AREVA’s worldwide
Technical Center

Technical Center serves as the bridge from basic research to industrial application with main focus on basic technologies organized in the four technology lines materials, corrosion, welding – chemistry and radiochemistry – qualification of components – thermal hydraulic testing and systems and components testing.

The large variety of skills enables the Technical Center to provide long term programs or to solve in short term complicated issues with its root cause analysis teams. Customers from all over the world use e.g. the world’s largest valve test facility in Karlstein, Germany, up-to-date corrosion test loops in Le Creusot, France and the 3-axial shake table in Lynchburg.

The continuation of an OECD program with the PKL project (PKL is a 1,300 MW PWR test facility in Erlangen with 1:1 scale in height and 1:12 scale in diameter) confirms the reputation of the Technical Center. The PKL project comprises integral tests simulating conditions in the frame of beyond design accidents or shut down / outage situations. The results will allow all participating countries to further improve the safety of their plants.

The Technical Center continuously enhances its testing facilities and laboratory equipment and demonstrates the willingness to reliably support customers and the industry with its unique capabilities.
AREVA operates in its Technical Center in France, Germany and the US own and often worldwide unique research and testing facilities and laboratories.

Highly skilled researchers, experts and technicians are working with this equipment ...

- on new technologies for CO₂ free power production,
- on the development of methods and tools for the design, construction, operation and maintenance of nuclear power plants,
- on the qualification of components for nuclear applications and ...
- on comprehensive services providing solutions for day-to-day problems of the industry.
Comprehensive Service in Chemistry and Radiochemistry

The technology line “Chemistry and Radiochemistry” is located in Erlangen (Germany), Le Creusot, Montpellier (France) and Lynchburg (US). It operates:

- Analytical chemistry and radiochemistry laboratories
- Micro-Loops for studies on material transport phenomena
- Laboratories for new materials synthesis and electrochemistry
- Hot cell facilities

New Materials Chemistry

The following services are provided by our new materials chemistry:
- Synthesis and shaping of ceramic nanopowders
- Elaboration of ceramic and metal assemblies
- Storage of electricity: H₂ production and CO₂ treatment
- Electrochemistry under pressure and temperature
- Separation and purification of effluent from energy cycle

Analytical Chemistry

Our Analytical Chemistry services cover:
- Chemical analyses of solutions, solids and gases
- Surface analyses and surface protection
- Study of chemical and electrochemical processes (cleaning, electro deposition)
- Technical assistance and case analysis

Micro-Loops

The field of Micro-Loops includes:
- Cation release measurement of steam generator tubing
- Oxide growth kinetic in high temperature water
- Synthesis of colloids in LWR environment
- Deposits formation in steam generator support plates
- Deposits on fuel cladding under thermal flux
Radiochemical Analysis

We analyze radionuclide inventories and vectors for characterization of radioactive waste from Nuclear Power Plant (NPP) operation and decommissioning. This also includes core scrap. Furthermore, we monitor activity in nuclear systems, in primary system materials and in deposits of primary circuits. Our services include:

- Effluent monitoring and environmental surveillance
- Fuel failure estimation from coolant and offgas activity
- Investigations on the behavior of radionuclides during NPP normal operation and measures to influence radionuclide behavior
- On-site support for sampling, radiochemical analysis programs and fuel sipping
- Diverse radiochemical work during NPP commissioning
- Experimental and theoretical studies on the behavior of radionuclides under NPP accident conditions and on the behavior of core melts
- Planning, commissioning and refurbishing of radiochemical laboratories
- Radiation protection technology and engineering
- Transport services for radioactive materials
- Health physics, dosimetry, incorporation monitoring
- Operation, development and optimization of radiation measurement methods and devices

Hot Cells

Hot Cells are used for post-irradiation examinations on materials, for reactor pressure vessel surveillance programs as well as failure analyses.

Technical Center

providing a comprehensive scope of laboratory services and key technologies

Comprehensive Service
- Chemistry
- Radiochemistry

Concentrated Materials Expertise
- Materials
- Corrosion
- Welding

Qualification and Commercial Grade Dedication
- Equipment Qualification
- Commercial Grade Dedication

Worldwide unique Thermo Hydraulic Platform
- Thermo Hydraulics
- Component Qualification
- Component Testing

These technologies support nuclear power plants from new build phase and during the complete lifetime.

When anomalies are detected, the cause is quickly identified and preventive or corrective measures are defined.

