# Method for Analyzing Smoke and Heat Distribution from a Fire in a Power Plant Room: FAI Fuel Cycle Facility and Fire Model

**Presented by:**

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## PURPOSE

- **Brief Description of Current FAI Fire Model Capabilities: Emphasis on Tracking Different Smoky Layer in Each Room (Or Node)**
- **Simple Worked Example for Impact of Placement of Target (Cable Tray)**

## OUTLINE

- **Describe Essential Capabilities**
- **Advantage of the Capabilities**
- **Application of the Capabilities**
- **Worked Example: International Collaborative Exercise**

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# FAI Fire Model: Essential Capabilities

## Purpose of Model:

- Predict accident consequences in general fuel cycle facilities, not just reactors.

## Facility Representation:

- Facility is nodalized in a manner similar to MAAP, CONTAIN, etc.: Plant is divided into regions according to plant layout; "true" regions may be subdivided. Regions are connected by flow paths considering doors, hatches, ventilation ducts, etc. Regions contain or are divided by structures such as cable trays, cabinets, walls, ceilings, etc.

## Key Features:

- Each region contains its own distinct "smoky" layer (hot, low density) atop its own "lower" layer (cold, high density); structures "see" the correct layer
- Density-driven and pressure-driven flow between regions includes two-directional counter-current gas flows through a single opening: Layers in adjacent rooms are exchanged considering relative position of neutral plane and elevation of each layer and flow path bottom and top.
- Pilot fire prescribed by user drives problem
- Plume model carries combustion products and lower layer gas into smoky layer
- Radiation network couples heat conductor surfaces, conduction network connects conductors in multiple dimensions
- Aerosols carried by flow & deposited on surfaces

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## FAI Fire Model: Advantage of Essential Capabilities

**Advantages:**

- Smoky layer temperature and thickness varies throughout facility -- Equipment is exposed to the correct gas temperature
- Radiation network couples surfaces, an important part of heat balance, even surfaces that do not directly see the pilot fire
- Level of detail appropriate to problem, uses real plant layout and features, without excess nodalization and run time of CFD methods

## FAI Fire Model: Application of Capabilities

**Capabilities are applied by selecting the detail of nodalization:**

- **Cable Tray Temperature Response:** Temperature distribution calculated either 1D or 2D, account for radiation heat load and ohmic heating; view factor to fire can vary along tray.
- **Equipment Cabinet Response:** Outer shell and internal components have different temperatures, consider surface radiative heat and ohmic heating, natural circulation with proper gas layers.
- **Wall, Ceiling, Structural Member Response:** Can Use 1D or 2D conduction, nodalize to capture detail for gas layer elevation and view factors.
- **Next Figure Illustrates These Applications**

