
**Nuclear criticality safety — Solid
waste excluding irradiated and non-
irradiated nuclear fuel**

*Sûreté-criticité — Déchets solides à l'exclusion du combustible
nucléaire irradié et non irradié*



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy, nuclear technologies and radiological protection*, Subcommittee SC 5, *Nuclear installations, processes and technologies*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Nuclear criticality safety considerations can play a significant role in the production, management, transport and disposal of waste containing fissile nuclides. Such waste can present particular challenges from a nuclear criticality safety perspective.

- The fissile content of waste can vary significantly. Most waste has a relatively low fissile content; however, there is the potential for waste to contain some items with significantly higher fissile inventory or for fissile nuclides to move and/or increase in local concentration. Typically, there are also large variations associated with the moderators, absorbers and scattering materials which make up the waste matrix.
- The uncertainties associated with the quantity, distribution, concentration and elemental fractions of fissile nuclides associated with a waste material can be large. Typically, there is also significant uncertainty associated with the moderators, absorbers and scattering materials that may comprise the waste matrix.
- Very large volumes of waste requiring criticality assessment can arise. Often the average fissile concentration can be low, but the total fissile mass can be significant.
- The physical and chemical form of waste can be very diverse, with a wide variety of potential effects on nuclear criticality safety (e.g. moderation, neutron poisons, neutron reflectors, etc.).
- The timescales that require nuclear criticality safety to be demonstrated for waste may be very long (and could be as large as hundreds of thousands of years or more when considering final disposal). Over such timescales, there is the potential for key parameters to change - for example, nuclide proportions as a result of radioactive decay, chemical changes in the waste matrix, re-distribution of fissile nuclides and moderators, separation of poisons. There is the potential for significant variability in the distribution of fissile nuclides within the waste volume at the time of disposal.
- There is often a requirement to transport waste within the public domain, which can be subject to differing limits and constraints when compared with where the waste was produced.

The purpose of this document is to support nuclear criticality safety throughout the waste life cycle while taking into account the potential to have a significant negative impact on other important areas such as:

- Radiological safety: For example dose control, risk of nuclear material ingestion/inhalation, the potential for contaminated wounds when handling waste, etc. If the nuclear criticality safety limits are set with little consideration of the other areas, resulting in large criticality safety margins, there is the potential for reworking waste to ensure compliance, incurring unnecessary radiological risk.
- Environmental considerations: For example additional handling, processing and storage leading to additional discharges, use of services such as electricity and water, generation of additional contaminated and non-contaminated packaging materials, generation of increased waste volumes.
- Conventional safety: For example additional risks of acute or chronic physical injuries.
- Cost: For example excessive or disproportionate costs which might be better spent reducing risk elsewhere. Final disposal space (e.g. deep geological disposal or shallow/ surface disposal) is an expensive, finite resource – with costs being directly linked to the volume of waste produced. Cost may also arise from, for example, the numbers of packages produced and the number of package movements required.
- Delay: For example potential for excessive delay due to development of overly complicated engineered solutions or safety arguments.

The criticality safety specific requirements and guidance within this document are to be applied with an awareness of this wider context to ensure that an appropriate balance between the criticality safety considerations and these other important factors is achieved.

Nuclear criticality safety — Solid waste excluding irradiated and non-irradiated nuclear fuel

1 Scope

This document provides specific requirements and guidance on the nuclear criticality safety of waste containing fissile nuclides, generated during normal operations. This document is intended to be used along-side and in addition to ISO 1709.

This document applies specifically to the nuclear criticality safety of solid nuclear wastes. It also applies to residual quantities of liquids and/or slurries which are either intimately associated with the solid nuclear waste materials or arise as a result of processing or handling the waste.

This document does not apply to bulk or process liquids (including higher concentration process solutions) or irradiated or un-irradiated fuel elements.

NOTE The term fuel element is sometimes applied to fuel assembly, fuel bundle, fuel cluster, fuel rod, fuel plate, etc. All these terms are based on one or more fuel elements. A cylindrical fuel rod (sometimes referred to as a fuel pin) for a light-water-reactor is an example of a fuel element.

All stages of the waste life cycle are within the scope of the document. This document can also be applied to the transport of solid nuclear waste outside the boundaries of nuclear establishments.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 12749-3, *Nuclear energy, nuclear technologies and radiation protection — Vocabulary — Part 3: Nuclear fuel cycle*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1709, ISO 12749-3 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

waste

<nuclear criticality safety> any kind of solid material containing or contaminated with fissile nuclides for which no further use is foreseen, not including irradiated or un-irradiated fuel elements

Note 1 to entry: This also includes:

- a) solids containing or contaminated with fissile nuclides for which no further use is foreseen, but for which further work to prepare the waste for final disposal is programmed, e.g. volume reduction;