HEALTH PHYSICS SOCIETY PROGRAM FOR ACCREDITATION OF CALIBRATION LABORATORIES

Leon West
University of Arkansas

Frank X. Masse
Massachusetts Institute of Technology

Kenneth L. Swinth
Battelle Pacific Northwest Laboratory

ABSTRACT

The Health Physics Society has instituted a new program for accreditation of organizations that calibrate radiation survey instruments. The purpose of the program is to provide radiation protection professionals with an expanded means of direct and indirect access to national standards, thus introducing a means for improving the uniformity, accuracy, and quality of ionizing radiation field measurements. Secondary accredited laboratories are expected to provide a regional support basis. Tertiary accredited laboratories are expected to operate on a more local basis and provide readily available expertise to end users. The accredition process is an effort to provide better measurement assurance for surveys of radiation fields. The status of the accreditation program, general criteria, gamma-ray calibration criteria, and x-ray calibration criteria are reviewed.

INTRODUCTION

In 1986, the Board of Directors of the Health Physics Society approved a plan to establish a standing committee for the purpose of initiating and maintaining an accreditation program for laboratories which calibrate survey instruments. By midyear of 1987, the policy and general criteria for the program were firmly established[1]. Also, specific criteria for gamma-ray and x-ray calibrations were defined[1], and organizations were invited to submit applications. The purpose of the program, as defined in the policy, is to provide radiation protection professionals with an expanded means of direct and indirect access to the standards maintained by the U.S. National Bureau of Standards, thus introducing a means for improving the uniformity, accuracy, and quality of ionizing radiation field measurements.

This paper reviews the purpose, organization, levels of accreditation, and present status of this new program. Requirements for accreditation in gamma and x-ray categories are presented. The information presented here is a general summary of

the HPS program, and is not binding information. The HPS Secretariat[1] should be consulted for details of the actual program and the binding requirements. Application information may be obtained directly from the Health Physics Society[1]. The authors are the present chair (L.W.) and past chair (F.X.M.) of the HPS standing committee, and chair (K.L.S.) of the operations group.

STATUS AND TRENDS

At the present time, a person seeking calibration of a survey instrument will find the best available information in a directory[2] compiled through a joint program between the National Bureau of Standards (NBS) and the Conference of Radiation Control Program Directors, Inc. The directory provides general information concerning institutions and companies which provide calibration services. However, the user of these calibration services has no assurance, other than performing individual audits, of the quality of services rendered by the organizations listed in the directory.

In 1981, the National Bureau of Standards recommended a national program[3] to provide measurement assurance for ionizing radiation measurements. National radiation standards are known in general to within less than ± 3 percent. Field measurements have a desirable accuracy of ± 20 percent for radiation survey measurements. Special Publication 603 suggested two intermediate levels (secondary and tertiary) should be considered to achieve the desirable field accuracy[3].

The Health Physics Society (HPS) has adopted the secondary/tertiary heirarchy. Secondary accredited laboratories are intended to be somewhat regional in scope, requiring instrument interchanges with NBS and requiring the ability to support tertiary laboratories. Tertiary accredited laboratories are intended to provide the bulk of the calibration services to end users, requiring instrument interchanges with secondary laboratories. A standing committee provides primary management of the program. The process of accreditation review and evaluation is assigned to an operations group which is funded entirely from revenues received. An advisory group assists the operations group.

GENERAL CRITERIA

The purpose of an accredited laboratory is to support accurate measurements for radiation protection by providing reliable and prompt calibration of survey instruments. Secondary accredited laboratories have the additional responsibility of providing priority services to tertiary accredited laboratories, including calibrations, proficiency tests, consultation, training, and instrument evaluations.

Organizational structure requirements for the Secondary Accredited Laboratory (SAL) require that the laboratory supervisor hold a bachelor's degree in one of several defined disciplines. In the Tertiary Accredited Laboratory (TAL), an associate or bachelor's degree is acceptable for the supervisor. The person in charge of day-to-day operations must have at least three years of experience in instrument calibrations.

Laboratory design is addressed in general terms. Temperature, pressure, and humidity must be monitored at all times.

Calibration equipment must include secondary (or tertiary) radiation measurement standards that cover the range of calibrations performed. Separate working standards are recommended for routine laboratory reference. A high-quality thermometer and barometer must be capable of ± 1 percent accuracy. Secondary accredited laboratories must also be capable of monitoring relative humidity in the range 15 to 65 percent with an accuracy of ± 5 percent. All equipment must have been calibrated prior to accreditation and must be subject to continuing quality control.

Operational procedures must be defined in the laboratory protocol. The protocol defines the scope of the calibrations performed, the accuracy goals, the method of tracing the calibration of each supporting piece of equipment used in the radiation calibration, and the uncertainty assessment.

Accuracy and quality assurance are maintained by routine quality control procedures and by proficiency testing. Two sets of barometers and thermometers are required to provide a continuous intercomparison in the SAL. In the TAL, a single barometer and thermometer may be used if they are recalibrated periodically. Recalibration of equipment is required when the need is demonstrated. Proficiency testing of the SAL is to be performed at least annually by the National Bureau of Standards. Proficiency testing of a TAL is to be performed at least annually by a Secondary Accredited Laboratory.

