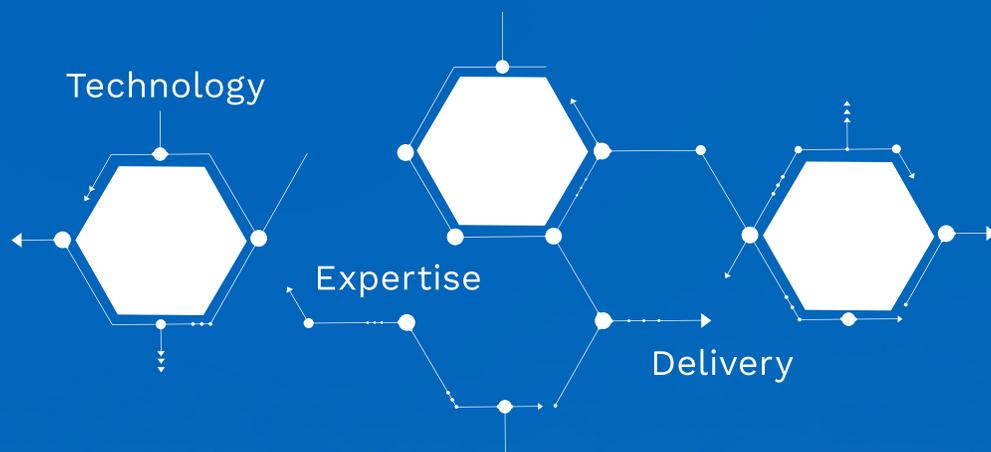


framatome

Chemistry Services



The right mix.



Excellent Chemistry

The Heart of Plant Reliability and Performance

Challenge

The Electric Power Research Institute (EPRI) estimated in a study released in 2001 that corrosion damage costs the U.S electric power generating industry \$17.3 billion annually, or about 7.9 percent of the cost of electricity to consumers. Presently, as much as 50 percent of all forced outages are attributable to corrosion damage. An estimated 22 percent (\$3.8 billion) of this cost is considered avoidable. Finding ways to eliminate and prevent corrosion is crucial to cost of operation and ensuring safety standards. Today's plants need more than collection of data – those results need to be accurately analyzed and interpreted to deliver a solution for long-term performance of the plant. When emergent issues arise or for prevention of unplanned outages, plants need a trusted team of experts experienced in chemistry, technology, and safe operational excellence.



Solution

Ensuring safe and reliable operations is the driving force for the nuclear industry and at Framatome, your performance is our everyday commitment. Our road to excellence begins with a culture of accountability and delivery of cost-effective solutions critical to your success. Tangible results that ensure safety, quality, performance, and delivery are paramount. Our team of experts is dedicated to advancing safety, reliability and economic performance to ensure efficient management of your key plant assets. Our seasoned team has painstakingly crafted an unmatched, comprehensive approach to meeting each of your specific chemistry needs.

Framatome continues to enhance the Chemistry & Technical Services of our innovative Chemistry and Materials Center (CMC). Where you face corrosion challenges, we deliver comprehensive support and the convenience of one-stop solutions.

You Can Count on Framatome to Deliver Balanced, Precise Chemistry Solutions That:

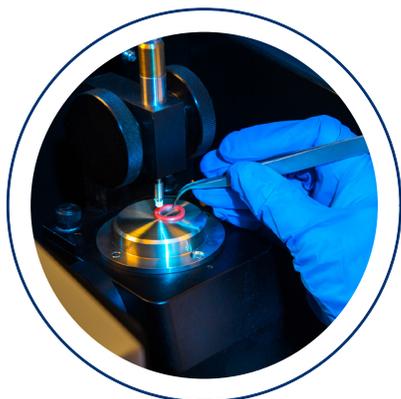
- Increase safety and efficiency
- Resolve emergent issues quickly
- Reduce plant operating cost
- Address obsolescence and equipment reliability issues
- Improve your plant performance

Your performance
is **our** everyday **commitment**



Quality Control You Can Trust

We maintain the industry's most rigorous quality control standards. The strength of Framatome's responsive global resources delivers proven high-tech results based on substantial R&D. At Framatome, you get to know the people behind the technology. We embrace personal ownership of our projects, and take great pride in what we help customers achieve. Whatever your need may be, we always consider the long-term value for the life of your plant, not just the next project. That's why our relationships and ongoing research lead to predictable results, emphasizing safety every step of the way.



Other chemistry service providers may collect data – but, only tested experts like Framatome can accurately interpret the meaning. We expect those who wear the Framatome name to match the promise of a company built on responsiveness, innovation, sustainable development, and open, honest dialogue with your teams.

