

Fuel Assembly Components Testing

Design Validation and Life Time Assessment

Comprehensive testing and competencies to support the hydraulic and mechanical design validation, mechanical properties and the life time justification of fuel assembly components

Challenge

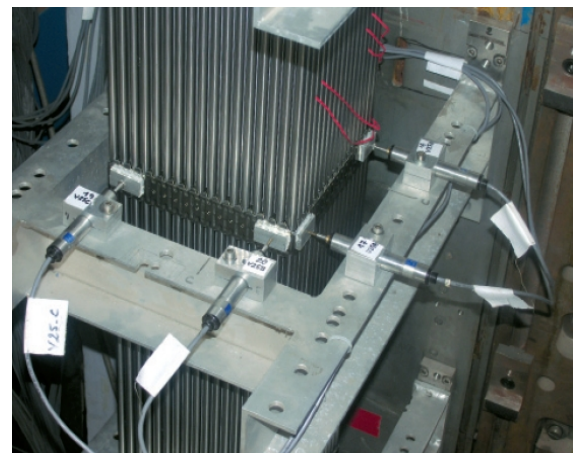
In nuclear power plants, fuel assemblies (FA) must withstand situations like hydraulic forces, wear, vibrations and fretting in normal operation, as well as dynamic loads during abnormal situations like earthquakes or Loss of Coolant Accidents (LOCA).

Solution

Framatome offers a wide variety of test facilities and expert competencies for hydraulics, mechanics, vibration and wear. Tests are related to design qualification, mechanical properties characterization and life time justification, and provide input data for hydraulic and mechanical calculations.

Our scope of services includes:

- Characterization of wear mechanisms
- Direct measurement of hydraulic lift forces on grids, top or bottom nozzles
- Measurement of pressure drop coefficients at real reactor Reynolds number
- Identification of vibration modes, stiffness and mechanical characteristics measured on full scale fuel assembly prototypes
- Measurement of grid lateral stiffness on unique dynamic crush test bench
- Measurement of friction and wear between fuel rod clad and grid cell elements like spring or dimple on unique AURORE and FANI benches
- Instrumentation of each apparatus (force, displacement, pressure, temperature, vibrations)
- Development of specific software to pilot benches and to perform data acquisition
- Signal and data processing (friction coefficient, wear rate, etc.)



CALVA bench: full scale fuel assembly instrumented with strain gages and displacement sensors

Customer benefits

- Reliable test results through well-equipped laboratory with sophisticated benches and measurement systems
- Short reaction times even for complex tasks
- Available laboratory infrastructure in associated disciplines (materials, calibration, ...)
- Comprehensive testing thanks to in-house competences in hydraulic, mechanical and vibration engineering, reducing interfaces

Your performance

is **our** everyday **commitment**

Technical information

Loops 1,000 & 3,000

- Water flow up to 800 kg/s
- Temperature up to 110 °C
- Pressure drop coefficient and hydraulic lift force applied on grids, top or bottom nozzles

AURORE and FANI test benches

- Sliding, impact, impact-sliding, fretting
- Force up to 240 N, water environment, 320 °C and 154 bar
- Wear on fuel rod cladding or thimble tubes

CALVA test bench

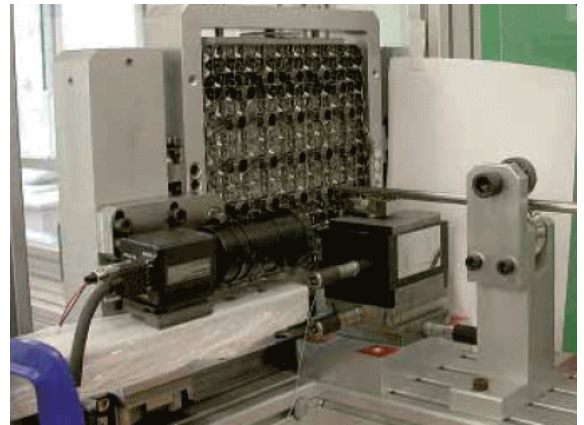
- Mechanical and vibration tests on full scale fuel assembly in air
- Fuel assembly vibration modes, axial and lateral stiffness, strains on thimble tubes

Dynamic crush test bench

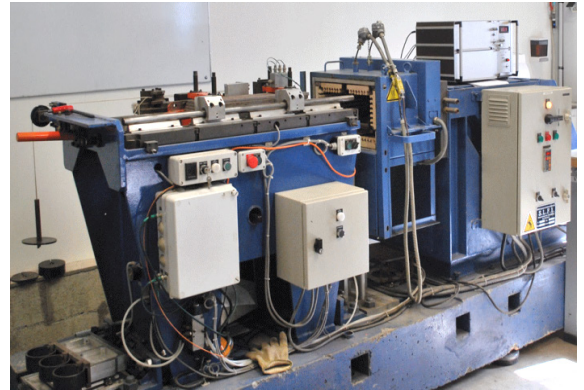
- Impact speed up to 1 m/s
- Temperature up to 320 °C
- Grid/fuel bundle slip load, grid lateral stiffness

Delphine II bench

- Fuel rod insertion speed up to 15 m/min
- Friction loads during fuel rod insertion in the fuel assembly skeleton



Delphine II test bench



Dynamic crush bench for fuel assembly grids

Key figures

- More than twenty years of experience and analysis
- Comprehensive testing infrastructure

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