Designation: E1018 – 26

Standard Guide for Application of ASTM Recommended Cross Section and Associated Nuclear Data File[1]

This standard is issued under the fixed designation E1018; 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 guide covers the establishment and use of an ASTM-recommended file that consists of a set of nuclear data cross sections, uncertainty data, and associated product decay data for analysis of single or multiple sensor measurements in neutron fields related to light water reactor (LWR) pressure vessel surveillance (PVS). These fields include in- and ex-vessel surveillance positions in operating power reactors, benchmark fields, reactor test regions, and research reactors.

1.2 Requirements for establishment of ASTM-recommended cross section files address data format, evaluation requirements, validation in benchmark fields, evaluation of error estimates (covariance file), and documentation. A further requirement for components of the ASTM-recommended cross section file is their internal consistency when combined with sensor measurements and used to determine a neutron spectrum through such approaches as a least squares spectrum adjustment.

1.3 Specifications for use include: identification of the energy region of applicability, data processing requirements, and application of uncertainties.

1.4 This guide is directly related to and should be used primarily in conjunction with Guides E482 and E944, and with Practices E185 and E693.

1.5 The ASTM-recommended file for cross sections, uncertainty data, and associated product decay data represents a generally available data set for use in sensor set analysis. However, the availability of this data set does not preclude the use of other validated nuclear data, either proprietary or nonproprietary. When alternate cross section files that deviate from the requirements laid out in this standard are used, the deviations should be noted to the customer of the dosimetry application.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E170 Terminology Relating to Radiation Measurements and Dosimetry

E185 Practice for Design of Surveillance Programs for Light-Water Moderated Nuclear Power Reactor Vessels

E482 Guide for Application of Neutron Transport Methods for Reactor Vessel Surveillance

E693 Practice for Characterizing Neutron Exposures in Iron and Low Alloy Steels in Terms of Displacements Per Atom (DPA)

E844 Guide for Sensor Set Design and Irradiation for Reactor Surveillance

E853 Practice for Analysis and Interpretation of Light-Water Reactor Surveillance Neutron Exposure Results

E854 Test Method for Application and Analysis of Solid-State Track Recorder (SSTR) Monitors for Reactor Surveillance (Withdrawn 2025)[3]

E910 Test Method for Application and Analysis of Helium Accumulation Fluence Monitors for Reactor Vessel Surveillance

E944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance

E1005 Test Method for Application and Analysis of Radiometric Monitors for Reactor Vessel Surveillance

E2005 Guide for Benchmark Testing of Reactor Dosimetry

[1] This guide 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, 2026. Published June 2026. Originally approved in 1984. Last previous edition approved in 2020 as E1018 – 20. DOI: 10.1520/E1018-26.

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

[3] The last approved version of this historical standard is referenced on www.astm.org.

in Standard and Reference Neutron Fields

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *benchmark field*—a limited number of neutron fields have been identified as benchmark fields for the purpose of dosimetry sensor calibration and dosimetry cross section data development and testing (**1, 2**).[4] See Terminology E170. These fields were permanent facilities in which experiments could be repeated. In addition, differential neutron spectrum measurements have been performed in many of the fields to provide, together with transport calculations and integral measurements, the best state-of-the-art neutron spectrum evaluation. To supplement the data available from benchmark fields, most of which are limited in fluence rate intensity, reactor test regions for dosimetry method validation have also been defined, including both in-reactor and ex-vessel dosimetry positions. Table 1 lists some of the neutron fields that have been used for data development, testing, and evaluation. Many of these fields may not be available any longer, but new nuclear data files are still validated against the historical measurements made in these fields. Other benchmark fields used for testing LWR calculations are described in Guide E2005.

3.1.1.1 *standard field*—these fields are produced by facilities and apparatus that are stable, permanent, and whose fields are reproducible with neutron fluence rate intensity, energy spectra, and angular fluence rate distributions characterized to state-of-the-art accuracy. Important standard field quantities must be verified by interlaboratory measurements. These fields typically exist at the National Institute of Standards and Technology (NIST) and other national laboratories.

3.1.1.2 *reference field*—these fields are produced by facilities and apparatus that are permanent and whose fields are reproducible, less well characterized than a standard field, but acceptable as a measurement reference by the community of users.

3.1.1.3 *controlled environment*—these environments are well-defined neutron fields with some spectral definitions, employed for a restricted set of validation experiments over a range of energies.

3.1.2 *dosimetry cross sections*—cross sections used for dosimetry applications and which provide the cross section for production of particular (measurable) reaction products. These include fission cross sections for production of fission products, activation cross sections for the production of radioactive nuclei, and cross sections for production of measurable stable products, such as helium.

3.1.3 *evaluated data*—values of physical quantities representing a current best estimate. Such estimates are developed by experts considering measurements or calculations of the quantity of interest, or both. Cross section evaluations, for example, are conducted by teams of scientists such as the ENDF/B Cross Section Evaluation Working Group (CSEWG) (see also 4.1).

3.1.4 *Evaluated Nuclear Data File (ENDF)*—refers to a file that captures the neutron cross sections and other nuclear data evaluated from available experimental measurements (**15**) and calculations. Various compilations of evaluated nuclear data are released by various groups. The current standard format is designated as ENDF-6 (**16**), but a new more general data library format, GNDS, is being developed to support future library releases (**17**).

3.1.4.1 *ENDF/B files*—evaluated files officially approved by CSEWG. See format document ENDF-102 available at the CSEWG website (**18**) after suitable review and testing. The

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

TABLE 1 Partial List of Characterized Neutron Fields Used for Validating Dosimetry Cross Sections

Neutron Field	Sample Facility Location	Energy		Useful Energy Range for Data Testing[A]	Reference Documentation
		Median	Average		
		Standard Fields			
Thermal Maxwellian	NIST	...	...	<0.51 eV	
^{252}Cf(s.f.) Fission	NIST (**3**)	1.68 MeV	2.13 MeV	100 keV–8 MeV	Ref (**3**) Designation XCF-5-N1
^{235}U Thermal Fission	NIST (**3**) Mol-χ_{25} (**4**, **5**)	1.57 MeV	1.97 MeV	250 keV–3 MeV	Ref (**3**) Designation XU5-5-N1
ISNF	NIST (**6**) NISUS (**7**) Mol-$\sum\sum$ (**8**)	0.56 MeV	~1.0 MeV	10 keV–3.5 MeV	Ref (**3**) Designation ISNF(5)-1-L1
		Reference Fields			
BIG TEN	LANL (**9**, **10**)	0.33 MeV	0.58 MeV	10 keV–3 MeV	Ref (**9**) Fast Reactor Benchmark 20
CFRMF	INL (**9**, **11**)	0.375 MeV	0.76 MeV	4 keV–2.5 MeV	Ref (**9**) Dosimetry Benchmark 1
		Controlled Environments			
PCA-PV	ORNL (**12**)	...	...	100 keV–10 MeV	Ref (**12**)
EBR-II	INL (**13**)	...	...	1 keV–10 MeV	Ref (**13**)
FFTF	HEDL (**14**)	...	...	1 keV–10 MeV	Ref (**14**)

[A] The requirements for the data testing energy range are much stricter for reference and standard fields than for controlled fields. These testing energy ranges reflect comparison with calculations based on published spectra for reference and standard fields, but only address data reproducibility for controlled environments.