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cRIO Facility Control Solution

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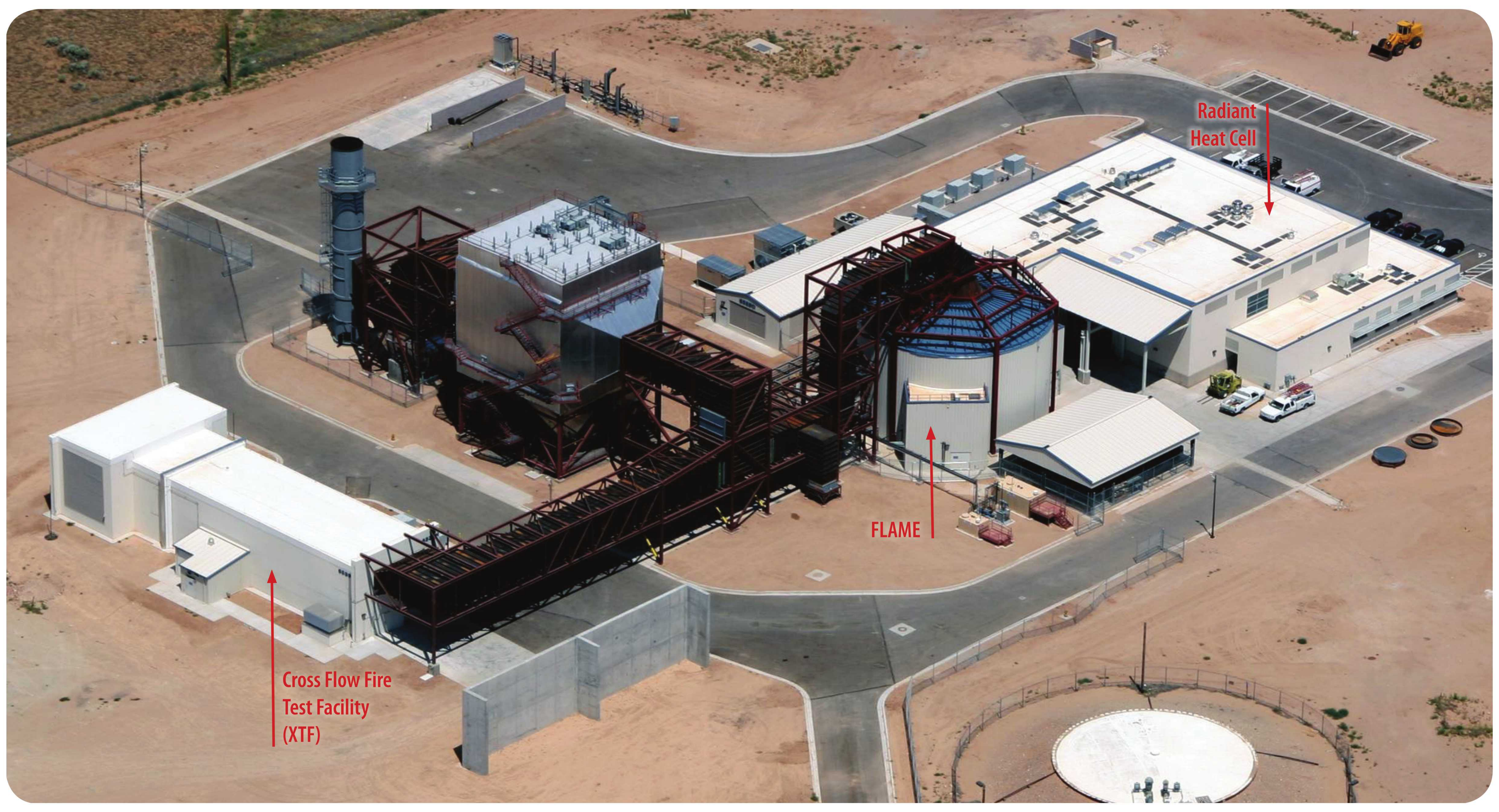
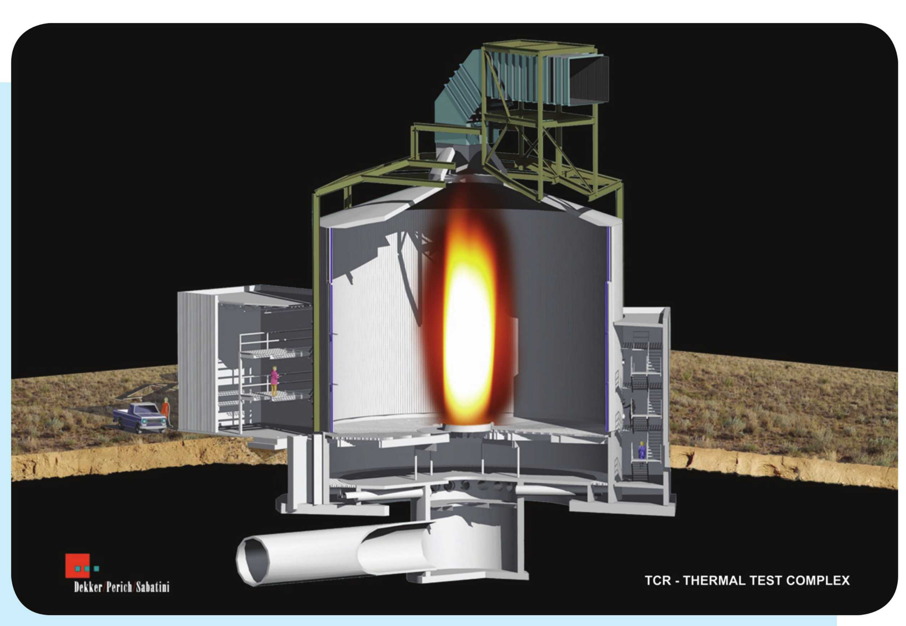


