Discovery at the Interface of Science and Engineering: **Science Matters!**

# Engineering Sciences
# Fire Science & Technology

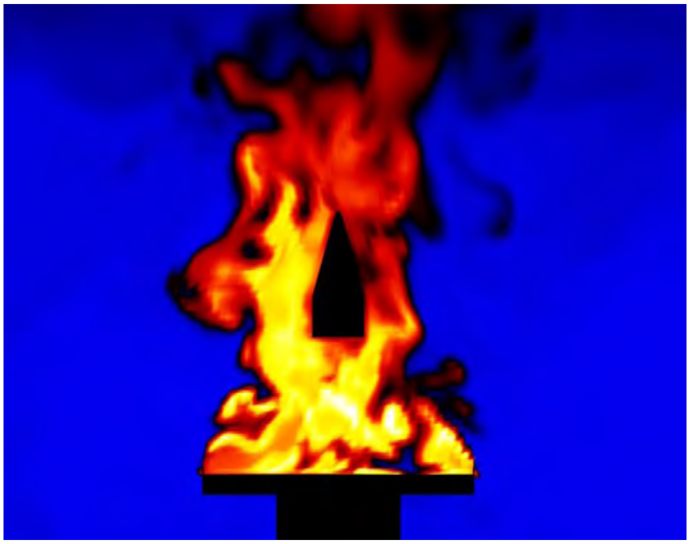

Figure 1. Fire simulation of a validation experiment of a complex calorimeter in a well-controlled fire.

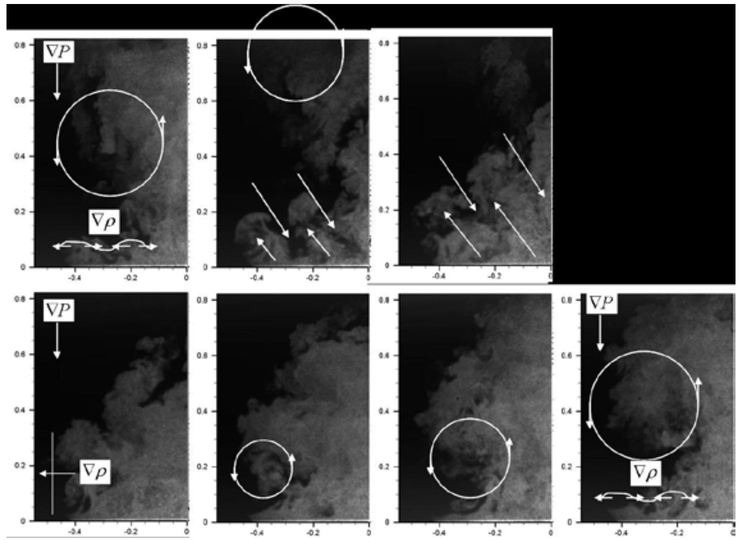


Figure 2. Sequence of PLIF frames showing two separate Rayleigh-Taylor instability modes in a helium plume that lead to bubble and spike structures that are swept into large, coherent vortices characteristic of plumes and fires. Both modes contribute significantly to the overall mixing in plumes.

## Sandia is generating unprecedented data sets for fire model validation

*Spatially and temporally rich data sets are helping Sandia researchers understand and corral fire's unpredictable ways.*

Fire has always been one of humankind's greatest threats and one of its most useful tools. The modern world also knows it as an exquisitely complex chemistry problem.

High-tech, laser-based diagnostics and large-scale, high-performance computer simulations techniques are giving Sandia researchers a virtual telescope to peer into the world of large-scale, complex fires. These techniques (illustrated in Figures 1-3) are returning data that are helping us to better predict how a weapons system will respond in a fire.

Our plume experiment (Figure 2), for example, illustrates the causes and contributions to a fire's growth and behavior. As Figure 2 shows, turbulent mixing processes in the near source region of buoyant plumes are initiated by two independent manifestations of Rayleigh-Taylor instabilities. Heavier air overlying lighter helium results in mixing due to the formation of helium bubble and air spike structures. As the bubble and spike structures mix, the edge of the plume becomes unstable and results in a toriodal vortex that grows, engulfing the bubble and spike structures. This vortex draws in heavy air over the light helium and the cycle repeats itself.

