

# Computational Fluid Dynamics for the Nuclear Power Industry

The Center for Nuclear Waste Regulatory Analyses® (CNWRA®) 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, CNWRA scientists and engineers solve a wide variety of problems while focusing on regulatory compliance.

CNWRA 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

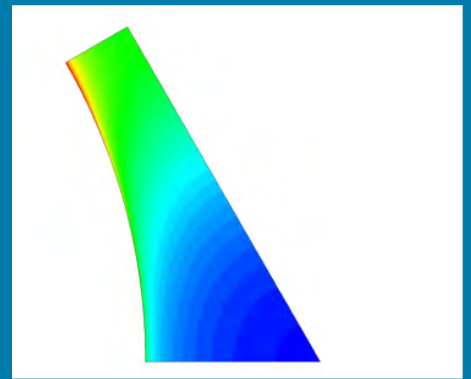
- Acoustic analysis
- Nozzle flow applications
- Algorithm development
- Code customization

## 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

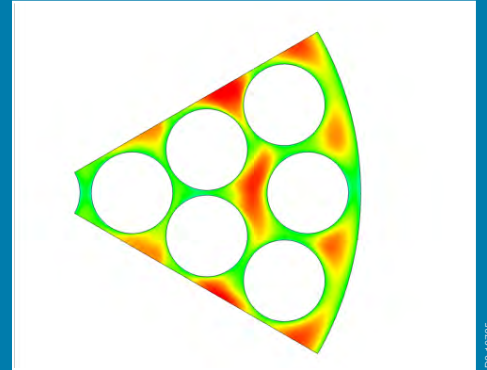
## Fire Dynamics Simulations

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



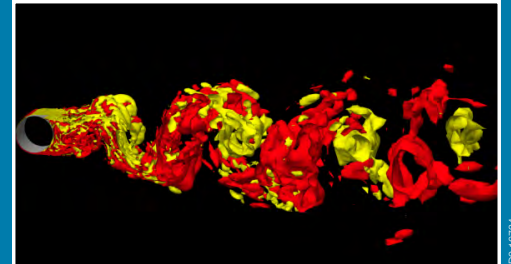
DO 16804

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



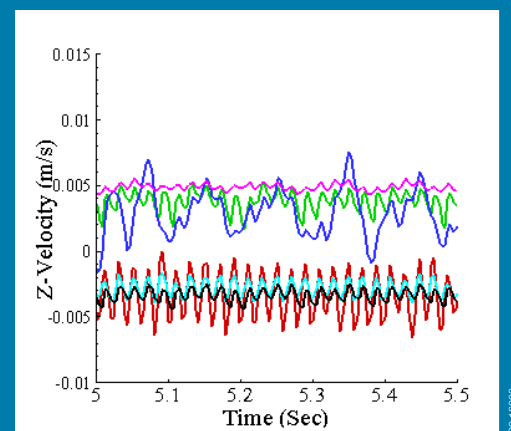
DO 16735

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



DO 16734

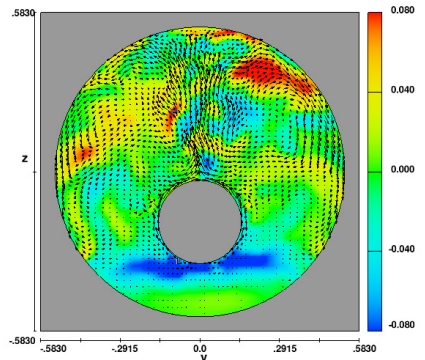
CNWRA performed three-dimensional simulations for high-speed flow over a circular cylinder to validate multiscale hybrid turbulence models.



DO 16803

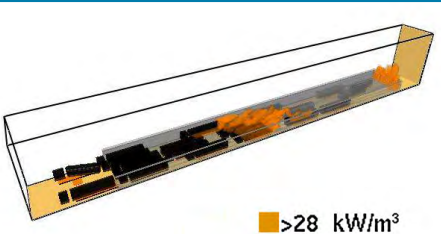
Flow unsteadiness, which is important for determining heat, momentum, and mass transfer in the gap between tightly packed fuel rods, is shown through velocity fluctuation signals.

DO 16723



Using CFD simulations, CNWRA 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 16722



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

**We welcome your inquiries.  
For additional information,  
please contact:**

**Debashis Basu, Ph.D.**  
Research Engineer  
(210) 522-8333  
International: 001-210-522-8333  
dbasu@swri.org

**Center for Nuclear Waste  
Regulatory Analyses**

Southwest Research Institute  
6220 Culebra Road (78238-5166)  
P.O. Drawer 28510 (78228-0510)  
San Antonio, Texas USA

**www.swri.org**

**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*

An Equal Employment Opportunity/Affirmative Action Employer  
Race/Color/Religion/Sex/Sexual Orientation/  
Gender Identity/National Origin/Disabled/Veteran  
Committed to Diversity in the Workplace

20-0290\_JCN 234-535 tp