Facility Description

The Thermal Test Complex (TTC) was designed to serve as an international resource for validation of fire physics models as well as the nuclear-weapons-complex hardware qualification facility for fires. This $40 million facility, completed in the winter of 2005, offers one-of-a-kind capabilities and positions Sandia as a technical leader in the fire science community. Experimental fire research, validated modeling tools, and phenomenological model development capabilities form the basis of an integrated capability to solve high-consequence problems in fire prevention, fire consequence analysis, and fire mitigation (firefighting).

The Thermal Test Complex (TTC) serves two functions: to evaluate the thermal loads from fire environments and the multi-physics response of hardware subject to fires. The facility has been designed to study quiescent large-scale combustion events as well as to assess the effect of wind. Fires include hydrocarbon liquid and solid fires and propellant fires.

Quiescent (calm) wind fire experiments are performed in the seven-story, 60-foot diameter **FLAME** test cell that has water-cooled walls and well controlled/characterized airflow equipment. Laser diagnostic equipment is used in the cell to help understand the burning process. Systems to allow jet fuel, methanol, and other liquid fuels as well as hydrogen, methane, and other gas fuels are part of the design. A 5.2 Megawatt (MW) radiant heat lamp array permits radiant heat tests.

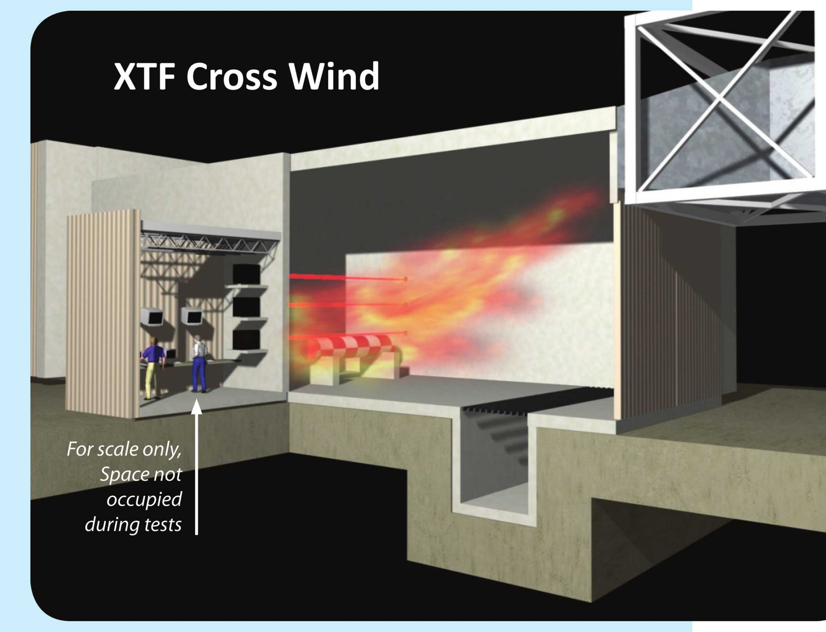


Primary Purpose
Controlled Fires in Quiescent Conditions
Model Development and Validation
Testing under Repeatable Conditions

Capabilities

Test Facility Size (approx)	50 ft high x 60 ft diameter
Area (± 5%)	3,100 gsf
Maximum Fuel Fire	20.0 MW
Maximum Fire Test Duration	1 hour
Airflow	0–150,000 scfm inlet
Fuels	JP-8, Methanol, Hydrogen

