U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

DRAFT REGULATORY GUIDE AND VALUE/IMPACT STATEMENT

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Division 8
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TEST AND CALIBRATION OF RADIATION PROTECTION INSTRUMENTATION

A. INTRODUCTION

Section 20.201 of 10 CFR Part 20, "Standards for Protection Against Radiation," requires that licensees make surveys in order to evaluate radiation dose rates incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation. Portable radiation protection instruments are frequently employed in conducting these surveys. Although the requirement to use properly calibrated instruments is not explicitly mentioned in § 20.201, it is implicit in the requirement to conduct such surveys as are necessary to ensure compliance with Part 20 and to evaluate the extent of radiation hazards that may be present. Surveys made with improperly calibrated instruments may not be adequate because they may fail to provide sufficiently accurate measurements of radiation levels or concentrations of radioactive material. To rely on such surveys could defeat the basic objectives of the survey requirement.

This guide provides information to licensees on criteria acceptable to the NRC staff for the test and calibration of hand-held portable instruments used to make surveys. Bench, area, or portal radiation monitors; passive personnel dosimeters; laboratory counting equipment; and air-monitoring equipment are not considered portable survey instruments for the purposes of this guide. No detailed procedures for test or calibration of radiation protection instruments are presented herein because the specific techniques to be used for any given test or calibration must be tailored to the need and peculiarities of the instrumentation, radionuclide sources, environment, and circumstances of each licensee or applicant. This guide emphasizes the criteria necessary to relate instrument calibrations to national radiation standards.

This regulatory guide and the associated value/impact statement are being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. They have not received complete staff review and do not represent an official NRC staff position.

Public comments are being solicited on both drafts, the guide (including any implementation schedule) and the value/impact statement. Comments on the value/impact statement should be accompanied by supporting data. Comments on both drafts should be sent to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch, by NOV 30 1984

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Any information collection activities mentioned in this draft regulatory guide are contained as requirements in 10 CFR Part 20, which provides the regulatory basis for this guide. The information collection requirements in 10 CFR Part 20 have been cleared under OMB Clearance No. 3150-0014.

B. DISCUSSION

With certain exceptions and supplements, this guide endorses ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration,"* as the basis for the criteria for test and calibration of survey instruments. This standard was approved by the American National Standards Institute (ANSI) on September 13, 1977. It contains information needed for test and calibration of portable radiation protection instruments used for the measurement of ionizing radiation. The ANSI Joint Subcommittee N13/42, which was responsible for development of this standard, was composed of about equal numbers of manufacturers and users of survey instruments. Therefore, this standard benefits from the experience and recommendations of both groups.

A national directory of commercial calibration services has recently been published as a cooperative project of the Conference of Radiation Control Program Directors and the National Bureau of Standards (NBS).** The directory provides a listing of the types of radiation services offered, the calibration methods used and the estimated accuracy of the calibrations, the radiation energies and intensity ranges available for calibrations, and the types of instruments and radioactive sources that vendors are prepared to calibrate. Users should be aware that instruments calibrated by a firm listed in this directory may not meet all the criteria outlined in this guide and that all firms offering calibration services may not be listed in the directory.

*Copies are available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

**This directory is designated NBS GCR 80-296, "The Directory of Commercial Calibration Services for Ionizing Radiation Survey Instruments," April 1981. It may be purchased as stock number PB 82-206401 from the National Technical Information Service, Springfield, Virginia 22161.

C. REGULATORY POSITION

Instrument calibration programs that meet the requirements and recommendations of ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration," are generally acceptable to the NRC staff for test and calibration of hand-held portable instruments used for complying with the survey requirements of § 20.201 of 10 CFR Part 20 subject to the following:

1. In all calibration procedures, the type, geometry, intensity, and energy spectrum of the radiation field in which the survey instrument is to be calibrated should be appropriate to the instrument's intended use, and the field should remain essentially stable during the time interval in which the calibration is actually performed. If scattering contributions to instrument readings are significant, they should be added to the value of the radiation field for all detector positions used for calibration purposes as recommended in Section 6.2 of ANSI N323-1978. Sources suitable for use in calibration are listed in the Appendix to ANSI N323-1978.

