EDF, a Utility and Its Own Needs in the Field of Transport of Nuclear Materials

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I INTRODUCTION

As one of the most important producer of nuclear electricity in the world, EDF is concerned by all the aspects of the transport of nuclear materials and more particularly by those related to the nuclear fuel cycle. EDF is not itself a specialist in this field and most of the transports along the nuclear fuel cycle is done for our own account by our usual partners such as COGEMA or TRANSNUCLEAIRE.

Since the beginning of the french nuclear program, we have generally used for these transports casks that already exist on the market and which were well suited to our needs. Nevertheless, new and specific needs appeared during the progress of our nuclear program and have lead us to:

- study and build new casks or packages,
- use existing casks for new purposes,
- develop a device for the measurement of fuel assemblies burn up,
- develop a software to optimize the evacuation of irradiated fuel for reprocessing.

The purpose of this paper is to describe these realizations but as a preliminary, we will present briefly the importance of the transport of nuclear materials for EDF.

II THE TRANSPORT OF NUCLEAR MATERIALS AT EDF

In 1989, EDF has 47 Pressurized Water Reactor (PWR) connected to the grid that must be supplied with new fuel and whose irradiated fuel and wastes must be evacuated at the right time. This represents annually, at the moment, about:

- 170 to 270 shipments by road of new fuel assemblies,
- 120 shipments by rail of irradiated fuel to the reprocessing plant of LA HAGUE,
- 32 000 packages of various type of wastes that must be transported by road or rail to THE MANCHE disposale site and from 1991 to THE AUBE disposal site.

Table 1

Transports of nuclear materials to and from EDF's PWR

		1986	1987	1988
Number of fresh fuel assemblies delivered	U	2655	2709	1670
	MOX		16	32
Number of irradiated assemblies sent to LA HAGUE		1137	1354	1403
Number of packages of LLW sent to the disposal site		31210	32700	31390

In addition to the transports concerning PWR's, we must also mention the transport of nuclear materials related to the Gas Cooled Reactors (GCR) which must also be supplied with new fuel assemblies and whose irradiated fuel must also be evacuated. Since the decision of stopping these plants by 1994 has been taken, these transports will reduce progressively, but they still represent annually, about:

- 30 to 40 shipments by road of new elements,
- 70 to 80 shipments of irradiated fuel elements to the reprocessing plant of marcoule.

To these transports concerning directly the operation of EDF nuclear plants, we must add the transports of nuclear materials all along the fuel cycle (UF6, Plutonium oxide, reprocessing wastes....) which are done for us generally by COGEMA.

The data mentioned above show the importance for EDF of transport of nuclear materials even if, on the financial aspect, it represents only a slight part compared to the others stages of the nuclear fuel cycle. The casks or packages used for the transport of nuclear materials of EDF are generally the same as those used for this purpose elsewhere in the world; they are:

- 30-B and 48-Y cylinders for the shipment of UF6,
- RCC-3 or RCC-4 for the shipment of new uranium fuel assemblies,
- TN-12, TN-13 or LK-100 for the transport of irradiated fuel assemblies,
- 200 litres drums or concrete packages of various sizes for the transport of the Low Level Wastes produced by out plants.

III SPECIFIC NEEDS FOR EDF IN THE FIELD OF TRANSPORT OF NUCLEAR MATERIALS

All the casks or packages above-mentioned, although well suited to our needs, have been designed for most of them before the implementation of our PWR plants.

New needs arised connected with the necessity of being able to send various irradiated or contaminated materials for examination to our "hot-cell" laboratory situated on the site of CHINON, the repair of damaged fuel assemblies, the use of higher enrichment of uranium in our fuel, the great number of data that has to be taken in account to program the evacuations of irradiated fuel assemblies to the reprocessing plant or the Plutonium recycling in PWR.

3.1 Examination of irradiated or contaminated materials

EDF has, on the nuclear site of CHINON, a "hot-cell" laboratory (SCMI: Service de contrôle des Matériaux Irradiés) that can perform all type of destructive or non destructive examinations of contaminated or irradiated materials. For this purpose, ROBATEL has developed for EDF a type B cask, the ROBATEL R-62 (figure 1 and 2), which can transport in dry or underwater conditions:

- an irradiated 17 x 17 PWR assembly, safe or with a few leaking rods,
- a control rod assembly, a burnable poison assembly, a thimble plug assembly or a neutron source assembly,
- various pieces of contaminated or irradiated materials (control rod guide tube support pin, fuel rod, ...).

