Designation: D7727 – 21

Standard Practice for Calculation of Dose Equivalent Xenon (DEX) for Radioactive Xenon Fission Products in Reactor Coolant[1]

This standard is issued under the fixed designation D7727; 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 applies to the calculation of the dose equivalent to ^{133}Xe in the reactor coolant of nuclear power reactors resulting from the radioactivity of all noble gas fission products.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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.*

1.4 *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]

D3648 Practices for the Measurement of Radioactivity

D7282 Practice for Set-up, Calibration, and Quality Control of Instruments Used for Radioactivity Measurements

D7902 Terminology for Radiochemical Analyses

3. Terminology

3.1 *Definitions:*

3.1.1 *dose-equivalent Xe-133 (DEX), n*—shall be that ^{133}Xe concentration (microcuries per gram) that alone would produce the same acute dose to the whole body as the combined activities of noble-gas nuclides ^{85m}Kr, ^{85}Kr, ^{87}Kr, ^{88}Kr, ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, and ^{138}Xe actually present.

3.1.1.1 *Discussion*—This is the general definition of DEX. Each utility may have adopted modifications to this definition through agreement with the U.S. Nuclear Regulatory Commission (U.S. NRC). The definition as approved for each utility by the U.S. NRC is the one that should be applied to the calculations in this practice.

4. Summary of Practice

4.1 A sample of fresh reactor coolant is analyzed for noble gas activities using gamma-ray spectrometry. The individual activity of each detectable radioactive fission gas is divided by a factor that normalizes its dose to that of ^{133}Xe. This practice replaces the previous practice of calculating the reactor coolant $\bar{E}$ calculation when allowed by the plant's revised technical specifications. The quantity DEX is acceptable from a radiological dose perspective since it will result in a limiting condition of operation (LCO) that more closely relates the non-iodine RCS activity limits to the dose consequence analyses which form their bases.

NOTE 1—It is incumbent on the licensee to ensure that the dose conversion factors (DCFs) used in the determination of DEX are consistent with the DCFs used in the applicable dose consequence analysis used by the plant in their dose calculation manual for radioactive releases.

5. Significance and Use

5.1 Each power reactor has a specific DEX value that is their technical requirement limit. These values may vary from about 200 to about 900 μCi/g based upon the height of their plant vent, the location of the site boundary, the calculated reactor coolant activity for a condition of 1 % fuel defects, and general atmospheric modeling that is ascribed to that particular plant site. Should the DEX measured activity exceed the technical requirement limit, the plant enters an LCO requiring action on plant operation by the operators.

5.2 The determination of DEX is performed in a similar manner to that used in determining DEI, except that the calculation of DEX is based on the acute dose to the whole body and considers the noble gases ^{85m}Kr, ^{85}Kr, ^{87}Kr, ^{88}Kr, ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, and ^{138}Xe which are significant in terms of contribution to whole body dose.

[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.04 on Methods of Radiochemical Analysis.

Current edition approved Dec. 15, 2021. Published January 2022. Originally approved in 2011. Last previous edition approved in 2016 as D7727 – 11 (2016). DOI: 10.1520/D7727-21.

[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.