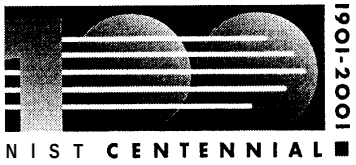
NISTIR 6774

Workshop On Fire Testing Measurement Needs: Proceedings

William Grosshandler
(Editor)



National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

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William Grosshandler
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Building and Fire Research Laboratory

August 2001

U.S. Department of Commerce
Donald Evans, Secretary

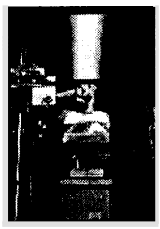
National Institute of Standards and Technology
Dr. Karen H. Brown, Acting Director

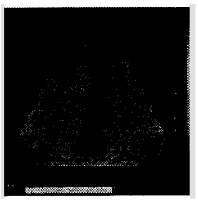
H. ADVANCED FIRE MEASUREMENT AND PREDICTIVE METHODS

Anthony Hamins and Kevin McGrattan, Building and Fire Research Laboratory
National Institute of Standards and Technology, Gaithersburg, MD 20899

A. Hamins & K. McGrattan, NIST

Advanced Measurements & Predictive Methods





Anthony Hamins
Fire Testing Laboratories Workshop
June 19,2001

NIST National Institute of Standards and Technology Technology Administration, U.S. Department of Commerce

RESEARCH PROGRAMS DESIGNED TO REDUCE FIRE LOSS

1. Reduced Risk of Flashover (Flashover)
   To accelerate the development and implementation of technologies that will reduce **50%** the cost to eliminate flashover in residential buildings by **2011.**
2. Advanced Fire Service Technologies (AFST)
   To enhance, through research, fire fighter safety and effectiveness that help achieve a **50%** reduction in line-of-duty fatalities and burn injuries in the **U.S.** by **2012.**
3. Advanced Measurement and Prediction Methods (AM&PM)
   To provide basic measurement and prediction methods that underpin the goal of reducing fire losses.

Advanced Measurements

Objectives (1)

- Characterize measurement uncertainty: accuracy, precision & signal interpretation by models/analysis.
- Implement new and improved measurement methods & instruments.
- Document best practices.
- Produce reference data against which predictions can be compared and validated and make that data available electronically.
- Assess key test methods (ASTM cone calorimeter, ISO 9705 room fire,...)

Advanced Measurements

Objectives (2)

- Understand the physics of fire to improve predictions (models):
  - Quantitative heat release rate, heat flux (spectral and total radiation), room flows, soot/smoke, water sprays.
  - Gas phase processes - combustion, radiation, transport
  - Condensed phase processes-pyrolysis, soot formation/destruction
  - Interaction of gas-phase and condensed phase processes.
  - Building fire model & real-scale validation, HVAC/smoke flows
- Develop tools and knowledge that enable of performance based fire codes.

60 on-going projects

Experimental

- Large-scale calorimetry (tour)
- Characterization of soot optical properties (new)
- Gas velocity in doorway flows **(new)**
- Temperature ▸
- Heat flux ▸
- Large planar measurements of sprinkler flows
- Less fire-prone materials (tour)
- Characterization of thermal imagers **(new)**

fire structure

applications

Predictive Methods

- Community-scale fire spread
- Cone Calorimeter modeling
- Fire Dynamic Simulator (tour)

CFD fire modeling

Large Fire Laboratory/ Large-Scale Calorimetry (Stroup)

New smoke abatement system

Large-scale fire experiments

- Implement advanced measurement capabilities.
- HRR measurement to 10 MW
- Uncertainty as standard test output
  - mass flow measurement in exhaust duct using Helium doping

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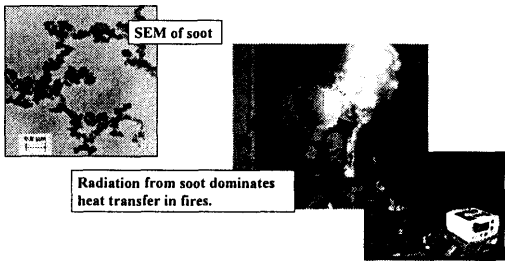
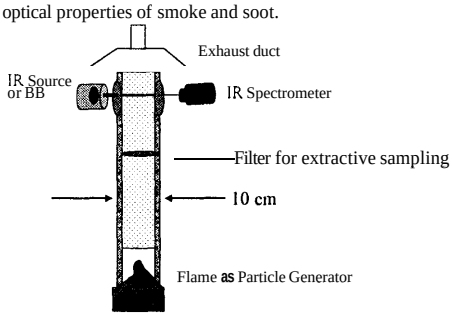
Soot Optical Properties (Mulholland) new

Understanding soot optical properties will improve fire measurements and predictions radiation from soot dominates heat transfer from fires.



