CHAPTER 57

ANSI Standards for Liquid Scintillation Counting

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The history of ANSI standards has been previously chronicled by Roger Ferris;[1] therefore, only a brief sketch of ANSI committees will be given here. The acronym, ANSI, stands for the American National Standards Institute based in New York. ANSI publishes industrial standards for instruments and relevant technology associated with their use. Once a standard is published, it remains in force for 5 years, after which it may either be reaffirmed for another 5 years or allowed to expire. These ANSI committees are composed of unpaid volunteers representing instrument manufacturers, relevant suppliers, government agencies, and knowledgeable users of the technology.

ANSI committee N42 was formed in 1975 for the expressed purpose of writing standard methods of calibration of nuclear detection instruments. A subcommittee, N42.2, was formed and delegated to do the actual writing of the standards. The chairman of the writing committee for N42.15, "Performance Verification of Liquid Scintillation Counting Systems,"[2] was Roger Ferris. N42.15 was first published in 1980 and reaffirmed in 1984. Yutaka Kobayashi succeeded Ferris for the revision of N42.15 which is currently under review. Kobayashi is also the writing committee chairman for N42.16, "Specifications for Sealed Radioactive Check Sources Used in Liquid Scintillation Counters."[3] N42.16 was published in 1986. The purpose of both of these standards was to provide users with concise and simple directions for calibrating their liquid scintillation counters. It was the hope of the committee that instrument manufacturers would incorporate and encourage the use of these standards, and in the same vein, regulatory agencies would require these or similar procedures to be adopted into the quality assurance programs of those using liquid scintillation counters under jurisdiction.

The objective of the instrument standard was to provide simple tests to verify the satisfactory performance of the instrument. It was decided early to exclude any discussion of quench correction methods. This was in keeping with our objective of maintaining the length of the standard to a few pages. We focused on only three parameters for instrument evaluation: performance,

stability, and background. It was the consensus of the committee that tritium, generally the weakest radionuclide most commonly counted, would be a desirable check source with which to assess performance. If the instrument performed well with a tritium check source, measuring the more energetic radionuclides should not be a problem; however, instrument performance can be assessed using a check source containing any other radionuclide which may be more pertinent to a particular laboratory. The requirements are that the check source used be chemically stable and that the sample container dimensions conform to those specified in the International Electro-technical Commission (IEC) Standard Number 582.[4] The IEC standard 582 specifies the dimensional limits for glass and plastic vials for both the standard and miniature sizes used in liquid scintillation counters. This standard is international and was written for the benefit of instrument manufacturers in Europe and the United States. It should be noted that, today, only the standard for the large vials, the 20 mL size, is followed. The miniature vials counted today vary in size from microvials which hold only a few hundred μL to those which hold 7 mL.

To evaluate performance, commercially produced check sources usually sold as "unquenched standards" are recommended. They are usually sold as sets consisting of tritium, ^{14}C, and background check sources prepared in an oxygen-free atmosphere. If a check source with energy greater than ^{14}C is required, a ^{36}Cl check source (beta emission with an E_{max} of 712 keV) may be purchased. The advantage of using a commercial unquenched standard set is that they are usually traceable to the National Institute of Standards and Technology (NIT&S) and can be used to evaluate counting efficiency within known statistical limits. The question of establishing traceability for regulatory purposes is an ongoing problem in this field. To evaluate performance, the sample chemistry is not critical so long as the check source is stable over a period of time and the same check source is used daily. It is essential to use the same check source each time to eliminate any systematic error which may be introduced by another check source containing the same radionuclide. The ANSI standard recommends that each instrument be assigned its own set of check sources. To monitor stability, it is essential that the daily readings of the check sources be recorded. A daily inspection of this record will be a good indicator of the stability of the instrument. An example of a useful log sheet is appended to this standard.

In Table 1, the Table of Contents for ANSI Standard N42.15, "Performance Verification of Liquid Scintillation Counting Systems," is shown. The essence of both the introduction and scope has already been discussed above.

