



Standard Test Method for Measuring Fast-Neutron Reaction Rates by Radioactivation of Iron¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method describes procedures for measuring reaction rates by the activation reaction $^{54}\text{Fe}(n,p)^{54}\text{Mn}$.

1.2 This activation reaction is useful for measuring neutrons with energies above approximately 2.2 MeV and for irradiation times up to about 3 years (for longer irradiations, see Practice E261).

1.3 With suitable techniques, fission-neutron fluence rates above $10^8 \text{ cm}^{-2}\cdot\text{s}^{-1}$ can be determined. However, in the presence of a high thermal-neutron fluence rate (for example, $>2 \times 10^{14} \text{ cm}^{-2}\cdot\text{s}^{-1}$) ^{54}Mn depletion should be investigated.

1.4 Detailed procedures describing the use of other fast-neutron detectors are referenced in Practice E261.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D1193 Specification for Reagent Water

E170 Terminology Relating to Radiation Measurements and Dosimetry

E181 Test Methods for Detector Calibration and Analysis of Radionuclides

E261 Practice for Determining Neutron Fluence, Fluence Rate, and Spectra by Radioactivation Techniques

E844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, E 706 (IIC)

E944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance, E 706 (IIA)

E1005 Test Method for Application and Analysis of Radiometric Monitors for Reactor Vessel Surveillance, E 706 (IIIA)

E1018 Guide for Application of ASTM Evaluated Cross Section Data File, Matrix E706 (IIB)

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology E170 for definitions of terms relating to radiation measurements and neutron dosimetry.

4. Summary of Test Method

4.1 High-purity iron is irradiated in a neutron field, thereby producing radioactive ^{54}Mn from the $^{54}\text{Fe}(n,p)^{54}\text{Mn}$ activation reaction.

4.2 The gamma rays emitted by the radioactive decay of ^{54}Mn are counted in accordance with Test Methods E181. The reaction rate, as defined by Practice E261, is calculated from the decay rate and irradiation conditions.

4.3 Radioassay of the ^{54}Mn activity may be accomplished by directly counting the irradiated iron dosimeter, or by first chemically separating the ^{54}Mn activity prior to counting.

4.4 The neutron fluence rate above about 2.2 MeV can then be calculated from the spectral-weighted neutron activation cross section as defined by Practice E261.

5. Significance and Use

5.1 Refer to Guide E844 for guidance on the selection, irradiation, and quality control of neutron dosimeters.

5.2 Refer to Practice E261 for a general discussion of the determination of fast-neutron fluence rate with threshold detectors.

5.3 Pure iron in the form of foil or wire is readily available and easily handled.

¹ This test method is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.05 on Nuclear Radiation Metrology.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.