FROM SHIPPING CASK TO INTERIM STORAGE: SPENT FUEL TRANSFER TECHNOLOGIES AT LA HAGUE

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ABSTRACT

The La Hague commercial reprocessing plants must be able to receive, unload and store a combined total of 1,600 MTU each year. This rate of reception required several innovative design concepts which have been successfully implemented at the NPH and T0 facilities to meet the dual goal of safety and high availability.

THE NPH CASK UNLOADING FACILITY

The NPH cask unloading facility has two underwater unloading lines with a total throughput capacity of 800 MTU/year. This facility is designed to receive 300 casks per year. Each line has a cask reception area, cells for cask preparation before unloading and after unloading and an unloading pool connected to the NPH storage pool. In the NPH cask unloading facility, the shipping cask is received and transferred in the preparation cell. The cask is provided with a skirt to avoid cask external contamination and damage. Hoists are connected to the skirt and the cask is cooled externally via its fins by circulating water through the annulus between the skirt and the cask. Prior to internal cooling, the cask is vented to detect any radioactive gas release. The detection of krypton 85 indicates the presence of damaged fuel in the cask and a special handling procedure is then applied. When the temperature and activity of water have reached acceptable values, cooling is stopped and the cask is prepared for transfer in the unloading pool. The cask is then immersed with the cask transfer crane, the lid is removed and the fuel assemblies are taken one by one and placed in stainless steel baskets. The major steps of the NPH unloading process are as follows :

- inspection of casks for irradiation and contamination; removal and inspection of protective covers;
- cask transfer to the preparation station before unloading;
- remote installation of a protective sleeve to prevent external contamination of cask cooling fins during immersion;
- connection to a process network to detect any Kr-85, cool the fuel assemblies and verify their mechanical integrity;
- partial unscrewing and removal of the cask end plug bolt; transfer of the cask and immersion in the unloading pool;
- removal of the cask plug; removal of the fuel assemblies by a jib crane and transfer to a storage basket; fuel assemblies are individually extracted by the operator;
- transfer of storage baskets to the fuel storage pool;
- final decontamination of the cask by a washing bell (covering the entire empty cask placed on a rotating stool) and fitted inside with high-pressure jets. This arrangement practically eliminates any necessity of manual decontamination.
- torquing the cask end plug bolt; draining and rinsing the internal cavity; drying of the cask internal cavity by vacuum evaporation and leak-testing after closure of orifices;
- preparation for departure (installation of protective covers and final irradiation/contamination inspection).

The first unloading line of the NPH cask unloading facility is being transformed and reused for cask dry loading of glass containers that will be shipped out to the customers of Cogema.

THE T0 SPENT FUEL RECEIVING/HANDLING FACILITY

The T0 spent fuel receiving/handling facility provides the structures, equipment, and services to receive, unload and transfer shipments of spent fuel assemblies for emplacement in storage. The T0 facility includes 1) a receiving and shipping building, 2) a cask preparation cell, and 3) a cask unloading and loading cell which features dry unloading of transportation casks (with a maximum residual heat release of 85 kw) with one cask connecting system, 2 fuel assemblies cooling pits, one fuel assembly handling crane, 4) one area for post-unloading cask operations.

Shipping casks enter the T0 receiving cell on a trolley which is positioned on a "go-between" rotating plate. This intermediate storage position increases the availability of the receiving area since a fully loaded cask can be stored in this area while an unloaded cask is shipped out. The necessary inspection, radiation monitoring and contamination monitoring are performed in the receiving and shipping area. Impact absorbers, weather covers and other cask shipping equipment are then removed with the overhead crane of the cask preparation cell.

A 130 ton rated capacity bridge crane is used to raise the cask onto a self-propelled dolly for the following operations, inspection of the cask closing systems, monitoring of the internal atmosphere of the cask cavities using special containment tools, detection of damaged fuel elements by a Kr 85 counting method in the cask internal cavity, removal of the cask cover and unscrewing of the cask plug, installation of the connecting devices for the connection operations with the unloading cell.

The cask is then transferred into the fuel unloading bay below the unloading cell. The connection between the internal cavity of the cask and the unloading cell is made by a connecting device which guarantees the necessary containment while limiting the surface contamination. The containment of the cell and of the cask cavity is provided by the connecting device and by the cask itself.

