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Nuclear criticality safety — Evaluation of systems containing PWR UOX fuels — Bounding burnup credit approach

Sûreté-criticité — Évaluation des systèmes mettant en œuvre des combustibles REP UOX — Approche conservative de crédit burnup

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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 27468 was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies, and radiological protection*, Subcommittee SC 5, *Nuclear fuel cycle*.

Introduction

For many years, criticality evaluations involving irradiated uranium oxide (UOX) fuels in pressurized water reactor (PWR) considered the fuel as un-irradiated. Information on and consideration of the fuel properties after irradiation could usually have resulted in considerable criticality safety margins.

The use of PWR UOX fuel with increased enrichment of ^{235}U motivates evaluation of burnup credit in existing and new applications for storage, reprocessing or transport of irradiated fuel. A more realistic estimation of the actual effective neutron multiplication factor, k_{eff}, of a system involving irradiated fuel is possible with methods available to nuclear criticality safety specialists. Thus, the maximum estimated k_{eff} value during normal conditions and incidents can be reduced compared with the assumption of an un-irradiated fuel.

Moreover, the safe use of burnup credit can reduce the overall risk (fewer cask moves, etc.).

Therefore, for the safe use of the burnup credit, this International Standard highlights the need to consider new parameters in addition to those that need evaluation for un-irradiated fuel. It presents the different issues that should be addressed to support evaluations of burnup credit for systems with PWR fuels that are initially containing uranium oxides and then irradiated in a PWR.

This International Standard identifies a bounding approach in terms of k_{eff} calculation. Other approaches may be used (e.g. calculation of the average configuration with k_{eff} criteria covering credible variations/bias/uncertainties) especially if there are additional mechanisms to control the subcriticality (e.g. use of boron, gadolinium or dry transport).

Overall criticality safety evaluation and eventual implementation of burnup credit are not covered by this International Standard. However, the burnup credit evaluation in this International Standard should support use of burnup credit in the overall criticality safety evaluation and an eventual implementation of burnup credit.

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1 Scope

This International Standard establishes an evaluation methodology for nuclear criticality safety with burnup credit. It identifies important parameters and specifies requirements, recommendations, and precautions to be taken into account in the evaluations. It also highlights the main important technical fields to ensure that the fuel composition or history considered in calculations provides a bounding value of the effective neutron multiplication factor, k_{eff}.

This International Standard is applicable to transport, storage, disposal or reprocessing units implying irradiated fissile material from pressurized water reactor (PWR) fuels that initially contain uranium oxide (UOX).

Fuels irradiated in other reactors (e.g. boiling water reactors) and fuels that initially contain mixed uranium-plutonium oxide are not covered in this International Standard.

This International Standard does not specify requirements related to overall criticality safety evaluation or eventual implementation of burnup credit.

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

ISO 14943, *Nuclear fuel technology — Administrative criteria related to nuclear criticality safety*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
actinide
element with atomic number in the range from 90 to 103

NOTE Many actinides are produced during the irradiation due to neutron capture on other actinides and/or decay of other actinides and/or by (n,2n) reactions, etc. The corresponding nuclides are all neutron producers and some are net (considering neutron production and absorption) neutron producers in a slow neutron energy spectrum.