SESSION 4 - THE REAL WORLD

THE FORENSIC MODEL

Douglas J. Carpenter, MScFPE, CFEI, PE

Columbia, Maryland

2009 NIST FIRE MODELING WORKSHOP

WHY FDS IS NEEDED IN FORENSICS?

- **The Testing of Hypotheses using the Scientific Method:**
  - **Origin, Cause, Responsibility.**
- **The Timing of Discrete Events:**
  - **Response of fire protection systems.**
  - **Size of fire.**
  - **Onset of thermal burns.**
  - **Incapacitation or death from products of combustion.**
- **Differential Damage:**
  - **Change in outcome due to:**
    - **Violations of codes and standards.**
    - **Human action or inaction.**
    - **System action or inaction.**

ACCEPTANCE OF MODELS IN COURTS OF LAW

- **Federal Rules of Evidence (FRE) :**
  - Applicable in all civil and criminal cases in all United States courts.
  - Regulates the admissibility of proof to ensure proof offered is reliable.
  - Requirements vary by state. Some have adopted FRE, in whole or in part.
- **Admissibility of Expert Testimony:**
  - Tests: Relevance, Qualifications of Expert, and Reliability of Opinions.
- **Reliability of Opinions**
  - The holding in *Daubert v. Merrell Dow* (509 U.S. 579, 113 S.Ct. 2786) apply.
  - *Daubert* set forth factors to evaluate reliability of a theory or technique:
    - Can it be or has it been tested?
    - Has it been subject to peer review?
    - Is there a known or potential error rate of the technique?
    - Is it generally accepted by the relevant scientific community?
  - Tests are flexible and list is neither necessary nor exclusively applied.

ACCEPTANCE IN COURTS OF LAW

- The FDS code is admissible by default since it is a product of the federal government.
- The reliability of an individual FDS model can be challenged.
- Unaware of any FDS model being excluded as a result of a "Daubert Challenge."

SELECTION, INPUTS, AND VALIDATION

- Responsibility of the selection of appropriate applications for FDS is with the user and is based on education, knowledge, experience of the user and of the technical community.
- User must assess relative accuracy:
  - How accurate does the model have to be to answer the technical issue at hand or to test competing hypotheses?
  - Can FDS generate the required accuracy?
  - Model documentation and V&V efforts useful in selection.
- Uncertainty in Inputs:
  - Sensitivity analysis.
  - Bounding analysis.
- Application may require model specific study:
  - Validation.
  - Calibration.

EXAMPLES: GOOD, BAD AND UGLY

THE GOOD:

- **Sprinkler suppression:**
  - **Required Delivered Density (RDD).**
  - **Exponential decay of HRR .**
- **Response time of fire protection systems:**
  - **Thermal Detectors (e.g. heat detector, sprinkler, fusible link).**
  - **Optical Detectors (e.g. smoke detector, beam detector).**
- **Energy, mass, and species transport:**
  - **Thermal environment.**
  - **Carbon monoxide.**
  - **Propane.**
  - **Effect of natural or forced ventilation.**

EXAMPLES: GOOD, BAD AND UGLY

THE BAD AND UGLY:

- Changes in boundary conditions based on non-validated assumptions.
- No bounding analysis when important input has significant uncertainty.
- Insufficient grid resolution: One cell to model two-way vent flow.
- Specifying a fast growing fire to accelerate time to post-flashover phase.
- Modeling the response of smoke detectors in multi-level condo using geometry of a box (i.e. 1st story) and a box doubled in size (i.e. 2nd story).
- Connectivity of blocks of cells (e.g. nominally 1:60 then 60:1).
- Size of cells too large (1 foot cell size). Smaller cells significantly changed results.
- 2-D modeling for a highly 3-D application.

DISCUSSION

Outside of a more accurate code, are there considerations associated with its use in forensics that NIST should take into account in the future development of FDS?