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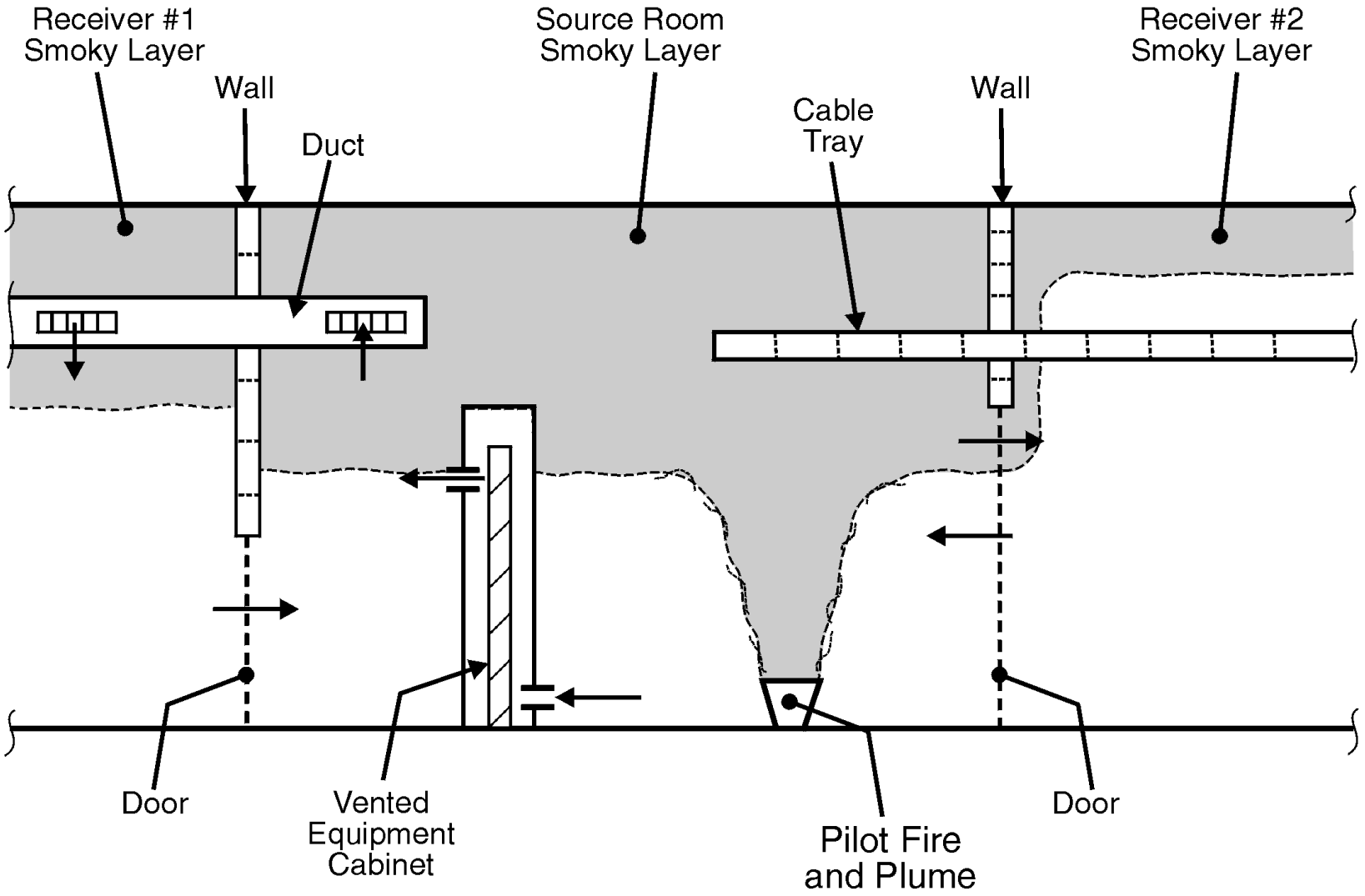
*Method for Analyzing Smoke and Heat Distribution from a Fire in a Power Plant Room: FAI Fuel Cycle Facility and Fire Model, M.G. Plys et al, Nordic PSA Conference, Oct. 2-3, 2001*

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## FAI Fire Model Worked Example: International Collaborative Exercise

**Benchmark Problem:** International Collaborative Project to Evaluate Fire Models for Nuclear Power Plant Applications benchmark calculation for 3rd Meeting, held at EPRI on January 15-16, 2001, briefly described here.

**Description:** Prescribed burning rate and radiative load from pilot fire in long room (15 m long x 9 m wide x 4.6 m tall), goal to predict temperature or ignition of target cable tray. Only opening is crack under door at one end of room; immediate next figure shows room schematic.

**Nodalization:** Room divided into 4 sections: Node 1 at end of room with crack under door; adjacent Node 2 has trash bag pilot fire; Nodes 3 and 4 are "dead end" middle and far end of room.

**Worked Example:** Base case response for cable directly under pilot fire, view factor based on 2.2 m separation, cable in Node 2 with pilot fire. Variation moves cable to Node 4 far dead end, view factor based on 10 m separation. (Can put both cables in same calculation).