2. Uncalibrated scales or ranges should be identified on the instrument with a tag (or label) attached to the instrument that is marked "Calibration has not been verified since (enter date)."

3. For each scale normally used for radiation protection surveys, a periodic performance test (sometimes called constancy check) as described in Sections 4.6, 4.7, and 5.4 of ANSI N323-1978 should be applied to each survey instrument prior to each use in order to check its operability and its response relative to the reference readings recorded at the last calibration as recommended in Section 4.6 of ANSI N323-1978.

4. This guide takes no position on Section 4.5, "Calibration Records," of ANSI N323-1978.

5. In addition to the guidance given in Section 5.1 of ANSI N323-1978 for the selection of a laboratory standard when national (or derived) standards are not available, the information given in Appendix A to this guide may be used.

6. The NRC staff considers testing and calibration of radiation protection instrumentation to be an important part of the efforts to maintain occupational radiation exposures as low as is reasonably achievable (ALARA).

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC staff's plans for using this regulatory guide. This guide applies to all licensees required to make surveys according to § 20.201 of 10 CFR Part 20.

This proposed guide has been released to encourage public participation in its development. Except in those cases in which the applicant or licensee proposes acceptable alternative criteria for the test and calibration of portable survey instruments, the information to be described in the active version of this guide reflecting public comments will be used by the NRC staff as guidance in the following ways: NRR will use the guide in connection with the review of new and renewal license applications or for amendments to a license resulting from major revisions to the instrument calibration program; NMSS considers that this guide could provide guidance to their licensees in the establishment of instrument calibration programs; I&E will reference this guide in its inspection procedures for reactors.

APPENDIX A

ADDITIONAL METHODS FOR SELECTING LABORATORY STANDARDS FOR USE IN CALIBRATING RADIATION PROTECTION INSTRUMENTATION

Section 5.1 of ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration," provides information for selecting laboratory calibration standards when national standards or derived standards are not available. This appendix provides additional ways that may be used in such cases. Examples of national measurement standards that need to be developed (or improved) include standards for high-energy photons, high-energy electrons, beta radiation, and fast neutrons.

The technical terminology used in this appendix has been taken from Section 2, "Definitions," of ANSI N323-1978. Several of the definitions are reprinted here with the permission of the Institute of Electrical and Electronics Engineers, Inc.

reproducibility (precision). The degree of agreement of repeated measurements of the same property expressed quantitatively as the standard deviation computed from the results of the series of measurements.

sensitivity. The ratio of a change in response to the corresponding change in the field being measured.

standard (instrument or source)

(1) national standard. An instrument, source, or other system or device maintained and promulgated by the U.S. National Bureau of Standards as such.

(2) derived or secondary standard. A calibrated instrument, source, or other system or device directly relatable (that is, with no intervening steps) to one or more U.S. national standards.

(3) laboratory standard. A calibrated instrument, source, or other system or device without direct, one-step relatability to the U.S. National Bureau of Standards, maintained and used primarily for calibration and standardization.

test. A procedure whereby the instrument, component, or circuit is evaluated for satisfactory operation.

transfer instrument. Instrument or dosimeter exhibiting high precision which has been standardized against a national or derived standardized source.

uncertainty. The estimated bounds of the deviation from the mean value, generally expressed as a percent of the mean value. Ordinarily taken as the sum of (1) the random errors at the 95% confidence level and (2) the estimated upper limit of the systematic error.

1. CALIBRATION STANDARDS FOR PHOTON RADIATION FIELDS

1.1 Photon Radiation Field of Certified Intensity

The user's survey instrument is exposed to a photon radiation field emitted by a laboratory standard source that has been certified* by the source supplier to have either a specified exposure rate at unit distance (e.g., one meter) under specified scattering conditions (for calculating exposure rates over a range of distances) or specified exposure rates at various distances under specified scattering and exposure conditions.

The supplier's certificate should state that the specified exposure rates from the laboratory standard source are known with an uncertainty no greater than ±10% of the exposure rates that would be generated from a similar national standard source containing the same amount of radionuclide under specified exposure and scattering conditions.

