FEEDBACK FROM OPERATIONAL EXPERIENCE IN FRONT-END TRANSPORTATION

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SUMMARY

Transport forms an integral part of the nuclear fuel cycle, representing the strategic link between each stage of the cycle. In a way there is a transport cycle that parallels the nuclear fuel cycle. This concerns particularly the front-end of the cycle whose steps - mining, conversion, enrichment and fuel fabrication - require numerous transports.
Back-end shipments involve a handful of countries, but front-end transports involve all five continents, and many exotic countries. All over Europe such transports are routinely performed with an excellent safety track record. Transnucléaire dominates the French nuclear transportation market and carries out both front and back-end transports.
For instance in 1996 more than 28,400 front-end packages were transported as well as more than 3,600 back-end packages.
However front-end transport is now a business undergoing much change. A nuclear transportation company must now cope with an evolving picture including new technical requirements, new transportation schemes and new business conditions.
This paper describes the latest evolutions in terms of front-end transportation and the way this activity is carried out by Transnucléaire, and goes on to discuss future prospects.

INTERNATIONAL MOVEMENTS

Transportation of front-end nuclear materials is characterised by two main features:

- it is a world-wide business,
- it uses classical transportation means.

A world-wide business

A large flow of material comes from or goes to various countries all over the world. At the very first step of the fuel cycle for instance, concentrates, under the form of yellow cake or U_3O_8, are received from supplying countries like the C.I.S., South Africa, West Africa, Canada, Australia, The Czech Republic and Namibia. These materials are mostly shipped by sea in liner vessels to a European port and then routed by rail to the Malvesi conversion plant or by truck to the UK. Other material can be transported by rail from continental European countries.

In 1996 Transnucléaire shipped 26,500 drums of U_3O_8 representing 7,560 tons of uranium.
After conversion to UF_4 the uranium is trucked in tankers to the facility in Pierrelatte where it is transformed into natural and then to enriched UF_6. Natural UF_6 also arrives directly by ship from Canada.
The natural UF_6 produced in France is sent to the enrichment facilities mainly in Japan, Europe (Germany, the Netherlands and Great Britain) as well as the United States.
In 1996 Transnucléaire shipped 600 type 48Y cylinders representing a total of 5,100 tons of uranium or 7,500 tons of natural UF_6 and 1,220 type 30B cylinders representing 1,880 tons of uranium or 2,745 tons of UF_6.
After enrichment UF_6 is transferred to the fuel fabrication plant. The fabricated nuclear fuel can then be delivered to the Nuclear Power Plants as fresh fuel assemblies. Although both road and rail are used for this particular purpose, fresh fuel assemblies are mainly delivered to the French nuclear power plants using road vehicles. Only 10% to 20% of these transports are performed by rail. French NPPs also receive fresh fuel assemblies by road from Sweden, Spain and Germany.
In 1996 Transnucléaire shipped 775 packages containing fresh fuel assemblies, representing a total of 1,550 assemblies, to French and foreign NPPs in countries such as Sweden, Belgium and South Africa.

Classical transportation means

Current front-end transportation has two main characteristics which are (a) the technical means and (b) the shipment outline.

(a) Three kinds of packages - all multimodal - are routinely used in front-end shipments whether for non-fissile or fissile materials: industrial type packagings, type A packagings and type B packagings. In this framework, Transnucléaire mostly uses:

- For U_3O_8 = 55 gallon industrial steel drums.
  are usually loaded into a 20' container which holds 14 tons net of material.
- For depleted and natural UF_6 = 48Y cylinders.
  A new protection concept is being considered and studied by Transnucléaire.
- For enriched UF_6 = 30B cylinders. These packages can be used for road, rail and sea shipments to Russia, USA, Japan, Sweden, U.K. and Germany.
  Transnucléaire is studying a new protective overpack design for the 30B cylinder.
- For UO_2 powder or pellets = BU-J, BU-D, GB-1660, DHTF are mainly used.
- For PWR fuel assemblies = RCC. In France, the RCC concept (MCC-4, RCC-3 and RCC-4) is the only presently approved package for PWR fresh fuel assemblies.

(b) Nevertheless, in spite of this diversity, most front-end transports are carried out using standard transport means. In effect, a packaging filled with front-end cycle material can often be shipped using regular lines, multipurpose railcars or vehicles which might transport at the same time other kind of goods. This remark also applies to transfer and handling points such as harbours or railway stations. In other words, these transports do not fundamentally differ from non-radioactive materials when transported or handled. Still, several growing evolutions lead to think that this transportation framework is changing.

STRENGTHENING TECHNICAL CONDITIONS

Although safety and security restrictions, as well as regulations, have not been as severe in the past as for back-end products, these aspects become increasingly important. This concerns technical aspects of transportation, and especially concerning the transportation means themselves.

48Y cylinder

In the past years, several front-end packagings have shown - during highly detrimental simulation tests - that they would not resist to the most violent of prescibed accidental conditions without losing all or a part of their integrity. The 48Y, one of the most used container designs (around 100,000 of them exist of which 80 % in the United States) was one such case.
The new 1996 edition of the IAEA regulations will be made applicable on 1st January 2001 and will be more severe for front end transports. The main new item concerning the 48Y, is the need to withstand, without rupture of the containment system, the same thermal test which applies for type B packages (exposure to an all-engulfing fire for 30 minutes in conditions which give an average temperature of at least 800°C). The franco-japanese program TENERIFE has set out a series of tests and has demonstrated the incapacity of the 48Y design to resist this thermal test: the cylinder seemed to withstand the high temperature, but not for 30 minutes. Transnucléaire has thus decided to study a new protection concept for the 48Y in order to satisfy the new AIEA regulations. The results of testing should indicate if new thermal protection must be added to the existing.
One of the consequences will be the strengthening of these packagings, which will involve a reevaluation of the transportation system and might also involve cost increase.

