



Designation: E693 – 12^{ε1}

Standard Practice for Characterizing Neutron Exposures in Iron and Low Alloy Steels in Terms of Displacements Per Atom (DPA)¹

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^{ε1} NOTE—The title of this practice was updated editorially in May 2017.

1. Scope

1.1 This practice describes a standard procedure for characterizing neutron irradiations of iron (and low alloy steels) in terms of the exposure index displacements per atom (dpa) for iron.

1.2 Although the methods of this practice apply to any material for which a displacement cross section $\sigma_d(E)$ is known (see Practice E521), this practice is written specifically for iron.

1.3 It is assumed that the displacement cross section for iron is an adequate approximation for calculating displacements in steels that are mostly iron (95 to 100 %) in radiation fields for which secondary damage processes are not important.

1.4 Procedures analogous to this one can be formulated for calculating dpa in charged particle irradiations. (See Practice E521.)

1.5 The application of this practice requires knowledge of the total neutron fluence and flux spectrum. Refer to Practice E521 for determining these quantities.

1.6 The correlation of radiation effects data is beyond the scope of this practice.

1.7 *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.*

1.8 *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.*

¹ This practice 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. Referenced Documents

2.1 ASTM Standards:²

E170 Terminology Relating to Radiation Measurements and Dosimetry

E521 Practice for Investigating the Effects of Neutron Radiation Damage Using Charged-Particle Irradiation

E821 Practice for Measurement of Mechanical Properties During Charged-Particle Irradiation

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

3. Terminology

3.1 Definitions for terms used in this practice can be found in Terminology E170.

4. Significance and Use

4.1 A pressure vessel surveillance program requires a methodology for relating radiation-induced changes in materials exposed in accelerated surveillance locations to the condition of the pressure vessel (see Practice E853). An important consideration is that the irradiation exposures be expressed in a unit that is physically related to the damage mechanisms.

4.2 A major source of neutron radiation damage in metals is the displacement of atoms from their normal lattice sites. Hence, an appropriate damage exposure index is the number of times, on the average, that an atom has been displaced during an irradiation. This can be expressed as the total number of displaced atoms per unit volume, per unit mass, or per atom of the material. Displacements per atom is the most common way of expressing this quantity. The number of dpa associated with a particular irradiation depends on the amount of energy deposited in the material by the neutrons, and hence, depends on the neutron spectrum. (For a more extended discussion, see Practice E521.)

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.