Once the cask is in the connecting position, a mechanical device is lowered from the cell and is connected to the cask. The cask plug is removed by a gripper and stored inside the cell. A special system ensures that the upper face of the plug remains clean during all unloading operations. After the cask is opened, the BWR or PWR spent fuel elements are removed from the cask one by one with a remotely controlled handling crane. The integrity of each fuel element is checked before being transferred to lag storage. When the unloading operations have been completed, the cask seals and plug are then replaced, and the cask cavity is rinsed and dried, using a vacuum pump and a cold trap. This operation is necessary to meet the specification set forth by the European Transportation Authorities as well as to prevent corrosion of the aluminum alloys used for certain internal cask structures. Monitoring of the irradiation and contamination levels of the cask is performed before the cask is loaded onto its carrier. The T0 facility features several items of advanced equipment design, such as: 1) the connecting device that allows opening of the cask without any contamination of the external surface of the cask and of the plug; 2) a remotely operated, seismically designed, fully stainless-steel lined spent fuel handling crane; 3) a monitoring robot to verify the absence of contamination from the shipping cask; 4) a self-positioning fuel assembly unloading robot; 5) a computerized spent fuel transfer system.

COMPARATIVE ASSESSMENT

A comparative assessment of the two facilities leads to the following observations:

Process flexibility: by design, the T0 facility handles only uniform standardized casks such as the TN 12/2, TN 13/2, TN 17/2 and LK 100 casks. In contrast, the NPH facility is more flexible and can unload all types of shipping casks, irrespective of their closure design, whether designed for dry or underwater shipping.

Production of effluent and waste: T0 limits significantly the volume of effluents produced as it omits the following two underwater unloading operations: cooling/rinsing of casks by circulating water before unloading, decontamination of the cask top and bottom, and accessories such as the skirt, submerged lifting beam, etc. Only the docking hardware can be contaminated. Operating experience has demonstrated that the dry process reduces the volume of liquid effluent by a factor of 3. There is also a reduction in the volume of low-level solid waste produced as a by-product of decontamination after cask unloading. The volume of solid waste per cask is reduced by a factor of 2.

Failed fuel detection: at NPH, inspection for failed fuel rods is performed during preparation for cask unloading when the total Kr- 85 activity is determined and internal cavity cooling water activity is measured. Individual assemblies with failed rods cannot be identified and when failed fuel is detected, all of the fuel assemblies of the cask must be segregated in bottles. In contrast, T0 allows identification of individual failed fuel assemblies during the rinsing/cooling phase which is performed in individual pit.

Cask processing time: past operating experience has demonstrated that preparation time before and after unloading is shorter in the T0 facility that in the NPH facility. However, the high degree of automation used at T0 during unloading operations reduces partially or totally the time savings. When a cask with 32 BWR assemblies is processed, the time required for the full cask processing cycle is about equivalent in both facilities. For PWR fuel casks, the time gained per cask at T0 is between 1 and 1.5 shifts (8 hrs to 11 hrs).

Radiation exposure: the dry unloading process requires fewer operations in direct contact with the casks and operations are controlled remotely from the control room. Operating experience has demonstrated that operators receive about three times less exposure at T0 than at NPH.

Safety: at NPH, the casks are transferred to the different work stations by a 1,300-kN crane. Therefore, strict controls and safeguards implementation are required to cope with the consequences of cask drops particularly in the cask unloading pool. At T0, use of the 1,300-kN crane is limited to loading and unloading casks on the self-propelled lorry, which significantly limits the risk of cask drops. In addition, the dry process eliminates the risk of criticality accidents, but there may be a risk of disseminating contamination in the hot cell following a fuel rod failure.

The dry process requires safeguards to prevent overheating and damage of fuel. The objective is to limit the temperature of the fuel assemblies in all possible configurations (including immobilization of casks or fuel assemblies in the hot cell).

At T0, the types of operations performed and the systems provided to ensure containment integrity eliminate the risk of external contamination of casks. At NPH, external contamination cannot be prevented (See Table I).

TABLE I
La Hague Spent Fuel Unloading Facilities Operating Results

	NPH	T0
Total number of unloaded casks since start-up } as of 09/92	1830 casks	944 casks
MTU unloaded } as of 09/92	7360 MTU	5000 MTU
Maximum number of casks unloaded in a year	240 casks	200 casks
Number of operators per shift	10 operators	8 operators
Average personnel dose mSv/year	1.25 mSv/year	0.45 mSv/year
Fuel assemblies unloading: personnel dose rate mSv/year	0.8 mSv/year	0 mSv/year
Volume of liquid effluents	30 m^3/cask	10 m^3/cask
Activity of liquid effluents	1.85 gBq/m^3	1.85 gBq/m^3
LLW solid waste	1.2 m^3/cask	0.6 m^3/cask
Total Processing time including cask preparation before and after unloading (15 and 25 hours)		
TN 12 (32 BWR)	78 hours	78 hours
TN 17 (12 PWR)	70 hours	59 hours