The radiolysis tests made in order to qualify the R-62 for underwater transport of fuel assemblies has been published in the previous PATRAM [e.g. ABASSIN et al. 1986]. The main characteristics of the R-62 are summarized in Table 2.

Table 2

Main characteristics of the ROBATEL R-62

outer lenght		6645 mm
outer diameter		1500 mm
overall weight when loaded		37.5 tons
maximum enrichment of the fuel transported		3.5 w/o u235 in u (*)
residual heat allowed	*dry*	6 kw
	underwater	14 kw

(*) : an enrichment of 4.5 % is allowed under certain circumstances

During the last two years, we have performed, with the R-62, the shipment to the SCMI for examination of:

- an irradiated assembly from the site of TRICASTIN,
- irradiated fuel rods, control rods or instrumentation guide tubes from GRAVELINES, TRICASTIN, DAMPIERRE and BLAYAIS.

3.2 Repair of damaged fuel and use of partially irradiated fuel

Up to now, according to our policy and if they respect the reloading criterions, most of the leaking fuel assemblies of EDF are reloaded in core without greater consequences. Nevertheless, a repair of the damaged assembly can sometimes be necessary and the reasons are:

- leakers which exceed our reloading criterion,
- grid damages as a consequence of handling difficulties,

- severe damages induced by baffle jetting or loose parts migrations.

Since these assemblies are generally scattered among the different plants of the same nuclear site, it is attractive to gather them together in the same pool for their repair in order to optimize costs, time operation and occupational doses [e.g. PONTICQ et al. 1987]. Therefore at EDF, we perform underwater transfers of irradiated fuel assemblies in order to minimize the risks of damaging the fuel cladding. These transfers are carried out with the ROBATEL R-62 above-mentioned or the TRANSNUCLEAIRE TN-12 which is the normal cask used for shipping fuel assemblies to the reprocessing plant.

The TN-12 is used when there is an incompatibility of the plant concrete structures with the R-62 or when the number of fuel assemblies that has to be transferred is high. Since the TN-12 has been designed for use in dry condition, as a consequence, its use for the transfer underwater of damaged fuel assemblies require a suitable procedure that has been realized in collaboration with COGEMA.

Sometimes, special needs related with core management studies also require underwater transfer of fuel assemblies between plants of the same site. That was the case at GRAVELINES where a transfer of two 4.5% enriched assemblies with the R-62 between two plants have been carried out. The characteristics of the transfers we have carried out, up to now, are summarized in Table 3.

Table 3

Underwater transfers of irradiated fuel assemblies carried out at EDF

Cask	*Site*	*Number of transfers*	*Nb of ass transfered*	*Enrichment (% U235 in U)*
R-62	*Tricastin*	2	2	3.25
	Gravelines	4	4	4.5
	Dampierre	1	1	3.25
TN-12	*Bugey*	1	3	3.25
	Fessenheim	2	4	3.25

In addition, for these transfers between plants of the same site, the radiolysis problem can be neglected since the time required to carry them out is very short, generally less than one week.

3.3 Measurement of fuel assemblies burn-up

Since 1985, EDF has begun to switch from a 3.25% w/o U235 in U enriched fuel to 3.7% enriched fuel in its 900 MWe units and a prototype irradiation program of several 4.5% enriched assemblies is also under way.

The casks used presently to send irradiated fuel assemblies to the reprocessing plant have generally been designed for the transport of fuel assemblies with an initial enrichment of less than 3.5% in U235 w/o. Thus, to avoid any criticality problem during the transport and at the reprocessing plant, the demonstration that an appropriate burn-up has been reached will probably be necessary.

That's why EDF has started to develop, in collaboration with the french CEA, a device (figure 3) to measure the burn-up of the fuel assemblies. A prototype of this device, based on the measurement of the neutron and gamma rays emitted from the spent fuel, will be tested soon on the site of TRICASTIN.

3.4 Development of a software to program irradiated fuel assemblies evacuations

The elaboration of the program of irradiated fuel assemblies evacuations to the reprocessing plant of LA HAGUE is becoming a complex operation when one has to take into consideration:

- the high number of plants in operation,
- the increase of the number of assemblies that must be evacuated,
- the limited number of casks,
- the specific constraints of the plants (for example, a plant cannot have an evacuation simultaneously with a delivery of new fuel assemblies or two evacuations of irradiated fuel cannot be done simultaneously on the same site).