The definitions given are concise, simple, and accurate. They were not written to be encyclopedic; and thus do not meet with everyone's approval. Our objective was to make the definitions easy to understand and appropriate for this standard. In this section, we have also defined standard sources as those which are directly traceable to NIT&S and those which are supplied by other sources which certify traceability to NIS&T. The standard specifies four different types of check sources which can be used to conduct the various

Table 1. Table of Contents of ANSI N42.15, "Performance Verification of Liquid-Scintillation Counting Systems"

Section
1. Introduction
2. Scope and Purpose
3. Definitions 3.1 General 3.2 Standards and Check Sources 3.3 Symbols
4. References
5. Operations and Tests 5.1 General 5.2 Test Procedures
6. Precautions 6.1 Measurement of Radioactivity 6.2 Abnormal Observation of Check Source Count Rate 6.3 Abnormal Observation of Background Check Source Count Rate
Appendixes Appendix A: Statistical Tests of Reproducibility: The X^2 Test and other criteria Appendix B: Performance Monitoring Log for Liquid Scintillation Counter

instrument performance tests. Only the flame-sealed check sources of known activity can be used in all tests.

Section 5, Operations and Tests, describes the frequency of testing, tests for counting efficiency, determination of background, and statistical methods for assessing instrument stability. Although this standard uses a tritium check source for determining counting efficiency, any check source more appropriate for a given laboratory may be used. The standard recommends the monitoring of instrument performance following installation, after instrument service, replacement of a check source, or after any other circumstance which may influence performance. The key recommendation is daily monitoring and data recording in an instrument log.

The last section, Precautions, discusses various factors which may influence the counting data. They include correcting for short-lived radionuclide decay, the instrument resolution time with respect to sample activity, chemiluminescence, and photoluminescence. These and other topics with which the user should be familiar are included in this section.

The Table of Contents shown here is for the current standard. A revised version of this standard is currently out for ballot. The revision was necessary because the current standard does not mention the fact that all new liquid scintillation counters use the equivalent of a multichannel analyzer instead of the classic pulse height analyzer. The new standard also includes a more detailed revision of precautions relative to photomultiplier tube performance.

A complimentary standard, ANSI N42.16, "Specifications for Sealed Radioactive Check Sources Used in Liquid Scintillation Counters," has been published. The Table of Contents is reproduced in Table 2. This standard

Table 2. Table of Contents: ANSI N42.16, "Specifications for Sealed Radioactive Check Sources Used in Liquid-Scintillation Counters"

Section
1. Introduction
2. Purpose
3. Definitions
3.1 General
3.2 Standards and Check Sources
4. References
5. Materials
5.1 Solvents
5.2 Organic-Scintillator Solutes
5.3 Radioactive Material
5.4 Sample Container
5.5 Purging Gas
6. Description of Check Sources
6.1 Check Sources
6.2 Expiration Date of Check Sources
7. Precautions
7.1 Organic Scintillator Solute Purity
7.2 Background Activity from Low-Potassium Glass
Appendixes (A through E)

covers only tritium, ^{14}C, and background check sources. It specifies the range of radioactivity to be contained in the two radioactive check sources and the source for both to be radio-labeled toluene. In summary, for the check sources, the solvent specified is analytical-grade (or better) toluene, the primary scintillator is diphenyloxazole (PPO), the secondary scintillator is one of three listed in the standard, and the check source is purged with an inert gas before sealing. The glass container must meet the IEC standard 582 previously discussed, and the final volume of the sample contained in the check source shall be 15 mL +/- 0.2 mL. The useful life of the check source is limited to 5 years from the time of sealing.

In conclusion, it should be stressed that these standards have been written for the benefit of all users. The ANSI committee welcomes suggestions for any other standard which may be useful to users of liquid scintillation counters.*

REFERENCES

1. Ferris, R. "ANSI Standards for L.S. Counters," in *Liquid Scintillation Counting: Recent Applications and Development*, C.T. Peng, D.L. Horrocks, and E.L. Alpens, Eds. (New York: Academic Press, 1980) Vol.1, p. 241.

*Copies of any ANSI standard may be obtained by writing:
IEEE, Inc
345 East 47th Street
New York, New York 10017

2. American National Standard. *Performance Verification of Liquid-Scintillation Counting Systems*, ANSI N42.15-1980(R84) (New York: IEEE,Inc).
3. American National Standard. *Specifications for Sealed Radioactive Check Sources Used in Liquid Scintillation Counters*, ANSI N42.16-1986 (New York: IEEE,Inc).
4. Dimensions of vials for liquid scintillation counting, IEC Pub No 582, Technical Committee No. 45: International Electrotechnical Commission,(IEC), Nuclear Instrumentation, Geneva, Switzerland. 1977.