LARGE-SCALE SPENT FUEL CASK RECEPTION AND

DRY UNLOADING AT LA HAGUE

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ABSTRACT

The two new commercial reprocessing plants at La Hague, France, must be capable of receiving, unloading, storing and reprocessing a combined total of 1600 MTU of spent light water reactor fuels each year when they commence full-scale radioactive operations at the end of 1988 and in 1991. This rate of reception and production requires that plant systems achieve a high availability factor, but not to the detriment of the safety of operating personnel or of the environment. At the same time, reprocessing operations must be conducted at predictable and reasonable cost in order for them to represent a viable commercial venture.

Several innovative design concepts have been developed and implemented at the La Hague plants to meet the dual goals of safety and availability. One such innovation is in the addition of a dry spent fuel cask receiving and unloading facility, called TØ, which began radioactive operations at the UP3 reprocessing plant in September 1986. The TØ facility, which will operate in parallel with the wet unloading NPH facility, in service at the UP2 reprocessing plant since the early 1980's, was designed to receive and unload about 200 spent fuel shipping casks per year, or the equivalent of UP3's 800 MTU annual production capacity. The facility features a special connection system enabling the cask to be opened, automatically and remotely unloaded, and then closed without contaminating the cask externals or the cask receiving cell.

THE TØ DRY CASK UNLOADING FACILITY

Design Criteria

The TØ dry spent fuel cask receiving and unloading facility at the UP3 reprocessing plant was designed to meet two primary criteria, which are the same for all of the La Hague facilities. The first design criteria involves the reduction of individual dose rates to less than 0.5 Rem per year, or an average of 0.25 mRem per hour worked. This criteria is ten times more stringent than the regulatory requirements in France. The second design criteria was to achieve a guaranteed production rate of 800 MTU during an annual operating period of 215 days.

In order to satisfy these main criteria, design efforts focused on increasing shielding and containment, reducing operator exposure through the use of remote and automatic systems in a centralized process control mode, using equipment with proven reliability records, minimizing down-time for maintenance by designing for rapid remote component replacement, and minimizing secondary waste production by operating in a completely dry environment.

Facility Description

The TØ dry unloading facility consists of a spent fuel cask preparation building and a cask unloading cell. It is connected at the front end to the AML spent fuel cask receiving and shipping building, and at the back end to the spent fuel storage pool "D", where the fuel will be stored for about three years prior to reprocessing (see Fig. 1) Casks received at La Hague are TN12, TN13, TN17, Mark II and LK 100 type casks, with a maximum residual heat release of 85 kW. They may contain from 6 to 32 fuel assemblies, depending on the cask type and whether they are PWR or BWR fuels.

Upon reception at the AML facility, the cask is placed horizontally on a cart and transferred to the cask preparation building at the TØ facility. The cask preparation building has four work stations located around a rotating platform in the center of the cell: cask

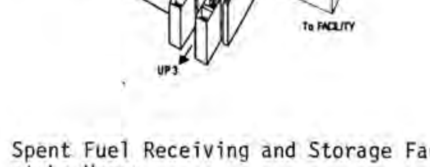

Fig. 1. Spent Fuel Receiving and Storage Facilities at La Hague.

reception/shipping, cask preparation prior to unloading, cask unloading, and cask treatment after unloading. This layout increases facility throughput, since a loaded cask can be stored or prepared for unloading in one of the work stations while another cask is being unloaded or prepared for shipment.

The unloading cell is located above the cask unloading station of the cask preparation building. The unloading cell floor has a hatch with a special connection system that enables an airtight seal to be formed between the top of the cask and the bottom of the cell hatch, thus preventing the spread of contamination outside the cell and the cask internals. The unloading cell systems include an automated fuel removal crane and grapple, a spent fuel cooling pit, and a fuel channel connected to spent fuel storage pool "D".

Sequence of Operations

Outside the cask preparation building, the cask has been checked for compliance with transportation standards relative to radiation and contamination, and the outer bolts have been loosened. The cask is then lifted to the vertical position using a 130-ton overhead crane, carried through sliding shield doors into the cask preparation building, and lowered onto a pre-programmed self-propelled cart that operates remotely (Fig. 2).

