Computational Fluid Dynamics for the Oil and Gas Industry

Computational fluid dynamics (CFD) is a tool that can be used effectively in a variety of onshore and offshore petroleum industry applications. The Geosciences and Engineering Division (GED) at Southwest Research Institute® (SwRI®) has extensive CFD experience, performing detailed simulations of complex engineered and natural systems and providing clients with optimized design solutions.

Our CFD capability can be applied to any stage of the petroleum production process, including exploration, extraction, transport, and processing. These solutions limit expensive experimentation and provide virtual solutions with short turnaround times.

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

Unsteady Turbulent Flow Analysis

- Acoustic analysis
- Nozzle flow applications
- Atmospheric gas dispersion
- Hydrodynamic analysis
- Algorithm development
- Code customization

Natural Hazard Analysis and Environmental Fluid Flow Studies (Upstream Engineering)

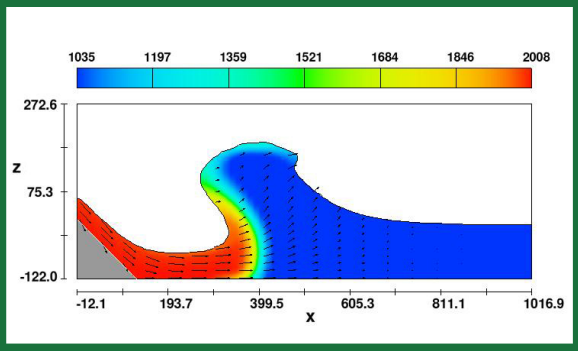
- Simulation of landslide-generated tsunamis
- Free surface flow evaluation using volume-of-fluid technique
- Offshore structures analysis for flow-induced vibration
- Mesh-free, smoothed particle hydrodynamics code capable of modeling flow with large deformation

Multiphase Flow CFD Analysis

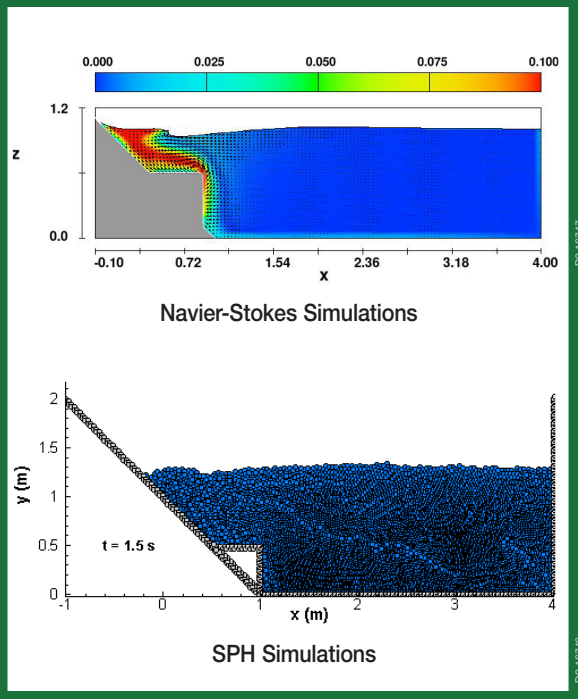
- Fluid flow analysis of engineered systems coupled with natural porous media
- Moisture flow and evaporation-condensation simulation
- Multimode heat transfer including phase change
- Conjugate heat, mass transfer, and fluid flow
- Experimental and analytical support to computational models

Fire Dynamics Simulations

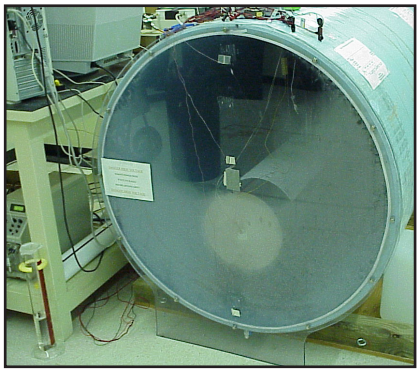
- Leak-, rupture-, and spill-related fire analysis
- Smoke propagation assessment
- Use of NIST Fire Dynamics Simulator and other commercial codes

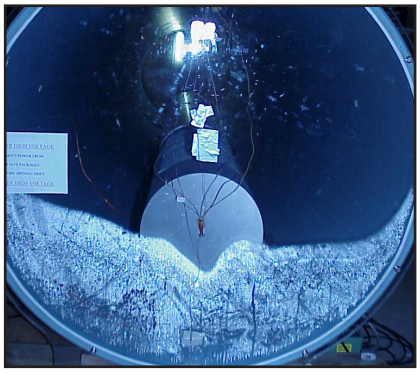


GED engineers use the volume-of-fluid (VOF) method to simulate the landslide-generated tsunami at Lituya Bay, Alaska.

