United States
Nuclear Regulatory Commission

Fire Modeling: Current Status

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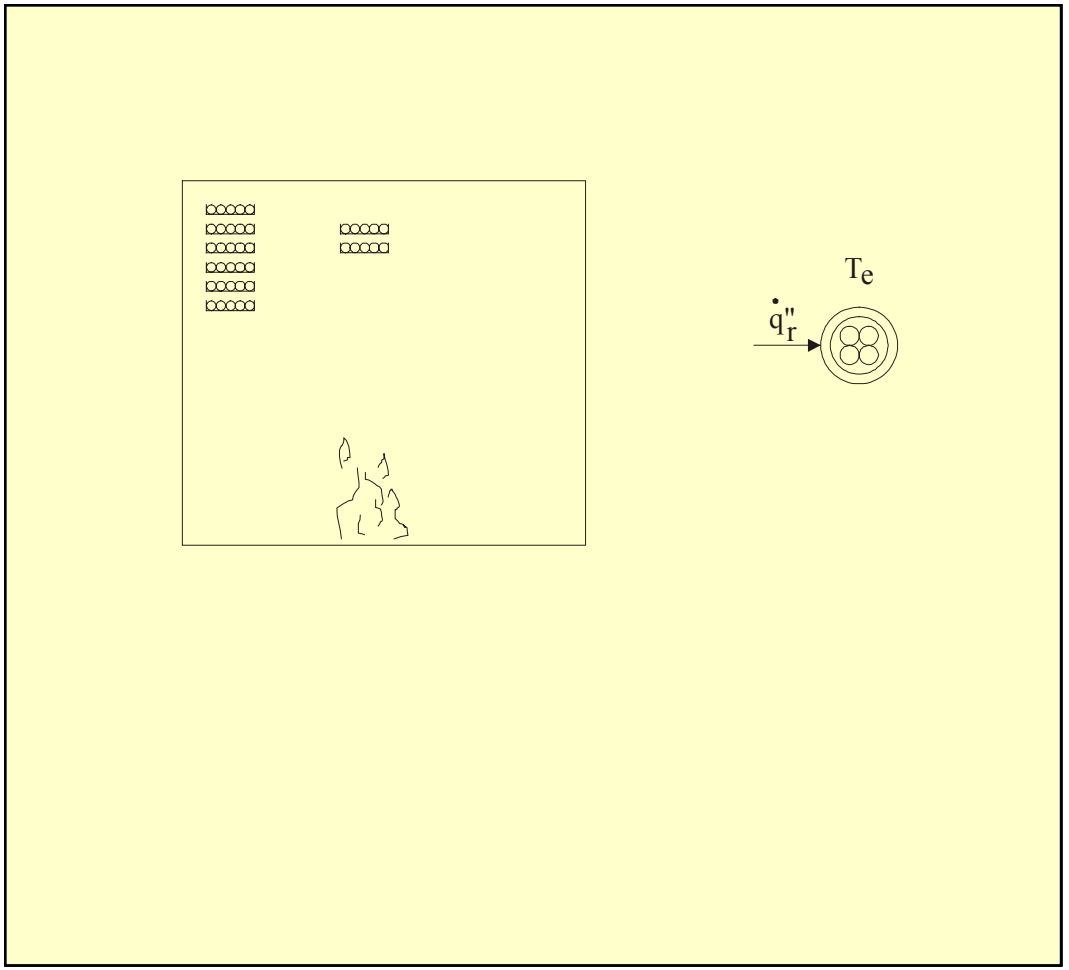
Outline

- Background
- NRC fire modeling R&D overview
- Results from a benchmark exercise
- Concluding remarks

Fire Modeling

- **Phenomenological models for consequences of specified fires**
  - **Environmental conditions**
  - **Impact on systems, structures, and components (SSCs)**
- **Multiple applications, e.g.,**
  - **Predict possibility of and time-to-damage of SSCs**
  - **Assess impact on safety margin associated with proposed change**
- **Varied levels in complexity**
  - **Separate elements**
  - **Few zone**
  - **Full mesh**



