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REVIEW OF ANSI N13.11: A STATUS REPORT*

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In 1983, the American National Standards Institute (ANSI) issued the dosimetry standard titled "Personnel Dosimetry Performance - Criteria for Testing" as ANSI *N*13.11[1]. This standard forms the basis for the National Voluntary Laboratory Accreditation Program (NVLAP) which has become familiar to dosimeter processors in recent years[2]. This standard is particularly important because the Nuclear Regulatory Commission (NRC) requires that all licensees have personnel dosimetry devices processed by processors that are NVLAP accredited[3]. This standard is currently undergoing review and modifications are going to be made. This paper contains a brief history of the events leading to the development of ANSI N13.11 - 1983, information concerning the present standard and associated performance test results, and the selection of the review group. Following that, the status of the review is presented and statements regarding the future outlook for the standard are made.

History

Development of ANSI N13.11. In 1973, the Conference of Radiation Control Program Directors appointed a task force to implement its recommendation for establishing a continuing personnel dosimetry performance test program. The task force asked the Health Physics Society Standards Committee (HPSSC) to develop a new standard for personnel dosimeter performance. In 1975, a Health Physics Society (HPS) working group chaired by Margarete Ehrlich of the National Bureau of Standards (NBS) was given the task of writing the standard. In 1976, a draft standard was submitted for comment. In 1978, the draft standard was published for trial use and comment. That version of the standard formed the basis of a pilot test program conducted by the University of Michigan. The present standard was issued in 1983. It is a result of revisions of the draft standard based primarily on modifications made as a consequence of the pilot test program.

The Current Standard. The test categories, irradiation ranges, and tolerance levels associated with the current standard are presented in Table 1. The test requires 15 dosimeters per category. The calculated bias (i.e., accuracy) plus standard deviation (i.e., precision) must be less than or equal to the tolerance level. In equation form, this is

$$|B| + S \leq L.$$

The irradiations are to be performed with the dosimeters mounted on Lucite slab phantoms. The reporting convention requires that the absorbed dose at 1 cm depth be reported for accident cases and that the shallow (0.007 cm) and deep (1 cm) dose equivalent be reported for the others as specified in Table 1.

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Performance Test Results. The standard is the basis of the performance tests required by the NVLAP administered by the NBS. Certification by the NBS requires passing an on-site assessment as well as the performance test program[4]. Table 2 shows the performance test results obtained during the first four years (1984-1987) since the beginning of the certification program. Since 93% of the tests have been passed, it is concluded that the standard is not very difficult to meet. This is particularly obvious when the values of the accuracy plus precision are considered.

Selection of the Review Group. It is, theoretically, the policy of ANSI and the HPSSC to have their standards reviewed every five years. In September, 1986, the HPSSC issued a call for volunteers to participate as members of the N13.11 review work group[5]. In February, 1987, the review group members were selected by the HPSSC and notified. The review group consists of the nine voting members and four consultants identified in Table 3. The group has a diverse background and is experienced in all areas associated with the standard.

Status of the Review

Activities of the Review Group. The review group issued a call for comments on the existing standard in the HPS Newsletter[6]. At the first meeting, the review group heard formal presentations by several persons interested in the standard. The group has received additional input by mail, telephone, and personal contact. Group members and consultants have also commented on the standard based on their expertise. From all these inputs, the group identified sixteen different issues which need to be resolved prior to revising the standard. The approach chosen by the group is to develop a concensus position on each issue and then make any necessary revisions. This method was chosen because many of the issues are interrelated and changes in one area can affect several others in the standard. The sixteen issues are identified by title in Table 4, but they are actually a series of comments and questions of a technical nature related to each identified area of concern. Working toward the resolution of these issues has been the agenda of the work group meetings. Table 5 is a listing of the meetings to date.

Discussion of the Issues. Each of the issues in Table 4 is considered in this section. The associated discussion reflects the current attitude and thinking of the review group as a whole. The reader should, however, be advised that these currently accepted positions do not necessarily reflect the views of individual group members nor is it certain that they will ultimately find their way into the final version of the revised standard after it has undergone review and approval by the various organizations involved.

1. Philosophy. The review group believes that the existing standard has done a good job toward improving and unifying the practice of dosimetry. It is recognized that every workplace situation cannot be covered in a test standard, but the current one can be broadened somewhat to allow more improved and realistic testing without dramatically increasing the number of dosimeters required. It is not expected that every processor will need or even desire to be accredited in every category, but will select the appropriate ones for his operational situation. The review group also recognizes that algorithms used in the performance tests shouldn't necessarily have to be

the ones used in field monitoring situations if the processor can demonstrate that the ones routinely used in the field lead to superior results. The group believes that operational aspects of the dosimetry program can be as important as specific test results, but they are not properly a portion of this standard.

