



Standard Test Method for Application and Analysis of Solid State Track Recorder (SSTR) Monitors for Reactor Surveillance, E706(IIIB)¹

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1. Scope

1.1 This test method describes the use of solid-state track recorders (SSTRs) for neutron dosimetry in light-water reactor (LWR) applications. These applications extend from low neutron fluence to high neutron fluence, including high power pressure vessel surveillance and test reactor irradiations as well as low power benchmark field measurement. **(1)** This test method replaces Method E 418. This test method is more detailed and special attention is given to the use of state-of-the-art manual and automated track counting methods to attain high absolute accuracies. In-situ dosimetry in actual high fluence-high temperature LWR applications is emphasized.

1.2 This test method includes SSTR analysis by both manual and automated methods. To attain a desired accuracy, the track scanning method selected places limits on the allowable track density. Typically good results are obtained in the range of 5 to 800 000 tracks/cm² and accurate results at higher track densities have been demonstrated for some cases. **(2)** Track density and other factors place limits on the applicability of the SSTR method at high fluences. Special care must be exerted when measuring neutron fluences ($E > 1\text{MeV}$) above 10^{16} n/cm^2 . **(3)**

1.3 High fluence limitations exist. These limitations are discussed in detail in Section 13 and in references **(3-5)**.

1.4 SSTR observations provide time-integrated reaction rates. Therefore, SSTR are truly passive-fluence detectors. They provide permanent records of dosimetry experiments without the need for time-dependent corrections, such as decay factors that arise with radiometric monitors.

1.5 Since SSTR provide a spatial record of the time-integrated reaction rate at a microscopic level, they can be used for “fine-structure” measurements. For example, spatial distributions of isotopic fission rates can be obtained at very high resolution with SSTR.

1.6 *This standard does not purport to address the safety problems 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 418 Method for Fast-Neutron Measurements by Track-Etch Techniques²

E 844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance, E706 (IIC)³

3. Summary of Test Method

3.1 SSTR are usually placed in firm surface contact with a fissionable nuclide that has been deposited on a pure nonfissionable metal substrate (backing). This typical SSTR geometry is depicted in Fig. 1. Neutron-induced fission produces latent fission-fragment tracks in the SSTR. These tracks may be developed by chemical etching to a size that is observable with an optical microscope. Microphotographs of etched fission tracks in mica, quartz glass, and natural quartz crystals can be seen in Fig. 2.

3.1.1 While the conventional SSTR geometry depicted in Fig. 1 is not mandatory, it does possess distinct advantages for dosimetry applications. In particular, it provides the highest efficiency and sensitivity while maintaining a fixed and easily reproducible geometry.

3.1.2 The track density (that is, the number of tracks per unit area) is proportional to the fission density (that is, the number of fissions per unit area). The fission density is, in turn, proportional to the exposure fluence experienced by the SSTR. The existence of nonuniformity in the fission deposit or the presence of neutron flux gradients can produce non-uniform track density. Conversely, with fission deposits of proven uniformity, gradients of the neutron field can be investigated with very high spatial resolution.

3.2 The total uncertainty of SSTR fission rates is comprised of two independent sources. These two error components arise from track counting uncertainties and fission-deposit mass

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 Discontinued; see 1983 *Annual Book of ASTM Standards*, Vol 12.02.

³ *Annual Book of ASTM Standards*, Vol 12.02.