Consider our comprehensive services for all of your chemistry needs **today and tomorrow.**

Chemistry Services

- Chemistry and Radiochemistry Laboratory Services
- Component and System
- Commercial Grade Dedication
- Corrosion Evaluation and Management
- Deposit Analysis and Characterization
- Fuel Chemistry
- Metallurgical Laboratory Services
- Oil & Grease Waste Characterization
- Operational Chemistry Evaluation
- Root Cause and Failure Analysis
- Startup & Shutdown Chemistry and Dose Reduction
- Water Chemistry Consulting Services

Chemistry and Materials Center

Comprehensive Laboratory Support

Framatome's Chemistry and Materials Center (CMC) provides routine, emergent, and specialized chemistry, corrosion, and metallurgical testing and analysis support for operating nuclear power plants. Additionally, the lab supports internal Framatome production, research, and development. The CMC serves as an integral part of Framatome's technical expertise in power plant chemistry, material dedication, and qualification.

Using only the latest equipment and cutting-edge technologies, we can analyze radioactive and non-radioactive samples of solids, liquids, and gases from all locations in PWR and BWR plants. These include but are not limited to:

- Consumable materials
- Cooling water
- Environmental samples
- Foreign materials
- Fuel deposits (crud)
- Reactor coolant
- Reactor water
- Resins
- Secondary plant water
- Steam generator deposits

A One-Stop Chemistry Resource

As your one-stop chemistry services resource, the CMC provides key services to Framatome customers in their on-going efforts to reduce corrosion damage to plant components and fuel. We can also provide specialty testing and technical capabilities to address specific customer needs, including regulatory and materials performance issues.



Only the finest, seasoned technical experts in power plant chemistry and corrosion control staff our CMC. Our responsive experts will foster a culture of open, honest dialogue with your teams.

Plus, high-quality, on-time delivery of lab results complements current Framatome engineering solutions for routine and long-term customer needs, whether servicing existing plants or preparing for the design and construction of new plants.

The Industry's Most Innovative Chemistry Services

- Significant facility investment
- 8,000 square feet; two stories
- Houses eight laboratories

Analytical Equipment Capabilities

- Fourier Transform Infrared (FTIR) Spectrophotometer
- Incubator and TCLP System
- Inductively Coupled Plasma — Mass Spectrometer (ICP -MS)
- Ion Chromatograph (IC)
- Ion Selective Electrodes
- Particle Size Counter
- Scanning Electron Microscopy (SEM)
- Stereo Microscopes
- Test Loops
- Total Organic Carbon Analyzer (TOC)
- X-ray Diffraction (XRD) Spectrometer
- X-ray Fluorescence (XRF) Spectrometer

Commercial Grade Dedication Equipment & Materials Testing

An essential part of the commercial grade dedication process is verification of material composition. The materials and metallurgy lab uses advanced analysis methods to verify compliance with purchase specifications, and metallography to investigate material properties of manufactured components. Our lab is supported by a full machine shop for sample preparation services. Custom welding services are also available.

Material Analysis

- ALLOY ANALYSIS (AES, LECO GDS500-A) — Glow discharge optical atomic emission spectrometry for quantitative materials analysis
- CARBON/SULFUR ANALYSIS (LECO CS230) — Inductively coupled combustion/infrared detection for PPM-level sensitivity with as little as one gram of material
- ALLOY SCREENING (XRF) — Non-destructive X-ray fluorescence allows quick identification of material alloy family (steel, aluminum, Inconel, Monel, brass, bronze) for sorting or high-level analysis
- FTIR — Analysis of non-metallic components using Fourier Transform Infrared spectroscopy

Mechanical Testing

- TENSILE/COMPRESSION – Up to 125,000 lbs.-force (yield, ultimate, elongation, and reduction of area)
- HARDNESS — Rockwell B, C, Superficial N; Shore A, D
- MIRCO-HARDNESS — Knoop & Vickers methods

Corrosion Testing

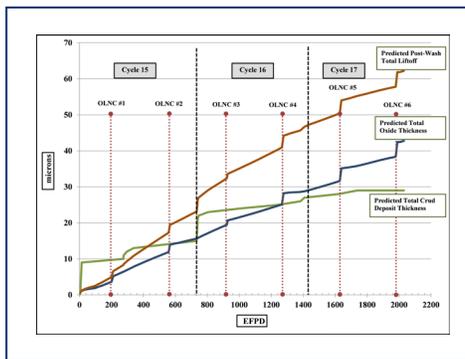
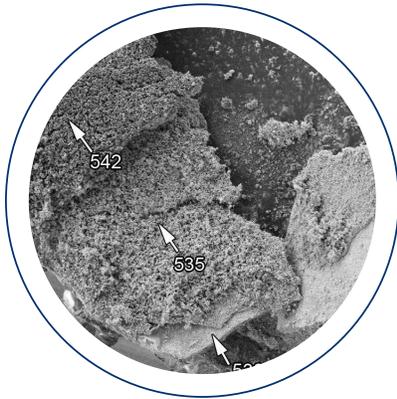
- STATIC AUTOCLAVES — Three 1-gallon static autoclaves allow short-term evaluation of corrosion and material investigations at primary coolant conditions, up to 1500 PSIG and 750°F
- DYNAMIC AUTOCLAVES — Ideal for longer-term investigations of corrosion performance and material performance issues at reactor operating conditions

