10 years of transport of vitrified High Level Waste (HLW) from COGEMA La Hague

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The Residues Returns Obligations:

COGEMA has been using, for decades, its large experience of Reprocessing in both Gas Cooled reactors (GCR) and LWR fuels with the following facilities:

- Marcoule UP1 plant started up in late 50's
- La Hague UP2 plant started up in 1966 first with GCR fuels and from 1976 with LWR Fuel (including foreign fuels)
- La Hague UP3 plant started up in 1990

Foreign Utilities signed Reprocessing Contracts with COGEMA from 1970's, providing returns of residues to the country of origin where they will be managed in a safe storage facility. Therefore, for nearly 30 years Spent Fuel coming from Japan, Germany, Belgium, Switzerland and the Netherlands are processed on La Hague site.

LWR spent fuels are typically made of 96% Uranium, 1% Plutonium, 3% of fission products and other actinides and structural pieces. Uranium and Plutonium are valuable energy resources which can be recovered (through reprocessing) and recycled into new fuel. The ultimate waste separated, sorted out and then safely conditioned for foreign returns, are of several types :

- Fission products containing 99 % of the activity are conditioned in universal canisters in R7/T7 facility
- Hulls and End pieces are compacted in universal canisters in ACC facility
- Technological waste are compacted in universal canisters in ACC facility
- Sludges, coming from the La Hague effluents processing, were conditioned in bituminized drums in STE3 facility. It has to be pointed out that the on-line conditioning significantly decreased from 1995 following an optimization of the effluent process.

The two first categories come directly from the fuels and the two last ones come from the fuels processing.

Efforts were made by COGEMA to reduce the overall volume of residues from 3 m^3/tU, which was the anticipated volume in the design of the UP2 800 and UP3 facilities to 0,4 m^3/tU, which is the volume obtained thanks to the very good performance of the processes.

In addition to these contractual obligations, COGEMA has a legal obligation to return the residues to the foreign owner. Indeed the French Law n° 91-1381 of December 30, 1991 stipulates that :

"the storage of imported waste, beyond the technical time dedicated to the Reprocessing, is forbidden on the French territory".

Most of the activity (99%) being contained in the vitrified residues, it was decided to return in priority this type of residues.

The vitrified residues : A safe conditioning and a mastered technology

- Fission products and actinides are Highly Active Waste :
- Fission products are highly radioactive (but mainly for a relative short period)
- Actinides will remain radioactive for several thousands years by lower activity

Therefore it is necessary to transport and to dispose them safely, and to ensure they will remain safe for several thousand years. This waste will be stored in underground geological repositories.

Borosilicate Glass was selected to incorporate these high radioactive wastes because of its amorphous structure particularly suitable for immobilizing in a solid form, the Fission products and the Actinides, as well as more than 30 different chemical elements present in the waste.

The vitrification process used at La Hague (the so-called AVM process "Atelier de Vitrification de Marcoule") consists in calcinating fission products and melting it with glass frit into a metallic furnace.

The vitrified waste has the following advantages :

- Mechanical and thermal stability
- Homogeneity
- Radiation resistance
- High containment capacity, low volume
- Corrosion resistance, low leachibilty
- Easy fabrication (mastered technology)
- Flexibility with respect to the composition of waste to be conditioned

The molten glass product is poured into the stainless steel canister for an average volume of 150 l and 400 kg of glass, leading to a total weight of about 490 kg per canister. The outer dimensions are 1,340 mm height and 430 mm diameter.

The production is controlled :

- by the COGEMA Quality Assurance Department who implement stringent quality assurance and quality control programs, focusing on the quality of the glass components and on the process control during glass production
- by ANDRA who is in charge of the final disposal in France, so it includes the control of the quality of the residues produced at La Hague. ANDRA has to check that the parameters of all vitrified residues comply with the glass specification
- by a third party (Bureau Veritas) entrusted by the Customers to evaluate the COGEMA's measures to maintain the specified residue quality

In addition to these controls, the foreign authorities regularly come at La Hague for surveying missions, checking the records and quality measures implemented by COGEMA.

After its production, the canister is certified by COGEMA and by Bureau Veritas, who both examine the conformity of the canister production characteristics (recorded in the Canister Quality File) to the guaranteed parameters of the HLW specification (as of today, less than 5 % of the total production does not meet the specification).

The canister is temporarily stored in La Hague pits waiting for transport to the site selected by the customer.