Key Uncertainties

- **Initial/boundary conditions**
  - **Characteristics of ignition scenario**
  - **Fuel bed and room geometry**
  - **Ventilation**
  - **Target SSC characteristics**
- **Model applicability and performance**
  - **Validation data base**
  - **User knowledgeability**
- **Scenario-specific phenomena**
  - **Explosive faults**
  - **Effect of suppression activities**

Fire Modeling R&D: Activities

- International Collaborative Project to Evaluate Fire Models for NPP Applications
- Collaborations with NIST and EPRI
- Fire model evaluation and guidance development

International Collaborative Project

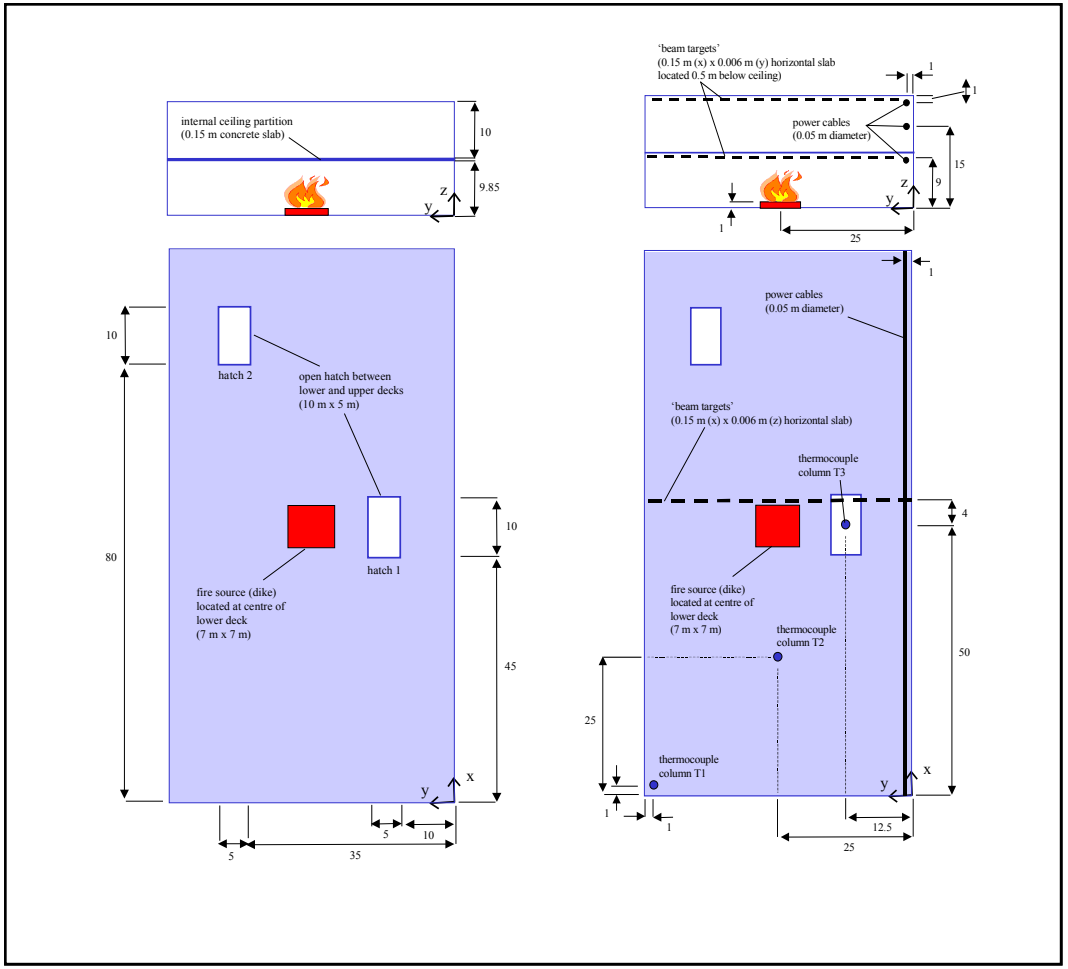
- General Objectives
  - Evaluate capabilities and limitations of current state-of-the-art fire models
  - Develop improved fire modeling methods and tools
- Key Elements of Approach
  - Benchmarking exercises
  - New experiments
  - Blind tests