**Results in Figures**: Upper left, smoky layer gas temperature, peaks at 76 C in Node 2 with pilot fire, just under 50 C in Node 4 far dead end. Lower left, cable in Node 2 reaches 130 C; cable in room 4 reaches 37 C. Upper right, smoky layer thickness varies; End with door fills first, dead ends must push air through source node.

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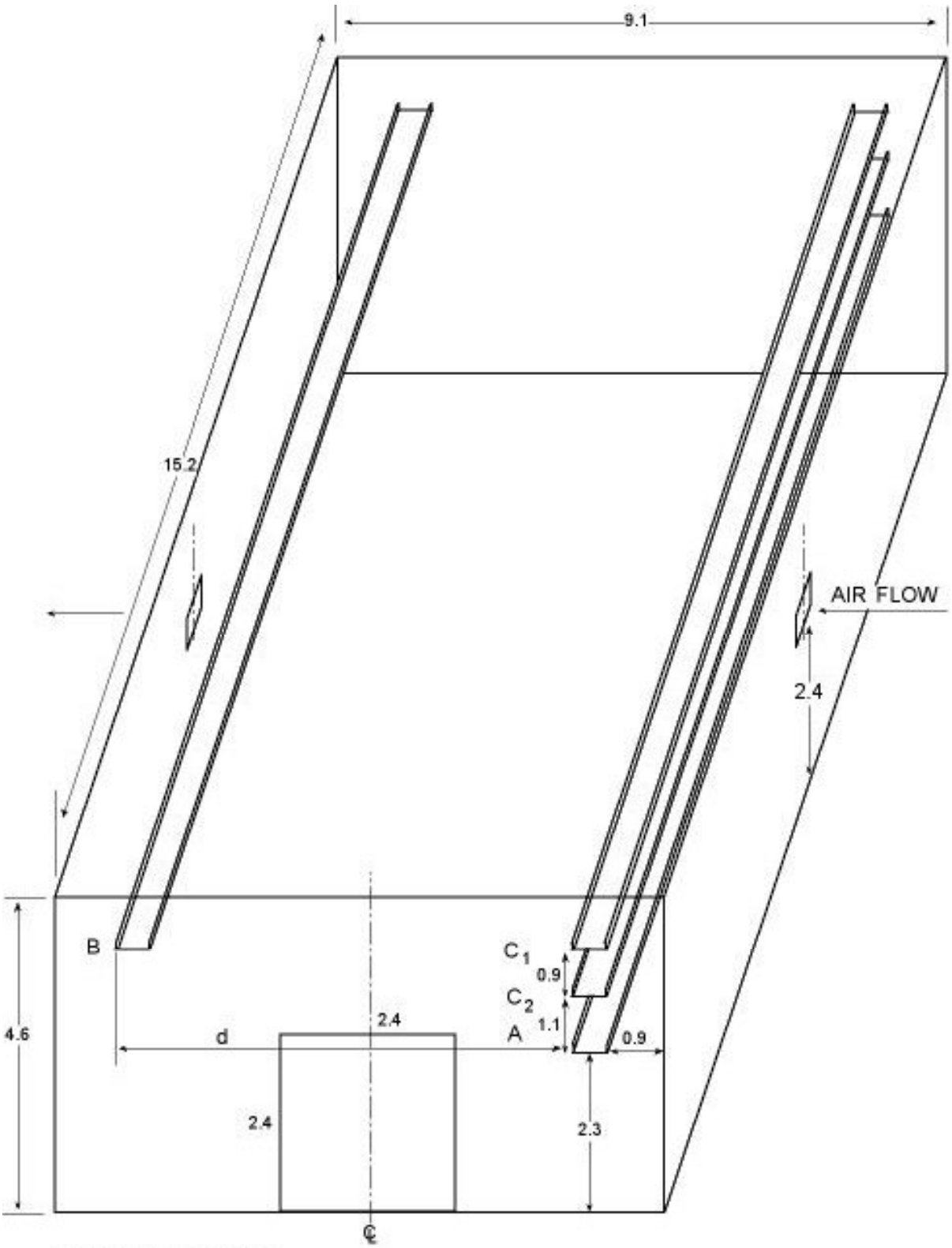


