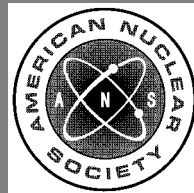


# American Nuclear Society

**specification for radiation  
shielding materials**

**an American National Standard**



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## **American National Standard**

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**Foreword** (This Foreword is not a part of American National Standard "Specification for Radiation Shielding Materials," ANSI/ANS-6.4.2-2006.)

The need for this standard was identified in mid-1977 by Working Group ANS-6.4. At that time, it was recognized that an increasing number of different material/design shielding concepts were being introduced into nuclear power plants to solve neutron and gamma-ray streaming problems. For protection against neutron streaming, materials varying from water-filled rubber bags, rubber balls, special concretes, treated plastics, and silicone gels were proposed, while lead-filled silicone rubber and gels were proposed for gamma-ray streaming. With such a variety of materials, some only a year or two after initial commercial introduction, a clear need was discerned to standardize the specification of these materials to assist the material manufacturer in the type of information he or she needs to provide to the user.

The focus of the working group's initial work was to orient the standard toward the reporting requirements used by material suppliers rather than toward the preparation of specifications by designers and end users. This focus has been maintained through the development of this standard as that representing the true needs of nuclear power plants in this area. The standard was reaffirmed in 1997 and again in 2004, at which time a working group was appointed and charged with revision of the standard.

Working Group 6.4.2 of the American Nuclear Society Standards Committee had the following membership at the time of this revision:

R. E. Faw (Chair), *Individual*

C. C. Graham, *AmerenUE Callaway Plant*  
S. J. Haynes, *Sandia National Laboratories*  
T. M. Lloyd, *EnergySolutions*  
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R. W. Roussin, *Individual*  
J. K. Warkentin, *Individual*  
N. B. Willoughby, *Individual*

Subcommittee ANS-6, Radiation Protection and Shielding, had the following membership at the time of its approval of this standard:

W. C. Hopkins (Chair), *Individual*

F. A. Alpan, *Westinghouse Electric Company*  
J. Tanner, *Pacific Northwest National Laboratory*  
R. E. Faw, *Individual*  
J. C. Wagner, *Oak Ridge National Laboratory*  
R. M. Westfall, *Oak Ridge National Laboratory*  
T. M. Raby, *National Institute of Standards and Technology*  
N. Hertel, *Georgia Institute of Technology*

Consensus Committee N-17, Research Reactors, Reactor Physics, Radiation Shielding, and Computational Methods, had the following membership at the time it reviewed and approved this standard:

T. M. Raby (Chair), *National Institute of Standards and Technology*

A. Weitzberg (Vice Chair), *Individual*

W. H. Bell, *American Institute of Chemical Engineers* (Alt. R. D. Zimmerman, *American Institute of Chemical Engineers*)  
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D. Cokinos, *Brookhaven National Laboratory*  
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N. Hertel, *Georgia Institute of Technology*

W. A. Holt, *Individual*  
W. C. Hopkins, *Individual*  
M. A. Hutmaker, *U.S. Department of Energy*  
L. I. Kopp, *Individual*  
P. M. Madden, *U.S. Nuclear Regulatory Commission (Alt. A. Adams, U.S. Nuclear Regulatory Commission)*  
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J. E. Olhoeft, *Individual*  
W. J. Richards, *National Institute of Standards and Technology*  
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R. Tsukumura, *Aerotest Operations*  
S. H. Weiss, *National Institute of Standards and Technology (Alt. Thomas J. Myers, National Institute of Standards and Technology)*  
W. L. Whittmore, *General Atomics*

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This is a preview of "ANSI/ANS-6.4.2-2006". [Click here to purchase the full version from the ANSI store.](#)

# Specification for Radiation Shielding Materials

## 1 Scope

This standard sets forth physical and nuclear properties that shall be reported by the supplier as appropriate for a particular application in order to form the basis for the selection of radiation shielding materials.

## 2 Conformance

The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation. To conform with this standard, materials that are to be considered for use as a radiation shield shall be evaluated against the physical and nuclear properties that the standard sets forth. Accuracy of the determined values shall be provided. Unless otherwise specified, it will be assumed that all values are at a pressure of 1 atm. Units used in specifying properties shall be in the SI system as specified in this standard but may be expressed in other convenient units as well.

## 3 Terms and definitions

The following terms and definitions are provided to assure uniform understanding of the selected terms as are used in this standard. A large number of additional terms that are used are defined in the following documents: "Standard Terminology Relating to Methods of Mechanical Testing," ASTM E6-06 [1];<sup>1)</sup> "Terminology Relating to Density and Specific Gravity of Solids, Liquids, and Gases," ASTM E12-70 (R1991, withdrawn 1996) [2]; "Standard Terminology of Fire Standards," ASTM E176-05a [3]; "Standard Terminology Relating to Rubber," ASTM D1566-06 [4]; "Cement and Concrete Terminology," ACI-116R-00 (R2005) [5]; and *Glossary of Terms in Nuclear Science and Technology* (1986) [6].

**Arrhenius model:** A model commonly used in accelerated aging tests that relates the rate of reaction of a material to temperature by a simple exponential function,  $r = A \exp(-\Phi/kT)$ , where  $r$  is the reaction rate,  $A$  is a material constant (frequency factor),  $\Phi$  is the activation energy of the material (eV),  $k$  is Boltzmann's constant ( $0.8617 \times 10^{-4}$  eV/K), and  $T$  is the absolute temperature (K).

**bremsstrahlung:** Gamma radiation emitted by an electron when it is deflected by the Coulomb field of an atomic nucleus of charge  $Z$ ; the fraction of energy radiated as photons by an electron of initial energy  $E$  (MeV) is approximated numerically by  $ZE/1000$ .

**equivalent test:** A test method utilized in place of a standard or reference test that achieves the same end result.

**induced radioactivity:** Radioactivity due to the interaction of an external neutron radiation field with the nuclides of a material.

**operating range:** The range of values over which a parameter, indicative of environmental conditions, is stated to vary during the expected life of a material as it performs its intended function.

**photoneutron:** Neutron released from an atomic nucleus in a photonuclear reaction with a gamma ray of sufficiently high energy. The threshold energy required of the gamma ray is  $\sim 2$  MeV for beryllium and deuterium but  $> 8$  MeV for other elements.

**specific gravity:** For the purposes of this standard, specific gravity is considered numerically equal to density expressed in units  $\text{g}/\text{cm}^3$ .

**trace element:** An element found in small quantities (usually  $< 1\%$ ) within a material.

**trace radioactivity:** Radioactivity due to trace amounts of naturally occurring radioisotopes contained within a material.

<sup>1)</sup>Numbers in brackets refer to corresponding numbers in Sec. 8, "References."