The overall preparation of the returns:

From 1977, COGEMA started the overall preparation of these returns. The Reprocessing Agreements signed between the Customers and COGEMA specify that:

- The waste must be conditioned in a form suitable for the transport and final disposal
- The relevant specification of the residues must be agreed

These agreements also called for accounting rules to be established in order to notify quantity of residues to be returned to each customer.

The following actions were conducted :

1. The conditioning process :

   The conditioning facilities for Vitrified Residues were respectively commissioned in 1989 for R7 facility and in 1992 for T7 facility.

2. Approval of the COGEMA process by the French and Foreign authorities

   The vitrified residues specification was approved in France in 1986, in Germany and Switzerland in 1988, In the Netherlands in 1989, in Japan in 1990 and in Belgium in 1992. Bilateral governmental letters were exchanged with most of the countries to consolidate the legal strength of the obligations already signed between the industrial partners.

   The approval of the specification was subordinated to a process qualification by foreign authorities like Germany (PkS acting on behalf of BfS, checked and accepted the "handbook of process qualification" which consisted in an independent review of the vitrification process) and like Belgium (ONDRAF qualified the vitrification process and the vitrification facilities).

   The customers and authorities task is to check whether the residues respect the regulations imposed on the foreign territory for the interim storage but also for the long term final disposal (with respect to the criteria already defined today).

3. Implementation of the U. R. ("Unité Résidus") accountancy system

   This system was implemented, from 1992, to permit the residues allocation and physical attribution to the customers. This system relies on the "Code of Waste Management" (CWM) whose guiding principles are :

   - Implementation of a quality assurance system
   - Auditable system
   - Consideration of the French Law of 30/12/1991
   - Rules defined with customers
   - Accounting system based on simple and already implemented principles
   - Fairness distribution of the residues between customers

   This analytic accountancy system permits to characterize the residue in URPF (Unité Résidu Produit de Fission), allocate the UR to each customer depending on the Reprocessing actually done for each customer and physically attribute canisters to the customer.

The UR accounts (shown in the so-called "UR Register") are certified each year, by a third party "Bureau Véritas" acting on behalf of the customers and audited by APAVE acting on behalf of the French Authorities to check that the UR accounts respect the legal and the contractual obligations.

4. Establishment of the administrative process to be applied to organize the returns

A lot of administrative authorizations are necessary to permit the returns :

- Generic license for the foreign receipt site. The German Gorleben site (40 years storage minimum) and the Japanese Rokkasho Mura site (30 to 50 years storage) were licensed for HLW receipt in 1995, the Belgian Dessel (75 years storage minimum) site in 1996, the Swiss Zwilag site (40 years storage) in 2001 and the Dutch Covra site in 2003 (40 years storage).

- The clearance for destorage which reflects the acceptance of the selected canisters for receipt on the Foreign territory

- Flask approval certificate in France, in the countries the flask has to pass through and in the destination country. The Flask designer applies safety report in each country for that purpose.

- Waste transfer document (Euratom directive 92/3 of February 3, 1992) aiming at authorizing the transfer of waste between countries. COGEMA applies to the French Authority who contacts the foreign Authority for formal agreement

- Export license. COGEMA applies to the French Authority who contacts the foreign Authority for formal agreement

- The transport plan describing the transport conditions.

- The French transport authorization resulting from discussion between the French, the foreign authorities and the industrial partners.

- The foreign transport authorizations (specific in each foreign country)

- The clearance for transport based on the results of the canisters destorage and flask loading, the customer check with the receipt site and with his authorities that the consignment can be received on the foreign territory.

In addition to these administrative documents, a consensus has to be reached for the transport date and route. Bilateral (for Belgian, German and Swiss cases) and trilateral governmental meetings (in Dutch and Japanese returns) are organized, upon need, to permit the industrials and the authorities to present their own constraints.

5. A destorage facilty

COGEMA adapted the NPH facility (used as a central spent fuel unloading station) and created a facility dedicated to destorage (the so-called "DRV"). The commissioning of this facility took place in 1994.

The foreign Authorities, the customer and partially Bureau Véritas witness the destorage and loading steps :

- Final control of the canisters *(visual inspection, non contamination controls, g and n dose rates and an Activity Release Test specific to the Japanese customers)*

- Loading and control of the flask

These representatives can acknowledge that the canisters and the flask are, respectively, meeting the destorage criteria and the transport and receipt site requirements (for Gorleben and Zwilag : T° and Dose rates around the flask are limited).

The results are included in the Canister Quality File "destorage part ". After the destorage controls, the canister is once again certified by COGEMA and by Bureau Veritas.