The source supplier should determine the exposure rates for the laboratory standard source by comparison with a secondary standard source of radiation maintained in the supplier's laboratory. In the intercalibration of these sources, at least three replicate comparisons should be made in order to avoid errors that might result from operator mistakes, instrument drift, instrument malfunction, etc.

If possible, the exposure rates at a fixed distance (e.g., one meter) from the supplier's secondary source should be certified by the National Bureau of Standards according to one of its standard calibration services. The changes in exposure rate (or intensity) of the supplier's secondary source should be measured with the supplier's radiation measurement system at least monthly.

*The supplier should provide any pertinent data on source purity that may, over time, affect calibration values, as specified in International Commission on Radiation Units and Measurements Report No. 12, "Certification of Standardized Radioactive Sources," September 15, 1978.

This new exposure rate should be verified to remain within ±2% of the calculated value that is obtained by correcting the initial value (certified by the National Bureau of Standards) for radioactive decay. As an alternative, the source supplier may determine the exposure rates for very strong sources by using a transfer instrument as discussed in Section 5.1 of ANSI N323-1978.

A transfer instrument used as discussed in the preceding paragraph and in Sections 1.2 and 1.3 of this appendix should be calibrated by exposure to standard fields at the National Bureau of Standards or at a laboratory that has satisfactorily participated in an appropriately documented measurement quality assurance program with the National Bureau of Standards.* The transfer instrument should have a reproducibility of at least ±2% as recommended in Section 5.1(1) of ANSI N323-1978. When used as a secondary standard, a transfer instrument should have an uncertainty no greater than ±10% (after the application of any necessary calibration factors) as recommended in Sections 5.1 and 5.3 of ANSI N323-1978.

When used as a secondary standard, the transfer instrument should preferably be operated by persons offering radiation dosimetry and calibration services such as those who are certified by the American Board of Radiology in one of the areas of radiological physics, the American Board of Health Physics, or the American Board of Industrial Hygiene (radiological aspects).**

1.2 Photon Radiation Field of Measured Intensity

The exposure rates at specified distances from a laboratory source to be used for instrument calibration can be measured using a transfer instrument as discussed in Section 5.1(2) of ANSI N323-1978.

The exposure rates generated by the laboratory source should be known with an uncertainty no greater than ±10% of the exposure rates that would be generated from a similar national standard source containing the same amount

*Currently, the regional calibration laboratories accredited by the American Association of Physicists in Medicine participate periodically in a quality assurance program sponsored by the National Bureau of Standards.

**A discussion of the accuracy to be expected for a transfer instrument is given in Technical Report Series No. 133, "Handbook on Calibration of Radiation Protection Monitoring Instruments," pp. 55-56, published by the International Atomic Energy Agency in 1971. This report is available from UNIPUB, 345 Park Avenue South, New York, N.Y. 10010.

of radionuclide under specified exposure and scattering conditions. This uncertainty includes any uncertainty in the values indicated by the transfer instrument, which is discussed in Section 1.1 of this appendix.

1.3 Photon Radiation Field by Substitution

The survey instrument may be calibrated by comparison with a transfer instrument used as a secondary standard (see Section 1.1 of this appendix) when both instruments are located at fixed points within any appropriate radiation field. At each selected point, a technique involving either simultaneous exposure or substitution is used to compare readings of the transfer instrument and of the survey instrument under calibration.

The exposure rates should be known with an uncertainty no greater than ±10% of the exposure rates that would be generated from a similar national standard source containing the same amount of radionuclide under specified exposure and scattering conditions. This uncertainty includes any uncertainty in the values indicated by the transfer instrument.

