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Preparation for tritiated waste management of fusion facilities: Interim storage WAC

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HIGHLIGHTS

- Fusion devices including ITER will generate tritiated waste.
- Interim storage is the reference solution offering an answer for all types of tritiated radwaste.
- Interim storage is a buffer function in the process management and definition of the waste acceptance criteria (WAC) is a key milestone in the facility development cycle.
- Defining WAC is a relevant way to identify ahead of time the studies to be launched and the required actions to converge on a detailed design for example material specific studies, required treatment, interfaces management, modelling and monitoring studies.

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ABSTRACT

Considering the high mobility of tritium through the package in which it is contained, the new 50-year storage concepts proposed by the French Alternative Energies and Atomic Energy Commission (CEA) currently provide a solution adapted to the management of waste with tritium concentrations higher than the accepted limits in the disposals. The 50-year intermediate storage corresponds to 4 tritium radioactive periods i.e., a tritium reduction by a factor 16.

This paper details the approach implemented to define the waste acceptance criteria (WAC) for an interim storage facility that not only takes into account the specificity of tritium provided by the reference scheme for the management of tritiated waste in France, but also the producers' needs, the safety analysis of the facility and Andra's disposal requirements. This will lead to define a set of waste specifications that describe the generic criteria such as acceptable waste forms, general principles and specific issues, e.g. conditioning, radioactive content, tritium content, waste tracking system, and quality control. This approach is also a way to check in advance, during the design phase of the waste treatment chain, how the future waste could be integrated into the overall waste management routes and identify possible key points that need further investigations (design changes, selection of materials, etc.): the results obtained are shown. It supports the nuclear operator to ensure the compliance of the future waste packages with the disposal acceptance criteria.

1. Introduction

Fusion facilities like ITER will produce radioactive waste during operation and decommissioning [1,5]. This waste results from the activation of materials by 14 MeV neutrons and from contamination by tritium, which is used as fuel in the fusion reaction. Most of the waste will be tritiated, which requires a specific management strategy taking into account the physical and chemical properties of tritium, its capability to diffuse through metals and its half-life of 12.3 years. In the nuclear field, as well as in other industrial sectors, interim storage can be a necessary buffer function in process management.

A program for the creation of interim storage facilities for tritiated waste was defined in France, within the framework of the National Radioactive Materials and Waste Management Plan [PNG-

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MDR, Réf. [2]]. After a period of tritium decay, the waste packages will be shipped to the surface disposal facilities.

Waste acceptance criteria have to be established to specify the radiological, mechanical, physical and chemical characteristics of waste packages to be stored: for example, their radionuclide content or activity limits, the properties of the waste form and packaging. This paper presents the studies carried out on one of these interim storage facilities, for tritiated waste produced from fusion facilities like ITER, in order to establish the Waste Acceptance Criteria (WAC) taking into account all of the requirements. The implementation of this approach has provided relevant results by the identification of studies and actions required to improve the detailed design of the whole radwaste chain, early in the development.

2. Tritiated waste management in France

2.1. General principles

Waste management can be optimized as a whole system – from production to disposal – and comprises the following steps [6]:

- Waste production and primary waste sorting, treatment and characterization,
- Waste packaging compliant with storage, transportation and disposal requirements,
- Transportation and storage with an optimization of the storage periods,
- Waste package disposal.

This requires a great deal of interfacing between radwaste management, engineering, regulation and taking into account safety issues to find the optimum solutions in terms of cost efficiency.

At each stage of the waste management process, producers are involved and responsible for maintaining a high level of quality to prevent the occurrence of any problem.

2.2. Legal framework of radwaste management

Waste management is governed by law which complies with the international requirements: each government shall provide for an appropriate national legal and regulatory framework within which radioactive waste management activities can be planned and safely carried out.

Many different organisations play an active part in waste management: the waste producer, the processing contractors, the interim storage and the disposal facility licensees. Each is responsible for the nuclear safety of its activities and, on behalf of the State, the nuclear safety is supervised by the French Nuclear Safety Authority (ASN) which is an independent administrative authority.

The waste producer is a “nuclear operator” under French law, like ITER Organization.

CEA is a French government-funded technological research organisation based in ten research centers in France. CEA operates licensed nuclear facilities such as interim storage facilities.

Andra (National Radioactive Waste Management Agency) is a public body responsible for the designing, construction, operation, closure and monitoring of disposal facilities (repositories).

In France, the PNGMDR, prepared under the care of ASN, is a key tool in ensuring the long-term implementation of the principles laid down in the Program Act of June 28, 2006 concerning the sustainable management of radioactive materials and waste to protect individual health, security and the environment.

It aims primarily at producing a regular overview of radioactive substance management policy, to evaluate new requirements and to determine the objectives to be met in the future, particularly with regard to studies and research.

2.3. Strategy proposed for tritiated waste management

For the case of waste which can contain tritium in excess of the specific thresholds at the entrance of the disposals, a strategy has been established within the framework of the PNGMDR program [5]:

- Setting up a temporary storage site to allow for tritium decay if necessary for about 50 years, based on feedback from existing storage facilities (nuclear or industrial ones), until the waste can be accepted for disposal
- Selecting a temporary storage site that is located as close as possible to the producer
- Designing the future disposal sites considering the tritiated radwaste characteristics after an interim storage period of about 50 years,
- Making sure the producer takes into account waste sorting, consistency of the conditioning, characterization and treatment
- Paying special attention to the most out-gassing waste, considering for example detritiation techniques or high integrity containers.

The creation of new storage facilities by the Alternative Energies and Atomic Energy Commission (CEA) offers a satisfactory solution in terms of short- to medium-term safety, pending its future transfer to disposal facilities, which is the final long term site (Fig. 1).

Interim storage is well-adapted while waiting for availability of the permanent disposal facility or taking advantage of the activity and/or heat decay. Nevertheless, an optimized solution can be reached by combining different techniques such as incineration or thermal treatment in addition to the interim storage [4].

3. Input data for the interim storage facility design

The data required to launch the process to establish the Waste Acceptance Criteria (WAC) of the interim storage are detailed in the following paragraphs.

3.1. Interim storage functions

The technical interim storage functions are divided into several steps corresponding to the arrival of the packages, the interim storage period and associated monitoring actions, the shipment of the packages and in parallel a repackaging step is possible.

Arrival of the packages

- Collection of the packages provided by the producers.
- Loading/unloading of the transport casks and packages.
- Radiological control of the packages when received (contamination, dose rate, etc).
- Packages control and characterization (tritium activity, outgassing measurements, etc).
- Buffer storage of the packages.

Interim storage period

- Intermediate storage.
- Packaging retrieval when needed.
- Facility operation and maintenance.
- Monitoring of the packages.
- Environment monitoring (discharges).

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