Metallography

- MOUNTING — Hot-press or cold-set mounts for metallographic preparation depending on specimen and analysis to be performed
- GRAIN STRUCTURE AND SIZE — Physical comparison or computer measurements
- SURFACE EXAMINATION — Investigation of welds and microstructure
- SCANNING ELECTRON MICROSCOPE/EDS — The SEM can acquire images for general imaging of morphology from ~30x to well over 100,000x. The SEM is equipped with two accessories, an Energy Dispersive Spectrometer (EDS) and an electron back-scattered diffraction system. The EDS system can identify the elemental composition of material. The composition can often be quantified to weight percent. The elemental information can be displayed in a large number of formats including graphical spectra, quantitative line scans, elemental distribution mapping, Excel tables for concentrations, etc. The EDS software can also perform “feature analysis” to count and quantify porosity, sizes and compositions of inclusions in material, etc. Back-scattered electron images can also be employed to produce images with contrast based on variations in atomic number across a surface.

Fuel Chemistry & Crud

Risk Assessments



Framatome has developed tools and methods for performing EPRI-defined Level III and Level IV crud risk evaluations. These tools and methods have been successfully applied to support utilities with W, CE and/or B&W plants with Framatome fuel in their efforts to manage the risks for crud-related issues. The techniques have allowed plants to move from situations of high-crud risk, where significant crud deposition was measured, to lower, more manageable crud risk conditions, by using the following elements:

- Localized sub-channel and fuel rod resolution in determining the “clean” rod thermal-hydraulic conditions along the full length of each fuel rod.
- A thermal-hydraulic sub-channel code (COBRA-FLX) benchmarked to evidence of observed in-plant rod surface steaming.
- A fuel deposit interactive chemistry tool (CHEMCRUD) for predicting crud thickness, crud ΔT , crud composition/species, based on actual plant chemistry data and case studies for the most likely chemistry for the upcoming cycle.
- CHEMCRUD is benchmarked to fuel surveillance and crud samples collected (using a sampling method designed to recover intact crud flakes).

Features and Benefits

- Industry-leading capability for predicting Level III and IV crud risks with the application of Framatome’s CHEMCRUD chemistry deposition tool.
- CHEMCRUD is benchmarked to fuel surveillance and to crud samples collected using a sampling method designed to recover intact crud flakes.
- A sub-channel and fuel rod resolution is achieved for the core using COBRA-FLX to obtain the local thermal-hydraulic environment for Level III needs.
- Even higher resolutions (with >103 finer discretization) are achieved with a CFD code-predicted local thermal hydraulic environment for Level IV applications.
- The CHEMCRUD code, when using the applicable resolutions of thermal-hydraulic environment, provides a significant leap forward in the industry for predicting the complex nature of crud formation and evolution.
- Framatome’s tools can provide the necessary means for an effective crud risk management capability.

Supporting the Industry

BWR

- Boron monitoring
- Chemistry regime and operational changes impact assessment
- Cobalt reduction campaign strategies
- Coolant chemistry data assessment
- Corrosion product behavior and intruded chemicals evaluation
- Crud build-up-related risk assessment and crud scrape analyses
- Deposit and resin analyses
- Gamma spectroscopy data analysis
- Metallurgical examination of irradiated hardware
- Methanol Injection Technology to Reduce IGSCC
- Root cause and failure analysis
- SEM/EDS analysis
- Shimadzu X-ray diffractometer
- Startup and shutdown chemistry
- Water chemistry consulting services
- Zinc stearate analysis

PWR

- Benchmark testing service
- Boron monitoring
- Chemical cleaning of nuclear steam generators
- Chemistry & environmental services laboratory
- Chemistry & radiochemistry laboratory services
- Component & system chemical cleaning
- Consumable materials co-op database
- Corrosion evaluation and management
- Deposit analysis and characterization
- Deposit Minimization Treatment (DMT)
- Gamma spectroscopy data analysis
- High-efficiency resin analysis service
- Metallurgical laboratory services
- Operational chemistry evaluation
- Preventive maintenance cleaning
- Root cause and failure analysis
- SEM/EDS analysis
- Shimadzu X-ray diffractometer
- Startup and shutdown dose reduction
- Water chemistry consulting services
- Zinc stearate analysis



Framatome is an international leader in nuclear energy recognized for its innovative solutions and value added technologies for the global nuclear fleet. With worldwide expertise and a proven track record for reliability and performance, the company designs, services and installs components, fuel, and instrumentation and control systems for nuclear power plants. Its more than 14,000 employees work every day to help Framatome's customers supply ever cleaner, safer and more economical low-carbon energy.

Visit us at: www.framatome.com. Follow us on Twitter: @Framatome_ and LinkedIn

Framatome is owned by the EDF Group (75.5%), Mitsubishi Heavy Industries (MHI – 19.5%) and Assystem (5%).

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The logo for Framatome, featuring the word "framato" in a dark blue sans-serif font, followed by "me" in a lighter blue sans-serif font. The letter "o" in "me" is replaced by a stylized orange circle with a white dot in the center, resembling a flame or a drop.

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