Those competencies are particularly important regarding plant availability and lifetime management as well as for improving reactor safety.
Laboratories

Our laboratories perform a wide range of tasks, among them:
- Optical metallography
- Electron microscopy (TEM, SEM, Dual Beam)
- Nano machining
- Mechanical testing (tensile-, impact-, vibrational testing)
- Fracture mechanics testing
- Fatigue testing
- Examination and testing of irradiated samples
- Tribologic testing
- Structural analysis
- Residual stress measurements
- Ambulant metallography
- Corrosion test laboratories and test loops
- Welding workshop and heat treatment furnaces
- Software for numerical simulation (e.g. welding, mechanical behavior)
- Special test facilities for high heat flux experiments
- Metrology and calibration services

Competencies

Among our competencies are the characterization of materials on the makro-, micro- and nanoscale and the detection of effects of ageing (thermal, mechanical, corrosion or irradiation induced). Furthermore, we perform root cause analysis for the characterization of failure mechanisms and suggest remedial actions. We offer the following services:
- Characterization of materials on the makro-, micro- and nanoscale
- Detection of effects of ageing (thermal, mechanical, corrosion or irradiation induced)
- Root cause analysis for the characterization of failure mechanisms and suggestion of remedial actions
- Evaluation of mechanical and fracture mechanical materials properties
- Application of fracture mechanics codes and numerical simulation tools
- Characterization of corrosion mechanisms
- Simulation of corrosive environmental conditions
- Simulation of failure mechanisms
- Welding engineering and manufacturing development
- Welding metallurgy and welding techniques
- Welding monitoring methods
- Tribologic characterization of materials in different environments
- Material characterization under high temperature and high heat flux conditions
- Dimensional measurements and calibration
Services

We provide numerous services, such as:
• Comprehensive materials examinations and evaluation of material properties, also irradiated ones
• Fast and reliable root cause analysis and suggestion of remedial actions
• Competent consulting on materials, manufacturing and welding
• Competent consulting on corrosion behavior
• Competent ageing management with respect to all relevant aging mechanisms
• COMSY software system for ageing management
• Corrosion testing under realistic environments
• Fracture mechanics analysis and numerical simulations
• Safety analysis for plant life management
• Development of welding and coating/cladding procedures and equipment for shop floor fabrication and field operations
• Welding inspections and metallurgical characterization of welded joints
• Welding consulting
• Study of material surface resistance to high heat fluxes
The Technology Line „Qualification“ is located in Erlangen and Offenbach (Germany) and Lynchburg (US) and accompanies you with our expertise in qualification or commercial grade dedication of safety related components in your projects.

Qualification of components and systems according to national and international nuclear standards (IEC, IEEE, RCC-E, ASME, KTA, DIN, ISO, YVL ...)

Our competence ranges from the preparation of integrated qualification concepts to their realization: starting from a detailed analysis of the formal and technical requirements, we schedule the qualification activities and execute the complete qualification testing up to the final suitability analysis. We also consult the customer, safety authority or independent assessors in the licensing process.

Spectrum of Activities

Our engineers perform a wide range of tasks, among them:
- Development of qualification strategies
- Requirement analysis and project planning

Qualification of equipment against induced vibrations

Services
- Design verification based on experimental and calculative proof
- Provision of required documentation for type testing or certification
- Customized guidance in selection of suitable components for special requirements
- Suitability analysis on installed components with respect to updated requirements
- Seismic margin assessment for I&C and electrical systems.
Technical Center

Best practice and high level of expertise

- We provide all-in-one turnkey solutions.
- Long term international qualification experience.
- Complete sets of consistent qualification documentation.
- Supervision of interdisciplinary and integrated verification tests and calculations.

Qualification against Design Basis and Beyond Design Basis Accidents

Services
- Selection and design of suitable equipment
- Deriving qualification and acceptance criteria from safety analysis reports and systems engineering feedback
- Analysis of material probes to calculate “qualified lifetimes”
- Conducting “ongoing qualification” of equipment, which has been already installed in the plant
- Short and long term environmental monitoring and calculation of the residual lifetime.

Commercial Grade Dedication

Services
- Development of commercial grade dedication plans
- Definition of critical characteristics required to provide reasonable assurance
- Creation and oversight of test plans and inspections
- Creation of a comprehensive QA data package / dedication reports and documentation of test results.

