides procedures for calibration, field application, and reporting. This standard was prepared under the direction of the Health Physics Society Standards Committee and was processed and approved for submittal to ANSI by the American National Standards Committee on Radiation Protection, N13. It was subsequently approved and designated N545-1975 by the ANSI Board of Standards Review on August 20, 1975.

The specification of performance criteria of thermoluminescence dosimetry and the verification of the actual performance require appropriate statistical

ANSI N545-1975, "Performance, Testing, and Procedural Specification for Thermoluminescence Dosimetry (Environmental Applications)" may be obtained from the American National Standards Institute, 1430 Broadway, New York, New York 10018.

#### USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings required to the issuance or continuance of a permit or license by the Commission.

Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience. However, comments on this guide, if received within about two months after its issuance, will be particularly useful in evaluating the need for an early revision.

Comments should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Section.

The guides are issued in the following ten broad divisions:

- |                                  |                       |
|----------------------------------|-----------------------|
| 1 Power Reactors                 | 6 Products            |
| 2 Research and Test Reactors     | 7 Transportation      |
| 3 Fuels and Materials Facilities | 8 Occupational Health |
| 4 Environmental and Siting       | 9 Antitrust Review    |
| 5 Materials and Plant Protection | 10 General            |

Copies of published guides may be obtained by written request indicating the divisions desired to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Office of Standards Development.

concepts and techniques. Because wide applicability is intended, ANSI N545-1975 as well as the provisions and clarifications given below in the regulatory position are confined to simple statistical concepts and prescribe no specific statistical techniques. In fact, the implementation of some specifications by rigorous statistical methods may prove difficult for some users of the guide. Therefore, good approximate statistical methods are acceptable.

No specific criteria for good approximation are prescribed. However, the user should judge whether the sample size is adequately large for the approximation and whether the distribution of the measurements is sufficiently close to that assumed in the analysis. Problems relating to underlying distributions can be avoided by the use of nonparametric methods. Some of the specifications which are stated in terms of standard deviations can be reformulated in nearly equivalent specifications for tolerance limits for which simple nonparametric methods are available. Such reformulations are also acceptable. A. Hald<sup>2</sup> and W. J. Conover<sup>3</sup> are useful reference sources for parametric and nonparametric methods, respectively.

If every TLD is individually calibrated, the population parameters for certain errors can be computed directly, and statistical inference is not needed for specifications relating to these errors.

### C. REGULATORY POSITION

The requirements and recommendations for performance specifications, testing procedures, calibration procedures, field procedures, and reporting procedures that are included in ANSI N545-1975 are generally acceptable to the NRC staff as the basis for using thermoluminescence dosimetry for the measurement of X and gamma radiation in the environs of NRC-licensed facilities subject to the following additional provisions and qualifications.

1. Section 3, "Performance Specifications," of ANSI N545-1975 should be supplemented by the following statement: "Each performance specification shall be verified at the 95% confidence level."

<sup>2</sup> A. Hald, *Statistical Theory with Engineering Applications*, John Wiley & Sons, Inc., 1952.

<sup>3</sup> W. J. Conover, *Practical Nonparametric Statistics*, John Wiley & Sons, Inc., 1971.

2. Instead of Section 3.1 of ANSI N545-1975, the following should be used: "The performance of the TLD system shall be determined under laboratory conditions and in a known radiation field with an exposure equal to that resulting from an exposure rate of 10  $\mu$ R/hr during the field cycle. Ninety-five percent of the measurements shall fall within 10% of the known exposure."

3. Instead of Section 3.3 of ANSI N545-1975, the following should be used: "Ninety-five percent of the final values (after all appropriate corrections to the measurements are applied, including those for errors expected under field conditions) shall differ from the correct value by less than 30% of the correct value."

4. Instead of Section 4.3.1 of ANSI N545-1975, the following should be used: "Uniformity shall be determined by giving TLDs from the same batch an exposure equal to that resulting from an exposure rate of 10  $\mu$ R/hr during the field cycle. The response obtained shall have a relative standard deviation (coefficient of variation) of less than 7.5%."

5. Instead of Section 4.3.2 of ANSI N545-1975, the following should be used: "Reproducibility shall be determined by giving one TLD repeated exposures equal to that resulting from an exposure rate of 10  $\mu$ R/hr during the field cycle. The responses shall have a relative standard deviation (coefficient of variation) of less than 3.0%."

### D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the staff's plans for utilizing this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used in the evaluation of operating license applications docketed after July 15, 1977.

If an applicant wishes to use this regulatory guide in developing submittals for applications docketed on or before July 15, 1977, the pertinent portions of the application will be evaluated on the basis of this guide.