



American National Standard

ANSI/HPS N13.35-2009

**Specifications for the Bottle Manikin
Absorption Phantom**

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American National Standards Institute, Inc.



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Foreword (This foreword is not part of the American National Standard HPS N13.35-2009)

This standard establishes the specifications for the design and fabrication of bottle manikin absorption (BOMAB) phantoms. This revision updates the technical information contained in the 1999 version. The presentation of the information pertaining to the different sized phantoms has been reorganized.

The BOMAB phantom has been used for a variety of applications. However, the specifications in this standard are intended to provide guidance for BOMAB phantoms used to calibrate in vivo monitoring systems. The BOMAB phantom is used primarily to calibrate systems that measure radionuclides in the body that when metabolized their distribution approximates a whole body distribution (e.g. ^{137}Cs , ^{40}K). For in vivo calibrations, the phantom is typically used over the energy range from 100 keV to 3 MeV. Over this energy range right circular cylinders and elliptical cylinders adequately approximate the shape of the body. Also at these energies, the radiation interaction properties of the phantom materials adequately simulate tissue.

The importance of establishing standard specifications for phantoms is as valid today as it was when emphasized at the 1990 meeting of in vivo counting professionals held at the National Institute of Standards and Technology (NIST) (Kramer et al. 1991). The consensus of the NIST meeting attendees that standard specifications were needed for the calibration phantoms including the BOMAB phantom are still valid.

The standard contains four annexes. Annex A is normative and is considered part of this standard. Annexes B, C, and D are informative and are not considered part of this standard.

Suggestions to improve the standard are welcome. Suggestions should be sent to:

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1.0 Scope and Purpose

1.1 Scope

This standard provides the specifications for the design, fabrication, and quality (accuracy and precision) of new BOMAB phantoms. It is not intended to be applied to phantoms manufactured prior to the issuance of this standard. This standard addresses material composition, physical specifications, incorporation of the radioactive material in the phantom, quality assurance, quality control, and records. The standard does not specify particular fabrication techniques or specific component testing techniques, but instead addresses specifications for the finished phantom.

1.2 Purpose

The purpose of this standard is to provide specifications for the BOMAB phantom. The specifications provide guidelines to help ensure the BOMAB phantom adequately simulates the body for purposes of calibrating in vivo measurement systems. Specifications are provided for the design and fabrication of BOMAB phantoms that simulate several different body sizes. This standard should be used to guide fabrication of BOMAB phantoms of any size.

2.0 Definitions

Average soft tissue: The body tissues in a human subject other than osseous tissue, teeth, hair, and nails (ICRU 46 (p. 8)). Soft tissues include all the body fluids and muscle-like tissues and fatty tissues (e.g., adipose tissue). Radiation interaction data for average soft tissue in adults are defined in Table B1 of ICRU Report 46 (pp. 30–32).

Bioassay: Techniques used to determine the amount or concentration of radioactive material in the body relative to a standard using in vivo and/or in vitro measurement methods. Synonymous with radiobioassay.

Bottle manikin absorption phantom (BOMAB): A representation of the human body consisting of containers formed into elliptical cylinders and right circular cylinders of various sizes to simulate the head, neck, arms, torso, pelvis, thighs, and legs. The phantom is primarily used to calibrate in vivo measurement systems for radioactive material that is homogeneously distributed in the body.

Effective atomic number (Z_{eff}): The effective atomic number is calculated as described in Appendix C of ICRU Report 44. An element of this atomic number would interact with photons in the same way as the compound or mixture.

Electron density: Number of electrons (e_0) per unit volume, typically expressed in m^{-3} .

In vivo: From the Latin meaning “within a living organism.” Thus, in vivo counting of radioactive material is the measurement of radioactive material in living organisms.

Mass attenuation coefficient (μ/ρ): The quotient, in units of $\text{cm}^2 \text{g}^{-1}$, of dN/N divided by ρdl , where dN/N is the fraction of uncharged ionizing particles that experience interactions in traversing a distance dl in a material of density ρ .

Minimum detectable activity (MDA): The smallest amount of activity of an analyte in a sample that will be detected with a certain probability of non-detection (Type II error)—yet accepting a probability of erroneously deciding that a positive (nonzero) quantity of analyte is present in an appropriate blank sample (Type I error).

NIST: National Institute of Standards and Technology.

Phantom: A simulation of the human body or part of the body used for the calibration of in vivo measurement systems. A phantom is constructed to allow placement of radionuclides in a geometry approximating internal depositions.

QA: Quality assurance.

Reference values: The age- and gender-specific reference values for anatomical and physiological features of the human body