International Collaborative Project Benchmark Exercises

- Benchmark Exercise #1
  - Cable tray fires
  - Results reported in NUREG-1758
- Benchmark Exercise #2
  - Pool fires in large halls
  - More challenging for zone models
    - Large volumes, e.g. turbine halls
    - Large fires
  - Preliminary results reported in NUREG/CP-0181
  - Final results report to be issued soon

Benchmark Exercise #2 – General Parameters

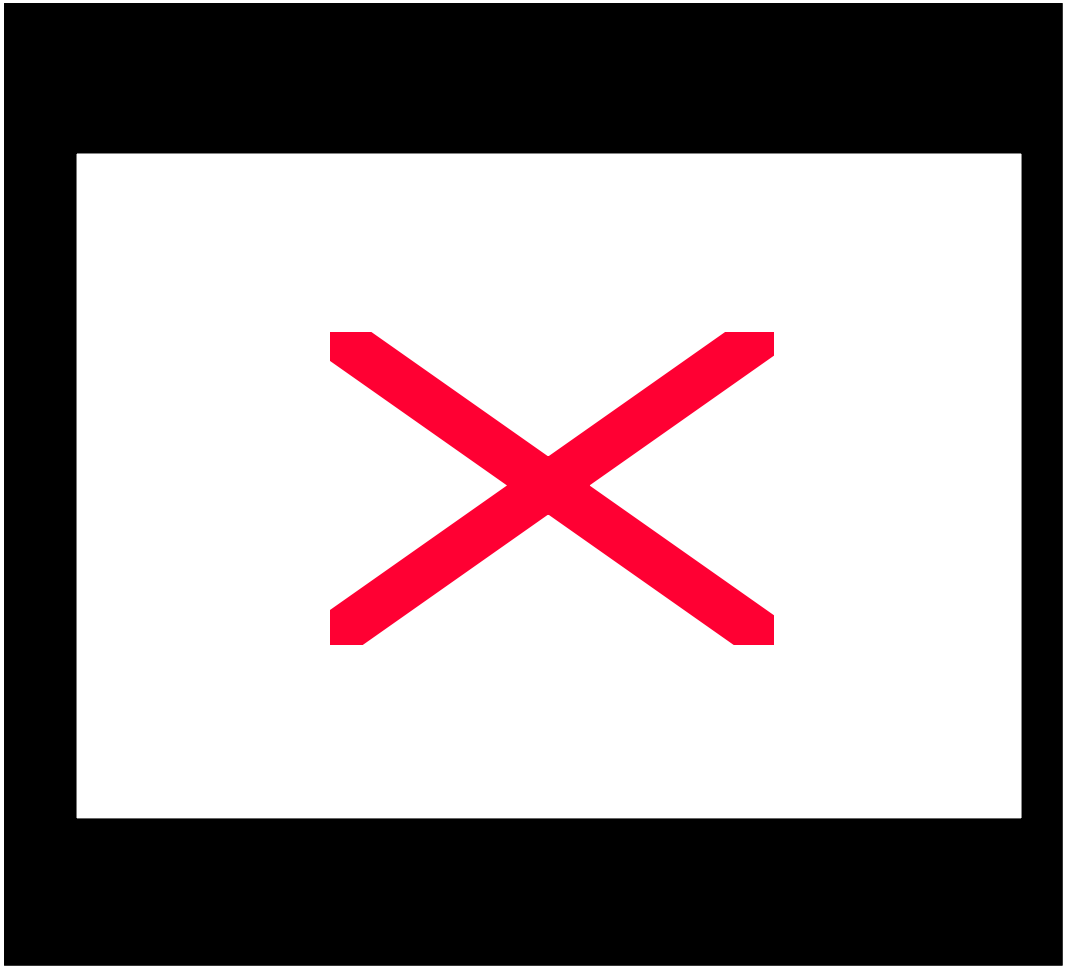
- Large turbine hall (100m x 50 m x 20 m)
- Large oil pool fire (grows to about 70 MW in 10 min)
- Open hatches between floors
- Beam and cable targets
- Cases for varying ventilation
  - Nearly sealed
  - Natural ventilation
  - Natural and mechanical ventilation



