framatome

COMPUTATIONAL FLUID DYNAMICS (CFD)

Powerful Tool for Performance, Reliability and Operability Assessment of the Nuclear Fuel and Related Products

Expert analytical solutions and licensing support for a wide range of engineering problems from design optimization and custom implementation, to life extensions, root cause analyses and first-of-a-kind applications.

Challenge

After the Fukushima accident, the regulatory requirements have become more stringent; there is increased scrutiny of new technical solutions, from plant life extensions to changes to operational limits. The continued applicability of legacy analysis methods and engineering assumptions to the industrialization of advanced reactors and advanced fuel designs, such as Accident Tolerant Fuel or metallic fuel, is also being scrutinized.

Solution

Framatome offers an integrated engineering services package combining Computational Fluid Dynamics (CFD) assessments with expert nuclear industry consulting and technical support for interfacing with the U.S. Nuclear Regulator Commission (NRC) and European safety authorities.

Our assessments can fully characterize the impact of design changes, implementation of advanced designs and innovative solutions on thermo-hydraulic performance, flow induced vibration and fluid structure interaction, fuel assembly distortion and resistance to debris deposition.

Our evaluations are performed under strict quality standards and rely on fully validated methods that provide high-fidelity solutions to complex turbulent flow, single and two-phase heat transfer, or multi-species transport problems that are superior to the capabilities of sub-channel or special-purpose codes. The quality of our assessments is what sets us aside from our competitors and from general CFD engineering firms.

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

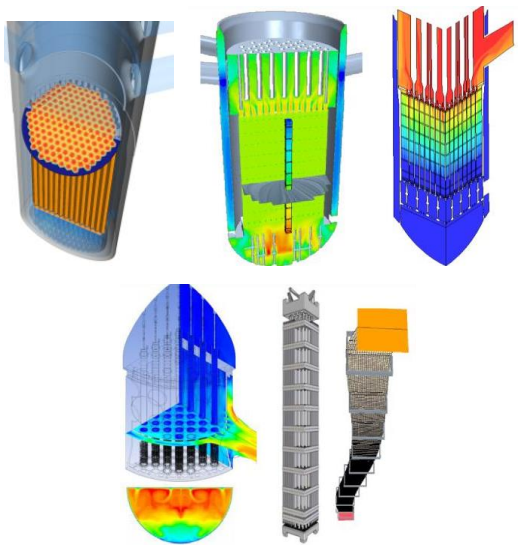

Fig 1: Assessment of fuel performance and system interdependencies at normal and upset conditions.

Customer benefits

Margin recovery driven by improved accuracy

- Advanced high-fidelity 3D methods, compliant with regulatory requirements, allow in-depth understanding of physical phenomena and coupling effects.

Reduction of development time and cost

- Built-in flexibility enables parametric design and custom modeling, resulting in reduced time-to-market.
- Optimization through cost-effective “Virtual Testing” at normal and upset operating conditions, prohibitive to physical testing.

High-quality technical solutions

- Coupled multi-physics solutions to complex flow and system interaction problems, better design solutions, and optimal integration within legacy hardware.

Technical information

Framatome offers the best integrated package on the market, combining high-fidelity CFD analysis with expert nuclear industry knowledge and licensing support. We can provide:

- Sound engineering solutions at any stage of the product development, from conceptual design to custom implementation and licensing, to operability optimization
- Experimental design, supplemental CFD virtual testing, and CFD-based remediation solutions to field issues
- Risk assessments and Root Cause Analyses.
- Application for various type of reactors including VVER.

Framatome developed general CFD tools for solving a wide range of steady state, transient, and unsteady problems to predict thermal performance (thermal mixing, heat removal capability, and DNB) and hydraulic characteristics (crossflows, pressure losses and hydraulic loads) of fuel components.

Special-purpose methods, with predictive capabilities far superior to conventional approaches, were tailored for specific applications such as: CHF, CRUD deposition, debris retention, flow induced vibration, fuel rod and fuel assembly bow.

All CFD methods were optimized through rigorous validation against an extensive database of proprietary experimental data from world-class test facilities such as Framatome's Karlstein, Le Creusot, Erlangen Technical Centers, and Richland PHTF, EDF's MANIVEL loop, and CEA's HERMES and OMEGA loops as well as against publicly available benchmark data.

Our modeling is standardized, user-independent, efficient, and robust, with all methods sharing a common setup that provides an "All-in-one" CFD toolbox used for product development and customization, licensing support, and operation. Access to state-of-the-art High Power Computing enables timely solutions to industrial-size problems encountered by our customers.

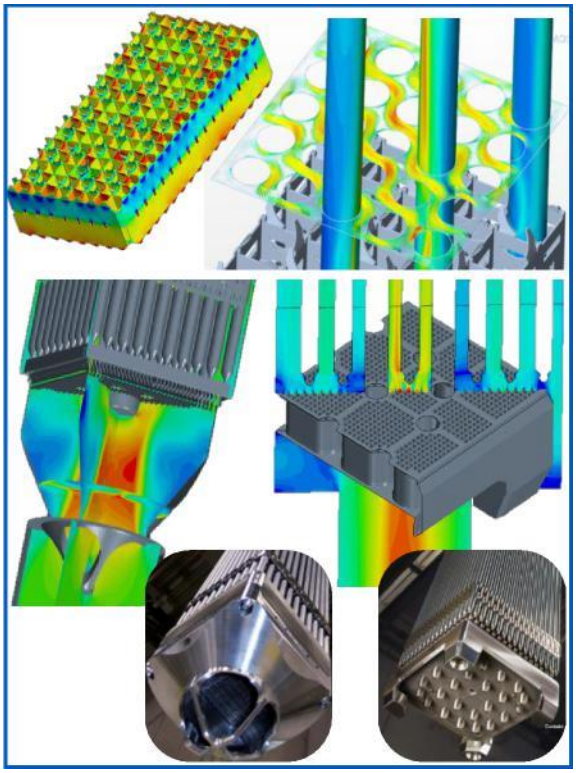

Fig 2: PWR / BWR fuel assessments based on actual 3D geometry and interactions with neighboring components

Key proficiencies

Global multi-disciplinary team of experts

More than 15 years dedicated to CFD methodology development, validation, and implementation

World-class computing platform

References

Framatome champions the introduction of reliable predictive methods that combine high-fidelity CFD with traditional empirical elements as a mainstream analysis tool for the nuclear sector.

Our methods evolve in line with the latest CFD code advancements and the availability of high power computing, with each methodology update being accompanied by extensive validation.

ASME V&V20 is used to evaluate the prediction errors and confidence intervals, and guarantee that the prediction uncertainties of key thermo-hydraulic parameters are maintained within the measurement uncertainty.

Framatome keeps abreast of the latest scientific advancements through successful partnerships with research institutes, national laboratories, and universities and by participating in collaborative benchmarking projects.

Detailed technical information on our CFD methods evolution, our current predictive capabilities, and validation status is available in the public domain as independent publications and as conference proceedings.

Framatome has an active and continuous presence at industry conferences such as: NURETH, TOPFUEL, ICONE, IMECE.

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