The destorage operations last 2 to 3 weeks (from the retrieval of the canisters from the vitrification pits to the control of the loaded flask).

6. Transport equipment designs and evolutions

6.1 Flasks

In the mid eighties, in order to transport canisters around the world in the best technical and economical conditions, designers started to design flasks that would be capable of transporting or transporting and storing in an interim way HLW canisters. Thermal power released by such canisters could possibly be going up to 2 kW after production according to COGEMA specification.

Solutions were proposed by both French and German designers.

One type of transport flask was proposed by COGEMA LOGISTICS, the TN28VT, with 2 basket designs allowing to transport either 20 canisters, releasing each one up to 2 kW for a maximum thermal output of 40 kW, or 28 canisters, with a maximum canister heat release of 1.46 kW each, and total heat output of 41 kW.

this flask was the first one to be loaded and transported (for German Customers).

One type of transport and storage flask was proposed by COGEMA LOGISTICS, the TS28, with a maximum heat output of 41 kW. This flask was the first one to be loaded with HLW canisters and transported to Germany.

These solutions gave utilities means to transport canisters back to their country, and to store canisters according to what was found as the most suitable solution:

- Either the canisters are unloaded from the transport flask, and stored in pits, as in Japan, Belgium and the Netherlands,
- or the flasks are put under interim storage configuration, as in Germany and Switzerland.

From the mid nineties, for the reasons described below, industrials started to design flasks with higher performance. COGEMA LOGISTICS proposed the TN 81and TN 85 flasks, with a target of 56 kW heat output, and increased activity contents.

6.2 Evolutions

The flask safety approval induces different type of constraints (activity, thermal power, weight, …) on the selection of the HLW canisters to be transported. These constraints usually remain stable in time, whereas HLW canisters characteristics tend to grow towards the specified production limits due to higher burn-up fuels being reprocessed (inducing higher contents on activity, such as Curium 244 for instance),

Adding to this the need to balance the URPF account, the specific criteria agreed upon with the customers (including the French customers even if they will not recover their residues in short term) and their Authorities for the acceptance on their territory (canisters filling rate and weight, Cs 137 activity, etc), the first generation HLW flasks did not permit a smooth selection process of all canisters.

The industrials launched in the mid nineties designs of new generation flasks with a target of 56 kW thermal output capabilities, and increased activity limits.

To this day, thanks to the common efforts of the involved industrials, a new type of generation flasks, the TN81, is loaded in La Hague, and will be returned to Switzerland in short term.

In parallel, industrials keep on working on other types of flasks such as TN 85, that should be available in the coming years, and enable a continuous flow of returns to Germany.

The other possible field of progress is the improvement of transport means to increase their heat output capabilities. Following investments were made :

- Thermal calculations to demonstrate the efficiency of road, rail or maritime transport means, with in some case a temperature measurement program of the flasks in transport configuration, in order to reduce conservatism of the calculation hypothesis when it is needed.

- Modification of Q70 rail wagons canopies to increase their thermal capabilities : Introduction in 2001 of “type C” canopies, that allow higher thermal powers.

- Paint of wagon canopies to reach higher emissivity factors on the surfaces, and obtain better thermal release capabilities.

With the development of new generation flasks, came the need for new generation wagons, with increased dimensional capabilities, higher canopy heat release performance, and higher payloads.

COGEMA LOGISTICS launched the development of Q76 wagons, with payloads around 118.5 tons under normal transport conditions at commercial speed of 100 Km/h, and 138 tons in exceptional transport conditions.

7. COGEMA LOGISTICS’ Global Acceptance activities for transports.

COGEMA LOGISTICS and the industrial partners involved in the international transportation of nuclear materials wish to increase the global understanding of these operations. COGEMA LOGISTICS and its partners and customers have been listening around the world to understand

local concerns and meet governments' officials, representatives of regional organisations (e.g. Pacific Island Forum, CARICOM, Association of Caribbean States), association members and media representatives. Transparency remains the mainstay of our information policy: we consider that we have the duty to make the relevant information accessible and continually assess the most appropriate way to achieve this.