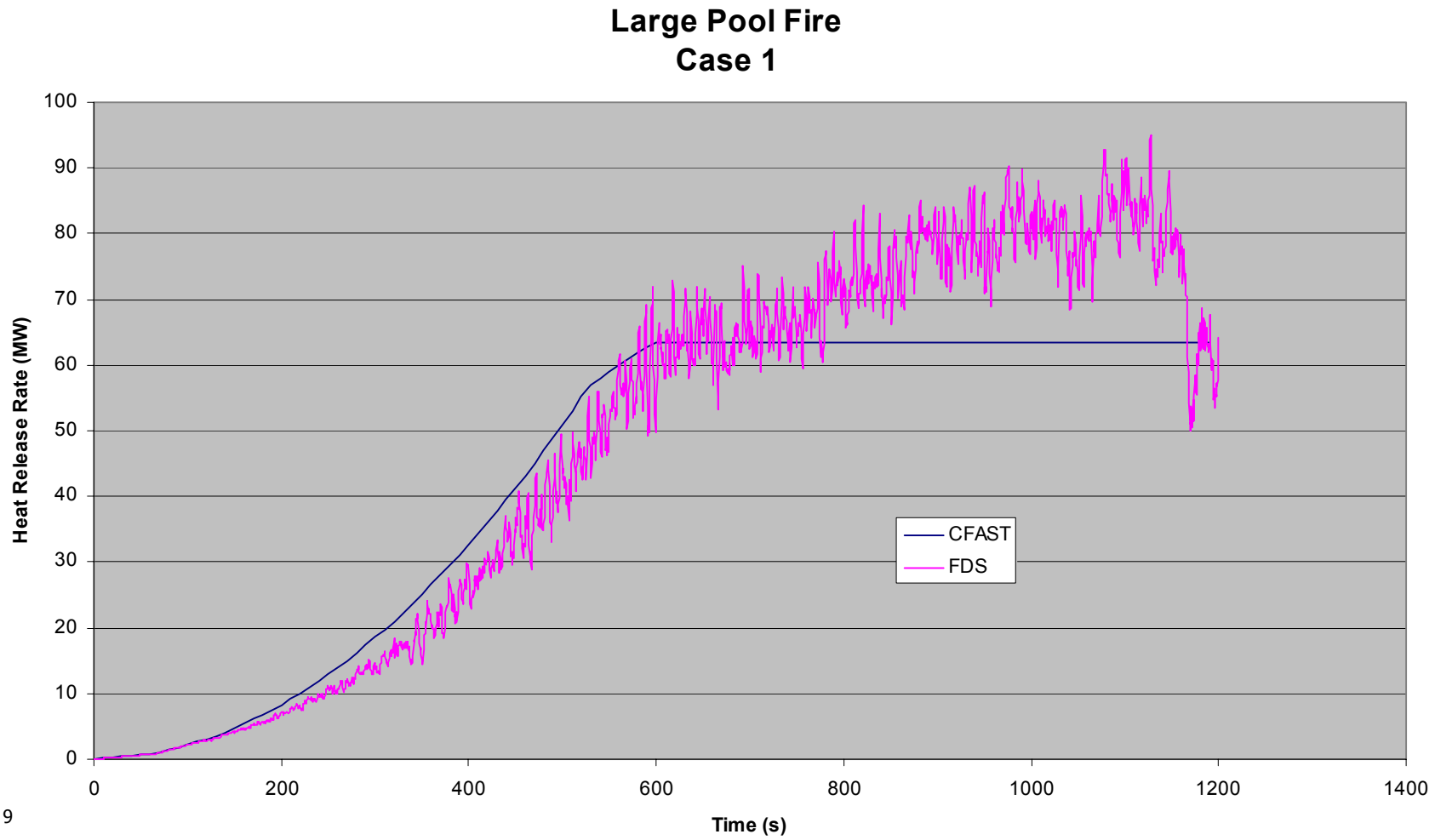
Benchmark Exercise #2 – NRC Analysis

Compares predictions of two NIST models