2. CALIBRATION STANDARDS FOR NEUTRON RADIATION FIELDS

A survey instrument that is to be used for estimating neutron dose equivalent rates should be calibrated by a laboratory neutron source that has been certified by the source supplier to give known neutron dose equivalent rates at specified distances. A technique for routine calibration of neutron remmeters with radioactive neutron sources is given in NBS Special Publication 633.*

The dose equivalent rate of the user's laboratory standard source should be determined by the supplier, taking into account the neutron emission rate (n/sec), the fluence rate (n/cm^2-sec), and the spectral distribution of the source. The fluence rate of the user's laboratory source should be determined by the source supplier by intercomparison with the same type of source calibrated by the National Bureau of Standards. Intercomparison of the sources may be made by the supplier using systems such as a long counter. For an unmoderated neutron source, conversion of fluence rate to dose equivalent rate should

*R. B. Schwartz and C. M. Eisenhauer, "Procedures for Calibrating Neutron Personnel Dosimeters," Center For Radiation Research, National Measurement Laboratory, National Bureau of Standards, NBS Special Publication 633, May 1982. This publication may be obtained from the National Technical Information Service, Springfield, Virginia 22161, order number PB82235961.

be made in accordance with the table of Neutron Flux Dose Equivalents given in § 20.4 of 10 CFR Part 20 using the average energy of the neutron spectrum. However, if a moderated neutron source is used, evaluation of the dose equivalent rate per unit fluence rate should consider the entire spectral distribution and not the average energy of this distribution.

The source supplier's certificate should specify that the dose equivalent rates calculated for the user's laboratory source are known to within ±10% of the dose equivalent rates that would be generated from a similar national standard source under the same exposure geometry and scattering conditions.

3. CALIBRATION STANDARDS FOR BETA RADIATION FIELDS

No recommendations for selecting a standard are included in this guide. Until techniques acceptable to the NRC staff are published and acceptable secondary standards become available, the applicant is advised to follow the guidance given in Section 5.1(3) of ANSI N323-1978 and the general recommendations in this guide.

DRAFT REGULATORY ANALYSIS

1. PROPOSED ACTION

1.1 Description

In order to make accurate surveys as required by § 20.201 of 10 CFR Part 20, portable hand-held radiation protection instruments must be properly calibrated and, in addition, tested before each use. The proposed action is to provide methods acceptable to the NRC staff for calibrating and testing these survey instruments.

1.2 Need

It is important to workers that radiation protection instruments be accurate and dependable. The instrument reading provides information on the radiation field in an area so that occupancy in that area may be limited during the performance of a required task. NBS Special Publication 603, "Requirements for an Effective National Ionizing Radiation Measurements Program, A Report to the Congress by the National Bureau of Standards,"* in cooperation with the Conference of Radiation Control Program Directors, Inc. (March 1981), assigned first priority to establishing procedures for traceability of radiation protection measurements to national standards with the need for making accurate survey measurements and calibrations a second priority. The proposed action is intended to provide reasonable guidelines for instrument testing and calibration.

1.3 Value/Impact

1.3.1 NRC

The most significant impact of this proposed action on the NRC would be the expenditure of 1 staff-year to develop the guidance. If the time of a staff

*Copies may be obtained from the National Technical Information Service, Springfield, Virginia 22161, order number PB81177636.

member of the NRC is valued at $40 per staff-hour, the cost to implement the proposed action would be $80,000.

The value of this proposed action to the NRC is that it will improve the regulatory process because it will facilitate licensing actions and it will assist licensees in complying with the survey requirements in § 20.201 and the NRC staff in inspecting and enforcing this regulation.

1.3.2 Other Government Agencies

The values and impacts of this proposed action on Agreement States are expected to be similar in kind to those described for the NRC (except for the costs of developing the guidance).

1.3.3 Industry

The impact of the calibration recommendations on the majority of the licensees is judged to be minor since they are believed now to calibrate survey instruments at least annually. If a licensee decides to discontinue in-house calibrations and to use commercial calibration services, an expenditure of up to $1000 may be required to purchase a backup instrument for making surveys while the primary instrument is being serviced. This impact is expected to be small because most large licensees are not expected to switch to commercial services, and most small licensees already use commercial calibration services.

The value to licensees of this proposed action is that it provides them with reasonable guidelines for instrument calibrations. Of additional potential value to licensees are the technical improvements in some survey instruments that industry may introduce in order to meet the recommended criteria for the calibration and periodic performance test (constancy check).