- We operate up-to-date laboratories and unique testing facilities. Numerous measuring techniques and testing methods are available for use on site.
- Our products and services are state of the art and are continuously upgraded to the latest technological standards.
- Our quality management is certified according to ISO 9001/2008 and also corresponds to further international requirements. The environmental management system fulfills the requirements of ISO 14001/2004.
- The testing laboratories are accredited as test / inspection body according to ISO 17025:2005 and 17020:2004 to ensure the quality and independence of test results and related interpretation.
Test Facilities

- **KOPRA** – Multifunction component test facility (fuel assemblies, CRDMs, valves)
- **BENSON** – High pressure thermal hydraulic separate effect tests
- **PKL** – Large scale test facility of a PWR primary loop
- **PETER, BRIAN** – Fluid dynamic test facilities (PWR and BWR fuel assemblies)
- **SUSI** – Sump sieve test facility
- **APPEL** – Pump test loop
- **GAP** – Large valve test facility
- **INKA** – Test facility for BWR integral tests
- **KATHY** – Multifunction thermal hydraulic test loop
- **HYDRAVIB** – Vibratory validation of lower RPV internal
- **ROMÉO & JULIETTE** – RPV flow distribution in upper and lower plenum
- **CALVA** – Dynamic mechanical testing on components
- **MAGALY** – Vibratory behavior of Rod Cluster Control Assembly (RCC-A) and Control Rod Guide Assembly (CRGA) and different flow conditions

Scope of Activities

- **Qualifications:**
  - Pumps
  - Valves
  - I&C under Loss of Coolant Accident (LOCA) conditions
  - Components of steam generators
  - Components of auxiliary systems

- **System tests:**
  - PWR / BWR integral system tests
  - Sump sieve and down stream integral testing

- **Heat transfer / limitations:**
  - Under severe accident conditions
  - Core flow focused on fuel elements
  - Heat exchanger

- **Fluid dynamics / fluid induced vibrations:**
  - Core flow and core components
  - Fuel assemblies
  - Singularities (T-junctions, etc.)

- **On-site activities:**
  - Measurements at NPP components
  - Data bases for example inspections
Resources

Our thermal hydraulic and components testing facilities comprise a total floor space of more than 2,000 m² and heights of up to 32 meters. Furthermore, we have:

- Crane capacities up to 100 t
- Thermal power supplies up to 25 MW
- Electrical power 20 MW
- Dose rate: $10^4 \times$ limit for unrestricted release
- Advanced measurement techniques

We are qualified to perform tests and inspections within the following range:

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Ranges</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>0 °C – 600 °C</td>
<td>0.3 K</td>
</tr>
<tr>
<td>Pressure</td>
<td>10 Pa – 40 MPa</td>
<td>0.5%</td>
</tr>
<tr>
<td>Volume flow rate</td>
<td>0.1 l/h – 1,500 m³/h</td>
<td>0.5%</td>
</tr>
<tr>
<td>Mass flow rate</td>
<td>0.1 kg/h – 4,000 kg/s</td>
<td>0.5%</td>
</tr>
<tr>
<td>Force</td>
<td>1 N – 10,000 kN</td>
<td>1%</td>
</tr>
<tr>
<td>Momentum</td>
<td>Up to 50,000 Nm</td>
<td>1%</td>
</tr>
<tr>
<td>Distance</td>
<td>1 µm – 10 m</td>
<td>0.5%</td>
</tr>
<tr>
<td>Velocity</td>
<td>1 mm/s – 100 m/s</td>
<td>0.5%</td>
</tr>
<tr>
<td>Acceleration</td>
<td>0.5 – 1,000 g</td>
<td>1%</td>
</tr>
<tr>
<td>Current</td>
<td>1 mA – 85,000 A</td>
<td>0.5%</td>
</tr>
<tr>
<td>Voltage</td>
<td>1 mV – 4 kV</td>
<td>0.5%</td>
</tr>
<tr>
<td>Electrical power</td>
<td>Up to 20 MW</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Highly qualified, experienced scientists, engineers and technicians, who are involved in the design, construction and maintenance of nuclear power plants, as well as toward developing new concepts to improve plant operation.

Our knowledge base was acquired over a period of many years, and is also valuable to prospective customers in other technological areas given the high quality requirements in the nuclear industry.

We offer meaningful solutions, technically, as well as economically.
AREVA supplies advanced technology 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 operating services. The group is actively developing its activities in renewable energies – wind, bioenergy, solar and energy storage – to become one of the leaders in this sector worldwide.

With these two major offers, AREVA’s 47,000 employees are helping to supply ever safer, cleaner and more economical energy to the greatest number of people.

www.areva.com