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DISMANTLING OF THE GEORGES BESSE 1 ENRICHMENT PLANT – TRANSPORT CHALLENGES

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ABSTRACT

AREVA's Georges Besse 1 enrichment plant at the Tricastin site in France has ended commercial production during early summer 2012. Whilst the ramp-up of the new Georges Besse 2 plant is currently underway, Georges Besse 1 is undergoing its preparation for dismantling.

The GB1 plant is a gaseous diffusion enrichment facility of enormous dimensions. It is essential to take into account any transport considerations at an early stage. The paper will present these challenges and how they are being solved.

Main subjects are:

- Classification of material
- Fissile exceptions under the previous TS-R-1 (2009 edition)
    - mass limits per packaging and per consignment
    - Beryllium
- Fissile exceptions under the new SSR-6 (2012 edition)
    - New mass limits
    - Cu-Be alloys
    - Allotropic forms of carbon
- Transport schemes

BACKGROUND

AREVA's Georges Besse 1 (GB-1) plant at the Tricastin site in France has enriched Uranium by gaseous diffusion. It was in continuous operation from 1979 to the end of commercial production in early summer 2012. Whilst the ramp-up of the new Georges Besse 2 plant is currently underway, Georges Besse 1 is undergoing its preparation for eventual dismantling. Transport considerations were taken into account at an early stage and led to important strategic choices in the project.

INTRODUCTION

The GB-1 plant is a gaseous diffusion enrichment facility of great dimensions, see figure 1.

Figure 1. Aerial View of the Georges Besse 1 Enrichment Plant

Some key figures are:

- The 4 main factory buildings have a surface of 19 ha (roughly equivalent to 40 football grounds).
- During operation, the hold-up of the cascade was 3000 metric tons of UF6.
- The nominal electric power consummation was 3000 MW, which is the equivalent of 3 reactors at the adjacent EdF Tricastin Nuclear Power Plant.
- The enrichment cascade consists of 1400 stages, divided into 70 groups of 20 diffusers.
- The diffusers contain 28 000 metric tons of ceramic barriers.
- The other main components are made from Nickel-coated carbon steel; the total mass of which is 160 000 metric tons. This is the equivalent of 20 Eiffel Towers or 4 aircraft carriers “Charles de Gaulle”.
- Only commercial Uranium of natural origin was enriched to a maximum of 5% U-235.

Figure 2 shows the inside of a group of diffusers. It is interesting to see the size of the components compared to the operator in the main alley.

