Within the AREVA group, FUEL activities manage all processes related to the design and manufacturing production of nuclear fuel assemblies.

FUEL focuses on safely packaging enriched uranium into fuel assemblies. We provide customer support for licensing and operation of fuel assemblies, as well as after-sales services.

Both our global network of engineering and manufacturing sites and close cooperation between all domains guarantee high quality products and services.

AREVA is the European leading supplier of fuel products and services for nuclear reactors worldwide.

As a responsible industrial actor, we strive to reduce our impact on the environment. To achieve this, AREVA FUEL activities continuously improve all processes in order to:

- Reduce water and energy consumptions, as well as waste production
- Use substitutes rather than dangerous products, whenever possible
- Recycle our industrial waste
- Reduce all releases into environment

On all our industrial sites, we carry out regular environmental surveys based on soil and water analysis and transparently communicate on them.

Ranked first in the global nuclear power industry, AREVA covers every stage of the nuclear fuel cycle, reactor design and construction, as well as related services.

Fuel assemblies for nuclear power reactors

Fuel designs and produces fuel assemblies for nuclear power reactors all over the world.
Nuclear power plants work in principle like fossil power plants. However, the required heat is produced by nuclear fission in the reactor instead of burning coal, oil or gas.

- The fuel in nuclear power plants is usually enriched uranium in the form of small cylindrical pellets.
- These pellets are loaded into tubes made of zirconium alloy. These fuel rods are welded at both ends to ensure that fuel and fission products are safely enclosed.
- The fuel rods are assembled into so-called fuel assemblies.
- Several hundreds of fuel assemblies form the “heat source” of 1 nuclear power reactor.

**Did you know?**

1 fuel assembly provides electricity during its 4 year operation time for about 10,000 domestic homes continuously, day and night, during the whole year.
Quality culture meets innovation for safe & reliable products

Fuel Design project team discussion

Quality inspection of cladding tubes

Manufacturing of pellets

Final visual inspection of tubes
Nuclear fuel is by no means an ordinary or easily substituted product. It is operated in a highly challenging environment and has to meet extraordinary safety requirements. A large number of high-level scientific and technical skills are needed to achieve flawless design and fabrication quality.

Our innovative products and services are a direct response to customers’ and energy end-users’ expectations, respecting the social environment we live in.

**Fuel Design**

We design all components of fuel assemblies and perform calculations for fuel management and licensing. We support our customers in achieving a safe and efficient operation of their reactors. To meet those challenges we maintain and develop codes and methods for designs and analyses of fuel assemblies.

Our design engineers work together, having access to all aspects – technical, environmental and highest levels of safety – throughout the world. They share best practices and expertise globally.

**Fuel Products**

We supply a variety of standard light water reactors with fuel. Well tailored, fuel assemblies are responding to specific reactor operation, fuel management and licensing requirements.

Our products not only meet the requests of our customers but go beyond that. They meet the highest technological expectations and are made of advanced materials which are now introduced in other industries – like zirconium alloy being used in chemical industry.

**Fuel Manufacturing**

In our worldwide network of fabrication plants we are manufacturing zirconium products (tubes and flat products), fuel pellets and fuel assemblies. Our teams work in close collaboration with design engineers and sales units.

Our key drivers are safety, security and quality. The main objective is not only to provide our products on time and of the highest quality to our customers but also to secure the environment and take care of our employees’ daily working conditions.

**Fuel Services**

We support our customers after our products are delivered to their sites. Our service engineers support our customers on site as well as by reloading fuel assemblies and providing customer trainings.

Since more than 30 years, we are supplying equipment for a variety of reactors, together with experienced personnel for inspection measurements and repair.

We have the capability to answer rapidly to customer questions and demands.

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**Did you know?**

Zirconium is the reference material for manufacturing of fuel assemblies. It guarantees uranium pellets’ confinement within the reactor thanks to specific qualities:

- excellent resistance to corrosion
- mechanical strength
- stability under irradiation
- low absorption of thermal neutrons

Fuel rods constitute the nuclear reactor’s first safety barrier.
Design driven by customer demand

Our engineering network brings together about 600 highly skilled and responsible engineers in France, Germany and the United States. Everyday we are learning how to take advantage of all of these available competencies and licensing experiences.

We accompany our products and cores throughout their lifetime – from design to after sales services. We support our customers in achieving a safe and efficient operation of their reactors.

Engineering Services

We design fuel assemblies for nuclear power reactors. We perform engineering analyses to support fuel assembly cores in operation in nuclear power plants built by AREVA and other vendors worldwide.

Sharing best practices, common tools and guidelines globally as well as continuous improvement is part of our quality culture.

AREVA is continuously keeping a strong focus on sustaining our people’s high competencies and people’s further development.