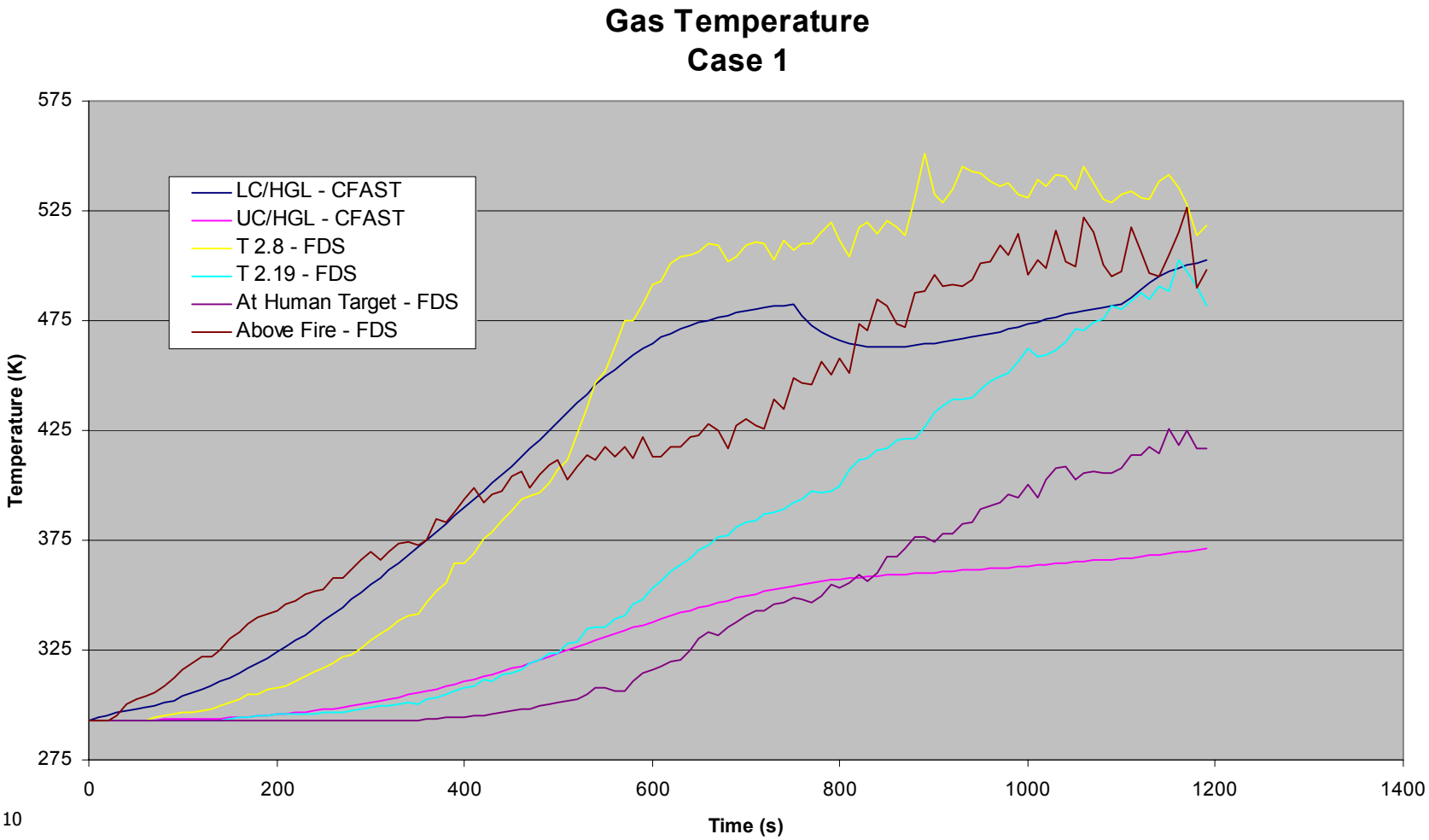
- CFAST (Zone model)
- FDS (100,000 cell CFD model)



