Starting DIADEM Medium-Level Waste Interim Storage's Construction – 15034

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ABSTRACT

As part of its decommissioning policy, the nuclear energy division of CEA has identified materials whose high enough radioactive features authorize neither sustainable storage in existing facilities nor evacuation to a French operational geological disposal.

Pending availability of definitive solutions, it was decided to explore the possibility to store these materials in a new installation, the subject of DIADEM project [1]. The need was first identified in Marcoule's site, especially to accommodate future waste dismantling of PHENIX reactor. Quickly the interest of a centralized storage for all CEA waste of this type appeared to bring together the best expertise to the design and operation of storage.

Waste will be stored either to use benefits of radioactive decay or to wait for the commissioning of a new disposal. DIADEM is designed for an operating estimated lifetime of fifty years.

This paper deals with the prior safety assessment completed in 2014, the project management and the first steps of the facility construction.

INTRODUCTION

The CEA has undertaken an extensive dismantling program for its shut-down nuclear facilities (research laboratories, experimental reactors, etc.). One of the major issues involved is to demonstrate its ability to manage the radioactive waste produced by these operations.

For the LL-IL and HL waste, long-term management solutions are being studied in the context of the French Law n°2006-739 dated 29 June 2006 [2], concerning the sustainable management of radioactive material and waste. The recommendations will only be available a few years from now, and the Law gave the objective of 2025 for the commissioning of a deep geological repository.

Today, the CEA waste management is organized within temporary storage units while awaiting the availability of a long-term solution. It was decided to study the possibility of storing SL-LIL and LL-IL waste in a new facility, known as the DIADEM project. The objective was to design and build a temporary storage unit for highly irradiating and/or highly α contaminated waste, to be used until the commissioning of the planned deep geological repository. The facility will be built at the Marcoule's Centre in the Rhone Valley, the site where much of the waste concerned is produced.

The DIADEM project began in 2006. First, the CEA carried out a feasibility study was carried out, which formed the basis for launching a consultation and call for tenders. The prime contractor was appointed in 2008, and the design studies were completed in early 2013. It is planned to commission the facility at the end of 2018.

DESCRIPTION OF THE DIADEM PROJECT

Main Features

DIADEM's role is to safely store containers of highly irradiating and/or high α content waste. The facility has been designed for a lifetime of at least fifty years (Fig. 1).

During these fifty years of storage, the facility must ensure that the containers are kept in a state of preservation which will enable their retrieval at any time with the current means of operation. It must also keep records of each container's characteristics, including its origin, nature and radiological contents.