2. Angular dependence. Testing for angular dependence will be introduced as category IX. The range will be 0.1-10 rem. For the shallow and the deep dose equivalent, L=0.5 and there are no limits on B or S (see item 3 below). The angles of incidence to be used both horizontally and vertically are 0°, ±40°, and ±60°. The tests will be limited to radiations from categories IIIB and IV (i.e., M100, M150, H150, and Cs-137).

3. Tolerance levels and performance criteria. The performance criterion will be changed from

$$|B| + S \leq L \quad to \quad |B| + S - E \leq L$$

where E is the estimated fractional uncertainty in the delivered dose or dose equivalent. The value of E is expected to be ≤ 0.05. The tolerance level, L, is 0.5 in all cases except in categories I and II where it is 0.3. The standard deviation, S, is to be calculated as described in the current standard.

A separate limit for B and for S has been established. That limit is 0.35. This separate limit does not apply for irradiations in categories I, II, VC, and IX.

The lowest dose equivalent allowed in categories III and IV is 30 mrem. The review group is concerned about the disproportionate effect of small absolute errors on the test results at these low levels. In an attempt to be fair to all processors, the test laboratory will modify the dose assignment program to assure that no more than one dosimeter in a test category can receive a dose equivalent between 30-70 mrem.

4. SI units. No changes are planned relative to SI units. The present units are clear, understandable, and familiar to the vast majority of those who are expected to use the standard.

5. Conversion factors and dose equivalent reporting conventions. The review group has not made any decisions regarding this important issue. In recent years there has been a proliferation of dose equivalent quantities and units, many of which are due to the International Commission on Radiological Protection (ICRP) and the International Commission on Radiation Units and Measurements (ICRU). The group is giving serious consideration to the recommendations of these bodies. A particularly close look is being given to the ICRU 39 methodology[7], but interpretation problems associated with application to angular test applications must be better resolved[8] before intelligent decisions can be made.

Volumes could be written about conversion factors and dose equivalent reporting conventions. For present purposes, however, it should be known that other standards review groups and the NRC are also trying to come to grips with this problem. Any solution must consider the effective dose equivalent concept from ICRP 26[9] and how it relates to the chosen methodology. Recent works such as ICRP 51[10], soon to be published works such as ICRU 43, additional works in progress by the ICRU, and a large amount of open literature papers on the subject must be reviewed, digested and understood by the group before recommendations are finally made.

6. Unexposed dosimeter category. This issue was studied because most dosimeters processed actually have zero (or below minimum detectable) doses. The issue has also been called the lower limit of detection (LLD). The issue is still open, but the review group will probably suggest that the LLD be calculated from available data and compared with values which constitute good LLDs (e.g., 0.5 of the lower level of the test ranges for each type of radiation specified in the current standard).

7. X-ray category. The new NBS beam codes will replace the ones currently in the standard. Category III will be divided into two subcategories: IIIA and IIIB as shown below.

IIIA	M30 M60	
	M100 M150 H150	IIIB

Subcategory IIIB is added because a large number of facilities do not have a significant number of photons below 50 keV.

There will be a subcategory VIA for participants in IIIA and a subcategory VIB for participants in category IIIB. This will insure that the tests in the x-ray category and the photon mixture category are consistent.

In category I (Accidents, x-ray), the new beam code M150 will replace the currently used MFI.

8. Beta category. Tl-204 will be added to category V. To accomplish this, the category has been restructured to have three subcategories as follows:

VA = Sr-90/Y-90
VB = Tl-204
VC = Sr-90/Y-90 or Tl-204 (no limit on B,S)

This will introduce a challange to those who select VC.

Category VII is the photon/beta mixture category and it will be divided into two subcategories as follows:

VIIA = VA + Cs-137
VIIB = VB + Cs-137

There will not be a VIIC subcategory at this time.

9. Neutron category. Discussion of this issue is ongoing, but it appears that we will retain the present moderated Cf-252 radiation specified in category VIII and add another neutron source, AmBe, as a subcategory. Questions associated with source to dosimeter distance (50-75 cm), separate reporting of neutron and gamma dose, and filtering of low energy AmBe photons are still under consideration.

10. Photon category. After consideration of various alternatives, it was decided not to make any changes in this category (i.e., IV).

11. Extremity dose category. Extremity dosimetry is not the concern of this standard. The HPSSC is working on a standard for extremity dosimetry. Our group might review that document for consistency with ANSI N13.11, but that will be the extent of our involvement with extremity dosimetry.

12. Phantoms. The Lucite slab phantoms specified in the current standard have proved to be adequate and are widely accepted. No changes are anticipated in this area unless further investigation of the angular dependence question leads us to a different phantom for those tests.

13. Blind test. Blind testing will not be a part of the standard. The review group likes the concept, but no practical method of doing it has been identified.

