



Standard Test Method for Measuring Reaction Rates by Analysis of Barium-140 From Fission Dosimeters¹

This standard is issued under the fixed designation E393; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes two procedures for the measurement of reaction rates by determining the amount of the fission product ^{140}Ba produced by the non-threshold reactions $^{235}\text{U}(\text{n},\text{f})$, $^{241}\text{Am}(\text{n},\text{f})$, and $^{239}\text{Pu}(\text{n},\text{f})$, and by the threshold reactions $^{238}\text{U}(\text{n},\text{f})$, $^{237}\text{Np}(\text{n},\text{f})$, and $^{232}\text{Th}(\text{n},\text{f})$.

1.2 These reactions produce many fission products, among which is ^{140}Ba , having a half-life of 12.752 days. ^{140}Ba emits gamma rays of several energies; however, these are not easily detected in the presence of other fission products. Competing activity from other fission products requires that a chemical separation be employed or that the ^{140}Ba activity be determined indirectly by counting its daughter product ^{140}La . This test method describes both procedure (a), the nondestructive determination of ^{140}Ba by the direct counting of ^{140}La several days after irradiation, and procedure (b), the chemical separation of ^{140}Ba and the subsequent counting of ^{140}Ba or its daughter ^{140}La .

1.3 With suitable techniques, fission neutron fluence rates can be measured in the range from $10^7 \text{ n (neutrons)} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$ to approximately $10^{15} \text{ n} \cdot \text{cm}^{-2} \cdot \text{s}^{-1}$.

1.4 The measurement of time-integrated reaction rates with fission dosimeters by ^{140}Ba analysis is limited by the half-life of ^{140}Ba to irradiation times up to about six weeks.

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.*

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.

Current edition approved June 1, 2013. Published July 2013. Originally approved in 1984. Last previous edition approved in 2008 as E393 – 08. DOI: 10.1520/E0393-13.

2. Referenced Documents

2.1 ASTM Standards:²

- C697 Test Methods for Chemical, Mass Spectrometric, and Spectrochemical Analysis of Nuclear-Grade Plutonium Dioxide Powders and Pellets
- 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
- E704 Test Method for Measuring Reaction Rates by Radioactivation of Uranium-238
- E705 Test Method for Measuring Reaction Rates by Radioactivation of Neptunium-237
- 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.

4. Summary of Test Method

4.1 For nondestructive analysis, the fission dosimeter is allowed to cool for five days or more. The 1.596-MeV gamma energy peak of ^{140}La , which is the daughter product of the ^{140}Ba , is then counted. This information, combined with the decay constants for the La and the Ba, and the fission yield of the ^{140}Ba gives the reaction fission rate. When the proper cross

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.