The cask is automatically transferred to the cask preparation station, where the cask closure systems are inspected for potential leaks and the cask internals are monitored to detect any damaged fuel elements. The cap and ring are then removed from the cask, and the internal bolts are loosened under a special shield.

The cask is then transferred to the unloading station below the unloading cell. A robot checks the position of the cask to ensure that it is vertical prior to connection to the cell; the self-propelled cart can adjust its load-bearing angle to compensate for significant misalignment. A connecting device is lowered from the unloading cell hatch onto the cask, where it is sealed. The cask plug is removed inside the connecting device such that the top of the plug is not contaminated.

When the cask has been opened, the overhead crane is remotely positioned above the cask and the first couple of fuel elements are removed by the operator. The coordinates are entered into the programmable controller so that the remaining elements may be removed automatically. As they are removed from the cask, the fuel elements are immersed in a cooling pit inside the cell, which also serves as a sipping test for fuel cladding integrity. The fuel elements are then transferred to the "D" storage pool via a channel.

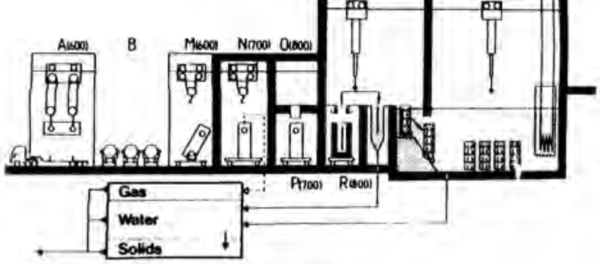

Fig. 2. Spent Fuel Dry Unloading Facility.

Once the unloading operation has been completed, the plug is replaced, the connection device is retracted, and the cask is transferred to the cask treatment station. There its internals are rinsed and dried, and the cask is monitored for external contamination prior to reshipment. Any maintenance required on the casks, such as seal replacement, can be performed remotely at the cask maintenance shop in the AML receiving facility.

Maintenance Capabilities

One of the requirements with respect to maintenance at the La Hague reprocessing plants is that maintenance must be performed remotely wherever specific activity is greater than 5.10^{-2} Ci/m^3, in order to meet the design criteria relative to personnel exposure. Since specific activity in the TØ dry unloading cell is expected to exceed that limit, maintenance will be fully remote, as is the case for all of the hot cells at La Hague.

A maintenance cell is located above the dry unloading cell; the floor of the cell slides open to provide total access to the unloading cell during maintenance operations. It is equipped with a modular bridge crane, seven telemanipulators and a telescoping servo-manipulator, in addition to CCTV.

The equipment in the unloading cell--especially the process crane and the cask connection device--have been designed in modular form, such that any failed component can be easily removed and replaced by the maintenance equipment with minimum down time, usually in a matter of hours. The maintenance equipment is itself modular so that it can be maintained in the same manner. Failed components are removed from the cell in shielded casks to prevent the spread of contamination.

Technical Innovations

While the TØ facility maximizes the use of standard equipment, several innovative concepts were developed by SGN in order to satisfy the specific requirements of a large-scale dry cask unloading facility. These include:

- a cask-to-cell mating system that enables the cask to be opened without contaminating the outside of the cask or the outer face of the plug
- a remote and automatic modular process crane that is capable of recording fuel element coordinates inside the cask in order to adapt unloading operations to the specific fuel element configuration
- a monitoring robot to verify the absence of contamination from the shipping cask.

CONCLUSION

A substantial effort was undertaken at La Hague to decrease occupational exposure to well below allowable thresholds, while increasing the throughput to four times that of the existing UP2 reprocessing plant. The challenge was particularly strong at the front end, given the quantities and varieties of spent fuels scheduled to arrive. The TØ dry unloading facility now in operation at the UP3 is capable of handling the entire 800 MTU annual production load of the plant in a single line, with minimal cask turnaround time. Its automated, remote operations and its remote maintenance capabilities guarantee personnel safety while contributing to plant availability. The technical innovations implemented at TØ are adapted to large-scale, centralized spent fuel receiving and unloading facilities, and may be associated with dry storage or disposal of the fuel, such as in a monitored retrievable storage facility or a geologic repository.