

## **Zirconium product manufacturing within AREVA: A strategic element for its customers and the whole nuclear fuel industry**

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### **Introduction**

In a general context of increasing demand for nuclear energy supply, fuel assembly security of supply and reliability appear more than ever as key points for all players in the nuclear fuel activities. Within the fuel assembly manufacturing industrial chain, zirconium product supply is a strategic issue.

### **Zirconium activities within AREVA**

AREVA, working through Framatome ANP, an AREVA and Siemens company, is the world leader in zirconium products, from zirconium sponge to finished flats, bars and tube products. Zirconium manufacturing activities comprise Cezus in France with 5 facilities (Jarrie, UGINE, Rugles, Montreuil-Juigné and Paimboeuf) and ANF Duisburg in Germany, representing globally the largest capacity in the world. We supply 40% of the zirconium world market and 30% of the cladding and guide-tube world market.

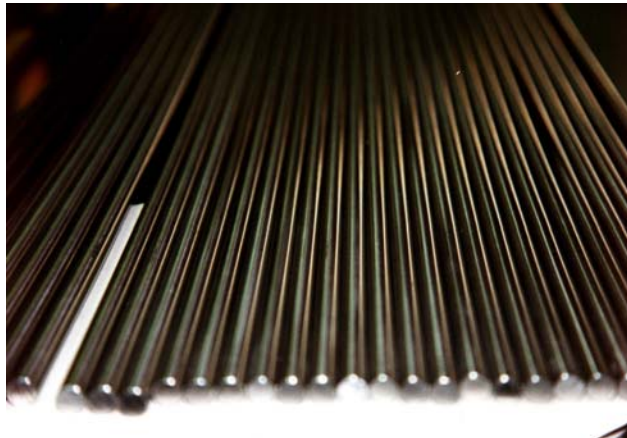
The plant furthest upstream is Jarrie, near Grenoble. Jarrie is the place where the zircon sand, imported from South Africa and Australia, enters the pipeline. Jarrie is characterized by impressive pipes and imposing furnaces. Following hafnium removal using a unique and patented chemical and thermal treatment that is 50 to 60 times less polluting than methods used by other producers (separation of liquids by solvents), the zirconium sponge (2200 tonnes per year) is produced and delivered to UGINE for further transformation.



*Nuclear zirconium sponge*

Ugine is located near Albertville. It has been the French capital of zirconium for 50 years.

Every year, the plant's three presses (to compact, to forge and extrude) and six VAR furnaces produce 5000 tonnes of ingots and 1200 tonnes of tube shell extrusions. Ugine also recycles up to 1000 tonnes of zirconium scraps and manufactures 100 tonnes of end plug barstock, its internal clients are Montreuil-Juigné and Rugles.



*Fuel rod endplug barstock*

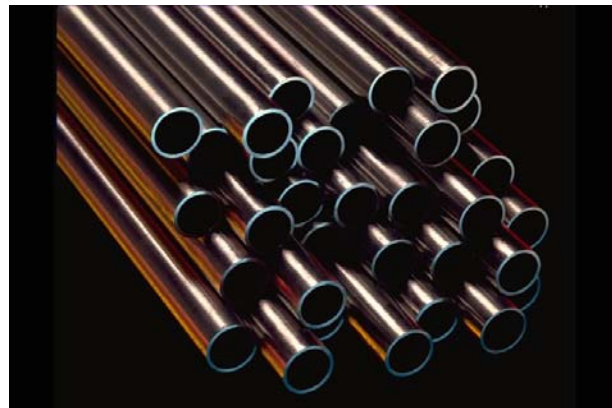
At this same site is our Research Centre. Here, engineers and technicians equipped with two furnaces, state-of-the-art electron microscopes, a spectrometer and a computerized control room allow the entire company to pursue technical and industrial excellence. Our long-term research programs are constantly improving processes and are developing new zirconium alloys (in the past M5™ alloy) that provide customers with higher quality and better value.



*Various sizes of TRES (tube-reduced extrusions) produced at Montreuil-Juigné*

The extrusions are dispatched to Montreuil-Juigné, near Angers, to be pilgered. The factory has one VMR 75 zirconium pilger mill and two heat-treatment furnaces. Following various operations of pickling, eccentricity correction, broaching and polishing, 1200 tonnes of zirconium tube-reduced extrusions (TRES) are delivered annually to Paimboeuf, Duisburg and also other clients that are competitors of AREVA.

The Paimboeuf factory, near Nantes, and the Duisburg factory, near Düsseldorf, manufacture PWR and BWR cladding tubes and guide tubes. Paimboeuf factory's production capacity is around 5000 km per year and Duisburg factory's is around 2000 km per year. After pilgering, chemical and thermal treatments and meticulous controls, the tubes are sent to fuel manufacturers where they will be loaded with uranium or pellets. Guide tubes will serve as part of the fuel assembly structural skeleton.



*Cladding Tubes*



The Normand factory, located at Rugles, receives slabs from Uginé and manufactures flat products in zirconium and hafnium: plates, square bars, channel strips and spacer strips for assembly components in PWR, BWR and CANDU fuel. It is here, near the Risle river, that we reheat slabs, hot and cold roll, pickle, polish and clean strips and sheets.

