



Standard Practice for Analysis of Spent Nuclear Fuel to Determine Selected Isotopes and Estimate Fuel Burnup¹

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1. Scope

1.1 A sample of spent nuclear fuel is analyzed to determine the quantity and atomic ratios of uranium and plutonium isotopes, neodymium isotopes, and selected gamma-emitting nuclides (^{137}Cs , ^{134}Cs , ^{154}Eu , ^{106}Ru , and ^{241}Am). Fuel burnup is calculated from the ^{148}Nd -to-fuel ratio as described in this method, which uses an effective ^{148}Nd fission yield calculated from the fission yields of ^{148}Nd for each of the fissioning isotopes weighted according to their contribution to fission as obtained from this method. The burnup value determined in this way requires that values be assumed for certain reactor-dependent properties called for in the calculations (1, 2).²

1.2 Error associated with the calculated burnup values is discussed in the context of contributions from random and potential systematic error sources associated with the measurements and from uncertainty in the assumed reactor-dependent variables. Uncertainties from the needed assumptions are shown to be larger than uncertainties from the isotopic measurements, with the largest effect arising from the value of the fast fission factor. Using this factor will provide the most consistent burnup value between calculated changes in heavy element isotopic composition.

1.3 This standard practice contains explanatory notes that are not part of the mandatory portion of the standard.

1.4 The values stated in SI units are to be regarded as the standard. Mathematical equivalents are given in parentheses.

1.5 *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 practice is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.05 on Methods of Test.

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² The boldface numbers in parentheses refer to a list of references at the end of this standard.

2. Referenced Documents

2.1 ASTM Standards:³

C1625 Test Method for Uranium and Plutonium Concentrations and Isotopic Abundances by Thermal Ionization Mass Spectrometry

C859 Terminology Relating to Nuclear Materials

D1193 Specification for Reagent Water

E244 Test Method for Atom Percent Fission in Uranium and Plutonium Fuel (Mass Spectrometric Method) (Withdrawn 2001)⁴

3. Terminology

3.1 *Definitions*—For definitions of other standard terms in this practice, refer to Terminology C859.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *gigawatt days per metric ton*—the gigawatt days of heat produced per metric ton of uranium plus plutonium initially present in a nuclear fuel.

3.2.2 *heavy element atom percent fission*—the number of fissions per 100 uranium plus plutonium atoms initially present in a nuclear fuel.

3.3 *Symbols*: Symbols used in the procedural equations are defined as follows:

3.3.1 F_5 , F_9 , F_I , F_8 —heavy element atom percent fission from fission ^{235}U , ^{239}Pu , ^{241}Pu , and ^{238}U .

3.3.2 F_T —total heavy element atom percent fission.

3.3.3 F_8^0 , N_5^0 —heavy element atom percent ^{238}U and ^{235}U in the pre-irradiated fuel.

3.3.4 $R_{5/8}^0$, $R_{9/8}^0$, $R_{I/8}^0$ —atom ratios of ^{235}U to ^{238}U , ^{236}U to ^{238}U , and ^{236}U to ^{235}U in the pre-irradiated fuel.

3.3.5 $R_{5/8}$, $R_{9/8}$, $R_{I/8}$ —atom ratios of ^{235}U to ^{238}U , ^{236}U to ^{238}U , and ^{236}U to ^{235}U in the final irradiated sample.

3.3.6 $R_{5/8}$, $R_{9/8}$, $R_{I/8}$ —atom ratios of ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{242}Pu and to ^{238}U in the final irradiated sample.

³ 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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.