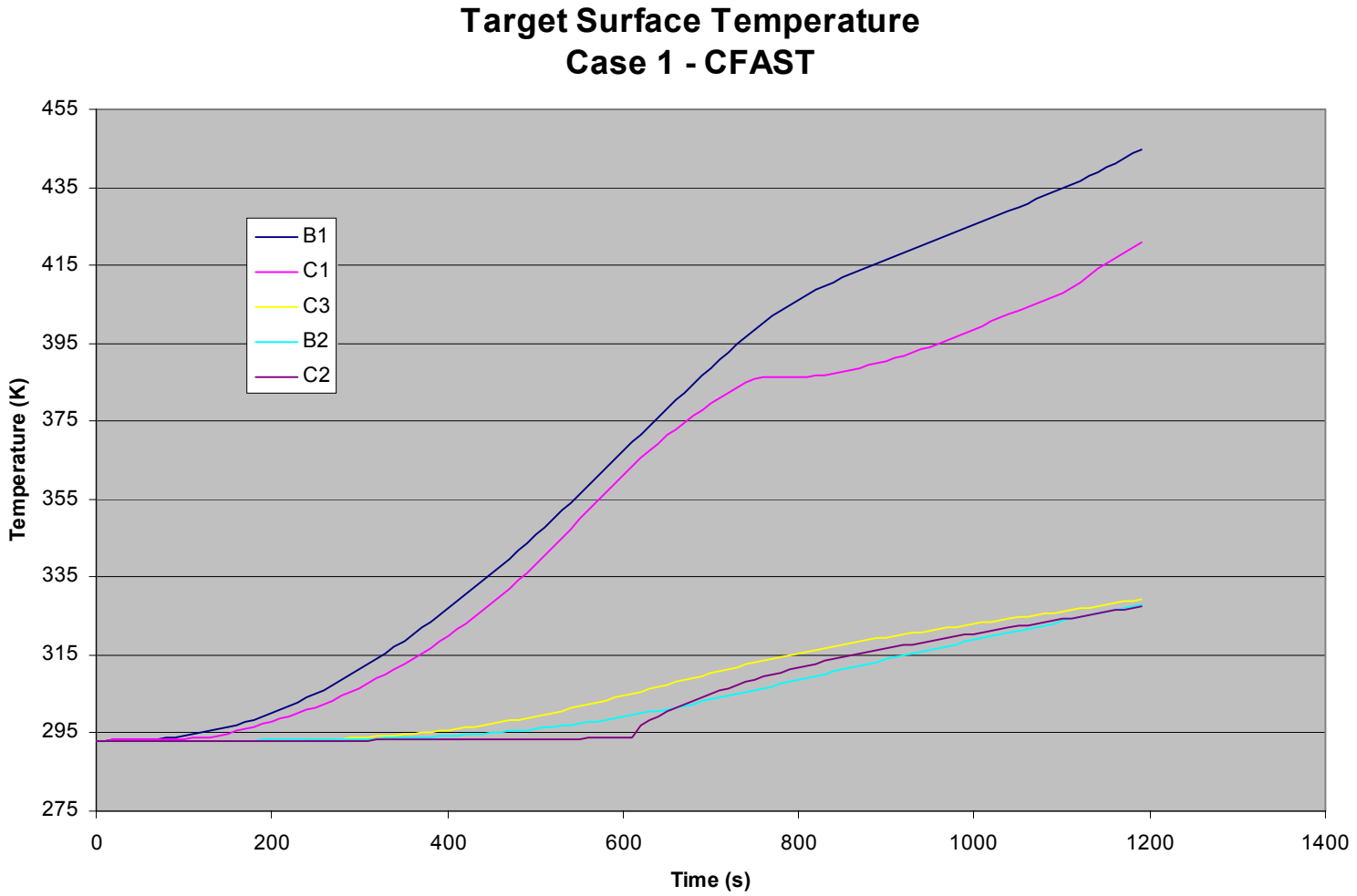
Comparison of Heat Release Rates



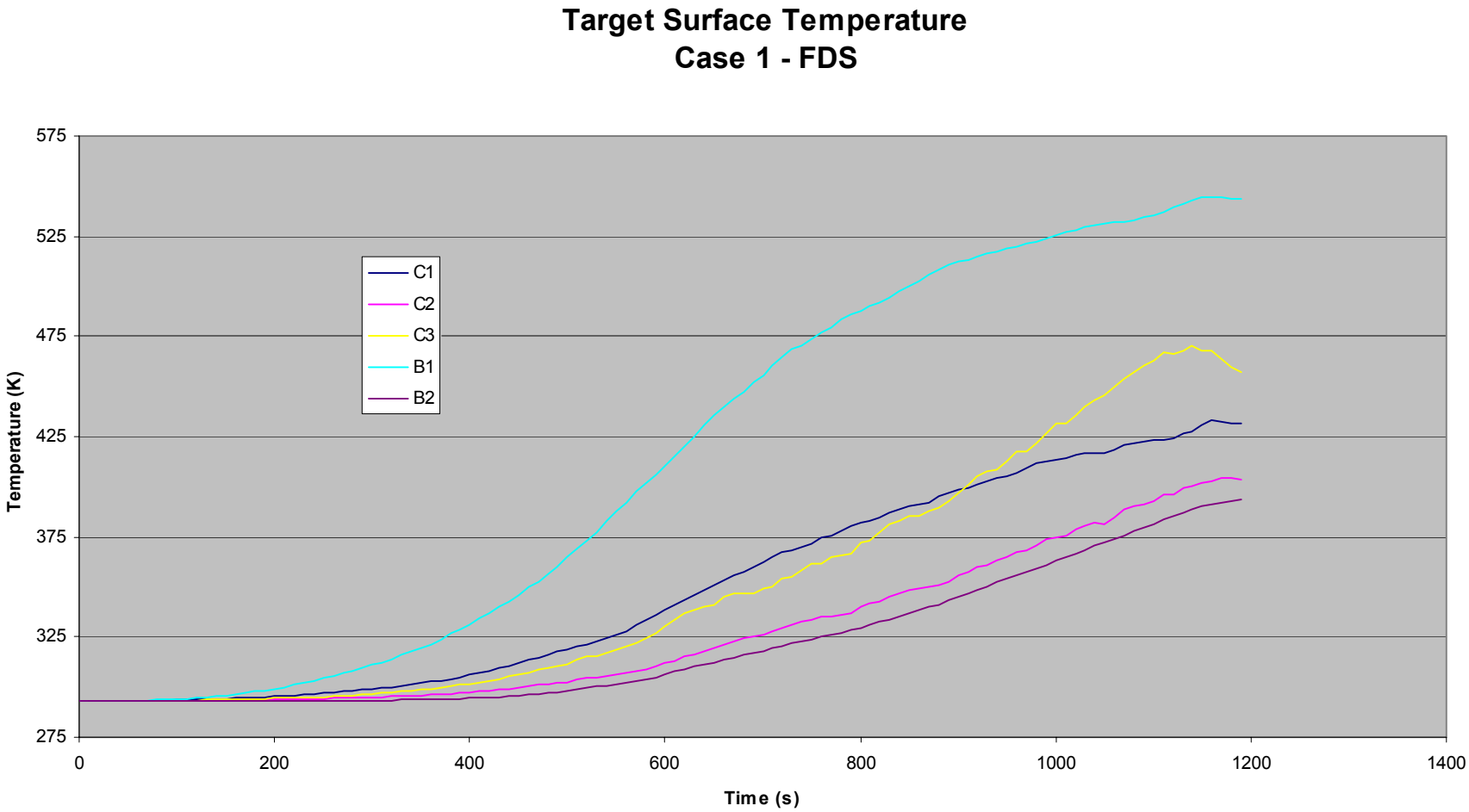
Comparison of Hot Gas Layer Temperature



Target Surface Temperature (CFAST)



Target Surface Temperature (FDS)



Preliminary Observations

- Qualitative predictions for targets not always consistent
- Target survival conclusions are consistent
- FDS (including Smokeview) provides a comprehensive tool to examine scenario phenomena
- Modeling of vertical flow through horizontal vents is complex
  - CFAST is limited in directly modeling vertical flows for fire scenarios in multi-level compartments
  - CFD models need to be exercised to obtain accurate representation of vent flows

Concluding Remarks

- Benchmark Exercise #2: report to be issued shortly
- Benchmark Exercise #3
  - NIST test data
  - FDT, CFAST, FDS
  - Report under preparation
- Other benchmark exercises
  - Pool fires
  - Cable flame spread
- Draft fire model verification and validation report
  - FDT, FIVE Rev 1, CFAST, FDS
  - Report under preparation