The Cross Flow Fire Test Facility, or XTF, is a 25-ft-high by 25-ft-wide by 84-feet long facility that is an indoor "fire wind tunnel" for testing objects with hazardous components (including explosives) at wind speeds up to 20 mph. Built with 30-inch reinforced concrete walls and special refractory concrete, the XTF also has radiant heat test capabilities. Systems to allow jet fuel, methanol, and other liquid fuels as well as hydrogen, methane, and other gas fuels are part of the design. A 3.1 Megawatt (MW) radiant heat lamp array permits radiant heat tests.

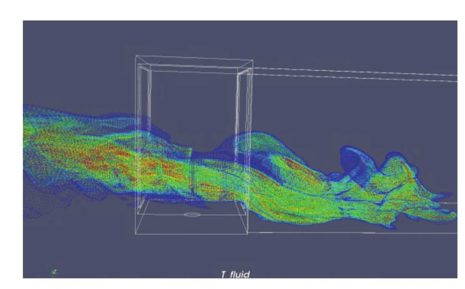


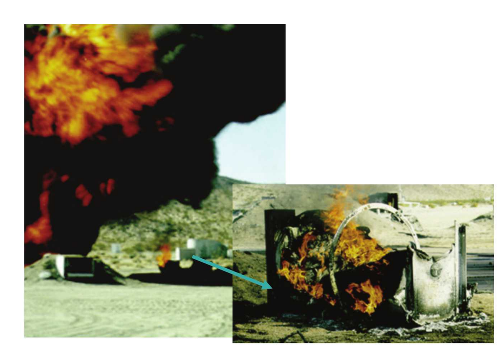
Primary Purpose
Fires in Crosswind Conditions (1-20 MPH)
Component, Subsystem, and System Testing
Model Development and Validation

Capabilities

Test Facility Size (approx)	25 ft x 25 ft x 60 ft	Maximum Radiant Test	2.8 MW
Area (±5%)	4,715 gsf	Maximum Explosive Load	106 lb equivalent TNT
Maximum Fuel Fire	20.0 MW	Airflow In	8,500–170,000 scfm

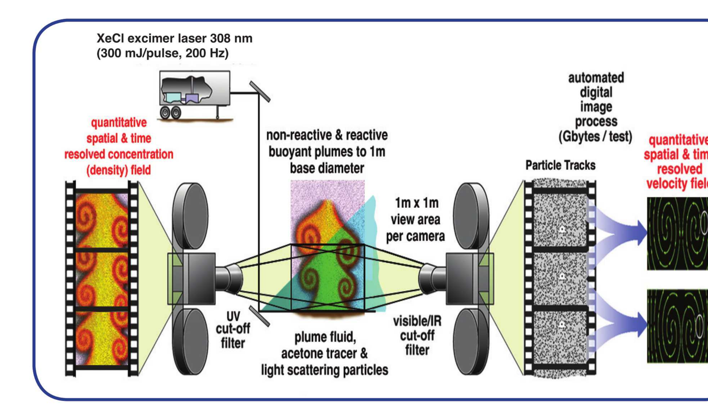
Engineering Fire Science into National Security Applications





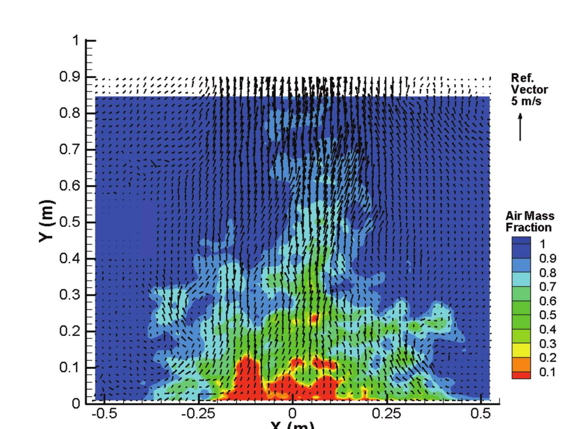
Objective: Develop a fundamental understanding of fire through discovery experiments (real & simulated) on key parameters affecting heat transfer – from soot optical properties at the nano-scale to a full system coupled thermal response in an accident scenario.

