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Secretariat:~~-~~ AFNOR

Date: 2024-~~02-24~~xx

~~Nuclear~~Fusion installations — Criteria for the design and operation of confinement and ventilation systems of tritium fusion facilities and fusion fuel handling facilities

Installations de fusion — Critères pour la conception et l'exploitation des systèmes de confinement et de ventilation des installations de fusion avec tritium et des installations de traitement des combustibles de fusion

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Foreword

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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 document 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).

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This document was prepared by Technical Committee ISO/TC 85, *Nuclear energy*, Subcommittee SC 2, *Radiological protection*.

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~~www.iso.org/members.html

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Introduction

Confinement and ventilation systems implemented in fusion facilities using radioactive materials and fusion fuel handling facilities ensure a safety function aiming at protecting the workers, the public and the environment from the dissemination of radioactive contamination, including but not limited to tritium, likely to be released from the operation of these installations.

This document applies specifically to confinement and ventilation systems for tritium fusion facilities and fusion fuel handling facilities and their specific buildings (such as fuel handling facilities, hot cells, examination laboratories, emergency management centres, radioactive waste treatment and storage station).

In such fusion installations, tritium is particularly focused, as their tritium inventory may be high and as it is likely to have a broader impact on workers, the environment or the members of the public than the other radionuclides.

In most countries, a tritium quantity is declared as high for tritium inventories in a facility site higher than a range of 10 g to 100 g. In the tritium fusion facilities in the scope of this document, the tritium inventory is deemed to be much higher than this range for the whole facility site.

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Fusion installations — Criteria for the design and operation of confinement and ventilation systems of tritium fusion facilities and fusion fuel handling facilities

1 Scope

This document specifies the applicable requirements related to the design and the operation of confinement and ventilation systems for fusion facilities for tritium fuels and tritium fuel handling facilities specific for fusion applications for peaceful purposes using high tritium inventories, as well as for their specialized buildings such as hot cells, examination laboratories, emergency management centres, radioactive waste treatment and storage facilities.

In most countries, a tritium quantity is declared as high for tritium inventories higher than a range of 10 g to 100 g. In the tritium fusion facilities in the scope of this document, the tritium inventory is deemed to be higher than this range for the whole site.

This document applies especially to confinement and ventilation systems that ensure the safety function of nuclear facilities involved in nuclear fusion with the goal to protect the workers, the public and the environment from the dissemination of radioactive contamination originating from the operation of these installations, and in particular from airborne tritium contamination with adequate confinement systems.

The types of confinement systems for other facilities are covered by ISO 26802 for fission nuclear reactors, by ISO 17873 for facilities other than fission nuclear reactors and by ISO 16647 for nuclear worksite and for nuclear installations under dismantling. The facilities covered by these three standards, notably ISO 17873, include tritium as a radioactive material among the ones to be confined, but tritium is not their driver of the risks for workers and for members of the public. Nevertheless, the tritium quantities and risks from fusion facilities create specificities for a specific standard (e.g. in fusion facilities, tritium is the driver of routine and accident consequences). Therefore, the scope of this document does not cover the other facilities involved in tritium releases (ISO 17873, ISO 16647 and ISO 26802), even though these other facilities create tritium releases (e.g. non-reactor fission facilities, tritium laboratories, tritium removal facilities from fission plants, tritium defence facilities).

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.

~~<std>ISO 10648-2:1994, *Containment enclosures — Part 2: Classification according to leak tightness and associated checking methods*</std>~~

ISO 10648-2, *Containment enclosures — Part 2: Classification according to leak tightness and associated checking methods*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at ~~https://www.iso.org/obp~~https://www.iso.org/obp

— IEC Electropedia: available at ~~https://www.electropedia.org/~~https://www.electropedia.org/

3.1
accidents

3.1.1
design basis accident
DBA
accident conditions against which a facility is designed according to established design criteria, and for which the release of radioactive material is kept within authorized limits

Note 1 to entry: from IAEA Safety and Security Glossary (2022 interim edition).

3.1.2
design extension conditions
DEC
postulated accident conditions not considered for design basis accidents, but considered in the design process for the facility in accordance with best estimate methodology, and for which release of radioactive material is kept within acceptable limits

Note 1 to entry: ~~from~~ From IAEA Safety and Security Glossary (2022 interim edition). This new IAEA expression has been introduced for upgrading existing facilities or designing new facilities, following the occurrence of core melt accident situations in fission facilities. DEC cover the former situations, that were in the past included in the Beyond Design Basis Accidents category, related to multiple failures in the facility as well the ones that were supposed to create core melt and that are now supposed not to impact the containment of the facility (and thus that would become a design condition for the confinement of the nuclear facility).

Note 2 to entry: For new fusion facilities using radioactive materials, this expression cover accidents scenarios that were also considered as beyond design basis accidents for former designs, but that shall be considered in the design process of the facility in order to limit radioactive releases within acceptable limits. For fusion facilities, examples of DEC covered by this expression are the multiple failures scenarios (e.g. combination of loss of coolant events and loss of vacuum accidents), explosion scenarios, generalised fire scenarios.

