

Computational Fluid Dynamics for Nuclear Power Plants

Computational fluid dynamics (CFD) tools have revolutionized the engineering design and optimization process by limiting expensive experimentation and providing virtual (computer-based) solutions with short turnaround time. CFD tools have recently been used for nuclear power plant (NPP) design, licensing, and operations.

The Center for Nuclear Waste Regulatory Analyses® (CNWRA®) at Southwest Research Institute® (SwRI®) completed several CFD-related projects and recently extended its CFD capabilities to in-reactor flow simulations.

Capabilities

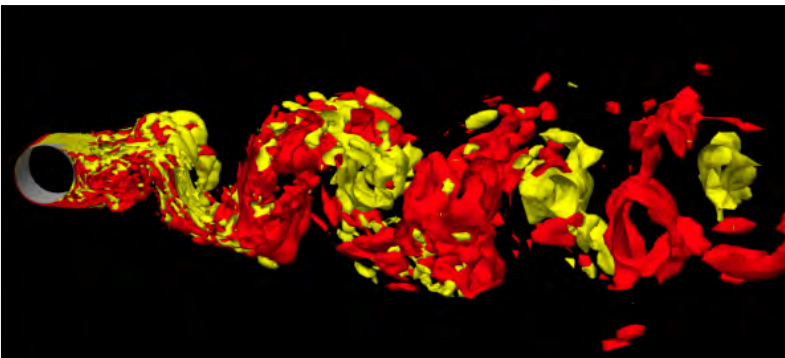
Our CFD capabilities include:

- Thermal-hydraulic analysis of rod bundles for single-phase flows as encountered in pressurized water reactors, metal-cooled reactors, and gas-cooled reactors
- Lower plenum flow analysis
- Thermal analysis of spent fuel casks
- Intermediate heat exchanger flow and thermal analysis
- Detailed component-level modeling of reactor sections and parts
- Numerical study of spent fuel storage facilities
- Particulate flow analyses for nuclear applications
- Numerical simulation of high-speed jet flows
- Multiphase flow simulation

Applications

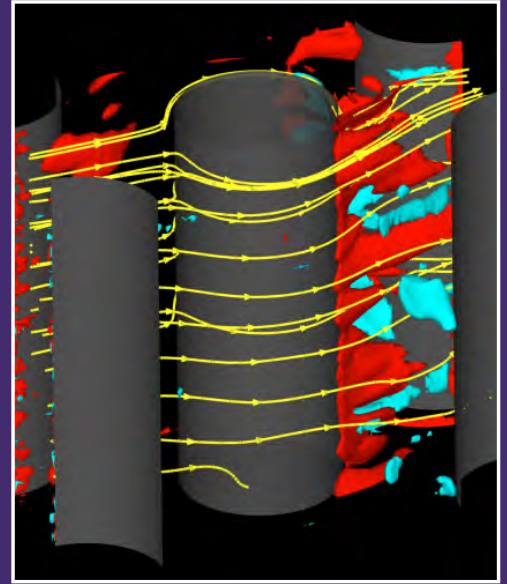
Clients who could benefit from CNWRA expertise include utilities, regulatory agencies, research organizations, and those involved in NPP design and production. Our focus is on technical assistance and research in CFD applications related to:

- Comprehensive flow and heat transfer analysis of primary and secondary systems and components of nuclear power reactors
- Circulation and heat transfer analysis of pool storage facilities
- Design and design verification for new NPP installations
- Licensing and regulatory support to new NPPs
- Operations, analyses, and upgrades for existing NPPs
- Analysis of existing or aging NPPs that are being evaluated for safety or license renewal



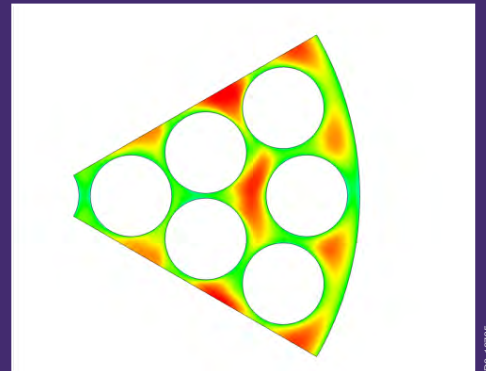
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CNWRA performed three-dimensional simulations for high-speed flow over a circular cylinder to validate multiscale hybrid turbulence models.



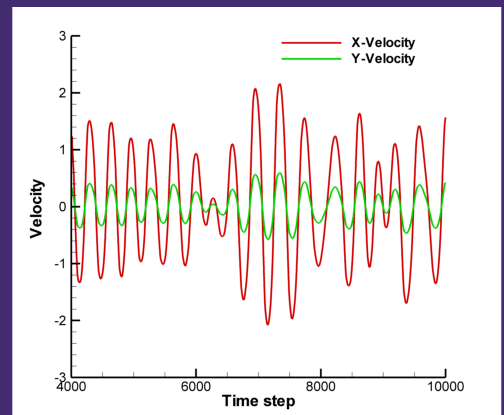
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CNWRA engineers have simulated flow across staggered cylinders encountered in heat exchangers and reactors. The figure shows the streamlines and vorticity surfaces in the domain.



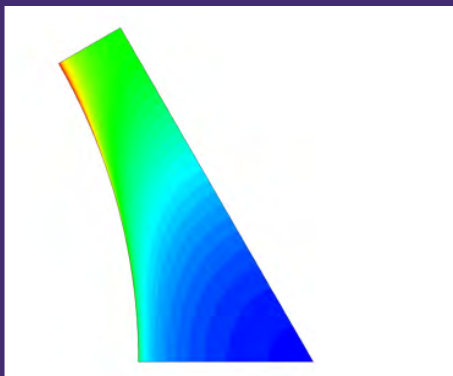
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Additional simulations show the time-averaged velocity distribution in a rod bundle.

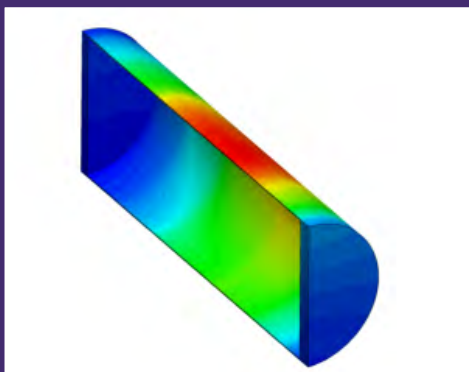


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Using unsteady RANS techniques, CNWRA scientists traced the time-dependent fluctuating velocity components for flow in fuel rod assemblies.



CNWRA simulated a 37-rod fuel assembly using a multiscale hybrid model to show temperature distribution.



CNWRA engineers performed thermal analysis of spent fuel storage canisters to understand the temperature distribution pattern and maximum temperature locations during transportation.

**We welcome your inquiries.
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Resources

Using a tailored selection from among commercial, open source, and in-house CFD software, CNWRA addresses diverse client requirements. Dedicated pre- and post-processing tools for mesh generation and visualization enhance problem-solving and communication of results to clients.

Software	Developer/Source
FLUENT	ANSYS-FLUENT
FLOW-3D	FLOW-Science
SPH-Tsunami	SwRI
MFIX	NETL
MULTIFLO	SwRI
FDS	NIST



Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,300 employees who perform contract work for industry and government clients.



*Benefiting government, industry
and the public through innovative
science and technology*