Our national transports are implemented daily and there is no strong opposition to them any more. Things are different in the field of international transports. These transport operations meet and exceed the international regulation of United Nations bodies like the International Maritime Organisation (IMO) and the International Atomic Energy Agency (IAEA). They also comply with the requirements of national regulations of the countries involved in the transports. In spite of that, opposition to our international transports has developed in the nineties. Since part of the opponents were misinforming general public on our activities, it has become necessary to implement an adapted communication and information policy.
Considering the implementation of the Global Acceptance policy, information is issued on classical media as a website, some booklets (from our thick, all-inclusive "Information files" to 4 page-leaflets) and cd-roms. We also arrange contacts with the public we aim at and make presentations of our activity to various audiences: in June 2003, at the occasion of a mission in Panama, we met students from 2 universities as well as members of a business confederation, foremost scientists and high-ranking civil servants. As an illustration, the doors of the COGEMA La Hague reprocessing facility (France) used to be opened to the general public until the enforcement of post-11.09.01, exceptional security measures. The information policy we implement is even addressing scholars, trade union members and "Hygiene Security and Labour Conditions Committee" members – in March 2003, we had the pleasure to welcome national trade union representative from the French SNCF (national railway company) at some COGEMA sites. In foreign countries (e.g. Panama, Brazil, Equator), we issue a complete information on the details of transports in agreement with the Authorities.

Moreover, some information missions are frequently arranged and implemented locally by Global Acceptance officers, particularly to issue information on our maritime shipments. These missions take place all year long and at the time of transports – at present time, four to five missions take place abroad each year. They permit to initiate or maintain dialogue with foremost officials. Besides, media missions aim at informing the general public, throughout media. They give us the opportunity to bring answers to journalists' questionings and permit to speak to associations and groups of interest.

Global Acceptance policy enables our interlocutors to develop a better perception of our activity. Visits of our sites by officials, Authorities and media allow them to erase the misinformation they were previously facing, and most of the people we have been in touch with now recognise the safety of our transport operations.

The transport operations :

1) Transport programmes

The transport programmes were established in order to meet with various technical, administrative and financial constraints.

- Availability of the high level waste canisters to be returned, depending on the spent fuel reprocessing programme,
- Availability of the de-storage facility (facility where the HLW canisters are loaded into the flask) in La Hague
- Availability of the storage facilities in the different countries
- Definition of transport modes and transport means
- Availability of the flasks, compatible with canisters, transport means, and storage facilities

- Cooling of the HLW canisters, in order to meet the flasks acceptance criteria
- Cost optimisation

The main adaptation to the transport programme occurred in 2001, after the French and German Authorities requested to carry out one single transport of 12 flasks per year, rather than 2 transports of 6 flasks, given the high involvement of police forces during those transports.

After a 4 months technical and administrative feasibility study, the industrials concluded a 12 flasks transport per year was possible, provided an increase of transport means in France and qualified human resources (for road transfer) and transport means in Germany.

This first shipment occurred successfully in November 2002, a little more than one year after taking the decision.

Such a feasibility study is also underway with the Swiss industrials and Authorities to carry out transports of two flasks, instead of transports of one single flask at a time. This study has been launched by the industrials for cost optimisation. The result should come out in the summer 2004.

The current transport programme is now the following:

- Japan : One transport per year with up to 8 flasks
- Germany : One transport per year with up to 12 flasks
- Belgium : Two transports per year, with one flask
- Netherlands : One transport per year, with one flask
- Switzerland : One or two transports per year, with one or two flasks (depending on the result of the above mentioned feasibility study)

2) Optimisation of transport equipment fleet

The size of the transport equipment fleet was optimised taking into account the provisional transport programmes.

The fleet of transport flasks was determined taking into account the following considerations:

- For Japanese returns, a maximum of 8 flasks transported per year to Japan in one maritime voyage, taking into account the longer transport duration by sea, flask unloading and the necessary return of the emptied flasks by batches (cost optimisation) to La Hague for flask maintenance operations and re-loading. 12 TN28VT were manufactured for the Japanese HLW returns.

- For Belgium and the Netherlands, taking into account a total of 3 returns per year to both countries, one TN28VT was manufactured for both clients.

- For Germany and Switzerland, as the flasks are used for interim storage, the size of the fleet is simply the total number of canisters to be returned divided by the quantity of canisters per flask (28). Supply of 12 flasks per year for German needs is a challenge for the flask manufacturer, which has been achieved up to now.

Concerning the fleet of rail wagons, as the HLW shipments were at first marginal with regards to spent fuel transports, the existing fleet of 36 Q70 wagons was originally enough to carry out the returns.

In 2001, new investments were needed for carrying a 12 flasks shipment per year to Germany, instead of 2 transports of 6 flasks as previously done. The decision taken by the industrials was to keep temporarily using the existing fleet of wagons, and to invest in the fabrication of new transport frames, canopies and 10 new generation wagons (Q76).