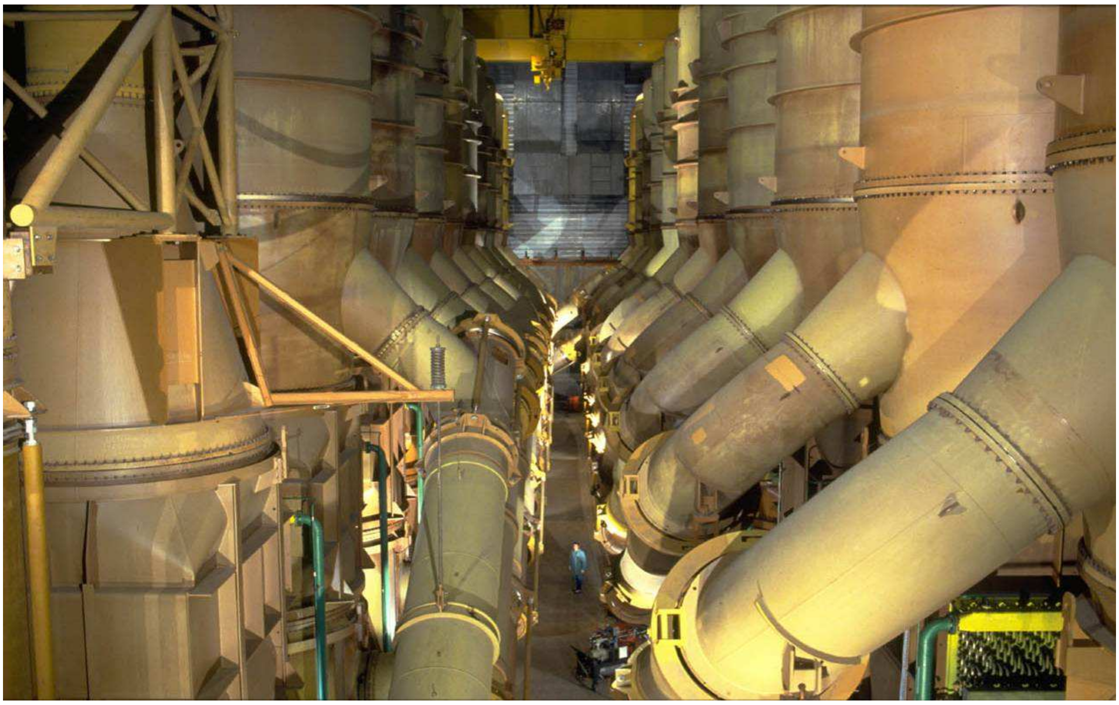

Figure 2. Inside View of a Group

The dismantling of such a nuclear installation is a long-term project which started almost seven years ago. Amongst other considerations, like the evaluation of the budget and how to obtain Competent Authority authorization, creating one or several scenarios was of major importance. While transport considerations are far from being the most critical issue, the impact on the project was considerable. Transport is an important link of the whole chain and figured prominently in the project risk analysis.

DISMANTLING SCENARIO

I. Stopping the Enrichment Cascade

Gaseous Uranium hexafluoride is enriched at around 80 °C. It becomes solid at normal room temperature. Crystallisation of UF6 in the process circuits needs to be avoided since it is not possible for safety reasons to re-vaporize solid UF6. Also, contact with the moisture of normal air will lead to a violent reaction which creates hydrofluoric acid, a very dangerous gas.

This first step was successfully completed in summer 2012 by pumping the UF6 and filling the circuits with nitrogen.

II. PRISME

PRISME is the French acronym for rinsing, chemical cleansing and aeration of the cascade. This phase is currently underway and is expected to be finished by the end of 2015. After completion the entire cascade will contain very little residual Uranium and will be under atmospheric pressure of normal air.

This marks also the final point of the current plant exploitation. Depending on the progress of the forthcoming authorizations for the dismantling phase, the plant might be mothballed for a fixed period in time.

III. Dismantling

Detailed safety studies of various dismantling scenarios are currently underway. These will be instructed by the French Competent Authority. The actual beginning of the dismantling phase depends on the publication of a Decree from the French Government. Thus, no final dismantling scenario and no definite time scale can be given at this point in time.

Once the authorizations have been obtained, dedicated deconstruction work shops will be built within the current plant. The actual dismantling operations are expected to take more than a decade. These are:

- Depositing of the components and internal transport to the deconstruction work shops. Dedicated tunnels will be constructed to avoid transports outside the current buildings.
- Deconstruction of the components in the work shops
- Size reduction and conditioning of the waste into packages
- The wastes produced are expected to have a Very Low Level Activity
- Transport of the packages to the waste depository site in France (ANDRA CIRES for VLL)

TRANSPORT CHALLENGES

The section describes the transport challenges which have been encountered and shows how they were resolved or avoided.

I. Material Classification

Non-irradiated Uranium Hexafluoride has an unlimited A2 value. Thus, it can be classed as “LSA-I” material as long as it is “non fissile” or “fissile-excepted”. The current and the past IAEA recommendation [1], [2], do not foresee “LSA-I fissile” material. Thus, the presence of not excepted fissile material will require the classification as “LSA-II fissile” and the compulsory use of fissile packages. The direct consequence is a considerably higher cost for fissile packages and the corresponding transports.

Challenge: Fissile packages have to be avoided because of costs and logistics organization before transport**.**

II. Fissile Exceptions

AREVA has participated actively in the discussions on fissile exceptions which led up to the current IAEA recommendations SSR-6 [1]. The differences with respect to the previous edition TS-R-1 [2] relevant to the GB-1 transports are:

1. New mass limits for fissile materials for transport in **“non fissile”** packages:

Mass limit	**SSR-6**	**TS-R-1**
Per package	85 g (< 5% enrichment) 220 g (< 1,5% enrichment)	15 g
Per convoy	425 g (< 5% enrichment) 1100 g (< 1,5% enrichment)	400 g

Since the waste depository site accepts up to 50 g of fissile material per package, the new limits are necessary and sufficient.

