Designation: C1562 – 10 (Reapproved 2018)

Standard Guide for Evaluation of Materials Used in Extended Service of Interim Spent Nuclear Fuel Dry Storage Systems[1]

This standard is issued under the fixed designation C1562; 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 Part of the total inventory of commercial spent nuclear fuel (SNF) is stored in dry cask storage systems (DCSS) under licenses granted by the U.S. Nuclear Regulatory Commission (NRC). The purpose of this guide is to provide information to assist in supporting the renewal of these licenses, safely and without removal of the SNF from its licensed confinement, for periods beyond those governed by the term of the original license. This guide provides information on materials behavior under conditions that may be important to safety evaluations for the extended service of the renewal period. This guide is written for DCSS containing light water reactor (LWR) fuel that is clad in zirconium alloy material and stored in accordance with the Code of Federal Regulations (CFR), at an independent spent-fuel storage installation (ISFSI).[2] The components of an ISFSI, addressed in this document, include the commercial SNF, canister, cask, and all parts of the storage installation including the ISFSI pad. The language of this guide is based, in part, on the requirements for a dry SNF storage license that is granted, by the U.S. Nuclear Regulatory Commission (NRC), for up to 20 years. Although government regulations may differ for various nations, the guidance on materials properties and behavior given here is expected to have broad applicability.

1.2 This guide addresses many of the factors affecting the time-dependent behavior of materials under ISFSI service [10 CFR Part 72.42]. These factors are those regarded to be important to performance, in license extension, beyond the currently licensed 20-year period. Examples of these factors are given in this guide and they include materials alterations or environmental conditions for components of an ISFSI system that, over time, could have significance related to safety. For purposes of this guide, a license period of an additional 20 to 80 years is assumed.

1.3 This guide addresses the determination of the conditions of the spent fuel and storage cask materials at the end of the initial 20-year license period as the result of normal events and conditions. However, the guide also addresses the analysis of potential spent fuel and cask materials degradation as the result of off-normal, and accident-level events and conditions that may occur during any period.

1.4 This guide provides information on materials behavior to support continuing compliance with the safety criteria, which are part of the regulatory basis, for licensed storage of SNF at an ISFSI. The safety functions addressed and discussed in this standard guide include thermal performance, radiological protection, confinement, sub-criticality, and retrievability. The regulatory basis includes 10 CFR Part 72 and supporting regulatory guides of the U.S. Nuclear Regulatory Commission. The requirements set forth in these documents indicate that the following items were considered in the original licensing decisions: properties of materials, design considerations for normal and off-normal service, operational and natural events, and the bases for the original calculations. These items may require reconsideration of the safety-related arguments that demonstrate how the systems continue to satisfy the regulatory requirements. Further, to ensure continued safe operation, the performance of materials must be justified in relation to the effects of time, temperature, radiation field, and environmental conditions of normal and off-normal service. Arguments for long-term performance must account for materials alterations (especially degradations) that are expected during the service periods, which include the periods of the initial license and of the license renewal. This guide pertains only to structures, systems, and components important to safety during extended storage period and during retrieval functions, including transport and transfer operations. Materials information that pertains to safety functions, including retrieval functions, is pertinent to current regulations and to license renewal process, and this information is the focus of the guide. This guide is not intended to supplant the existing regulatory process.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

[1] This guide 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] In general fuels of higher burnup (>45 MWd/kgU) and MOX fuels are not included in this guide. Guidance for these fuels are expected to be included in an Annex to be written later.

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:*[3]

C33/C33M Specification for Concrete Aggregates

C227 Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)

C295/C295M Guide for Petrographic Examination of Aggregates for Concrete

C859 Terminology Relating to Nuclear Materials

C1174 Practice for Evaluation of the Long-Term Behavior of Materials Used in Engineered Barrier Systems (EBS) for Geological Disposal of High-Level Radioactive Waste

2.2 *Government Documents:*[4]

10 CFR Part 50 Domestic Licensing of Production and Utilization Facilities

10 CFR Part 60 Disposal of High Level Radioactive Wastes in Geologic Repositories

10 CFR Part 63 Disposal of High Level Radioactive Wastes in a Proposed Geologic Repository in Yucca Mountain

10 CFR Part 71 Packaging and Transport of Radioactive Materials

10 CFR Part 72 Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste

2.3 *NUREG Standards:*[5]

NUREG-1536 Standard Review Plan for Dry Storage Cask Systems, January 1997

NUREG-1567 Standard Review Plan for Spent Fuel Dry Storage Facilities, Report, January 1998

NUREG-1571 Information Handbook on Independent Spent Fuel Storage Installations

NUREG/CR-6407 Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety, February, 1996, INEL Report 95/0551

ISG-1 Interim Staff Guidance Number 1, U.S. NRC, Spent Fuel Project Office

2.4 *American Concrete Institute Standards:*[6]

ACI 201.2R-97 Guide to Durable Concrete

ACI 209R-97 Prediction of Creep, Shrinkage and Temperature Effects in Concrete Structures

ACI 301-99 Building Code Requirements for Reinforced Concrete

ACI 318-02 Building Code Requirements for Reinforced Concrete

ACI 349-00 Code Requirements for Nuclear Safety Related Concrete Structures

ACI 359-01 Code for Concrete Reactor Vessels and Containments, also designated as ASME Boiler and Pressure Vessel Code, Section III, Div 2, Code for Concrete Reactor Vessels and Containments

2.5 *ANSI Documents:*[7]

ANSI/ANS-6.4-1985 Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants

ANSI/ANS-57.9 Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)

ANSI/ANS-57.10 Design Criteria for Consolidation of LWR Spent Fuel

2.6 *Other Documents:*

ASME-B&PV Sect III-Div 2 (2001) Code for Concrete Reactor Vessels and Containments[8]

EPRI-1994 Class I Structures License Renewal Industry Report; Revision 1, TR-103842, July 1994[9]

3. Terminology

3.1 The terminology of Terminology C859 applies to this document except as given below.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accident-level events or conditions*—the extreme level of an event or condition for which there is a specified resistance, limit of response, and requirement for a given level of continuing capability, which exceed "off-normal" events or conditions. They include both design basis accidents and design-basis for natural phenomena events and conditions. **NUREG-1536, NUREG-1567**

NOTE 1—Specific accident conditions to be addressed have been evaluated for each dry cask storage system (DCSS) and are documented in a Safety Analysis Report for that system.

3.2.2 *alteration mode*—a particular form of alteration, for example, general corrosion, passivation. **C1174**

3.2.3 *ASTM guide*—a compendium of information or series of options that does not recommend a specific course of action.

3.2.4 *canister—in a dry cask storage system (DCSS) for spent nuclear fuel*, a metal cylinder that is sealed at both ends and is used to perform the function of confinement, while a separate overpack performs the functions of shielding and protection of the canister from the effects of impact loading.

3.2.5 *cask—in a dry cask storage system (DCSS) for spent nuclear fuel*, a stand-alone device that performs the functions of confinement, radiological shielding, and physical protection of spent fuel during normal, off-normal, and accident conditions. **NUREG-1571**

3.2.6 *certificate of compliance—in a dry cask storage system (DCSS) for spent nuclear fuel*, a certificate issued by the

[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] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

[5] Available from National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, http://www.ntis.gov.

[6] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

[7] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[8] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[9] Available from Electric Power Research Institute (EPRI), 3512 Hillview Ave., Palo Alto, CA 94304–1395.