“During the development of our new fuel assembly design ATRIUM™ 11, it was most interesting for me to experience the dynamics of the product development. The flexible and fast reacting support of our testing facilities in Germany and in the United States was essential for the development of this high performing product.”

Dirk BLAVIUS, Safety, security and quality are the first priority of all fuel engineering teams.

ATRIUM™ 11 – the newest assembly of our ATRIUM™ family.

This innovative step in design benefits from our longstanding experience in the development, manufacturing and operation of more than 25,000 ATRIUM™ 10 assemblies for boiling water reactors.

Particular attention has been focused on increased robustness and reliability for all components.
Codes and Methods

Our comprehensive computer code systems allow us to model, predict and survey the phenomena relevant for the operation of pressurized and boiling water reactors.

They take into account interaction and feedback between the nuclear reaction, thermal-mechanical, thermal-hydraulical and mechanical behaviors of fuel assemblies and the entire core.

**ARCADIA® Modeling of 1/8 of the entire reactor core: 3-dimensional prediction of the rod surface temperatures**

**ARCADIA® – our outstanding future code system**

This coupled neutronics / core thermal-hydraulics / thermal-mechanics code system is applied for fuel assembly and reactor core design calculations as well as safety analysis. It contains outstanding modeling of the physics and supports even safer and more economical operation of the reactors.

The global convergence of different methods and experience to a competitive tool was only possible through international teamwork of highly skilled and dedicated engineers.
The **fuel assembly** is not a commodity

We design, manufacture and service a variety of fuel assemblies for all light water reactor types. More than 30% of all reactors in operation worldwide are fueled by AREVA.

Close cooperation between our teams in fuel design, manufacturing and after sales services guarantees **high quality**, **high performance** and continuously improved product portfolio.

AREVA fuel assemblies are made of **best in class materials** resisting the most challenging conditions.

**Fuel**

Fuel rods 1 consist of gas-tight and pressure-proof **zirconium alloy tube claddings** 2 that safely enclose the uranium pellets.

Inside these **fuel pellets** 3, heat is generated by nuclear fission.
Structural parts

- **Spacer grids** keep the rods at well defined positions, assuring that the coolant (water) can easily flow between the rods and through the grids. A typical grid size has 17x17 rod positions, of which 24 are reserved for guide tubes.

- **Guide tubes** are empty tubes to receive control rods. These consist of neutron absorbing material and are used to control the reactor.

- **Top and bottom nozzles** stabilize the whole assembly structure and enable handling.

A fuel assembly is a highly engineered product which is operated in challenging environmental conditions:

1. **Temperatures of more than 300°C (572°F).**
2. **Pressures up to 160 bar.**
3. **In only 1 second, 100 kilos of water go through 1 fuel assembly. Flow velocity is of 4 m/s (13 feet average/s).**
4. **Neutron irradiation** accelerates material embrittlement.

**Did you know?**

Fuel assemblies have a length of about **4 m** (13 feet) and assemble about **250 fuel rods**. Each rod, having an outer diameter of about **1 cm** (0.4 in.), contains roughly **300 pellets** of about **7 gram** (¼ oz) weight.
Once the design is finalized and all required tests are completed, manufacturing of fuel assemblies can be launched on an industrial scale. This requires specific expertise in chemistry, powder metallurgy, pilgering technique, state of the art welding, mechanical processes and machining.

Fuel assemblies are manufactured in three production lines:

- Production of fuel rods containing the uranium pellets
- Two component lines based on zirconium alloys and stainless steel for components which are necessary to maintain the fuel rods in a robust mechanical structure.

Our facilities located in Europe, Asia and the United States produce various designs of our products portfolio which brings flexibility and adaptability to the market worldwide.

**Fuel manufacturing process**

- **Uranium**
- **Zirconium components**
- **Steel components**

1. Powder > Pellets
2. Fuel Rods
3. Tubes and flat products
4. Spacer grids, Guide tubes
5. Bottom nozzle, top nozzle, Rod control cluster assemblies

Up to now AREVA manufactured more than 200,000 fuel assemblies.
More than just manufacturing facilities, it is a true network of production experts that are in constant contact to ensure on-time delivery of a high quality product to the customers, respecting the highest levels of safety and security, environment and working condition requirements.

A major strength of the manufacturing process is the early involvement of the fabrication teams in the fuel assembly design phase, then final design and ultimately the reactor operation feedback.

Our products have improved significantly over the years. This was achieved by sharing between all regions and all disciplines all available knowledge and best practices.

Supporting the community we live and work in

All our manufacturing sites have an open door policy with our local community. Opening our doors and explaining our activities is part of our responsibility. Experts inform visitors on the importance of safety and how we take this into account in our activities.