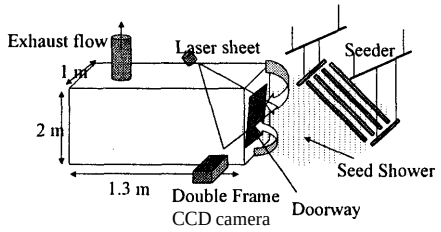
Soot Optical Properties (Mulholland)

Develop a calibration facility to facilitate refinement of new and traditional soot measurement methods and determination of optical properties of smoke and soot.

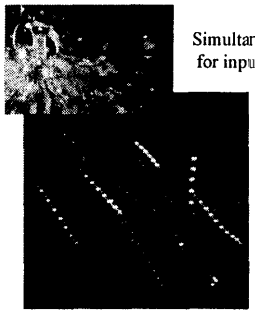


Particle Image Velocimetry (PIV) new
in Fire-Induced Doorway Flows (Bryant)

- Quantify the gas velocity (flow rate) into the ISO 9705 compartment
- Laser based non-intrusive technique
- High spatial and temporal resolution.
- Challenge: seeding of large non-isothennal regions (1m x 1m).



Planar laser measurements of Sprinkler Flows (Putorti & Atreya, UM)



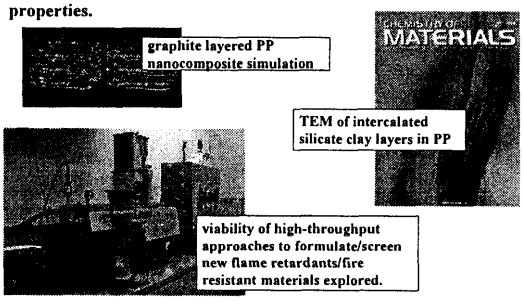
Simultaneous sprinkler droplet size & velocity for input and validation of CFD fire models

- Fluorescing droplets for sizing
- Particle tracking for velocity

- Non-intrusive, instantaneous
- Large area (1m by 1m)
- Laser sheet. 2D measurements.
- 2 lasers, 2 wavelengths, 2 pulses.
- High resolution film camera

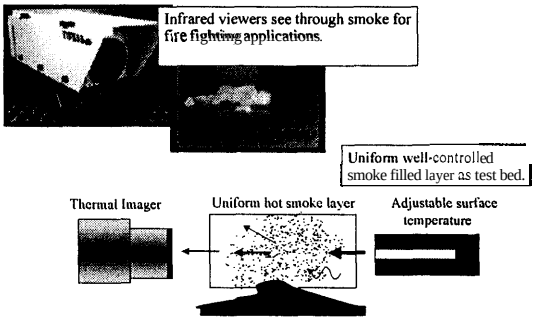
LESS FIRE-PRONE MATERIALS PROJECT (J. Gilman)

Commodity polymers with nm-sized inorganic layers interspersed can improve mechanical, thermal & flame resistant **properties.**



Characterization of Thermal Imagers (Widmann) new

Development of an Evaluation Facility to test the capabilities and limitations of commercially available thermal imagers.



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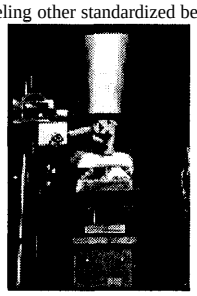
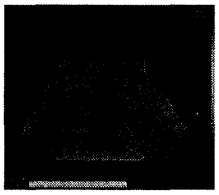
Modeling the ASTM Cone Calorimeter (Hostikka, Baum, McGrattan)

- DNS and LES
- Radiation: spectral, finite volume method
- Combustion: mixture fraction
- Modeling other standardized bench-scale fire tests?

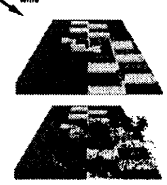




COMMUNITY-SCALE FIRE SPREAD (R. Rehm)

1993 Laguna Fire (Newsweek)

Wind

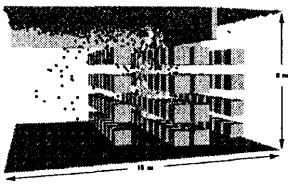


Site Specific Fire Model

- Fire spread between buildings and the r l ironm nt
- Fi protection strategies.
- ale performance of building materials and assemblies.

- physics-based fire spread calculation using NIST FDS model
- black dots represent smoke
- yellow represents fire

Fire Dynamic Simulator (McGrattan)



- Fire protection applications
- Performance based design
- **Large Eddy Simulation (LES)**
- **Mixture fraction**