For all these reasons, a software has been developed by EDF in order to be able to optimize the use of the casks, hired from COGEMA, and to take into account any new constraint appearing on our plant (figure 4).

3.5 Plutonium recycling in PWR

EDF decided in 1985 to recycle plutonium in its PWR and the first reload of 16 mixed-oxide assemblies was delivered to the plant of St-LAURENT B1 at the end of 1987. The presence of plutonium in the assemblies induce two kinds of technical difficulties which are:

- need of an appropriate neutron shielding,
- need to evacuate the heat produced.

So, TRANSNUCLEAIRE and COGEMA had to design a new package [e.g. LENAIL et al. 1988] which had to respect not only the transport regulations but also the specific constraints of EDF which were the following:

- the overall weight of the cask must be less than 5 tons due to the characteristics of the auxiliary bridges of EDF plants,
- the dose received by the staff during the unloading of the assemblies must be the lowest possible.

An active collaboration between all the partners concerned by this program of plutonium recycling at EDF has allowed TRANSNUCLEAIRE and COGEMA to design and build up on time a new type B/F cask, the FS-69, which satisfy the transport regulations as well as EDF's specific constraints.

The FS-69, which can carry two fuel assemblies with a maximum content of about 38 Kg of plutonium, is made of:

- two half-shells (the upper part can be removed for fuel loading and unloading),
- an internal arrangement which is very similar to the RCC packages used for uranium fuel, except that there is a shell covering each assembly in order to minimize the dose received by out staff during the manipulations of the unloading phase.

IV CONCLUSION

These few examples show the necessity for a utility like EDF to have an interest in the field of the transport of nuclear materials taking into account the appearance of specific needs since the beginning of our nuclear program.

This will be more true in the future, especially:

- for the transport of irradiated MOX fuel assemblies,
- and in the field of wastes where we are presently broaching a reflexion on the conditioning and the transport of the LLW produced by our nuclear plants [e.g. CELERI 1988].

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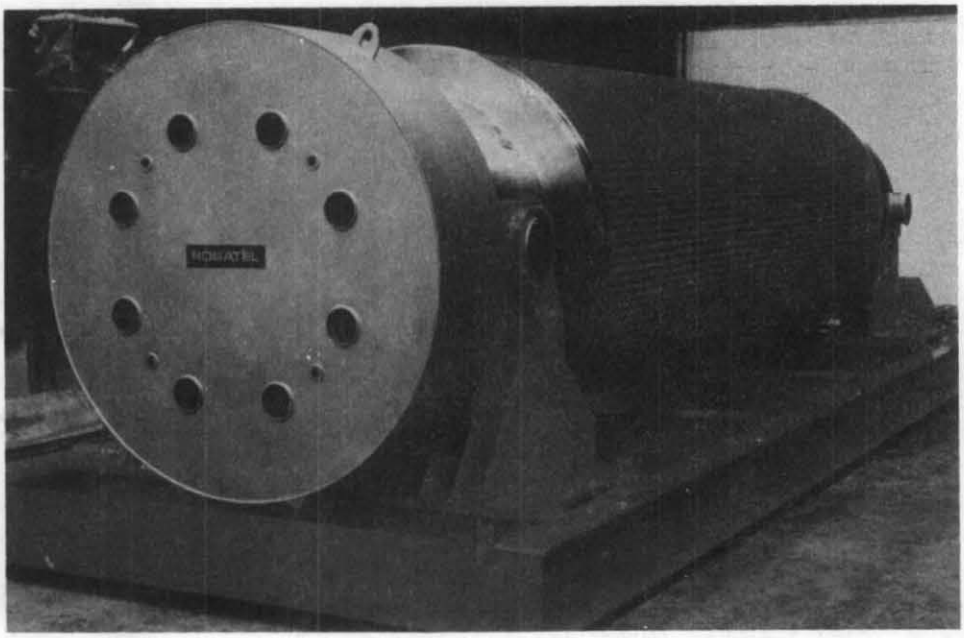

