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Nuclear criticality safety — Critical values for homogeneous plutonium-uranium oxide fuel mixtures outside of reactors

Sûreté-criticité — Valeurs critiques pour oxydes mixtes homogènes de plutonium et d'uranium hors réacteurs

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11311 was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 5, *Nuclear fuel cycle*.

Introduction

This International Standard provides specifications to establish process and equipment limits for controlling the nuclear criticality hazard (e.g. choice of process monitoring modes, choice of equipment geometry) in facilities (outside of nuclear reactors) involving mixed uranium-plutonium oxide (MOX) fuel.

The criticality risk for this type of fuel results from the presence of the fissile nuclides ^{239}Pu, ^{241}Pu and ^{235}U, and from other fissionable nuclides, such as ^{242}Pu, ^{240}Pu and ^{238}U, more or less neutron absorbing.

The systems considered are uniform and homogeneous mixtures, moderated and reflected by water. The geometries concerned are single units of spheres, cylinders and slabs. A limited number of important safety parameter values are then selected.

Actually, regarding the field of MOX fuel, there are insufficient directly representative experiments of damp powders for establishing the bias between calculations and measurements. Therefore, an inter-code comparison is done to conservatively estimate critical values for different fissile material specifications.

Because the use of calculation codes can be associated with different nuclear libraries, the preceding comparison is extended to the results obtained with the most common nuclear data libraries.

Consequently, this International Standard provides reference critical values for the safety parameters selected. These values are determined by inter-code comparisons with an acceptable accuracy and are defined as the lowest calculated critical values of the selected safety parameters. These values will help nuclear criticality safety assessors during their analysis to make technical prescriptions for criticality risk prevention and for production purposes.

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1 Scope

This International Standard specifies common reference critical values (of which the effective neutron multiplication factor, k_{eff} is equal to 1) for homogeneous water-moderated plutonium-uranium oxide mixtures based on an inter-code comparison of calculated critical values.

It is applicable to operations with unirradiated mixed uranium-plutonium oxide (MOX) outside nuclear reactors.

A classical validation approach for these systems is difficult because of the paucity of critical experiments for MOX fuel.

Various reference systems, in terms of isotopic compositions, thicknesses of water reflection, and densities of oxide are evaluated by different combinations of calculation codes and nuclear data libraries (i.e. different calculation schemes, see Annex B).

The critical values defined in this International Standard are the lowest of those calculated by each of these calculation schemes and accepted as credible.

The values in this International Standard are reference values and not absolute critical values.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 921, *Nuclear energy — Vocabulary*

ISO 1709, *Nuclear energy — Fissile materials — Principles of criticality safety in storing, handling and processing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 921 apply.

4 Reference systems concerned by this International Standard

4.1 Reference fissile media

4.1.1 Description

The reference fissile media are homogeneous and uniform mixtures of uranium and plutonium dioxides in water.