In touch with environmental protection officer, Romans (Isère, France)

Mario CHOFRE

“Every year, at our manufacturing sites, we take thousands of samples from the water, the air, flora and fauna to measure our impact on the environment. The results are regularly communicated to the public.”
Fuel services offer full customer support

Fuel assembly being loaded into the reactor

Testing of new equipment in a test vessel before the application in the reactor

Checking MULTI-INSPECTION system before application in nuclear power plant
Our services do not end with the delivery of the fuel assemblies. We also provide special assistance to the power plant operators to help them get the greatest added value from our products.

In order to support safe and effective power plant operation, AREVA has developed expanded fuel services offers based on its cross-field international expertise.

AREVA has over 30 years of nuclear fuel inspection and repair experience. Our certified service personnel, including tooling designers and field service technicians, have years of experience in their field. FUEL services experience feedback contributes to improvement in design and fabrication.

Our teams have a wide spectrum of experience:

- Fuel assembly handling, loading, and unloading operations
- Visual and dimensional examinations of fuel assemblies, fuel rods and components
- Failed fuel inspection and repair
- Fuel storage support
- Training courses for customers
- Development of special tools

One of the best and latest example for such a special tool is a high definition camera dedicated to inspect each rod of a fuel assembly and provide the highest level of visual details within a reactor.

Our day to day mission

is to respond to our customers, most urgent needs with the most efficient solution. With that aim, we can count on our international network of highly qualified and experienced experts located close to the customers, in Europe, Asia and the United States.

AREVA is an outstanding fuel services provider with experienced well-trained and flexible teams who bring daily added value to our customers.

In touch with
Field Services Manager,
Lynchburg (Virginia, U.S)

Vee DUNN

“When a customer calls us with a problem, we must be able to respond in a few hours. Even on Christmas Eve not so long ago, when one of our customers in the U.S. had a problem, the personnel and equipment were on site in two days, the damaged fuel was identified and replaced, all accomplished safely and error-free in five days, 23 hours and 45 minutes ...”
Our will: be the reference provider of fuel products and related services for customers worldwide in light water reactors market.

**Quality & reliability** – Work hand in hand with the customer to continually improve our portfolio of products and develop new solutions that contribute to reliability, performance and safety of our fuel assemblies.

**Safety & Security** – Be the best in class for nuclear and occupational safety, quality, environment protection, safety of supply, on-time delivery, organization of operations and competency management.

**Sustainable performance** – Constantly question our internal organization and processes to better perform with lower cost and more value for the customer.

**Unique market positioning** – For each of our customers, whatever his location, build dedicated and specific commercial as well as services offers.

**To give value to our company, we first give value to our people** – Build and strengthen our people expertise is our priority, worldwide. Develop and secure our key core competencies, caring about our teams individually and collectively drives us to success. Our key words are respect, recognition and leadership.

The FUEL teams worldwide are involved in driving the business towards excellence. The experience, know-how and expertise acquired throughout the years are most valuable to build efficient action plans supporting our long term vision.

"Our prime objective is to secure the highest safety levels inside our workplaces - and outside -, through the performance of our products. To achieve this and build the right team, developing our people’s talents is our major asset."

**Markus Birkhofer**
FUEL Business Unit Executive Vice President

"My conviction? Discover places and people while gathering experience is most valuable. International work leads to mobility and prepares for management."
Work for AREVA Fuel activities... how does it feel?

"After 10 years in human resources and central communications, today what I like the most is the operations which gives me autonomy and allows me to deepen my knowledge of industry everyday."

Caroline Marionnaud
Communication Manager - Paris (France)

"My team is in charge to ensure that the manufacturing for all fuel and related components for our customers is performed in a safe manner. Safety is a priority and is the main focus in our day-to-day operations. It is all of our responsibility to ensure operations are safe."

Bob Link
Environmental, Health, Safety and Licensing Manager, Richland (Washington, US)

"We live and work everyday with the will to better serve our customers. We continuously exchange with them: this is why we are able to solve together all types of issues and provide improved added value, both in terms of products and services."

Robert Koch
German Region Director Contracts & Services

"After 25 years in the chemistry business, I am Director of Zirconium Division. My best challenge? Safety, performance and added value for our customers, products, manufacturing sites, but most important for teams!"

Sylvie Baqué
Managing Director of Zirconium activities, Lyon (France)

3 words: “Safety is first” – this is all about FUEL.
AREVA supplies solutions for power generation with less carbon. Its expertise and unwavering insistence on safety, security, transparency and ethics are setting the standard, and its responsible development is anchored in a process of continuous improvement.

Ranked first in the global nuclear power industry, AREVA’s unique integrated offering to utilities covers every stage of the fuel cycle, nuclear reactor design and construction, and related services. The group is also expanding its operations to renewable energies – wind, solar, bioenergies, hydrogen and storage – to be one of the leaders in this sector worldwide.

With these two major offers, AREVA’s 48,000 employees are helping to supply ever safer, cleaner and more economical energy to the greatest number of people.

www.areva.com