Sandia National Laboratories

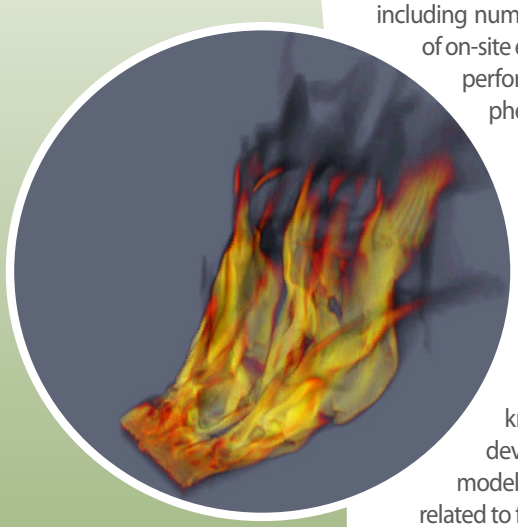
Energy, Climate & Infrastructure Security

# Thermal Phenomenological Modeling

## Leveraging a comprehensive suite of resources, Sandia National Laboratories performs complete investigations of thermal phenomena.

### Thermal Phenomena in Nuclear Energy

Fire is a dominant concern for the containment of radioactive material. To prevent nuclear material release into the atmosphere, Sandia models the presence of fire and intense heat during an accident involving nuclear material. Leveraging a comprehensive suite of resources including numerical modeling software and a number of on-site experimental and testing facilities, Sandia performs complete investigations of thermal phenomena.



Realistic fire simulation produced by Sandia developed FUEGO

### Numerical Modeling Using Codes

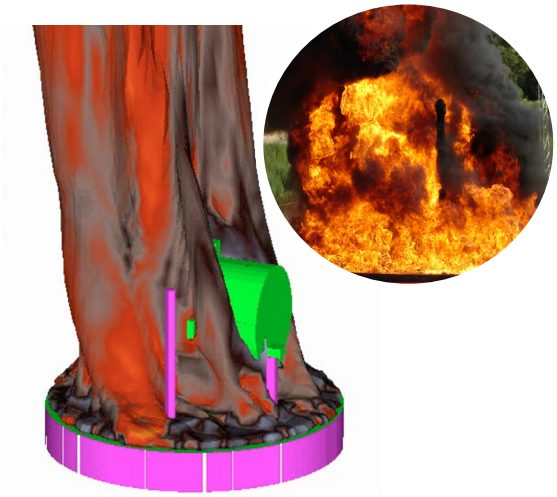
Sandia researchers have expertise in the development and application of a number of numerical thermal analysis codes. With high-performance computing capabilities and a broad knowledge of commercial and in-house-developed software, Sandia is capable of modeling the most difficult physics simulations related to fire and heat transfer.

- FUEGO: Developed at Sandia, FUEGO is a low Mach number fluid mechanics code. Typically used for heat and mass transport modeling, FUEGO can also be coupled with Syrinx to simulate fire environments.
- ARIA: This Sandia-developed Galerkin finite element-based program is capable of solving nonlinear, implicit, transient, and direct-to-steady state problems on massively parallel architectures. ARIA also solves coupled-physics problems.
- Patran: Patran is a finite element commercial code with a comprehensive selection of thermal loading possibilities. Sandia successfully coupled Patran with an in-house computational fluid dynamics fire code for the heat transfer analysis of objects affected by fire.

Sandia runs these numerically intensive simulations on Red Storm, one of the world's most powerful supercomputers.

### The Nation's Leading Fire Testing Facility

Sandia's Thermal Test Complex (TTC) was specially created for fire and thermal experiments. TTC provides a controlled environment in which to demonstrate the performance of components and assemblies under a variety of abnormal thermal environments.



Computer simulation of a large-scale open pool fire and benchmark test (shown right)

### Thermal Analysis in Action

The importance of fire in nuclear accidents has brought Sandia's work to the forefront of the field of thermal phenomenology. Leveraging its researchers' unmatched expertise and experience along with the extensive resources of the Labs, Sandia is able to conduct the most challenging experiments and numerical calculations.

Sandia has performed safety and risk analyses for several fire-related accident scenarios including fire in a shipping container caused by a vehicle collision, an explosion near a nuclear reactor and its impact on the plant, and how burning rocket fuel affects the nuclear battery after an explosion on a National Aeronautics and Space Administration (NASA) launch vehicle. These analyses have led to the development of technologies to mitigate and prevent the consequences of a release of nuclear or radioactive material.

### Publications


Harding, D. C., Akin, L. A., Yoshimura, R. H., & Miller, D. R. (2010, October). A stress-state modified strain based failure criterion for evaluating the structural integrity of an inner eutectic barrier. Conference paper at 2010 Packaging and Transportation of Radioactive Materials Conference, London, United Kingdom.

Lopez, C., Sorenson, K. B., Cook, J. R., & Murphy, A. J. (2008). Recent assessments in USA of spent fuel packages exposed to severe thermal environments different from regulatory standards. Packaging, Transport, Storage & Security of Radioactive Material, 19(2), 63-70.



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