*BWR channel strip*

### **An optimized and integrated organization**

The decision to organize the zirconium activities was guided by two cornerstones of Areva's strategy:

- Customers' satisfaction first and foremost: at Areva, we always seek to build enduring win-win relationships.
- Sustainable Development: to have a long-term future, a company must sell quality products and services in a profitable, safe and sustainable way.

We aim to be utilities' zirconium products partner in an integrated industrial chain approach from zirconium sponges to zirconium tubes and flat products. AREVA offers PWR and BWR claddings to companies even outside Framatome ANP, or added value semi-finished products such as contoured channel strips.

The amalgamation of Cezus, Zircotube (Paimboeuf tubing plant) and ANF Duisburg has enhanced our products and expertise. In the global nuclear market, economies of scale are key to profitability and investment. Gaining major status is our answer to the current market climate, and it guarantees our customers' long-term supply.

To ensure optimum reactivity with customers, zirconium activities have been organized into product lines. An upstream line, made up of Jarrie and Ugine, sends its semi-finished products to the downstream product lines:

- Flat product line in Rugles;
- Barstock line in Ugine; and
- Tubing line in Montreuil-Juigné, Paimboeuf and Duisburg.

This organization allows for optimal management and customer-driven product flows. We have worked on giving more direct access to our facilities for quick and reliable information on orders. As a result, each product line has dedicated sales assistants based in each specific production plant. The actions of our Sales Department are also supported, when necessary, by a local agent network. In some countries they help us communicate in the appropriate language.

Rationalizing zirconium production facilities and support functions has saved on costs; so has sharing best practices. In particular, tubing plants are also undergoing cross-qualification for mainstream products, thus further securing supply.

In order to optimize its industrial organization and to improve customer service (quality, supply chain and technical assistance), zirconium activities have been implementing for the past few years large-scale programs based on the deployment of a *global management*. Since it was decided to implement a product line organization, the tubing line has certainly evolved most. First set up in 1998 by pooling the management of Ugine extrusion shop and Montreuil-Juigné pilgering shop, it has undergone two activity extensions: first downstream in 2000 when CEZUS and ZIRCOTUBE merged, prompting integration of the Paimboeuf cladding plant; then after the Framatome ANP merger, which saw the Zirconium Business Unit creation, and the ANF Duisburg tubing mill brought under a common management. The changes left a unique operational team in charge of four plants in two countries – France and Germany - giving it a clearly international reach. Global management of the tubing line is alternatively ensured by Paimboeuf manager and Duisburg manager. Strong emphasis was placed on developing a common approach – with keen understanding and respect of each other’s culture, but especially through developing benchmarking initiatives and best practices exchanges.

The backbone of our strategy has also been to achieve efficiency and reliability by cross-qualifying both cladding mills for standardized products. For example, Montreuil-Juigné now supplies the same product to Paimboeuf and Duisburg.

Process optimization is going on through accelerated best practice sharing in pilgering, finishing, inspection, product and organization. Moreover, competency is globally managed in order to be put at the disposal of the different plants.

Even more savings will come by rationalization of our product portfolio – mainly through our ongoing program to simplify PWR and BWR tubing. A multi-year cost reduction action called “Opticost” plan also contributes to ensure our high level of competitiveness.

## A high priority on security and environment

As a key player in the nuclear industry and a long-term reliable supplier, the Zirconium Business Unit has set high priority on security and environment, fulfilling AREVA's commitment to Sustainable Development.

Extensive efforts have been made in the area of security and environment. We give examples of a few results below.

All zirconium manufacturing sites are ISO 14001 certified. Jarrie and Duisburg sites achieved OHSAS 18001 certification in 2001 and 2005, respectively.

Its equipment is environmentally friendly. As examples:

- Sponge process rejects 60% less liquid wastes than the usual processes.
- Investments on spent fluoronitric acid recycling station allow the recycling of 100% of waste nitric acid coming from the process in the Paimboeuf, Montreuil-Juigné and Rugles plants.
- The zirconium chips recycling program, started in 2003, aims at recycling the chips which are until now burnt or sold for use in other industries. The target is to achieve 80% of chips recycling thanks to new cleaning process.

Related to safety and security at work, a wide-ranging, large-scale action plan has been deployed throughout all plants in order to eradicate major zirconium fire risks:



*A Zirconium fire test*

- A team composed of safety managers from the sites has been created. An exhaustive and precise inventory of all possible danger locations in terms of zirconium fire has been established with a risk evaluation. Immediate actions (cleanings, equipment improvements, etc) have been thoroughly implemented.

- A training course has been designed to explain the risks associated with the zirconium, the safety procedures to follow and the attitude to have when confronting a zirconium fire. About 1200 persons including all employees from the Zirconium Business Unit and temporary workers and subcontractors have followed this training course. This specific expertise has been shared within other entities of AREVA and zirconium-user customers, thus answering their expectations.

**A long-term reliable supplier**

Having zirconium product manufacturing in its industrial organization makes Framatome ANP, and consequently AREVA, a unique integrated fuel assembly manufacturer, which gives the company quality, reliability and a robust supply chain. As world leader in zirconium products, AREVA also contributes to a globally increased long-term security of supply for all players in the nuclear fuel industry.