3.1.3
beyond-design basis accident
BDBA
postulated accident with accident conditions more severe than those of a *design basis accident* ~~(3.1.1)~~(3.1.1)

Note 1 to entry: from IAEA Safety and Security Glossary (2022 interim edition). This expression was first used for fission reactors after the first core melt accident situations that occurred in the 20th century, in order to identify the situations that were not considered in the design of the facility but for which specific requirements should be considered to reduce the likelihood of fission reactors core melt situations as well as the consequences of such situations, that are now covered by the IAEA expression "design extension conditions (DEC)" ~~(3.1.6)~~.(3.1.2). In the most recent years, for new facilities, BDBA cover only the accidents that are even beyond the DEC, and that shall be practically eliminated.

Note 2 to entry: IAEA defines also severe accidents as "accident conditions more severe than a design basis accident and involving significant core degradation". In a fusion facility, there is no possibility of core degradation and therefore this definition is not used.

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3.2
aerosol
solid particles and liquid droplets of all dimensions in suspension in a gaseous fluid

3.3
air exchange rate
ratio between the ventilation air flow rate of a containment enclosure or a compartment, during normal operating conditions, and the volume of this containment enclosure or compartment

Note 1 to entry: The SI unit is s^{-1} but the general usage is in d^{-1} for leaktight volumes or in h^{-1} for general ventilation.

3.4
air conditioning
arrangements that allow sustaining a controlled atmosphere (temperature, humidity, pressure, dust levels, gas content, etc.) in a defined volume, in order to ensure comfort of the personnel and/or the conditions for adequate operation of safety systems used in fusion facility

3.5
balancing damper
control valve
adjustable device inserted in an aerodynamic duct allowing balancing of the fluid flow and/or the pressure of the fluid during plant operation

3.6
barrier
physical obstruction that prevents or inhibits the movement of people, radionuclides or some other phenomenon (e.g. fire), or provides shielding against radiation

Note 1 to entry: from IAEA Safety and Security Glossary (2022 interim edition). In the context of this document regarding the confinement function, it concerns a structural element that defines the physical limits of a volume with a particular radiological environment and that prevents or limits releases of radioactive substances from this volume.

3.7
cell
shielded enclosure, shielding structure, of fairly large dimensions, possibly leak-tight

Note 1 to entry: See *containment enclosure* ~~(3.10).~~ (3.10).

3.8
containment
confinement
arrangement allowing users to maintain separate environments inside and outside an enclosure, blocking the movement between them of process materials and substances resulting from physical and chemical reactions that are potentially harmful to workers, to the public, to the external environment, or for the handled products

Note 1 to entry: the word containment is used for the leak-tight performances of a static physical *barrier* ~~(3.6)~~ (3.6) confining radioactive materials, whereas confinement is used for the global function of confining hazardous materials including also the use of active systems ensuing a *dynamic confinement* ~~(3.17).~~ (3.17). Therefore, confinement is used for the function of preventing or controlling the releases of radioactive material to the environment in operation or in accidents. Containment is used for the physical structures designed to prevent or control the release and the dispersion of radioactive substances. In te context of facilities handling radioactive materials it covers structural elements (cans, gloveboxes, storage cabinets, rooms, vaults, etc.), which are used to establish the physical integrity of an area.

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3.9
containment compartment
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compartment of which the walls are able to contain radioactive substances that would be generated by any plausible fire that breaks out in one of the fire compartments included

Note 1 to entry: It is often more practicable to limit the spread of a fire by using fire-resistant walls, and to prevent the spread of contamination in the adjacent volumes.

3.10
containment enclosure
enclosure designed to prevent either the leakage of products contained in the pertinent internal environment into the external environment, or the penetration of substances from the external environment into the internal environment, or both simultaneously

Note 1 to entry: See *cell* (3.7) (3.7).

Note 2 to entry: This is a generic term used to designate all kinds of enclosures, including glove boxes, leak-tight enclosures and shielded cells equipped with remotely operated devices.

3.11
containment envelope
volume allowing the enclosure, and thus the isolation from the environment, of those structures, systems and components whose failure can lead to an unacceptable release of radionuclides

3.12
containment system
confinement system
system constituted of a coherent set of physical *barriers* (3.6)(3.6) and/or dynamic systems intended to confine radioactive substances in order to ensure the safety of the workers and the public and the protection of the environment and to avoid releases of radioactive materials in the environment

Note 1 to entry: According to IAEA definitions, a containment system concerns the containment structure and the associated systems with the functions of isolation, energy management, and control of radionuclides and combustible gases. This containment system also protects the facility against external events and provides radiation shielding during operational states and accident conditions. These two last functions are not described in this document, due to the absence of link with the ventilation systems. In a fusion facility, the *dynamic confinement* (3.17)(3.17) is more important than in other facilities because of the tritium dispersion and permeation properties. Therefore, in fusion facilities, the term confinement system is more generally used.

3.13
contamination
presence of radioactive substances on or in a material or a human body or any place where they are undesirable or can be harmful

3.14
cubicle
generic term used to describe enclosures containing electrical equipment (power or instrumentation and control) or cables. Examples are cabinets, junction boxes, switchboards

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