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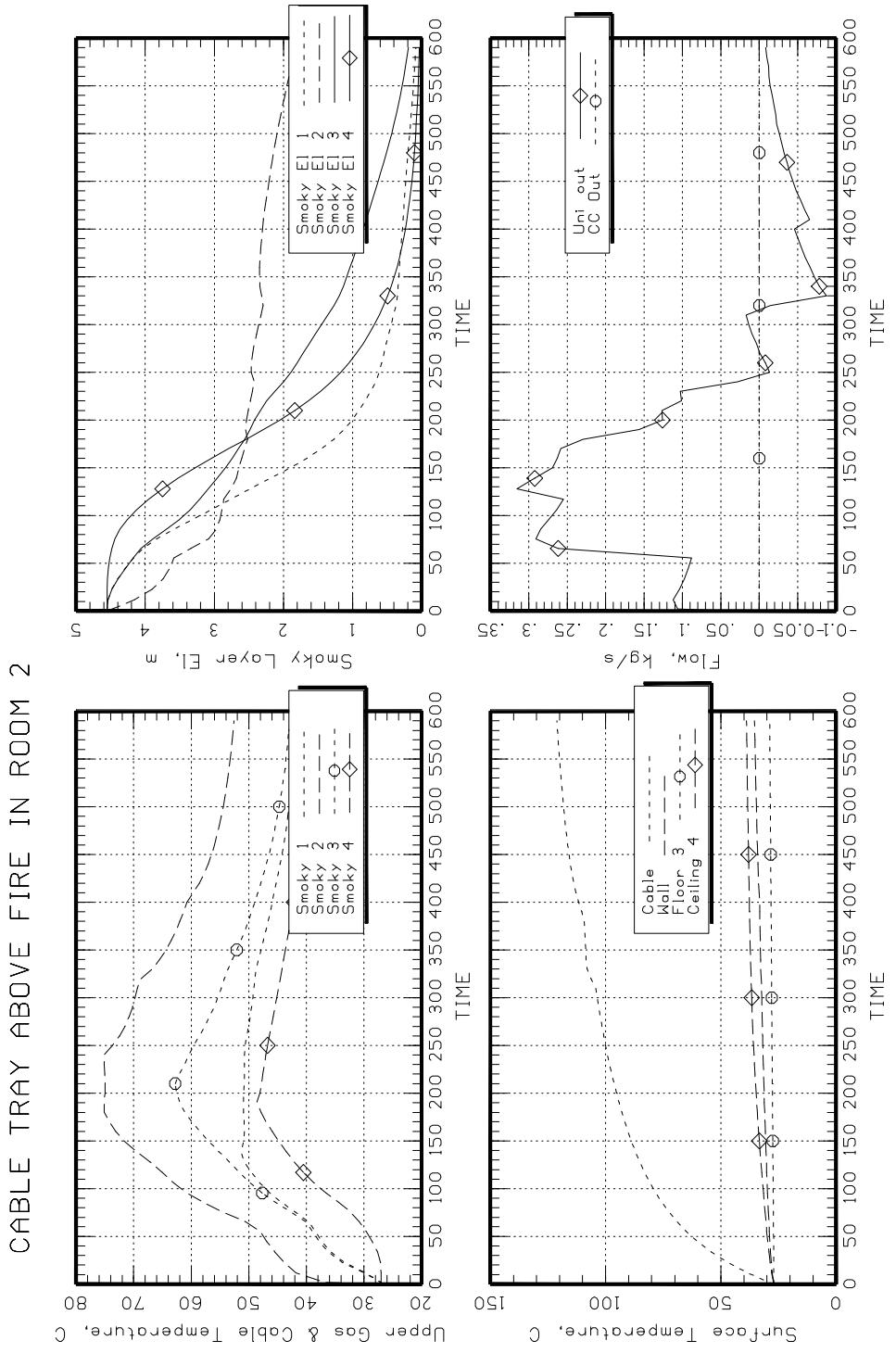