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND 2006-6097P

NNSA National Nuclear Security Administration

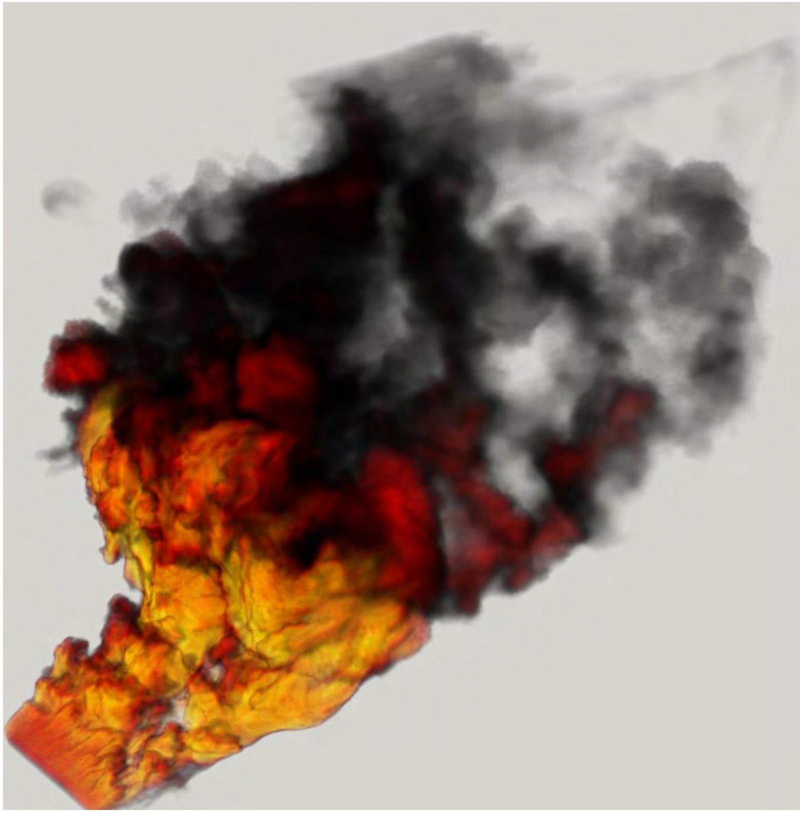
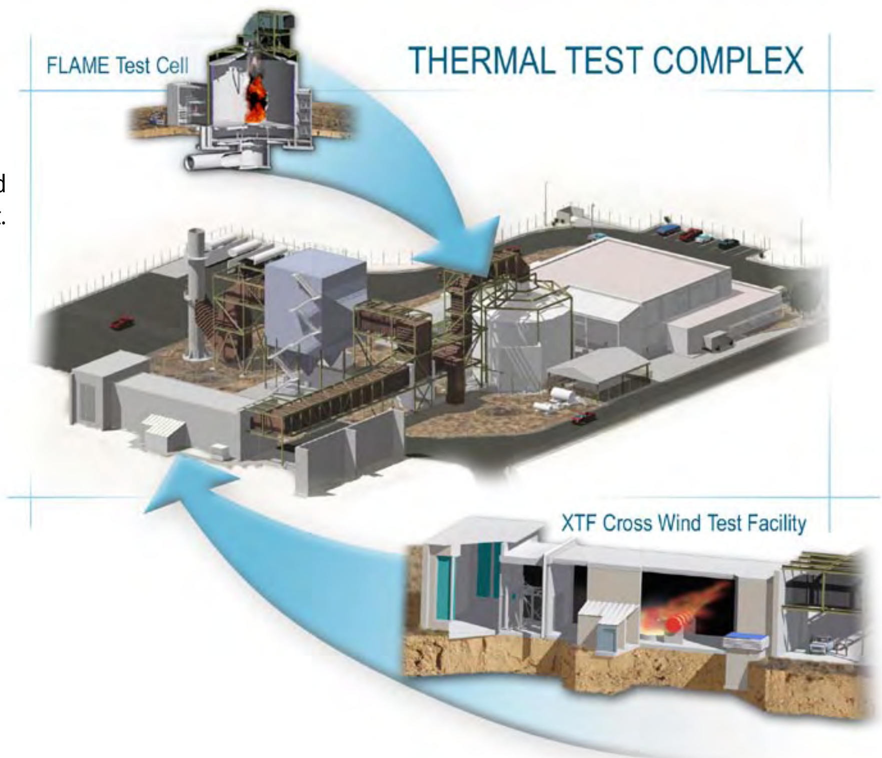


Figure 3. Fire simulation of a partially open enclosure in a crosswind. The inferno simulation represents 385 million unknowns (degrees of freedom) solved per time step with tens of thousands of time steps required.




State-of-the-art facilities for controlled experiments permit model development.