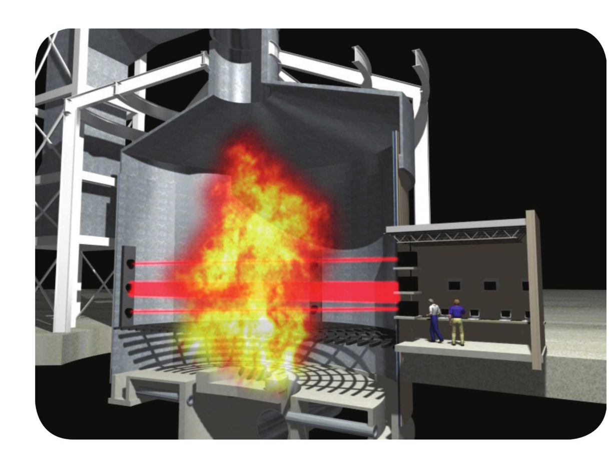
Utilize:
- Theoretical modeling
- Advanced diagnostics
- State-of-the-art, controlled facilities
- High performance computing algorithms & platforms
- Integrate capabilities to solve problems of national interest.



Experimental Fire Science is Critical to Meeting Our Simulation-Driven Engineering Vision

- **Discovery**
- **Validation**
- **Integrated Tests**
- **Enhance Understanding & Confidence**
- **Synergy with Modeling and Simulation**



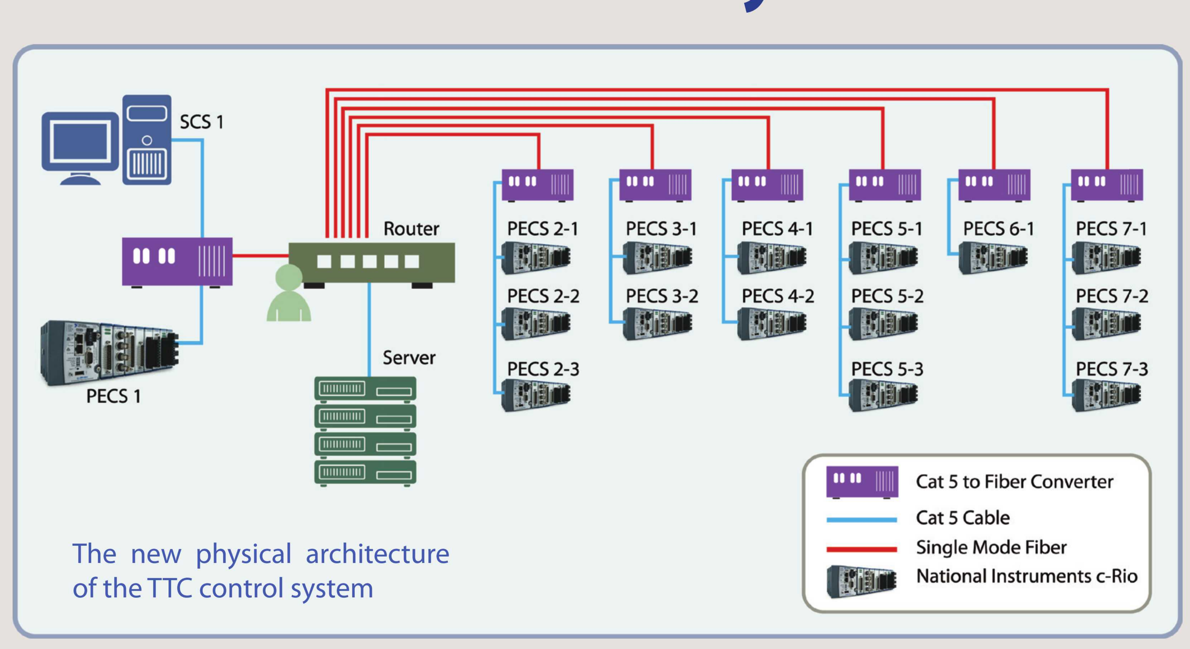


COTS Control System

In this system there is one personal computer (PC), serving as the operator station (OS1) running a Windows-based operating system (Windows 7). All components of the system are connected via a Ethernet LAN which also communicates with the cRIO modules. The system also has a limited interface with the facility control system, but this is external to the SCS.

The software architecture of the SCS is a combination of LabVIEW executables (.exe), Test Stand, Test Stand sequences, LabVIEW code, and LabVIEW RT (real-time software running on the cRIO modules) and consist of three packages:

Operator Station Package – The operator interface is a LabVIEW executable running an instance of the Test Stand Engine. The Test Stand Engine executes a set of sequences that represent one of the six test types selected by the operator (Radiant heat in the Radiant heat test cell; Radiant heat in the Flame test cell; Radiant heat in the XTF test cell; Liquid fuel in the Flame test cell; Liquid fuel in the XTF test cell; Gaseous fuel in the Flame test cell). The sequences will execute LabVIEW code that contains the high-level logic for PECS control or expose user interfaces to the operator. The LabVIEW code uses the LabVIEW DSC Engine to interact with the cRIO systems.



