Designation: E 525 – 90 (Reapproved 1996)

Standard Practice for Reporting Dosimetry Results on Nuclear Graphite[1]

This standard is issued under the fixed designation E 525; 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 practice covers procedures for determining and reporting the neutron fluence rate and fluence for the correlation of radiation-induced changes in nuclear graphites.

1.2 The purpose of this practice is to achieve better correlation and interpretation of new data in the field of radiation effects testing of specimens of graphites to be used for moderator or reflector components of fission reactors.

1.3 Excluded from this practice are graphite test specimens containing fissionable materials and specimens containing materials having high neutron cross sections.

2. Referenced Documents

2.1 *ASTM Standards:*

C 625 Practice for Reporting Irradiation Results on Graphite[2]

E 261 Practice for Determining Neutron Fluence Rate, Fluence, and Spectra by Radioactivation Techniques[3]

E 944 Guide for Application of Neutron Spectrum Adjustment Methods in Reactor Surveillance, (IIA)[3]

E 1018 Guide for Application of ASTM Evaluated Cross Section Data File (ENDF/A), E 706(IIB)[3]

3. Significance and Use

3.1 Practice C 625 covers information recommended for inclusion in reports giving graphite irradiation results, with the exception of neutron dosimetry results.

3.2 It is well documented **(1,2,3)**[4] that mechanical properties, physical properties, and physical dimensions of graphites are altered by exposure to high-energy neutron radiation and that the amount, rate, and energy spectrum of the radiation influences the magnitude and relationship of the changes.

3.3 It is also well documented **(4,5,6)** that graphite irradiation results obtained at different dose rates or different energy spectra, or both, can be adequately correlated through the use of appropriate atomic displacement functions. The function that is most widely used for the correlation and interpretation of graphite irradiation results is that developed by Thompson and Wright **(7)**.

4. Exposure Unit for Graphite Irradiations

4.1 The "Equivalent Fission Fluence for Damage in Graphite," Φ_G, is defined as follows:

$$\Phi_G = \frac{\int_0^\infty \int_{t_1}^{t_2} \sigma_s(E)p(E)\phi(E,t)\mathrm{d}t\mathrm{d}E}{\int_0^\infty \sigma(E)p(E)\chi(E)\mathrm{d}E / \int_0^\infty \chi(E)\mathrm{d}E} \quad (1)$$

where:

$\phi(E, t)$ = neutron fluence rate spectrum at time t,
$\sigma_s(E)$ = scattering cross section of carbon as a function of neutron energy,
$p(E)$ = atomic displacement weighting function,
$\chi(E)$ = spectrum for primary fission neutrons, and
$t_2 - t_1$ = duration of the irradiation test.

4.2 The two principal methods for obtaining neutron fluence rate spectra are: (*1*) calculations using reactor physics codes **(8, 9)**, and (*2*) computer-iterative techniques (see Guide E 944) using activation data from many different neutron detector materials, simultaneously irradiated in the reactor facility. It is recommended that spectra obtained by either method be checked by the activation of monitors having significantly different response functions.

4.2.1 The response function, $R(E)$, of an activation monitor is defined as follows:

$$R(E) = \sigma_a(E)\phi(E) / \int_0^\infty \sigma_a(E)\phi(E)\mathrm{d}E \quad (2)$$

where:

$\sigma_a(E)$ = activation cross section as a function of neutron energy, and
$\phi(E)$ = fluence spectrum at the measurement location.

4.2.2 Other considerations are discussed in Practice E 261 and other methods covering the use of individual detectors.

4.3 It is recommended that the fission spectrum, $\chi(E)$, the scattering cross section $\sigma_s(E)$ used in evaluating Eq 1, and all cross sections used in the evaluation of the neutron fluence spectrum, be processed from the most recent edition of the Evaluated Nuclear Data File (**10,** Guide E 1018).

4.4 An acceptable form of the atomic displacement weighting function $p(E)$ for evaluation of Eq 1 is the Thompson and Wright function. Group averaged values for this function are listed in Table 1 in the GAM-II energy group structure. Other

[1] This practice is under the jurisdiction of ASTM Committee E-10 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 15.01.

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

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