

American National Standard Check Sources for and Verification of Liquid-Scintillation Counting Systems

Sponsor

National Committee on Radiation Instrumentation, N42

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American National Standards Institute

Secretariat

Institute of Electrical and Electronics Engineers, Inc.

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Abstract: Tests and procedures to ensure that a liquid-scintillation counting system is producing reliable data are provided for designers and users. This standard does not cover the calculation of sample activity for quenched unknown samples, sample preparation, efficiency correlation (quench correction) procedures, or identification of unknown radionuclides.

Keywords: calculation of sample activity, liquid-scintillation counting systems, quenched unknown samples, tests and procedures for liquid-scintillation counting systems

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Introduction

(This introduction is not part of ANSI N42.15–1997, American National Standard Check Sources for and Verification of Liquid Scintillation Counting Systems.)

This standard is the responsibility of the Accredited Standards Committee N42 on Radiation Instrumentation. Committee N42 delegated the development of this standard to its subcommittee N42.RM. Drafts were reviewed by Committee N42, Subcommittee N42.RM, and other interested parties, and the comments received were utilized in producing the standard as finally approved.

This standard combines ANSI N42.15-1990, American National Standard Verification of Liquid-Scintillation Counting Systems, and ANSI N42.16-1986, American National Standard Specifications for Sealed Radioactive Check Sources Used in Liquid-Scintillation Counters, with modifications. This standard was approved by N42 letter ballot on 28 January 1997.

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American National Standard Check Sources for and Verification of Liquid-Scintillation Counting Systems

1. Overview

Liquid-scintillation counting systems are widely used for radionuclide assay in nuclear medicine, life science research, and industrial applications. A typical commercial system is a combination of a sample-changing device and a liquid-scintillation spectrometer such that a number of samples may be counted automatically. The typical liquid-scintillation spectrometer usually consists of a sample chamber and two horizontally opposed photomultiplier tubes viewing the sample chamber, with the associated electronics to detect and record the presence of radioactivity dissolved in the sample. The sample compartment may be either air-cooled or refrigerated (controlled temperature). The theory of the operation of this type of radioactivity detection system is summarized in NCRP Report 58-1985 [B10]¹. Additional references on theoretical and applied aspects of liquid-scintillation counting are given in Birks [B1], Bransome [B2], Horrocks [B5], Knoll [B7], Kobayashi and Maudsley [B8], Noakes et al. [B11], Peng et al. [B12], Ross et al. [B14] and Stanley and Scoggins [B16]. The liquid-scintillation counter is so named because the usual radioactive sample assayed is either dissolved or dispersed in a solution containing one or more organic scintillators.

1.1 Scope

The specifications for check sources to be used in the evaluation of liquid-scintillation counter performance are included in this standard.

Measures of performance considered in this standard are

- a) Counting system efficiency
- b) Reproducibility of sample and background count rates
- c) Preparation of check sources for performance evaluation

Definitions of some terms used here are given in Clause 3.

This standard does not cover the calculation of sample activity for *quenched* unknown samples. Accordingly, this standard does not deal with sample preparation, efficiency correlation (quench correction) procedures, or identification of unknown radionuclides.

¹The numbers in brackets correspond to those of the bibliography in Annex H.

1.2 Purpose

The purpose of this standard is to provide the user with the means of verifying the performance of typical liquid-scintillation counting systems.

1.3 Word usage

In the wording of this standard, two verbs have been used to indicate the degree of rigor indicated by a specific criterion. *Shall* indicates minimum criteria that must be met, while *should* indicates criteria that are recommended as good practice and are to be applied when practical.

2. References

This standard shall be used in conjunction with the following publications:

ICRU Report 22-1972, Measurement of Low Level Radioactivity.²

IEC 60582 (1977-01), Dimensions of vials for liquid scintillation counting.³

IEEE Std 398-1972 (Reaff 1991), IEEE Test Procedures for Photomultipliers for Scintillation Counting and Glossary for Scintillation Counting Field (ANSI).⁴

3. Definitions

3.1 background check source: A sealed vial of liquid-scintillation solution containing no added radioactive material.

3.2 background count rate (in radioactivity counters): Count rate recorded by the instrument when measuring a background check source in counts per minute.

3.3 check source: A radioactive source, not necessarily calibrated, that is used to confirm the continuing satisfactory operation of an instrument.

3.4 counting channel: A region of the pulse-height spectrum that is defined by upper and lower boundaries set by discriminators.

3.5 counting efficiency: The ratio of the count rate to the disintegration rate, usually expressed as a percentage: $E = (R/A) \times 100$. (See 4.4 for nomenclature.)

3.6 counting region: A region that identifies the first and last memory location of a contiguous series to be summed in a multichannel analyzer.

3.7 gain, photomultiplier tube: The ratio of the signal output current to the photoelectric signal current from the photocathode. (See IEEE Std 398-1972.)⁵

²ICRU publications are available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 800, Bethesda, MD 20814, USA.

³IEC publications are available from IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁴IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.