14. Distance from source. It should be clearly understood that the distance is to be measured from the center of the source to the center of the front face (i.e., the face nearest the source) of the phantom. Although discussion is continuing, it appears that no changes will be made for photon and x-ray distances ($\geq$ 100 cm). Neutron irradiation distances are unsettled, but values of 50-75 cm are under consideration. For betas, the minimum distance will be reduced to 30 cm to allow use of the Physikalisch-Technische Bundesanstalt (PTB) sources. Use of greater distances for betas is still under debate.

15. Category VI photon mixtures. All the concerns associated with this category have been handled with issues 7 and 10.

16. Environmental concerns. No changes will be made in this area. The review group believes that enough changes have been proposed for now. Environmental testing (e.g., heat, cold, humidity, etc.) would require an impractical number of dosimeters and would tax the test lab capabilities and increase the cost of accreditation.

Future Outlook

The review group will meet again in January, 1989 to attempt to resolve the outstanding issues and begin the rewrite of the appropriate sections of the standard. When a rewritten draft is completed, it will be submitted to the HPSSC for their approval.

Table 1. ANSI N13.11 Test Categories, Test Irradiation Ranges, and Tolerance Levels

	Test Category	Test Range	Tolerance Level	
			Deep	Shallow
I.	Accidents, x-ray (NBS technique MFI)	10-500 rad	0.3	No test
II.	Accidents, Cs-137	10-500 rad	0.3	No test
III.	X-rays (NBS techniques LG, LI, LK, MFC, MFI)	0.03-10 rem	0.5	0.5
IV.	Cs-137	0.03-10 rem	0.5	No test
V.	Betas (Sr-90/Y-90)	0.15-10 rem	No test	0.5
VI.	Photon mixtures (III + IV)	0.05-5 rem	0.5	0.5
VII.	Photon/beta mixtures (IV + V)	0.20-5 rem	0.5	0.5
VIII.	D_20 moderated Cf-252/Cs-137	0.15-5 rem	0.5	No test

Table 2. NVLAP Performance Test Results (1984-1987)

	Category	Avg.| B | +S[a]	Attempted/Passed	%Pass
I.	Accidents, x-ray	0.15	102/81	79
II.	Accidents, Cs-137	0.14	131/126	96
III.	X-rays	0.19	116/104	90
IV.	Cs-137	0.15	154/153	99
V.	Betas	0.20	136/129	95
VI.	Photon mixtures	0.19	116/105	91
VII.	Photon/beta mixtures	0.18	146/136	93
VIII.	Neutron/photon mixtures	0.14	101/99	98
			1002/933	93

[a]Average among those passing tests.

Table 3. ANSI 13.11 Review Group

Members

1. Doug Carlson, Department of Energy
2. Brian Colby, American Nuclear Insurers
3. Don Jones, Lawrence Livermore National Laboratory
4. Harley Piltingsrud, Public Health Service
5. Sami Sherbini, Nuclear Regulatory Commission
6. Steve Sims, Oak Ridge National Laboratory, Chairman
7. Chris Soares, National Bureau of Standards
8. Stan Waligora, Eberline
9. Gary Zeman, Defense Nuclear Agency

Consultants

1. Elizabeth Donnelly, Tennessee Valley Authority
2. Bill King, Harshaw
3. Bob Pollock, Siemens Gammasonics
4. Pete Roberson, University of Michigan

Table 4. Issues for Resolution

	Issue	Subgroup leader
1.	Philosophy	Jones
2.	Angular dependence	Piltingsrud
3.	Tolerance levels and performance criteria	Carlson
4.	SI units	-
5.	Conversion factors and H reporting conventions	Zeman
6.	Unexposed dosimeter category	Sherbini
7.	X-ray category	Carlson
8.	Beta category	Soares
9.	Neutron category	Waligora
10.	Photon category	Zeman
11.	Extremity dose category	-
12.	Phantom	-
13.	Blind test	Colby
14.	Distance from source	Jones
15.	Category VI photon mixtures	Waligora
16.	Environmental concerns	Piltingsrud

Notes:

Issues 4, 11, and 12 were handled by the entire group.

A voting member has lead responsibility on each subgroup.

No one person has lead responsibility on more than two subgroups.

No one person is a member of more than four subgroups.

Table 5. Review Group Meetings

June 23-24, 1987
September 22-23, 1987
January 20-21, 1988
May 3-4, 1988
August 24-25, 1988

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4. Hudson, C. G., "Personnel Dosimetry Accreditation - An Assessor's Perspective," Radiation Protection Management, 37-43, October 1986.

5. Health Physics Society, "N13.11 Standard Review," Health Physics Society Newsletter, XIV(9), 14 (1986).

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8. J. A. Dennis, "Celestial Spheres and Mortal Men", Editorial, Radiation Protection Dosimetry, 22, 147 (1988).

9. International Commission on Radiological Protection, Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, New York, 1977.

10. International Commission on Radiological Protection, Data for Use in Protection Against External Radiation, ICRP Publication 51, Pergamon Press, New York, 1987.