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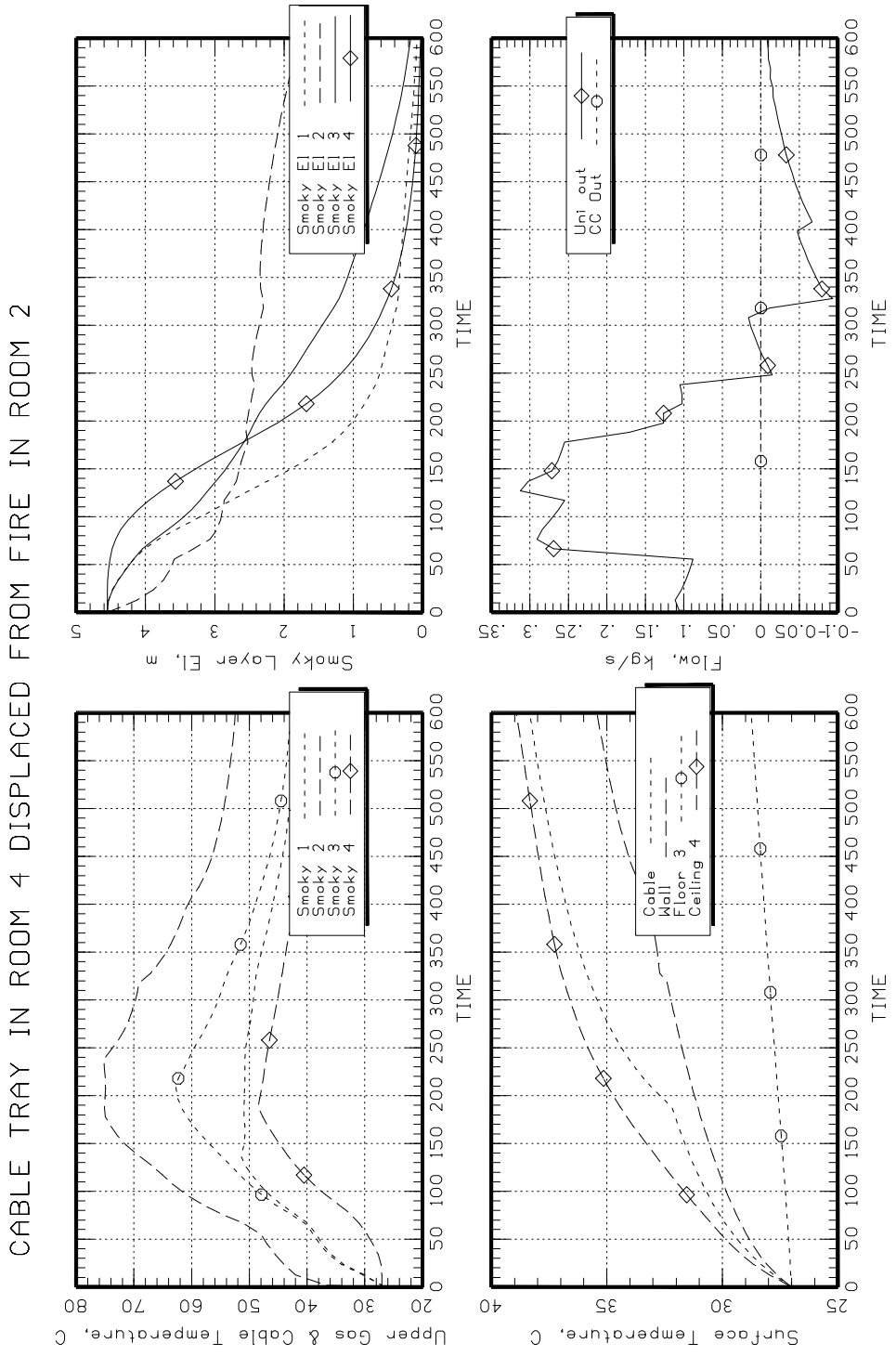


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