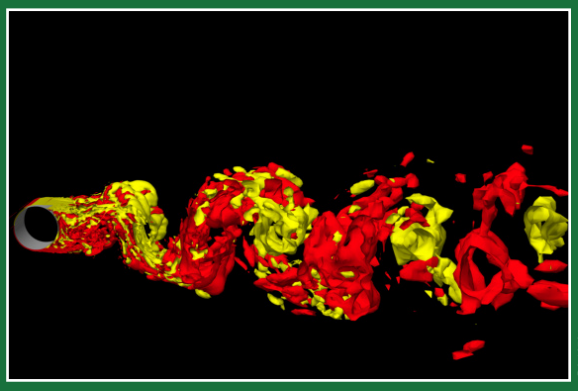


GED engineers performed time-dependent smoothed particle dynamics (SPH) simulations and Navier-Stokes simulations of a sliding wedge that capture wave and run-up height. These simulations can be used to determine impacts from landslide-generated tsunamis.

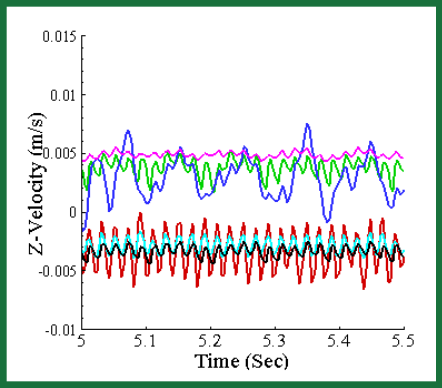




Two-phase flow simulations show zones of reduced temperature, elevated relative humidity, and preferential condensation.



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



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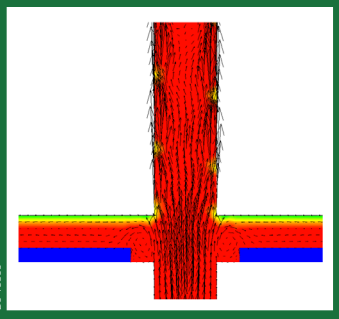
Flow unsteadiness is important for determining heat, momentum, and mass transfer and also for flow-induced vibration analysis.



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Using the VOF technique, GED developed computational models to simulate two-phase flows related to geophysical fluid dynamics.

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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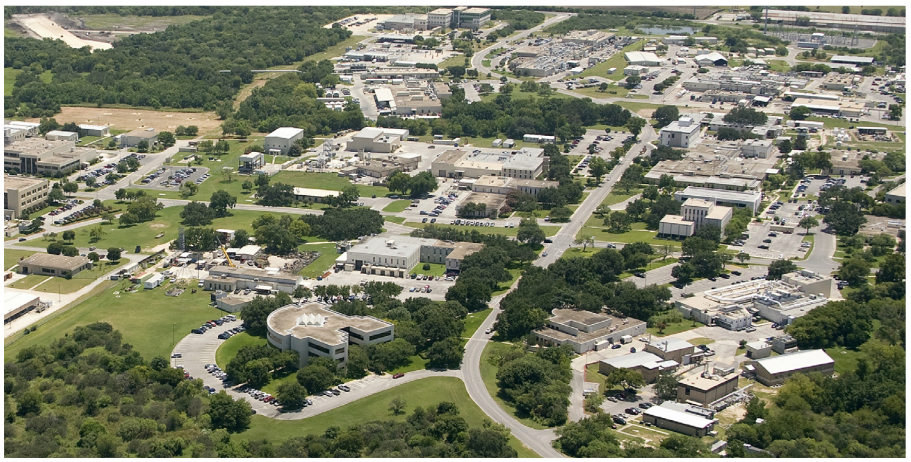

Southwest Research Institute is an independent, nonprofit, applied engineering and physical sciences research and development organization using multidisciplinary approaches to problem solving. The Institute occupies 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, 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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