MANAGEMENT AND STORAGE OF SPENT FUEL FROM CEA RESEARCH REACTORS

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Abstract

CEA research reactors and their interim spent fuel storage facilities are described. Long-term solutions for spent fuel storage problems, involving wet storage at PEGASE or dry storage at CASCAD, are outlined in some detail.

1. INTRODUCTION

The CEA nuclear R and D programs are largely based on the utilization of various types of research and experimental reactors located at CADARACHE, GRENOBLE and SACLAY, as for exemple :

- critical assemblies (EOLE, MINERVE, MASURCA, ...),
- training reactors (ULYSSE, SILOETTE),
- reactors dedicated to experimental safety studies (CABRI, PHEBUS, SCARABÉE),
- reactors dedicated to fundamental research with neutron beams (ORPHÉE, RHF),
- materials testing reactors (OSIRIS, SILOE).

The reactors of the last two categories are operating continuously all over the year while the others are either operated at low-power or used on a campaign basis only. Consequently, the spent fuel management and storage isssue is very specific to ORPHÉE, RHF, SILOÉ and OSIRIS reactors. The others reactors do not burn very much fuel and nearly all of them can keep operating with the same fuel loading during all their life time.

2. STORAGE OF SPENT FUEL AT REACTORS FACILITIES

Each of the four above reactors was designed with its own storage capacity at the reactor site, allowing, at least, for the residual power to decrease suffisantly before transportation of the spent fuels to a reprocessing plant.

The storage capacity represents approximately :

RHF	15 cores
ORPHEE	8 cores
OSIRIS	10 cores
SILOE	10 cores

This storage capacity seems very large. But, as no reprocessing has been made since 1987/1988 for the SILOE, ORPHEE and RHF fuels and since 1979 for the OSIRIS Caramel fuels, the local storage capacities have been rapidly filled up and it became absolutely necessary to provide for a large new interim storage capacity shared by all the reactors.

3. PEGASE INTERIM STORAGE FACILITY

Located at Cadarache, the PEGASE facility was before a pool type research reactor which has been fully utilized for gas cooled fuel assembly irradiations in large gas loops untill 1975. After the move to PWR, it was decommissioned and dismounted but it was decided to keep the large pools in service and to use it as an interim storage for the radioactive materials and the spent fuels of several facilities (EL4, Rapsodie, etc...).

Later on, specific racks had to be installed to receive the spent fuels from ORPHEE, OSIRIS, RHF and SILOE. As the cost of such spent fuel racks is very high, their number is strictly adjusted to the needs.

The total capacity, around 1.700 locations for all types of fuels, is almost completely utilized. If required, it could be extended by a factor 2 approximately by installing additionnal spent fuel racks.

Independantly of non research reactor fuels and wastes, the PEGASE interim storage contains presently :

RHF	18	fuel assemblies
ORPHEE	88	" "
OSIRIS	432	" "
SILOE	144	" "
Total	682	

Within the next 3 years, all the OSIRIS spent fuel assemblies will be reprocessed at the Marcoule APM plant. More space will then progressively become available for SILOE, ORPHEE, and RHF. Our polycy is to send these fuels back to the US as soon as the US.DOE is able to resume its previous fuel policy by taking back again all the spent fuel of US origin.

4. CASCAD DRY STORAGE FACILITY

Located at Cadarache near by the PEGASE facility, the CASCAD dry storage facility was built in 1989 with the following objectives :

- interim storage of spent fuels, the reprocessing or the final storage of which is not yet available or feasible.
- interim storage for periods of up to 50 years.
- storage capacity equal to 150 to 200 t of fuel.
- modular design to allow future extention.
- containment ensured by a double barrier design.

A comparative assessment of available solutions for fuel and waste storage indicated that dry storage in metal wells cooled by natural convection provided the best overall trade-off from the standpoints of cost-effectiveness, modular design and operating flexibility.

The storage tubes are made of welded rolled stainless steel sheeting. The tubes are 346 mm in diameter and 7 m high. They are supported by a concrete slab. The system is designed to withstand maximum earthquake loads. Each tube is fitted with a shock absorber to prevent any damage in case a fuel assembly is dropped. At the top, a concrete plug is provided for biological shielding. The tubes are leaktight and are equipped with a system for gas sampling. The atmosphere of the wells is air whereas the canisters containing certain fuels are filled with helium.

Containment is ensured by two static barriers, the fuel cladding and the storage tube wall.

The design objective was to set up a geometrical layout that would ensure not only the lowest possible temperature in the stored fuel, but would also be compatible with a passive natural convection cooling system.

The reliability of natural convection cooling was confirmed. The maximum temperatures liable to be encountered if the facility were filled to capacity are : tube wall 83° C, container 102° C, cladding 115° C, vault air exhaust 54° C.

The installation also comprises :

- a truck entry lock where the transport casks are prepared before unloading,
- a handling cell where the fuel is transferred from the casks to the wells,
- a control room where all the handling operations are controlled and the storage conditions monitored.

The facility is presently used for the storage of the EL4 GCHWR irradiated fuel, as well as some other fuels or waste materials with dimensions and properties compatible with vertical tube storage.

Provisions have been made to increase the capacity by a factor 2 if required in the future.