

# Computational Fluid Dynamics for Spent Fuel Storage and Transportation Systems

The Center for Nuclear Waste Regulatory Analyses® (CNWRA®) at Southwest Research Institute® (SwRI®) has the extensive experience and capability required for detailed computational fluid dynamics (CFD) simulations of spent nuclear fuel storage and transportation systems. We provide CFD research and technical assistance to clients in a variety of areas. These include simulating fire exposure conditions and modeling heat transfer and load optimization of spent fuel canisters.

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

## Thermal Analysis of Spent Fuel Casks

- Conjugate heat transfer and fluid flow analysis
- Radiation modeling
- Thermal analysis under accident and normal transportation conditions
- Thermal design verification and review

## Multiphase Flow CFD Analysis of Underground Storage Drifts

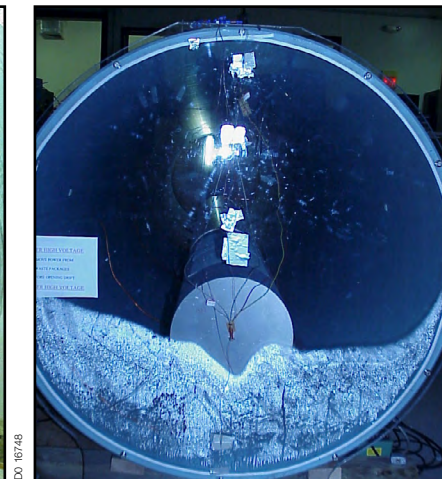
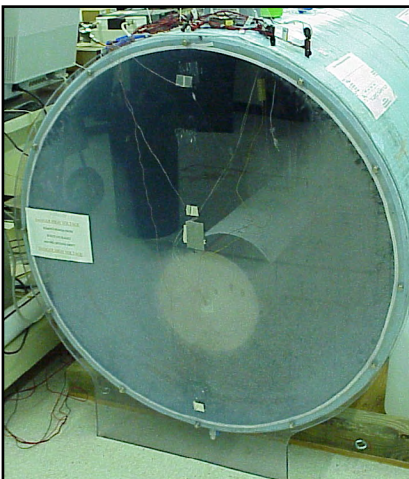
- Moisture flow and evaporation-condensation simulation
- Multimode heat transfer including phase change
- Conjugate heat, mass transfer, and fluid flow
- Experimental and analytical support to computational models

## Modeling of Surface-Based Dry Storage Facilities

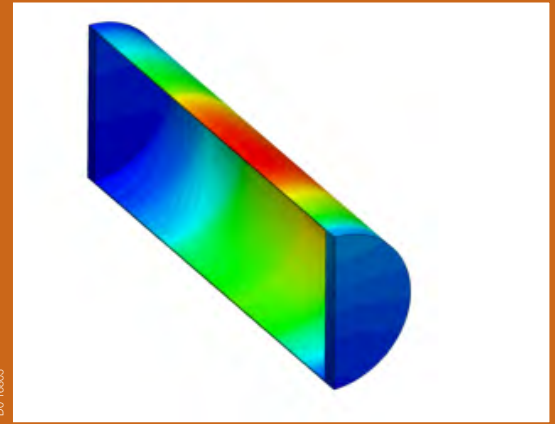
- Thermal analysis of stored casks
- Thermal optimization studies of cask arrangements
- HVAC analysis of spent fuel handling and storage facilities

## Fire Dynamics Simulations

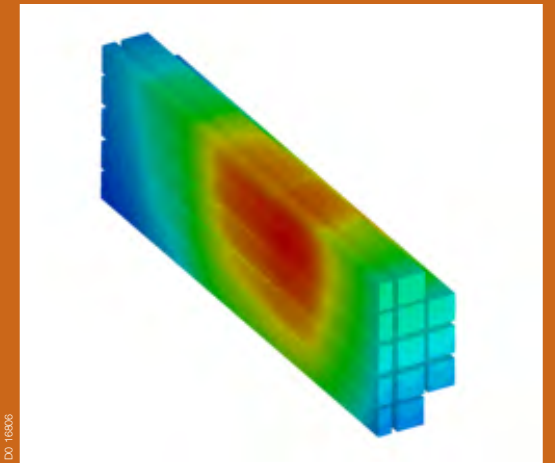
- Tunnel fires
- Other forms of pool fires
- Use of NIST Fire Dynamics Simulator and other commercial codes



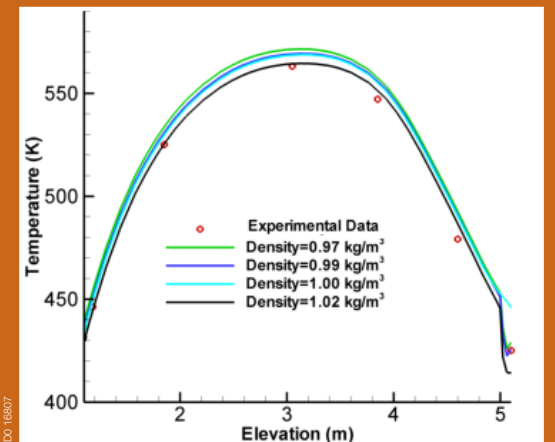
Two-phase flow simulations show zones of reduced temperature, elevated relative humidity, and preferential condensation.



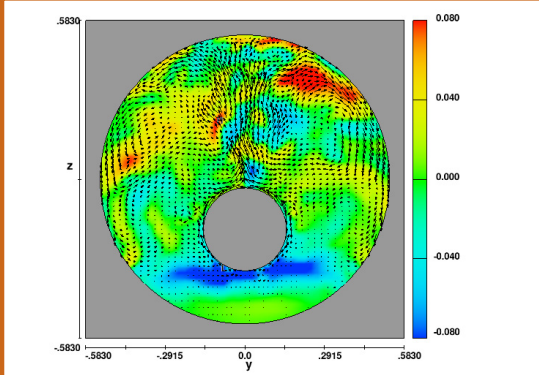
CNWRA engineers performed thermal analysis of spent fuel storage canisters to understand the temperature distribution pattern and maximum temperature locations during transportation.



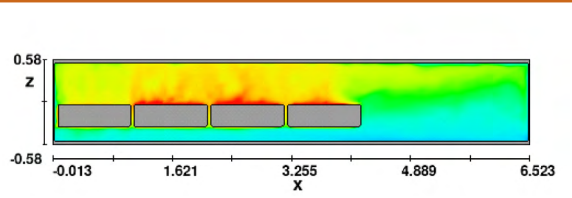
CFD analysis of the spent fuel assembly is used to determine the peak cladding temperature and general temperature distribution during normal transport conditions in a cask. Maximum peak cladding temperature must be below a specific value to satisfy regulatory criteria.



A numerical study was performed to understand the effect of coolant air density on fuel centerline temperature distribution of a dry spent fuel storage cask. Parametric studies are important to determine optimum input values and understand system behavior.



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.



CFD was also used to determine temperature distribution around stored spent fuel packages.

## 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

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