Figure 1

The cask ROBATEL R-62

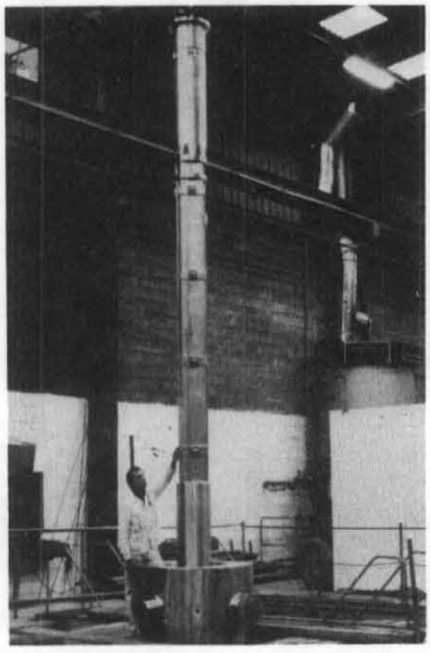

Figure 2

Loading into the R-62 of a " carquois " containing irradiated fuel rods for examination at the SCMI-CHINON

Figure 3

Device for the verification of the burn-up

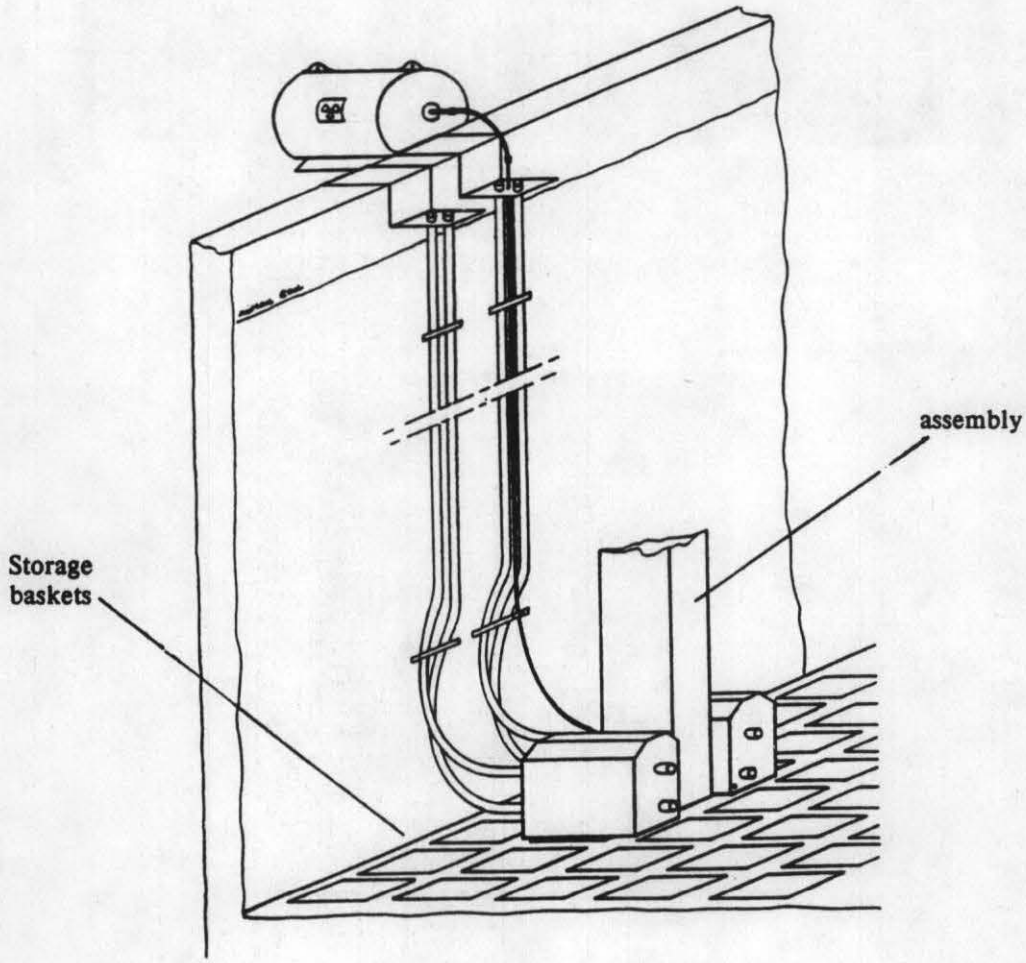

Figure 4

Optimization of irradiated fuel assemblies evacuations

to the reprocessing plant of LA HAGUE