30B overpack

30B cylinders are used for transportation of enriched UF_6. Because they contain fissile material, these cylinders have to be transported inside outer protective packages. Several problems met in recent years (corrosion of steel in some types of overpacks, fragility of valve inside the skirt of the cylinders...) have conducted different competent Authorities in the world to perform further technical tests (drop tests, etc...), to justify the maintaining of a subcritical configuration. The results of these tests have jeopardized the validity of some pending agreements, especially regarding the protection of the cylinder valve.

Solutions have been found with coordination between Competent Authorities and different nuclear companies in order to allow shipments of enriched UF_6 to continue and after many tests controlled by USEC and the U.S. Authorities a valve protection device « VPD » has been qualified.
Due to some subsequent delay in the fabrication of these new VPD in the USA, Transnucléaire decided to develop its own VPD design which has been approved by the French and European Competent Authorities and operated since June 1997.
However, considering the difficulties met in the adaptation of these VPD and anticipating the oncoming regulations in terms of physical protection, Transnucléaire also decided to develop a new kind of overpack in the long term which would allow all shipments of enriched UF_6 issued from either natural processing or reprocessing.

Drop and fire tests on the new overpack design have already been successfully performed. The Safety Analysis Report was submitted in late 1997 to French Authorities and the corresponding package approval should reasonably be obtained during the summer of 1998. Then production of overpacks can start in the last quarter of 1998 and first application for validation in other countries are already in progress.

TN UO_2

Transnucléaire is also developing a new package system for the transport of UO_2 in powder and pellet form enriched up to 5%, The design will be type AF according to 1985 and 1996 radioactive materials transport regulations and made with stainless steel and including thermical protection.
This container will contain high density polystyrene bottles and is aimed to replace all the different types of drums like GB-1660, BU-J, BU-D, DHTF, etc....
It is still a prototype but the first tests were scheduled for April 1998 and production should start in 1998.
The fact of being able to transport many different kinds of products in one single type of package should reasonably involve a reduction of management and transportation costs in the near future.

The RCC experience

RCC packagings have proved their ability to perform fresh fuel transports over thirty years. The packagings were first manufactured for Westinghouse, and then for Framatome and FBFC for supply of PWR plants.
Nowadays, there are 250 packagings in France for FRAGEMA delivery needs. The RCC package design has been upgraded according to French Competent Authority requests in order to ensure its full compliance to IAEA recommandations. A modified RCC package design is under qualification, while national and international shipments are still made using present RCC packagings under restrictive conditions of transport and with application of compensatory measures.

In the last year Transnucléaire organised a meeting between EDF and its various fuel vendors which allowed to discuss French Competent Authority remarks and to propose technical solutions.

Experience in Transhipment of cargo

For front end transportation, transhipment means are mostly classical, and are the same as those used for other goods. This system has its limits. It is not perfectly tailored to front-end transhipments and this is why the need for more dedicated ways of operation becomes a necessity.
In this framework, today, every transhipment of cargo is inspected by specialists. Transnucléaire always provides inspectors on site who are present at all loading and unloading operations, especially at Le Havre or at other ports.
All these examples show that for front-end shipments the technical aspects linked to packages, the material transported and the regulations become increasingly important.

A CHANGING MARKET

In order to be prepared to meet these new challenges which are of utmost importance, Transnucléaire is currently implementing a comprehensive front-end transportation system taking into account the latest changes whilst increasing the economic opportunities for its clients.

An evolving transportation solution...

As underlined above, transportation of front-end materials is a complex, international activity with large quantities of low activity materials shipped in common transport means. In this area, the competition is severe and the prices are low. Nevertheless, the front-end transportation activity undergoes several significant changes. More than ever this activity, mainly involving spot international shipments, meets technical problems similar to the back-end shipments, which are industrial logistical movements.
Transnucléaire has already taken specific steps to address this challenge. They can be summarised as an adaptation of the back-end system to some front-end specificities. The use of transport means (truck, wagons, vessels...) dedicated to radioactive transports is one of the industrial solutions which Transnucléaire has engaged.

A made-to-measure program

A lively example is provided by maritime transports. For years, quantities of U_3O_8, UF_6, UO_2 powder or UO_2 fresh fuel assemblies have been shipped from various countries to France. As the market was highly competitive, liner ships were extensively used in order to lower the price. Nevertheless, several uncertainties have rendered such transport operations more difficult.

Among these, one can quote:

- unreliability of sailing schedules,
- port handling means non compatible with packaging and transported materials specifications,
- no possibility of tracking the shipped materials,
- physical protection requirements are sometimes required,
- insurance and flag problems,
- transit or transhipment in an unexpected port.

Satellite tracking adapted to all transports, front-end as well as back-end, provides another layer of safety (in routine service or safety cases), physical protection and public acceptance matters. Today Transnucléaire operates about 50 vehicles and 2 ships each fitted with a satellite tracking system. A 24 hour live control room, associated with the emergency plan, increase the reliability of this system.

CONCLUSION

As in any business sector, pressure is mounting on nuclear transportation service suppliers. What makes this business rather unique is that safety and reliability are key features. The current trends are likely to render these issues more significant than ever. In this framework, industrial nuclear transportation companies must offer a broad and attractive series of flexible services in order to match the clients needs.

Transnucléaire has developed a comprehensive transport organisation system, relying on well-mastered procedures and capabilities. Today, this system allows to respond to the ongoing front-end transport evolutions.

The adaptation of dedicated back-end practices to front-end transports allows to offer a further increase in safety and reliability levels.