



American National Standard

ANSI/HPS N13.14-2018

Bioassay Programs for Tritium

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Foreword

(This foreword is not part of American National Standard N13.14)

This is the first revision of the original American National Standards Institute (ANSI) standard ANSI N13.14 issued in 1994. Since the original revision, there have been changes in the metabolic model for tritium, in the understanding of the proper inclusion of the respiratory and alimentary tract models, and in the analysis methodology. In addition, the ANSI/Health Physics Society (HPS) N13.39-2011 standard has been developed which provides great insight and recommendations for development of internal dosimetry programs.

This revision incorporates those considerations as well as recommendations for consideration of other tritium compounds such as organically bound tritium and tritides.

Key words: bioassay, internal dosimetry, tritium

Bioassay Programs for Tritium

1.0 Introduction

Individuals who work with tritium or tritium-labeled compounds, or who work in areas where these substances are handled, have a potential for exposure to tritium. Tritium, the only radioactive isotope of hydrogen, displays similar chemical behavior to the stable isotopes of hydrogen. Exposure to tritium gives rise to the possibility of intake via inhalation, skin absorption, ingestion, or a wound.

Individuals who work in conditions where a significant potential for substantial tritium intake exists (see Section 6.0) require a radiation protection program. Such a program should include air and surface monitoring of the work area, individual bioassay, and internal dosimetry evaluations.

The primary objective of a tritium internal dosimetry program is to estimate committed effective quantities due to intakes of tritium. The secondary objective is to assess the adequacy of the tritium radiation protection program. Bioassay data are used to estimate the quantity of tritium deposited in the body after an intake or to provide documentation that significant intakes have not occurred. Internal dosimetry procedures use bioassay data to estimate committed effective dose quantities to the individual.

This standard was first published in 1994 to provide information needed to develop and administer a program for tritiated water and some organic compounds. Since that standard was developed, metal tritides have become a much greater concern. This standard attempts to address these new hazards and incorporate the model for tritium metabolism promulgated in ICRP Publication 56 (ICRP 1989). This standard also expands upon recommendations of ANSI N13.39-2011 (HPS 2011b) helping the internal dosimetrist with the technical information that person needs to understand the differences across the span of tritium compounds and how that will drive different bioassay requirements. In addition, it drives the understanding of single-void (concentration) measurements rather than 24 hour sampling which is not described in N13.39 and really pertains only to tritium.

2.0 Purpose

This standard defines the minimum requirements for an internal dosimetry program used to monitor individuals who may be occupationally exposed to tritium or tritium labeled compounds.

3.0 Scope

This standard specifies:

- Conditions requiring a tritium internal dosimetry program;
- Choice of individuals required to participate in the program;
- Bioassay frequency;
- Analytical methods for determining tritium concentrations in biological samples;
- Methods for estimating committed effective dose from intakes of tritiated water, tritium gas, organic compounds of tritium, or metal tritides;
- Required sensitivity and accuracy for bioassay procedures;
- Recommended actions based upon estimated committed effective doses; and
- Recommended recording levels.

This standard does not specify:

- Appropriate radiation safety procedures and containment for working with tritium;
- Appropriate methods for air and surface monitoring of tritium work areas; or
- Interpretation of air and surface monitoring data.

While it is understood that personal air sampling is sometimes used for monitoring of tritium, sample media are less efficient for tritiated water, gaseous tritium, and organically bound tritium than for particulate samples and analysis of those samples may be nontrivial. As such, this standard focuses on the typical practice of bioassay and does not further discuss personal air sampling.

4.0 Definitions

4.1 Shall, Should, May

The word "shall" is used to denote a requirement; the word "should" denotes a recommendation; and the word "may" denotes permission, neither a requirement nor a recommendation. To conform to this standard, all tritium internal dosimetry programs shall include the requirements of this standard but not necessarily its recommendations.

4.2 Specific Terms

ALARA: as low as reasonably achievable

Annual limit on intake (ALI): the activity of a tritium intake which if taken alone would irradiate a person, represented by reference man (ICRP 2002), to the limit set for each year of occupational exposure. The ALI in this document is based on the 0.05 Sv limit in 10CFR20 and 10CFR835.

Bioassay, radiobioassay: the measurement of amount or concentration of radioactive material in the body or in biological material excreted or removed from the body and analyzed for purposes of estimating the intake or amount of radioactive material in the body. In this standard, bioassay will refer only to the determination of tritium activity concentration in urine samples.

Committed effective dose: the sum of the products of the committed organ or tissue equivalent doses and the appropriate tissue weighting factors (w_T), where s is the integration time in years following the intake. The commitment period is taken to be 50 y for adults, and to age 70 y for children (ICRP 103).

Committed equivalent dose: the time integral of the equivalent dose rate in a particular tissue or organ that will be received by an individual following intake of radioactive material into the body by a reference person, where T is the integration time in years (ICRP 103).

Confirmatory monitoring, confirmatory bioassay monitoring: monitoring performed to verify exposure conditions for workers thought not likely to be exposed at levels requiring routine monitoring. Typically, individuals assessed are those most likely to be exposed.

Derived air concentration (DAC): the concentration of tritium in air (Bq m^{-3}) which, if experienced by reference man for 2,000 h (50 wk at 40 h wk^{-1}) in "light activity" (0.02 $\text{m}^3 \text{min}^{-1}$ inhalation rate), would result in the ALI by inhalation and skin absorption.

Derived limit (DL): a limit associated with a measured quantity and related to basic limits by a defined model. Derived limits apply only to the circumstances for which they were calculated. Compliance with the DL implies compliance with relevant basic limits (e.g., derived air concentration).

GI: gastrointestinal (tract).

HT: gaseous molecule consisting of elemental tritium and nonradioactive hydrogen.

HTO: a water molecule in which one of the hydrogen atom positions is occupied by a tritium atom.

Intake: the amount of a radionuclide that enters the body. In this standard it refers to (1) the process of tritium or tritium compounds entering the body or (2) the quantity of tritium or tritium compounds taken into the body by inhalation, by ingestion, by absorption through the skin, by injection, or via a wound.

Intake retention fraction: the fraction of an intake expected to be in a metabolic compartment, e.g., organ, tissue, or excreta, at some time after intake.

Investigation level: the level of intake at or above which a bioassay or air monitoring result shall be investigated for purposes of confirming intake and assessing dose. See Section 8.1.3. ANSI/HPS N13.39-2011 recommends an intake amount of 0.1 ALI.

Metabolic model: a mathematical description of the biokinetic behavior of a given element or compound in the metabolic processes of cells, tissues, organs, and organisms.

Minimum detectable activity (MDA): minimum detectable activity is defined in ANSI/HPS N13.30-2011.

Monitoring: in this standard, measurement of radiation or activity for reasons related to the estimation or control of exposure to radiation or radioactive materials. Use of the term implies interpretation of measurement results.

OBT: organically bound tritium, i.e., tritium as part of an organic molecule. Refer to ICRP Publication 56 (ICRP 1989) for more information on tritium compounds.

Prior intake: intake of a radionuclide previous to the present or scheduled job assignment.

Radiation weighting factor, w_r : a factor chosen to represent the effectiveness of different types of ionizing radiation in producing biological damage at low doses.