2. New limit for Beryllium:

Mass limit	**SSR-6**	**TS-R-1**
Beryllium	Less than 4% in a Cu-Be alloy not considered	4 g

Beryllium is contained in a number of small components such as washers. It is not practical to extract these small components from the large objects. In most cases a Beryllium mass limit of 4 g is not sufficient leading to a classification as “fissile”.

New studies have shown that Beryllium contained in Copper alloys up to 4 % is of no concern to criticality. Commercially available Co-Be alloys have a Be content of 2 %.

Thus, the current deconstruction scenario is confirmed.

3. Allotropic forms of Carbon:

	SSR-6	**TS-R-1**
Allotropic forms of Carbon	Needs to be considered in criticality safety studies	No requirement

This is a new requirement in SSR-6 which has potentially a great impact on the choice of the dismantling scenario.

The melting of steel in a hot oven is under consideration for decontamination and volume reduction. This method creates a radioactive “slag” which contains a certain amount of carbon coming from the steel. This slag is potentially “fissile” because of the new SSR-6 requirement.

Further studies are needed to confirm this point, but the fusion scenario is becoming less attractive.

III. On-site transport:

French requirements for the on-site transport of dangerous goods outside of buildings have been reinforced recently. They are now virtually identical to the transport in the public domain.

As a consequence the current dismantling scenario foresees the transport of most components within the existing buildings, as well the construction of dedicated tunnels.

IV. Transport of Large Objects:

No significant progress has been made to simplify the transport requirements of large objects. The consequences are two-fold:

1. Despite limited space the current scenario foresees the creation of the deconstruction work shops in the existing buildings. New purpose-built work-shops in close vicinity would have been more cost-effective and would have allowed an optimisation of the dismantling operations.
2. The creation of dedicated transport tunnels.

TRANSPORT SCHEMES

Three types of packagings will be used:

- Flexible Intermediate Bulk Containers (volume 1 m^3), commonly referred to as Big Bags, for the crushed ceramic barriers,
- Metal boxes (volume 5 m^3) for all metallic parts
- “Unpackaged” for large unitary pieces of high density (stators, camshafts …)

The packages will be put into standard ISO 20” shipping containers. These shipping containers are not used as packaging as defined by SSR-6, paragraph 629.

The containers will be shipped to the ANDRA CIRES depository in the north of France which can accept a maximum of 8000 m^3 of waste per year from the GB-1 plant. The depository can be reached by road only. Rail transports require transhipment to the road at the nearest railway terminal which is about 20 km away. Since the CIRES can accept only a limited number of containers on a daily basis, an interim storage facility would be necessary next to the railway terminal.

At the Tricastin site two railway terminals exist for the shipments of UF6, Uranium oxides and uranyl nitrate. Waste shipments from these terminals would require an extension of the existing facilities or even a new construction.

Given the volume to be transported per year, the following two possibilities exist:

- Two to three road trucks per working day, each carrying two freight containers,
- One dedicated train per month having 17 wagons of three freight containers each.

Independent of the mode the transports are expected to last for 22 years.

Albeit that road transport is more economic than railway transport, no decision of the transport mode has been taken.

CONCLUSIONS AND LESSONS LEARNED

The resolution of the transport challenges highlights the lessons learned:

The main objective to avoid fissile packages will be achieved.

In more general:

- Active participation in the revision of the IAEA transport regulations on fissile exceptions has led to a significant cost reduction in future transport operations.
- Transport requirements need to be taken into account at an early stage in all decommissioning projects. This allows to be a stakeholder in the periodic revision of the transport regulations or to find alternative solutions.
- Some existing shortcomings of the current transport regulations need a long term approach before progress can be expected.
- On-site transport in France has virtually the same requirements than off-site transports.

REFERENCES

[1] Regulations for the Safe Transport of Radioactive Material 2012 Edition, Specific Safety Requirements No. SSR-6, International Atomic Energy Agency, Vienna, 2012.

[2] Regulations for the Safe Transport of Radioactive Material 2009 Edition, Transport Safety Requirements No. TS-R-1, International Atomic Energy Agency, Vienna, 2009.