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Standard Guide for Design, Fabrication, and Installation of Nuclear Fuel Dissolution Facilities[1]

This standard is issued under the fixed designation C1062; 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 It is the intent of this guide to set forth criteria and procedures for the design, fabrication and installation of nuclear fuel dissolution facilities. This guide applies to and encompasses all processing steps or operations beyond the fuel shearing operation (not covered), up to and including the dissolving accountability vessel.

1.2 *Applicability and Exclusions:*

1.2.1 *Operations*—This guide does not cover the operation of nuclear fuel dissolution facilities. Some operating considerations are noted to the extent that these impact upon or influence design.

1.2.1.1 *Dissolution Procedures*—Fuel compositions, fuel element geometry, and fuel manufacturing methods are subject to continuous change in response to the demands of new reactor designs and requirements. These changes preclude the inclusion of design considerations for dissolvers suitable for the processing of all possible fuel types. This guide will only address equipment associated with dissolution cycles for those fuels that have been used most extensively in reactors as of the time of issue (or revision) of this guide. (See Appendix X1.)

1.2.2 *Processes*—This guide covers the design, fabrication and installation of nuclear fuel dissolution facilities for fuels of the type currently used in Pressurized Water Reactors (PWR). Boiling Water Reactors (BWR), Pressurized Heavy Water Reactors (PHWR) and Heavy Water Reactors (HWR) and the fuel dissolution processing technologies discussed herein. However, much of the information and criteria presented may be applicable to the equipment for other dissolution processes such as for enriched uranium-aluminum fuels from typical research reactors, as well as for dissolution processes for some thorium and plutonium-containing fuels and others. The guide does not address equipment design for the dissolution of high burn-up or mixed oxide fuels.

1.2.2.1 This guide does not address special dissolution processes that may require substantially different equipment or pose different hazards than those associated with the fuel types noted above. Examples of precluded cases are electrolytic dissolution and sodium-bonded fuels processing. The guide does not address the design and fabrication of continuous dissolvers.

1.2.3 Ancillary or auxiliary facilities (for example, steam, cooling water, electrical services) are not covered. Cold chemical feed considerations are addressed briefly.

1.2.4 *Dissolution Pretreatment*—Fuel pretreatment steps incidental to the preparation of spent fuel assemblies for dissolution reprocessing are not covered by this guide. This exclusion applies to thermal treatment steps such as "Voloxidation" to drive off gases prior to dissolution, to mechanical decladding operations or process steps associated with fuel elements disassembly and removal of end fittings, to chopping and shearing operations, and to any other pretreatment operations judged essential to an efficient nuclear fuels dissolution step.

1.2.5 *Fundamentals*—This guide does not address specific chemical, physical or mechanical technology, fluid mechanics, stress analysis or other engineering fundamentals that are also applied in the creation of a safe design for nuclear fuel dissolution facilities.

1.3 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.

1.4 *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.*

2. Referenced Documents

2.1 *Industry and National Consensus Standards*—Industry and national consensus standards applicable in whole or in part to the design, fabrication, and installation of nuclear fuel dissolution facilities are referenced throughout this guide and include the following:

[1] This guide is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.09 on Nuclear Processing.

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2.2 *ASTM Standards:*[2]

C1010 Guide for Acceptance, Checkout, and Pre-Operational Testing of a Nuclear Fuels Reprocessing Facility (Withdrawn 2001)[3]

C1217 Guide for Design of Equipment for Processing Nuclear and Radioactive Materials

2.3 *ASME Standards:*[4]

ASME Boiler and Pressure Vessel Code, Sections II, V, VIII, and IX

ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications

2.4 *ANS Standard:*[5]

ANS Glossary of Terms in Nuclear Science and Technology (ANS Glossary)

ANS 8.1 Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

ANS 8.3 Criticality Accident Alarm System

ANS 8.9 Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials

ANS 57.8 Fuel Assembly Identification

2.5 *Federal Regulations*[6]—Federal Regulations that are specifically applicable in whole or in part to the design, fabrication, and installation of nuclear fuel dissolution facilities include the following:

10 CFR 50 Licensing of Production and Utilization Facilities

10 CFR 50, App B Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants

2.6 *This guide does not purport to list all standards, codes, and/or federal regulations that may apply to nuclear fuel dissolution facilities design.*

3. Terminology

3.1 *General:*

3.1.1 The terminology used in this guide is intended to conform with industry practice insofar as is practicable, but the following terms are of a restricted nature, specifically applicable to this guide. Other terms and their definitions are contained in the ANS Glossary.

3.1.2 *shall, should, and may*—The word "shall" denotes a requirement, the word "should" denotes a recommendation and the word "may" indicates permission, neither a requirement nor a recommendation. In order to conform with this guide, all actions or conditions shall be in accordance with its requirements but they need not conform with its recommendations.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accident*—an unplanned event that could result in unacceptable levels of any of the following:

3.2.1.1 equipment damage,

3.2.1.2 injury to personnel,

3.2.1.3 downtime or outage,

3.2.1.4 release of hazardous materials (radioactive or non-radioactive).

3.2.1.5 radiation exposure to personnel, and

3.2.1.6 criticality.

3.2.2 *accountability*—the keeping of records on and the responsibility associated with being accountable for the amount of fissile materials entering and leaving a plant, a location, or a processing step.

3.2.3 *basic data*—the fundamental chemical, physical, and mathematical values, formulas, and principles, and the definitive criteria that have been documented and accepted as the basis for facilities design.

3.2.4 *double contingency principle*—the use of methods, measures, or factors of safety in the design of nuclear facilities such that at least two unlikely, independent, and concurrent changes in process or operating conditions are required before a criticality accident is possible.

3.2.5 *eructation*—a surface eruption in a tank, vessel, or liquefied pool caused by the spontaneous release of gas or vapor, or both, from within the liquid. An eructation may bear some resemblance to the flashing of superheated water; but it best resembles a burping action that may or may not be accompanied by dispersion of liquid droplets or particulates, or both, and by a variable degree of liquid splashing. The potential for eructation is most often caused by an excessive heating rate combined with an inadequate agitation condition.

3.2.6 *geometrically favorable*—a term applied to a vessel or system having dimensions and a shape or configuration that provides assurance that a criticality incident cannot occur in the vessel or system under a given set of conditions. The given conditions require that the isotopic composition, form, concentration, and density of fissile materials in the system will duplicate those used in preparation of the criticality analysis. These variables will remain within conservatively chosen limits, and moderator and reflector conditions will be within some permitted range.

3.2.7 *poison or poisoned*—any material used to minimize the potential for criticality, usually containing quantities of one of the chemical elements having a high neutron absorption cross-section, for example, boron, cadmium, gadolinium, etc.

4. Significance and Use

4.1 The purpose of this guide is to provide information that will help to ensure that nuclear fuel dissolution facilities are conceived, designed, fabricated, constructed, and installed in an economic and efficient manner. This guide will help facilities meet the intended performance functions, eliminate or minimize the possibility of nuclear criticality and provide for the protection of both the operator personnel and the public at large under normal and abnormal (emergency) operating conditions as well as under credible failure or accident conditions.

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

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

[5] Available from American Nuclear Society, 555f N. Kensington Ave., La Grange Park, IL 60526.

[6] 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.