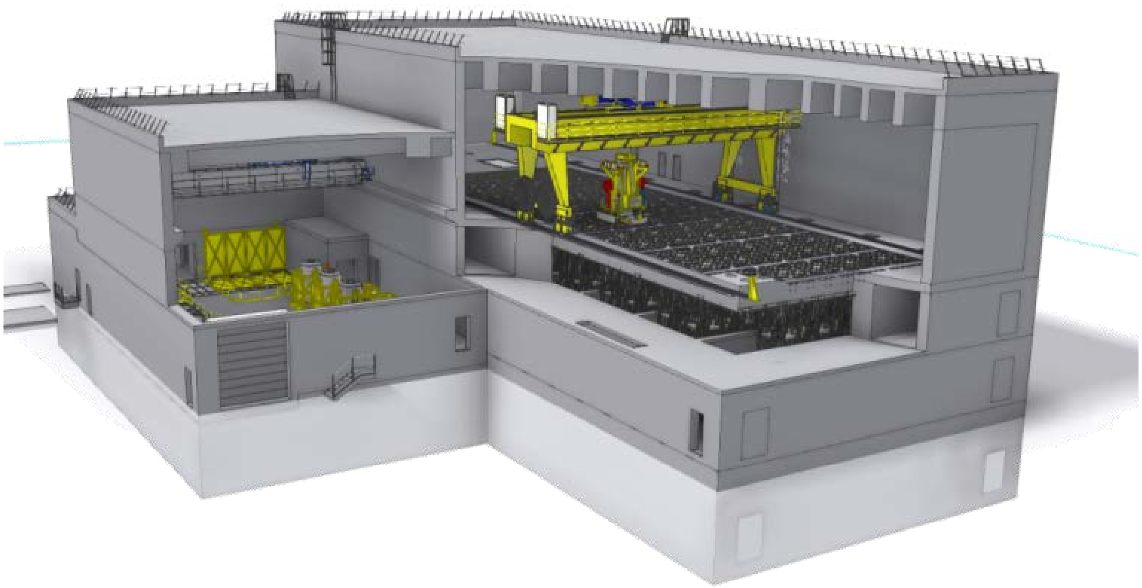

Figure 1:Schematic view of the future building

Key numbers are:

- ✓ Building dimensions 51m width x 57m length x 24m height
- ✓ General earthworks 23000 m3
- ✓ 5 floors
- ✓ Total useful area 5000 m2
- ✓ Nuclear ventilation 33000 m3 / h
- ✓ Total poured concrete 10 000 m3
- ✓ Thickness of walls for biological protection 1,4m

Containment

The facility is planned to receive 3 types of cylindrical stainless steel containers, with identical diameters (external Ø 498 mm) and with increasing heights (620mm, 1060mm and 2120mm) as shown in Fig. 2.

Figure 2: The three types of containers

The containers have 8 mm thick steel hoops. This extra thickness enables the containers to resist falls, and means higher corrosion resistance.

The lids will be screwed onto the containers in the waste-producer's facilities, and then welded in DIADEM (or in another facility) before placement in storage. The lid welding will guarantee leak tightness for periods of several decades.

These lids will be fitted with gripping points. For waste involving radiolysis phenomena (gaseous releases caused by radiation), the lids will also be equipped with metal filters which will allow gases to escape. These special filters are designed to only give gaseous pressure release, while blocking all particles.

Main functions

From the functional point of view, the DIADEM storage facility must carry out the following operations:

- ✓ reception and checking of the shipping packaging loaded with waste containers;
- ✓ preparation of the containers for storage by checking, decontamination if necessary, and lid welding operations;
- ✓ container storage and monitoring;
- ✓ maintenance of the containers' integrity throughout their storage period;
- ✓ archiving of all the information available related to each container;
- ✓ retrieval of the containers at the end of their storage period.

SAFETY ASSESSMENT COMPLETED

Preliminary Safety Report

The risk inventory and the analysis of the measures foreseen to prevent such risks, as well as the description of the appropriate measures for limiting the likelihood of accidents and their effects, led to the inclusion of the following main countermeasures:

Regarding the radioactive risks:

- ✓ the radioactive dissemination risk : physical barriers will be successively interposed in order to prevent the workers and the public from coming into contact with radioactive matter (the container, the transport packaging, the container preparation cell, the shielded carrier which will be used to move the container from the cell to the storage rack, the storage rack, the building's external shell)
- ✓ the external exposure risk : physical screens, such as concrete walls, will reduce the passage of radiation emitted by the waste;
- ✓ the criticality risk: as the waste contains fissile matter, the storage geometry will be suitably adapted in order to prevent the triggering of a chain reaction;
- ✓ the radiolysis risk : the gases produced by the decomposition phenomenon of the matter due to the action of radiation will be let out, in order to prevent the formation of an explosive atmosphere;
- ✓ the heat risk : the containers will be cooled throughout their storage period, in order to avoid the phenomenon of gaseous releases caused by high temperatures and any damage to the barriers set up.

Regarding the non-radioactive risks:

- ✓ surrounding facilities: potential aggressions can come from a fuel depot, a gas station and power supply closed building. Sufficient distances compared to fire or overpressure in case of explosion are taken into account;
- ✓ extreme meteorological conditions: the building design integrates temperatures from -11 to 43°C, wind speeds around 40m/s, ice and snow protection system and levels of depression and speeds generated by tornadoes;
- ✓ plane crash: the safety analysis is based on the probabilistic risk assessment drop on a safety target relative to the 10-6 criterion per year;
- ✓ flooding: the excesses of the Rhone river or the rise in groundwater water up to the level of the natural level, the high rainfall leading to runoff or infiltration of large extents are managed;
- ✓ earthquake and seismic hazard: the process building is designed to withstand earthquakes with added safety margin including paleoseismic characteristics and ensures the maintenance of sub-criticality, the containment of materials, the operating system of the thermal power and hydrogen exhausting, the possibility of recovering all the containers.