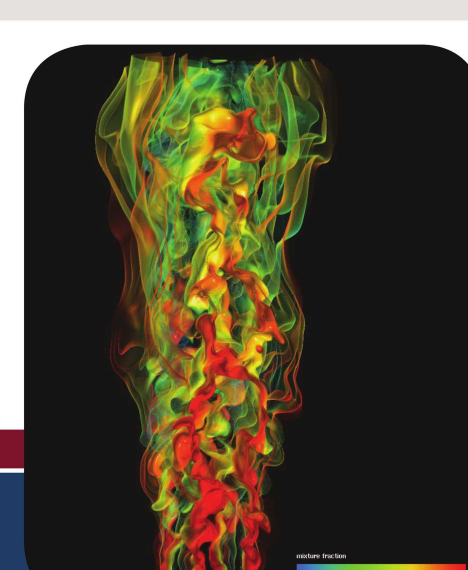
The new physical architecture of the TTC control system

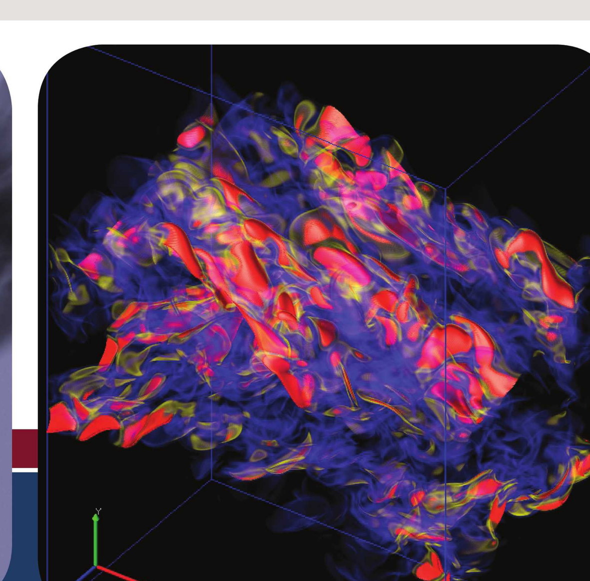
cRIO Packages – PECS hardware is controlled by embedded LabVIEW applications running on cRio controllers. These applications consist of code objects that model the physical operation of PECS equipment. These cRIO Packages share a common hardware communications interface.

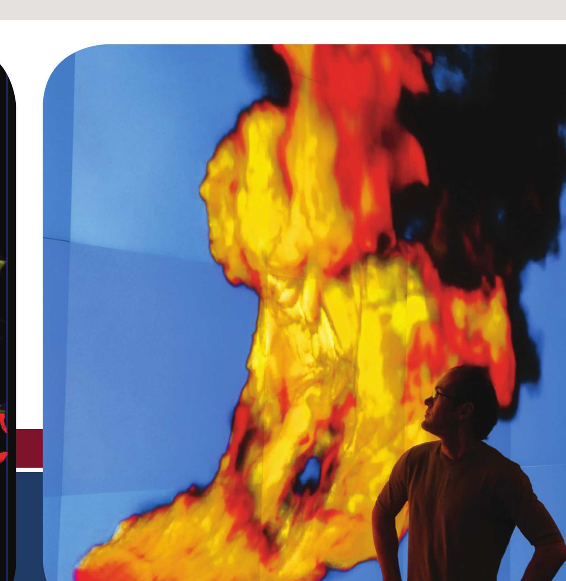
Maintenance Development Package (Distributed System Manager (DSM)) based) – Maintenance Development is a collection of LabVIEW interfaces and emulators that permit operators to characterize various aspects of SCS behavior. This package can replace the operator package with a set of hardware testing interfaces that enable testing of individual I/O points or hardware subsystems.

The SCS will coordinate with both internal and external components. The SCS will integrate and coordinate with the TTC facility control system (FCS – essentially process equipment in the field) for building functions such as freeze protection that must be monitored by the SCS. This coordination is limited to monitoring the FCS.

PECS usage and configuration is handled by a several LabVIEW RT programs which will run on cRio controllers. The cRIO RT Controller applications that run on each cRIO module will handle low- and mid-level PECS hardware operations and will exchange state data with the Operator Stations' DSC Engines. At the cRIO level control includes PID control of relevant hardware, and interactions between low- and mid-level hardware systems.







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