COMPARISON OF U.S. AND INTERNATIONAL STANDARDS FOR RADIATION PROTECTION INSTRUMENTATION

J. M. Selby, K. L. Swinth, and E. E. Hickey
Pacific Northwest Laboratory
Richland, Washington U.S.A.

INTRODUCTION

The quality and performance of radiation protection instruments are extremely important in providing conservative protection to radiation workers. International standards for radiation protection instrumentation, published by the International Electrotechnical Commission (IEC), specify general performance, type, and acceptance test requirements. The recent draft American National Standards Institute (ANSI) standards on radiation protection instrumentation provide more specific performance requirements and definitive performance tests.

The IEC Publication 395, Portable X or Gamma Radiation Exposure Rate Meters and Monitors For Use In Radiological Protection, was published in 1972 and is a recommendation that specifies general characteristics; general test procedures; radiation characteristics; and electrical, mechanical, safety, and environmental characteristics.[1] The recommendation applies to portable instruments intended to measure exposure rate due to x- or gamma radiation of energy between 50 keV and 3 MeV for the purposes of radiation protection.

Draft ANSI N42.17A-D8 (May 1987), "Performance Specification for Health Physics Instrumentation - Portable Instrumentation for Use In Normal Environmental Conditions," is a standard that establishes minimum acceptable performance criteria for health physics instrumentation for use in ionizing radiation fields.[2,3] The standard was written in 1981 by a task group that included manufacturers and users of these instruments as well as representatives from the regulatory bodies. As in IEC Publication 395, draft ANSI N42.17A-D8 specifies general, radiation, electrical, mechanical, safety, and environmental characteristics along with test procedures for each characteristic.

SIMILARITIES AND DIFFERENCES

The purposes of the two standards are essentially the same. However, IEC Publication 395 is specifically for portable x- or gamma radiation detection instruments, whereas draft ANSI N42.17A-D8 includes portable rate and integrating devices for beta, photon, and neutron radiations and monitors for surface contamination (alpha, beta, and photon). Both standards use similar sets of test conditions.

A noticeable difference between the two standards is the classification of instruments. IEC Publication 395 addresses limits of variation of indication for Class I, II, and III instruments. For example, the coefficient of variation for a

Class I instrument is <10%, and for a Class II and Class III instrument is <20%. In draft ANSI N42.17A-D8, a Class A instrument meets all the applicable requirements in the standard, a Class B instrument must meet only those requirements in specific sections, and a Class C instrument meets the requirements specified by the purchaser or user group.

Table 1 compares some of the test characteristics of the two standards and lists some of the requirements found in only one of the standards. The requirements found in IEC Publication 395 and draft ANSI N42.17A-D8 are similar. However, in most cases, the ANSI standard provides more specific guidance on methods for performing tests.

TESTING OF DRAFT ANSI N42.17A

The Pacific Northwest Laboratory (PNL) has evaluated the draft of ANSI N42.17A in terms of applicability and practicality and has also evaluated the performance of the instrumentation used in the study with respect to the requirements in the proposed standard.[2,3] Selected data are presented in Table 2. The testing of instruments against the draft ANSI N42.17A standard took place over a 2.5-year period and included procedure development, verification and instrument testing on more than 100 instruments. Five groups of instruments were tested including ionization chambers, Geiger-Mueller (GM) detectors, alpha detectors, neutron monitors, and others.

From the evaluation of the standard, a number of recommendations were made to the ANSI N42.17 working group regarding the requirements of the draft standard. Some major changes that were based on the testing program are: change in the coefficient of variation test requirement; change in the photon-radiation energy dependence test requirement; inclusion of an equilibration time for temperature, humidity, and ambient temperature tests; increasing the intensity for the magnetic field test; and a decrease in the acceleration level applied to instruments in the vibration test.

CONCLUSIONS

Standards such as the two discussed above are extremely valuable in assuring that quality and performance of radiation protection instruments are adequate to protect the health and safety of workers using the equipment. Evaluating the standards by testing instruments against the requirements in the standards can be beneficial to ensure that the provisions of the standard are applicable and can be applied to the appropriate instrumentation. As radiation protection instruments change and improve with advances in technology, the standards must be updated to reflect these changes.

ACKNOWLEDGMENTS

This work was performed for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

TABLE 1. Comparison Of Standards Requirements

Test Characteristics	Draft ANSI N42.17A-D8	IEC 395
Alarm Threshold	Alarm threshold shall be given as % of scale or decade of adjustment	Adjustment should be stated
Stability	±6% of reference for: 3 hrs: battery 24 hrs: A.C. power	Not addressed
Geotropism	Within ±6% of reference	±10% of reference orientation
Accuracy	±15%	±10% (C1) ±20% (C2) ±40% (C3)
Photon Energy Dependence	±20% from 80 keV to 1.25 MeV	±25% from 50 keV to 3 MeV, ±15% from 300 keV to 3 MeV (C1)
Photon Radiation Overload	Instrument shall continue to operate and be offscale	Remain full range if exposure over range
Extracameral Response	Not greater than 5%	Not addressed
Interfering Ionizing Radiation Response	Not greater than stated by manufacturer	Shall be designed to limit influence of other ionizing radiations
Temperature Dependence	Reference 22°C: ±15%: 0-40°C ±20%: -10-50°C	Not addressed
Vibration	±15% following harmonic loading of 2 G/15 min w/freq. 10-33 Hz	Not addressed
Ambient Pressure	±15%; 70-106 kPa reference 101 kPa	Effects of variation should be indicated
Mechanical Shock	±15% following 50 G 18 msec sinusoid shock on 3 axes.	Withstand shock of 30 G which is 18 msec sinusoid, any direction

TABLE 2. Selected Test Results

Test	Instrument Type	Number of Failures/Number Tested
Stability	Ion Chamber	1/9
	GM	1/35
Geotropism	Ion Chamber	0/10
	GM	0/24
Accuracy	Ion Chamber	1/9
	GM	7/19
Photon Radiation Energy Dependence	Ion Chamber	3/9
	GM	14/20
Temperature	Ion Chamber	9/17 (0^{o} to $40^{o}C$)
	GM	0/23 (0^{o} to $40^{o}C$)
Vibration	Ion Chamber	1/4
	GM	0/7
Ambient Pressure	Ion Chamber	0/10
	GM	0/5
Mechanical Shock	Ion Chamber	0/3
	GM	0/8

REFERENCES

1. International Electrotechnical Commission (IEC). 1972. IEC Publication 395, International Electrotechnical Commission, Geneva, Switzerland.

2. Kenoyer, J. L., K. L. Swinth, G. A. Stoetzel, and J. M. Selby. 1986. PNL-5813 Pt. 2, Pacific Northwest Laboratory, Richland, Washington.

3. Swinth, K. L. and J. L. Kenoyer, 1985. IEEE Trans. Nuc. Sci., NS-32, p. 23.