These constraints led to the design of a rack-type storage, in which a steel guiding structure, called a rack, will enable the containers to be stacked. The thickness of the rack walls will give sufficient radiation reduction to protect the personnel.

The containers will have a high mechanical resistance. Those likely to be subject to radiolysis will be equipped with filters which will allow the release of the gases produced while retaining the radioactive particles.

Container handling throughout the facility will be carried out remotely, using semi-automatic equipment and from behind very thick biological protection barriers, thus limiting external radiation exposure for the workers. The concrete rack walls are up to 140 cm thick.

The racks will be continuously ventilated in order to both remove radiolysis gas releases and cool the containers.

The facility has been designed to resist the most extreme conditions, and an additional safety assessment (“stress test” analysis, following the Fukushima accident) was carried out and sent to the Safety Authority as a complement to the Preliminary Safety Report (part 7 of the file).

Majors Instruction’s Steps

Given the type and the quantity of waste which must be stored, the DIADEM facility will be classified as a Basic Nuclear Facility, or “INB” in French. In conformity with the requirements of Decree n°2007-1557 dated 2 November 2007 and in application of Law n°2006-686 dated 13 June 2006 concerning nuclear industry transparency and safety, a public enquiry must be organized in the case of an INB creation.

To meet this requirement, the DIADEM project has written a Creation Authorization Request file, This file has approximately 1500 pages, and is made up of 12 parts together with 4 notices was assessed by :

- ✓ The Nuclear and Radiation Protection Safety Mission of the Ecology, Sustainable Development & Energy Ministry and The Nuclear Safety Authority from February 2012 to March 2013
- ✓ The Environmental Authority from June 2013 to February 2014
- ✓ The Related Public Enquiry from June 2014 to August 2014
- ✓ The Institute for Radiological Protection and Reactor Safety (IRSN) from September 2013 to October 2014

PROJECT MANAGEMENT

After sending the creation authorization request, the project and owner teams have been preparing the calls for tenders for the 12 work packages. Contracts were awarded during summer 2014. Although some work packages will only be implemented towards the end, the execution studies will be carried out as soon as the contracts are established, to ensure both an execution study synthesis and the spatial consistency of the building components among all the trades participating. The worksite began also during the last quarter of 2014.

The industrial set-up needed to be clearly defined, with a strong prime contractor and a genuine pooling of industrial expertise:

- ✓ CEA expertise is focused on waste characterization, packaging, corrosion tests, decontamination process, hydrogen source terms
- ✓ Prime contractor has the full responsibility of the project completion.
- ✓ Industrial set-up was puzzled in order to choose subcontractors only in their field of expertise.

It is planned to commission the facility at the end of 2018, after 6 months of tests and a unique on-site acceptance for all the contractors.

CONCLUSION

The commissioning of the DIADEM facility is a major issue for CEA, as it is a key factor in satisfactorily carrying out several major clean-up and dismantling programs on various nuclear sites (Marcoule, Fontenay-aux-Roses, Saclay, Cadarache). The facility is necessary until ANDRA’s deep geological repository (the CIGEO project) can be opened, all the more so as once the latter is operational, producers must respect waste transfer schedules spread over many years. The interim storage to be located in DIADEM will be needed.

REFERENCES

1. The Creation of a French Basic Nuclear Installation - Description of the Regulatory Process, WM2013 Conference, February 24 – 28, 2013, Phoenix, Arizona USA
2. 2006 Planning Act on the sustainable management of radioactive materials and waste
3. Decree n°2007-1557 dated 2 November 2007
4. Law n°2006-686 dated 13 June 2006 nuclear industry transparency and safety