Records must be maintained for the following information:

1. Calibration history of all standards and calibration equipment.

2. Inventory of standards and calibration equipment.

3. Procedures.

4. Permanent records concerning each calibration performed, including details of the instrument and customer.

5. Information to reconstruct a calibration.

6. Record of quality control activities.

7. Copies of all calibration reports issued.

8. Results of all proficiency tests.

Records must be initialed by the person collecting the information and kept at least until the next accreditation renewal is completed.

Calibration reports issued by an accredited laboratory must clearly indicate whether an accredited or non-accredited procedure was utilized for the calibration.

GAMMA-RAY CALIBRATIONS

The energy and exposure rate of the radiation field must be appropriate for the type of instrument to be calibrated. Gamma-ray sources listed in the HPS criteria include ^{241}Am (60 keV) ^{137}Cs (662 keV), ^{226}Ra (mean energy of 830 keV), and ^{60}Co (mean energy of 1.25 MeV). Source activities are not defined, since this is dependent on the range of exposure rates each accredited laboratory will offer.

Beam control is addressed in the HPS criteria with sections concerning shielding, collimation, exposure control and timer equipment.

Laboratory equipment must include two sets of ion chambers and supporting instrumentation; one set serves as an independent backup to verify the results of the secondary (or tertiary) standard ion chamber. Both secondary and tertiary laboratories must have a voltmeter appropriate for the instruments being calibrated. Additional equipment is required for the SAL, including a beam-axis locator, working standard ion chamber, pulser, oscilloscope, current source, and standard capacitors.

Exposure rate must be known as a function of distance from the gamma source. For the SAL, the minimum distance between the source and the detector must be 10 times the largest dimension of the detector. For the TAL, this distance requirement is relaxed to 5 times the largest dimension of the detector. Box-type calibrators may be utilized by a TAL under certain provisions defined in the criteria. Attenuators may be used, provided the effect on the gamma energy spectrum is known. Scattered radiation must not contribute more than 25 percent of the exposure rate response of the instrument; or the effect on accuracy of the scattered radiation must be known.

Accuracy requirements for the SAL are twice as rigorous as the TAL. Exposure rates above 100 mR/h must be known within ± 5 percent for the SAL and within ± 10 percent for the TAL. Between 0.5 mR/h and 100 mR/h, the accuracy must be ± 7 percent for the SAL and ± 15 percent for the TAL.

X-RAY CALIBRATIONS

A constant-potential x-ray machine is required for the SAL. Tube potential must range between 30 to 150 kV as a minimum. Ripple must be less than 5 percent. Exposure rate must not vary by more than ± 1 percent during calibrations. Maximum and minimum exposure rates are not defined by the criteria, but the fields must be appropriate for the instruments to be calibrated.

In the TAL, constant-potential machines are not required, but ripple must be known. If the ripple is greater than 10 percent, the effect on the calibration must be known. Exposure rates must not vary by more than ± 3 percent.

Requirements for radiation control and supporting laboratory equipment for x-ray calibrations are similar to those for gamma-ray calibrations. Filters must be available in the SAL to permit a variety of x-ray beam qualities.

X-ray beam qualities are defined in Table 1. The SAL is expected to provide calibrations for at least five of the beams of Table 1. The TAL must provide services for at least three of the beams.

TABLE 1

X-Ray Beam Codes

Beam Code*	Added Filter			First Half-Value Layer		Homogeneity Coefficient	
	Al (mm)	Cu (mm)	Pb (mm)	Al (mm)	Cu (mm)	Al	Cu
M30	0.50			0.36		64	
M50	1.021			1.02	0.032	66	62
H50	4.0		0.10	4.2	0.142	92	90
L80	1.284			1.83		58	
L100	1.978			2.8		59	
M100	5.0			5.0	0.20	72	55
H100	4.0	5.2		13.5	1.14	100	94
M150	5.0	0.25		10.2	0.67	87	62

*The numerical value indicates the nominal kVp.

Accuracy requirements for the SAL are again twice as rigorous as the TAL. Above 100 mR/h, exposure rates must be known within ± 5 percent for the SAL and within ± 10 percent for the TAL. Between 0.5 and 100 mR/h, the requirements are ± 7 percent for the SAL and ± 15 percent for the TAL. Scatter contributions are limited to 5 percent (SAL) or 10 percent (TAL).

ACKNOWLEDGMENTS

The time and effort contributed by Elmer Eisenhower, NBS, in the development of the HPS laboratory accreditation criteria is gratefully acknowledged on behalf of the Health Physics Society. Contributions of members of the HPS Laboratory Accreditation Standing Committee and Operations Committee are also acknowledged.

REFERENCES

1. Health Physics Society, "Accreditation of Calibration Laboratories for Portable Radiation Protection Instruments by the Health Physics Society", 8000 Westpark Dr., Suite 400, McLean, VA 22102 (1987).

2. H.T. Heaton, "Directory of Calibration Services for Ionizing Radiation Survey Instruments", U.S. National Bureau of Standards, NBS-GCR-88-539 (1988).

3. NBS, "Requirements for an Effective Radiation Measurements Program", U.S. National Bureau of Standards Special Publication 603 (1981).