Computational Fluid Dynamics for the Nuclear Power Industry

The Geosciences and Engineering Division (GED) at Southwest Research Institute® (SwRI®) has the extensive experience and capability required to perform detailed computational fluid dynamics (CFD) simulations of complex engineered and natural systems. From component-level simulations of reactor and fuel-cycle facility components to simulations of natural flow systems, GED scientists and engineers solve a wide variety of problems while focusing on regulatory compliance.

GED expertise is ideally suited to meeting the needs of a variety of commercial clients, regulatory agencies, and research organizations, particularly those involved in nuclear power plant design and production. For new nuclear power plants, we can provide design analysis, design verification, and licensing and regulatory support. For existing nuclear power plants, we offer technical assistance related to operations, analyses, and upgrades. Additionally, we can analyze existing or aging nuclear power plants that are being evaluated for safety or license renewal.

Our integrated multidisciplinary approach uses code customization, analytical model development and applications, and experimental investigation to accurately and effectively solve complex fluid flow and thermal problems in the following areas.

CFD Analysis of Nuclear Power Reactor and Fuel-Cycle Facility Components and Systems

- Thermal-hydraulic analysis of complex rod-bundle core of power reactors
- Lower plenum fluid flow and heat transfer analysis
- Customized turbulence modeling for anisotropic flows
- Intermediate heat exchanger flow analysis

Unsteady Turbulent Flow Analysis

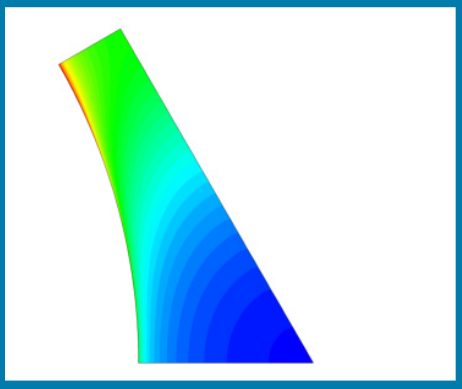
- Acoustic analysis
- Nozzle flow applications
- Algorithm development
- Code customization

Natural Hazard Analysis and Environmental Fluid Flow Studies for Reactor Sites

- Simulation of landslide-generated tsunamis
- Free surface flow evaluation using volume-of-fluid technique
- Offshore structures analysis for flow-induced vibration
- Mesh-free, smoothed particle hydrodynamics modeling of large deformations

Fire Dynamics Simulations

- Tunnel fires
- Smoke propagation assessment
- Other forms of pool fires
- Use of NIST Fire Dynamics Simulator and other commercial codes



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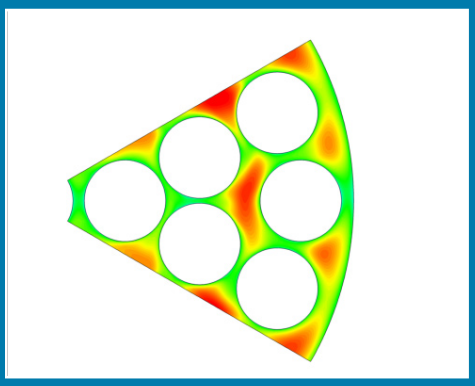
GED simulated a 37-rod fuel assembly using a multi-scale hybrid model to show temperature distribution.



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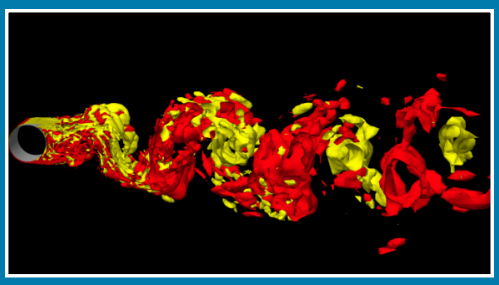
Additional simulations show the time-averaged velocity distribution in a rod bundle.



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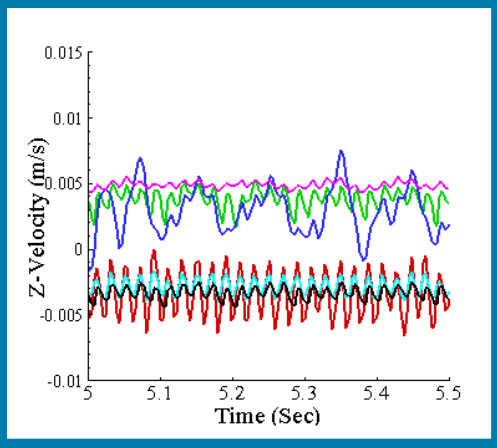
GED performed three-dimensional simulations for high-speed flow over a circular cylinder to validate multiscale hybrid turbulence models.



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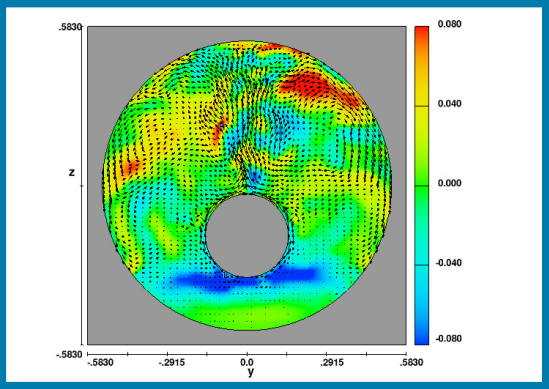
Flow unsteadiness, which is important for determining heat, momentum, and mass transfer in the gap between tightly packed fuel rods, is shown through velocity fluctuation signals.



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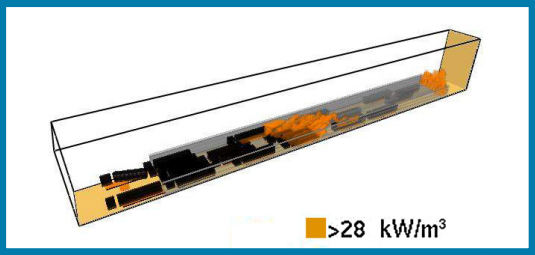
Using CFD simulations, GED predicted the thermal and fluid flow processes that could take place in a high-level waste repository. These simulations establish confidence in full-scale drift modeling results under expected repository performance conditions.



DO 16732

GED simulated a major fire that occurred in a highway tunnel to evaluate the thermal conditions during the fire.

Resources

Using a tailored selection from among commercial, open source, and in-house CFD software, GED 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

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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

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