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Standard Practice for Thermal Qualification of Type B Packages for Radioactive Material[1]

This standard is issued under the fixed designation E2230; 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 defines detailed methods for thermal qualification of "Type B" radioactive materials packages under Title 10, Code of Federal Regulations, Part 71 (10CFR71) in the United States or, under International Atomic Energy Agency Regulation SSR-6. Under these regulations, packages transporting what are designated to be Type B quantities of radioactive material shall be demonstrated to be capable of withstanding a sequence of hypothetical accidents without significant release of contents.

1.2 The unit system (SI metric or English) used for thermal qualification shall be agreed upon prior to submission of information to the certification authority. If SI units are to be standard, then use IEEE/ASTM SI-10. Additional units given in parentheses are for information purposes only.

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 standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.5 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.6 *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]

E176 Terminology of Fire Standards

IEEE/ASTM SI-10 International System of Units (SI) The Modernized Metric System

2.2 *Federal Standard:*

Title 10, Code of Federal Regulations, Part 71 (10CFR71), *Packaging and Transportation of Radioactive Material*, United States Government Printing Office, October 1, 2004

2.3 *Nuclear Regulatory Commission Standards:*

Standard Format and Content of Part 71 Applications for Approval of Packaging of Type B Large Quantity and Fissile Radioactive Material, Regulatory Guide 7.9, United States Nuclear Regulatory Commission, United States Government Printing Office, 1986

2.4 *International Atomic Energy Agency Standards:*

Regulations for the Safe Transport of Radioactive Material, No. SSR-6 (IAEA SSR-6 Revised) International Atomic Energy Agency, Vienna, Austria, 2018

Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition), No. SSG-26, (IAEA SSG-26) International Atomic Energy Agency, Vienna, Austria, 2014

2.5 *American Society of Mechanical Engineers Standard:*

Quality Assurance Program Requirements for Nuclear Facilities, NQA-1, American Society of Mechanical Engineers, New York, 2001

2.6 *International Organization for Standards (ISO) Standard:*

ISO 9000:2000, Quality Management Systems—Fundamentals and Vocabulary, International Organization for Standards (ISO), Geneva, Switzerland, 2000

ISO 13943 Fire Safety – Vocabulary, International Organization for Standards (ISO), Geneva, Switzerland, 2017

[1] This practice is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.13 on Spent Fuel and High Level Waste.

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[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.

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to the terminology contained in Terminology E176 and ISO 13943 (Fire Safety – Vocabulary). In case of conflict between Terminology E176 and ISO 13943, the definitions given in Terminology E176 shall prevail.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *hypothetical accident conditions, n*—a series of accident environments, defined by regulation, that a Type B package must survive without significant loss of contents.

3.2.2 *insolation, n*—solar energy incident on the surface of a package.

3.2.3 *normal conditions of transport, n*—a range of conditions, defined by regulation, that a package must withstand during normal usage.

3.2.4 *regulatory hydrocarbon fire, n*—a fire environment, one of the hypothetical accident conditions, defined by regulation, that a package shall survive for 30 min without significant release of contents.

3.2.5 *thermal qualification, n*—the portion of the certification process for a radioactive materials transportation package that includes the submittal, review, and approval of a Safety Analysis Report for Packages (SARP) through an appropriate regulatory authority, and which demonstrates that the package meets the thermal requirements stated in the regulations.

3.2.6 *Type B package, n*—a transportation package that is licensed to carry what the regulations define to be a Type B quantity of a specific radioactive material or materials.

4. Summary of Practice

4.1 This document outlines four methods for meeting the thermal qualification requirements: qualification by analysis, pool fire testing, furnace testing, and radiant heat testing. The choice of the certification method for a particular package is based on discussions between the package suppliers and the appropriate regulatory authorities prior to the start of the qualification process. Factors that influence the choice of method are package size, construction and cost, as well as hazards associated with certification process. Environmental factors such as air and water pollution are increasingly a factor in choice of qualification method. Specific benefits and limitations for each method are discussed in the sections covering the particular methods.

4.2 The complete hypothetical accident condition sequence consists of a drop test, a puncture test, and a 30-min hydrocarbon fire test, commonly called a pool fire test, on the package. Submersion tests on undamaged packages are also required, and smaller packages are also required to survive crush tests that simulate handling accidents. Details of the tests and test sequences are given in the regulations cited. This document focuses on thermal qualification, which is similar in both the U.S. and IAEA regulations. A summary of important differences is included as Appendix X3 to this document. The overall thermal test requirements are described generally in Part 71.73 of 10CFR71 and in Section VII of SSR-6. Additional guidance on thermal tests is also included in IAEA SSG-26.

4.3 The regulatory thermal test is intended to simulate a 30-min exposure to a fully engulfing pool fire that occurs if a transportation accident involves the spill of large quantities of hydrocarbon fuels from a tank truck or similar vehicle. The regulations are “mode independent” meaning that they are intended to cover packages for a wide range of transportation modes such as truck and rail.

5. Significance and Use

5.1 The major objective of this practice is to provide a common reference document for both applicants and certification authorities on the accepted practices for accomplishing package thermal qualification. Details and methods for accomplishing qualification are described in this document in more specific detail than available in the regulations. Methods that have been shown by experience to lead to successful qualification are emphasized. Possible problems and pitfalls that lead to unsatisfactory results are also described.

5.2 The work described in this standard practice shall be done under a quality assurance program that is accepted by the regulatory authority that certifies the package for use. For packages certified in the United States, 10 CFR 71 Subpart H shall be used as the basis for the quality assurance (QA) program, while for international certification, ISO 9000 usually defines the appropriate program. The quality assurance program shall be in place and functioning prior to the initiation of any physical or analytical testing activities and prior to submittal of any information to the certifying authority.

TEST METHODS

6. General Information

6.1 In preparing a Safety Analysis Report for Packaging (SARP), the normal transport and accident thermal conditions specified in 10CFR71 or IAEA SSR-6 shall be addressed. For approval in the United States, reports addressing the thermal issues shall be included in a SARP prepared according to the format described in Nuclear Regulatory Commission (NRC) Regulatory Guide 7.9. Upon review, a package is considered qualified if material temperatures are within acceptable limits, temperature gradients lead to acceptable thermal stresses, the cavity gas pressure is within design limits, and safety features continue to function over the entire temperature range. Test initial conditions vary with regulation, but are intended to give the most unfavorable normal ambient temperature for the feature under consideration, and corresponding internal pressures are usually at the maximum normal values unless a lower pressure is shown to be more unfavorable. Depending on the regulation used, the ambient air temperature is in the –29 °C (–20 °F) to 38 °C (100 °F) range. Normal transport requirements include a maximum air temperature of 38°C (100°F), insolation, and a cold temperature of –40 °C (–40 °F). Regulations also include a maximum package surface temperatures for personnel protection of 50 °C (122 °F). See Appendix X3 for clarification of differences between U.S. and international regulations.

6.2 Hypothetical accident thermal requirements stated in Part 71.73 or IAEA SSR-6, Section VII call for a 30 min