3) Evolution of transport

Since the first returns in 1995, some events have lead the industrials to adapt their procedure for the preparation and carrying out of the transports.

- Non contamination controls

In particular, the interruption of spent fuel transports in Europe in 1998 during to the contamination crisis (due to lack of communication) has also impacted the procedure for non-contamination checks of HLW packaging as follows:

- Increased number and steps of contamination controls during transport.
- Increase of documentation to record the non-contamination controls performed at each step of flask transfer from on vehicle to another.
- Specific procedure for notification of the involved parties and Authorities in case of contamination findings.
- In the specific case of shipments to Germany, witness at Valognes of the transport documentation and records by the German Authorities before departure.

These modifications were contractually agreed between COGEMA and its clients in 2000 and 2001.

This event did not cause any delay in the return of vitrified residues, except in the case of Germany, as the discussions on the revised procedures, which started in 1998, ended in early 2001.

In the case of Germany, the provisions for the assessment of validity of these new procedures is divided in three phases. This process allowed to take into account return of experience in 2002 after one year of operation, and to reasonably reduce some controls thereafter.

The flask transport documentation file upon re-start of transports in 2001 included more than 300 pages at first, which caused to manage more than 1800 pages in total for each one of both transports organised in 2001.

It is now an easier document (around 90 pages) with a clearer structure, which prevents from confusing the important regulatory or technical aspects, with various records, that are now appended to the main parts.

Such reasonable and bilaterally approved reduction of non-contamination controls was progressively applied and approved for the other European HLW shipment, with some slight differences, depending on each country specific requests. This process is currently going on positively for the Japanese shipments.

- External focus on transport activities

A specific feature of the HLW shipments has been the high public, media and non-governmental organisation involvement in these operations. This involvement is today reduced, with the exception of Germany.

Our transports have suffered various temporary physical or legal blockades, but despite those acts, were eventually carried out without too much delay thanks to the joint efforts of operational and legal staff, and the different national police forces.

These events caused the Authorities to systematically check the transport conditions, before a HLW return. One of their requests is to transport HLW flasks in special trains (one locomotive is pulling exclusively our flasks). The benefit for the industrials is more flexibility in terms of transport schedule, and reduced transport duration (as stops are shorter), yet at a higher cost when the number of transported flasks is low.

Generally speaking, HLW transports receive high public attention, and scrutiny from our clients (Quality Assurance audits are conducted once or twice a year, transport documentation is repeatedly checked after each operational step) and Competent Authorities (check of transport conditions prior departure, occasional in-transport audits, systematic audit by the German Authorities at Valognes before departure…).

4) Status of transports

90 % of the foreign spent fuel reprocessed at La Hague come from Germany and Japan. This is certainly the reason why the return process started with these two countries.

Since 1995 (date of the first return) and up to now more than twenty transports were already done.

- Nine returns to Japan (68% of the total flasks to be returned):

  A total of 19 flasks of 28 canisters and 18 flasks of 20 canisters were returned to Japan, for a total of 892 canisters.

- Six returns to Germany (35% of the total flasks to be returned):

  A total of 39 flasks of 28 canisters were returned to Germany for a total of 1092 canisters.

- Seven returns to Belgium (50% of the total flasks to be returned):

  Seven flasks of 28 canisters were returned to Belgium, for a total of 196 canisters.

- Four returns to Switzerland (25% of the total flasks to be returned):

  Four flasks of 28 canisters were returned to Switzerland, for a total of 112 canisters.

Challenges:

Despite the contractual and legal obligations clearly settled between the industrial partners but also between governments, the residues returns are not yet routine operations and are still carefully monitored by the public (especially in Germany) and by the Authorities. The return operations being highly sensitive they are scheduled, considering the political calendar (elections, diplomatic visits etc).

It also have to be pointed out that these residues returns remain of high importance for the COGEMA group, as they are a key point for a closed fuel cycle.

So the challenges for the near future are:

- as a general rule, to continue the returns at the customers and the authorities satisfaction

- to maintain the maritime transport capabilities for the Japanese HLW returns (which will end in 2006) but also for the future residue returns. For this purpose, permanent information and communication shall be delivered to the en-route states

- to maintain the flow of 12 flasks returned to Germany each year

In addition, the experience gained in the frame of HLW canisters returns will benefit to the preparation of returns of other types of residues to the foreign customers, for a start up from 2008.