The proposed action would have a hidden economic benefit to the industry. Presumably, a survey meter out of calibration is just as likely to be in error in the conservative direction as in the nonconservative direction, and overly conservative readings will translate into work interruptions, unnecessary precautions, delay, increased turnover and labor costs, etc.

1.3.4 Workers

For the workers, the values of improved calibrations of survey instruments include more accurate assessments of the quality of the working environment and

a probable reduction in external radiation exposure. A quantitative estimate of this reduction in dose is not available at this time.

1.3.5 Public

This guidance pertains to worker protection programs. But when survey instruments are used to measure dose rates in unrestricted areas, more accurate calibrations lead to a better assessment of the radiation risks to the public.

1.4 Decision on the Proposed Action

Paragraph 20.1(c) of the Commission's regulations in 10 CFR Part 20 states that radiation exposures to the public and to workers should be kept as low as is reasonably achievable (ALARA). The proposed action can provide an improvement in instrument reliability and a reduction in radiological risk without substantial costs. Therefore, the staff believes that the proposed action should be undertaken.

2. TECHNICAL APPROACH

The technical approach in the guidance is based on ANSI N323-1978, "Radiation Protection Instrumentation Test and Calibration." The action proposed here is to provide guidance on acceptable methods of calibration for portable hand-held survey instruments. Calibration of survey instruments is now required of all NRC licensees who perform surveys as required by 10 CFR Part 20. It is our intent that acceptable methods of calibration be a component of licensee instrument survey procedures as required by paragraph 20.201(b).

3. PROCEDURAL APPROACH

3.1 Procedural Alternatives

The proposed action, to publish guidance on calibration and testing procedures for portable hand-held survey instruments, could be accomplished by several methods: publishing an NRC regulation requiring that specific calibration procedures be used by all licensees, preparing or revising a regulatory

guide (based on the existing § 20.201 of 10 CFR Part 20) that endorses an ANSI standard on calibration procedures, or publishing a NUREG-series report or a branch position paper.

3.2 Discussion of Procedural Alternatives

Implicit in the survey requirement of § 20.201 of 10 CFR Part 20 is the need for adequate calibration of radiation protection instruments. The NRC staff does not consider it desirable to incorporate detailed calibration requirements into a regulation because possible technical advances in the state of the art may require costly changes in the regulations to accommodate them.

A NUREG-series report would be an appropriate vehicle for reporting on technical studies of various calibration methods. Regulatory guidance, however, is not established through NUREG-series reports. Since the proposed action includes establishment of an acceptable method for compliance with required surveying programs, a report is not considered suitable.

Branch position statements are intended as interim measures to be used when an immediate response is required. They are usually superseded when a more permanent mode of guidance is developed.

A regulatory guide can be prepared at reasonable cost within a reasonable time. A regulatory guide can establish acceptable methods and procedures for meeting a regulatory requirement.

Development of a regulatory guide allows extensive input from all segments of the nuclear industry and the public. A regulatory guide can describe calibration procedures acceptable to the NRC staff or endorse existing acceptable standard calibration methods such as those in ANSI N323-1978. The staff does not consider that revision of any existing regulatory guides could provide the objectives proposed here.

3.3 Decision on Procedural Approach

The staff has concluded that the development of a regulatory guide to endorse ANSI N323-1978 (with modifications) is the favored procedural approach.

4. STATUTORY CONSIDERATIONS

4.1 NRC Regulatory Authority

Authority for this guide is derived from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended, as implemented through the Commission's regulations.

4.2 Need for NEPA Statement

Issuance or amendment of guides for the implementation of regulations in Title 10, Chapter I, of the Code of Federal Regulations is a categorical exclusion under 10 CFR Part 51, § 51.22(c)(16). Thus, an environmental impact statement or assessment is not required for this action.

5. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS OR POLICIES

No conflict with any existing regulation or other government policy is known to exist.

6. SUMMARY AND CONCLUSIONS

The proposed action will reduce the time and effort required to process license applications and will achieve improved radiological safety for workers by increasing the reliability of radiation protection measurements.

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