



Standard Test Method for Measuring Reaction Rates by Radioactivation of Neptunium- 237¹

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1. Scope

1.1 This test method covers procedures for measuring reaction rates by assaying a fission product (F.P.) from the fission reaction $^{237}\text{Np}(n,f)\text{F.P.}$

1.2 The reaction is useful for measuring neutrons with energies from approximately 0.7 to 6 MeV and for irradiation times up to 30 to 40 years.

1.3 Equivalent fission neutron fluence rates as defined in Practice E 261 can be determined.

1.4 Detailed procedures for other fast-neutron detectors are referenced in Practice E 261.

1.5 *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:

E 170 Terminology Relating to Radiation Measurements and Dosimetry²

E 181 Test Methods for Detector Calibration and Analysis of Radionuclides²

E 261 Practice for Determining Neutron Fluence Rate, Fluence, and Spectra by Radioactivation Techniques²

E 262 Test Method for Determining Thermal Neutron Reaction and Fluence Rates by Radioactivation Techniques²

E 320 Test Methods for Cesium-137 in Nuclear Fuel Solutions by Radiochemical Analysis²

E 393 Test Method for Measuring Reaction Rates by Analysis of Barium-140 from Fission Dosimeters²

E 482 Guide for Application of Neutron Transport Methods for Reactor Vessel Surveillance, E706 (IID)²

E 704 Test Method for Measuring Reaction Rates by Radioactivation of Uranium-238²

E 844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, E706 (IIC)²

E 944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance, (IIA)²

E 1005 Test Method for Application and Analysis of Radiometric Monitors for Reactor Vessel Surveillance, E706 (IIIA)²

E 1018 Guide for Application of ASTM Evaluated Cross Section Data File, Matrix E 706 (IIB)²

3. Terminology

3.1 Definitions:

3.1.1 Refer to Terminology E 170.

4. Summary of Test Method

4.1 High-purity ^{237}Np (<40 ppm fissionable impurity) is irradiated in a fast-neutron field, thereby producing radioactive fission products from the reaction $^{237}\text{Np}(n,f)\text{F.P.}$

4.2 Various fission products such as ^{137}Cs - $^{137\text{m}}\text{Ba}$, ^{140}Ba - ^{140}La , ^{95}Zr , and ^{144}Ce can be assayed depending on the length of irradiation, purpose of the experiment, etc.

4.3 The gamma rays emitted through radioactive decay are counted and the reaction rate, as defined in Practice E 261, is calculated from the decay rate and the irradiation conditions.

4.4 The neutron fluence rate for neutrons with energies from approximately 0.7 to 6 MeV can then be calculated from the spectral-weighted neutron activation cross section as defined in Practice E 261.

4.5 A parallel procedure that uses ^{238}U instead of ^{237}Np is given in Test Method E 704.

5. Significance and Use

5.1 Refer to Practice E 261 for a general discussion of the determination of fast-neutron fluence rate with fission detectors.

5.2 ^{237}Np is available as metal foil, wire, or oxide powder. For further information, see Guide E 844. It is usually encapsulated in a suitable container to prevent loss of, and contamination by, the ^{237}Np and its fission products.³

5.3 One or more fission products can be assayed. Pertinent data for relevant fission products are given in Table 1 and Table 2.

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 Annual Book of ASTM Standards, Vol 12.02.

³ Vanadium-encapsulated monitors of high purity are available from the Isotope Sales Div., Oak Ridge, TN 37830.