

Fissile materials — Criticality safety in handling and processing — Recommendations

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Committees responsible for this British Standard

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- AEA Technology
- British Nuclear Fuels plc
- Department of Transport
- Health & Safety Executive

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Foreword

This British Standard has been prepared by Technical Committee NCE/9. It takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This guidance is based on an earlier issue, BS 3598:1970, the use of which has ensured that the nuclear industry achieved a good criticality safety record. Since its publication, more sophisticated methods of criticality assessment have become available which enable a wide range of problems to be examined and now permits, as an example, credit to be given for fissile material burn-up. Ten years later, BS 5882:1980, *A total quality assurance programme for nuclear installations* was published (this was revised and re-issued in 1990 and 1996). In 1987, BS 5750, *Quality systems, Part 1: Specification for design/development, production, installation and servicing* (subsequently issued as ISO 9001, EN 29001), was published, followed in 1991 by BS 5750-13, *Guide to the application of BS 5750 : Part 1 to the development, supply and maintenance of software* (subsequently issued as ISO 9000-3, EN 29000-3). These quality standards have provided a framework for the application of quality assurance to criticality safety which was not envisaged in 1970.

Consideration has also been given to the requirements of the draft International Standard ISO 1709:1990, *Principles of criticality safety in storing, handling and processing fissile material*, and to the American National Standard ANSI/ANS-8.1—1983, *Nuclear criticality safety in operations with fissionable materials outside reactors*.

A further section has been added to extend criticality safety assessment to include the effects of a criticality accident.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, an inside back cover and a back cover.

Introduction

The purpose of these recommendations is to provide guidance for those measures which should prevent the occurrence of a criticality accident during the manufacture, processing, handling, storage and transport of fissile materials outside the core of a nuclear reactor.

The rapid development of nuclear technology makes impossible any prescriptive requirements for the almost unlimited number of practical combinations of nuclear process conditions. It is appropriate, therefore, to give only generalized recommendations which enable individual operators to develop and justify their own approach to criticality safety.

The freedom from hazards arising from nuclear chain reactions in non-reactor core environments is referred to as “criticality safety”. This is a component of an overall safety case covering all aspects of nuclear process operations. The safety assessment may address the matter of the probability of the occurrence of a specified accident, including criticality.

All operations with fissile materials outside nuclear reactors should be performed in such a way as to prevent a nuclear chain reaction and the consequent release of energy. Though the energy will manifest itself principally as heat in the particular medium, the associated ionizing radiations may be lethal to nearby personnel. Because these dangers are “invisible”, personnel may not be aware that an incident has occurred, and there may not be any obvious signs of damage to the process equipment. The only indication of a potentially dangerous situation having arisen may be the sounding of high radiation alarms. Damage to equipment could also be caused, resulting in the possible escape of fission products generated by the incident and other radioactive materials, particularly if irradiated materials are being processed.

It may be possible to define minimum values for fissile material parameters below which criticality safety can never be prejudiced. In neutron interaction problems, however, consideration may need to be given to these minimum values or indeed even smaller quantities of such materials. An example is unirradiated depleted uranium metal, which cannot form a critical assembly but can act as an efficient neutron reflector.

Many nuclear installations in the United Kingdom are subject to the requirements of the Nuclear Installations Act 1965. [1] There is a close correlation between the guidance provided in clause 6 (Operational control) and nuclear site licences issued under this Act. Consequently, for those nuclear processes which fall outside its requirements, the guidance provided in clause 6 should ensure standards broadly equivalent to those on licensed sites.

1 Scope

This British Standard applies to all operations with fissile materials outside the core of an operational nuclear reactor and includes the manufacture, processing, handling, storage and movement of fissile materials. It is concerned with the limitations that have to be imposed on nuclear processes and equipment because the materials possess unique nuclear properties which can support nuclear chain reactions.

This standard is also applicable to the use of fissile materials in an experimental sub-critical nuclear plant where, although the nuclear reactivity approaches the critical state, these materials are not provided with the shielding and control systems associated with a nuclear reactor and which are designed to ensure its safe operation.

This standard does not replace any part of the regulations, standards and codes of practice which govern the overall operation of a nuclear process, but supplements them. It states the factors and technical criteria which form the basis on which the procedures relating to criticality safety should be established. It does not cover details of equipment, design or operational procedures, nor does it refer to the effects of ionizing radiations on man or materials or to sources of such radiations, either natural or as a result of nuclear chain reactions.

This standard does not apply to fissile materials that are contained within the core of a nuclear reactor, which is governed by appropriate national and international regulations. It is, however, applicable to the process whereby fissile materials are transferred to or from a nuclear reactor or stored near it.

2 Terms and definitions

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

2.1

abnormal condition

operating condition, including the presence or absence of specified materials, which is outside the conditions specified for normal operation of the nuclear process

NOTE This does not include deliberate or malicious acts by persons with sufficient technical knowledge and access to the nuclear process, or those events which are unlikely to be encountered even in the absence of all other controls.

2.2

burn-up credit

use of information on both the reduction in the fissile content and the presence of neutron absorbing fission products in nuclear fuel as a consequence of its previous irradiation in a nuclear reactor