National Institute of Standards and Technology
U. S. Fire Administration
Federal Emergency Management Agency

FIRE.GOV

Better fire fighting through research

Winter -- 2003

Fire Fatalities Studied Using Computer Model

Under the sponsorship of the National Institute of Occupational Safety and Health (NIOSH), NIST has examined the fire dynamics of the 1999 Iowa duplex fire that claimed the lives of three children and three firefighters. In the study, NIST performed computer simulations of the fire using the NIST Fire Dynamics Simulator (FDS) and Smokeview, a visualization tool, to provide insight on the fire development and thermal conditions that may have existed in the residence during the fire.

The NIST FDS computer simulation predicted fire conditions and events that correlate well with information from NIOSH and ATF (Bureau of Alcohol, Tobacco and Firearms) investigations. The critical event in this fire was the onset of conditions consistent with flashover in the kitchen. At this point, the fire started a transition from a single room and contents fire with smoke throughout the structure, to a fire that involved the majority of the structure within approximately 60 seconds.

This quick change in thermal conditions and flame spread through the duplex led to the three firefighters being trapped inside and succumbing to the effects of the fire environment.

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Front view of duplex

Burning Structures Provide Data to Understand Urban Fires

Dr. Dave Evans of the National Institute of Standards and Technology (NIST) is collecting data on the intensity and duration of radiant heat produced by burning structures. These measurements are used to estimate the heat release rate (a measure of fire intensity) and the potential ignition threat to adjacent combustibles. Understanding the radiant heat produced by burning structures is more important than the temperature of the fire. Thermal radiation emitted from the burning structure can affect people and objects at a great distance from the fire. Smoke and water spray can provide shielding from the full intensity of the thermal radiation emitted from a structure.

The measurements help NIST develop models for conditions where structures play an important part in the spread of fire, such as in some urban-wildland areas or fire in communities following earthquakes.

In cooperation with Chief Chuck Roger, Captain Roy Hodgson, and firefighters from the **Odenton, MD Volunteer Fire Department**, a small outbuilding was burned as part of a fire department training exercise and data collected to add to the information available.

Cont. page 2

Fire spreads to small structure from burning trees and shrubs.

An intense fire involving asphalt based shingles and siding spreads to the grass surrounding the building.

Fire Fatalities Studied Using Computer Model, cont.

Still image from FDS/Smokeview simulation.

The report of the NIST study, NISTIR 6854, *Simulation of the Dynamics of a Fire in a Two-Story Duplex—Iowa, December 22, 1999* is available in CD-ROM format. In addition to the report, the CD-ROM contains a video presentation, which provides a summary of the report and includes photos of the fire scene and videos of the computer model results. A copy of the NIOSH Report, F2000-04, dealing with the incident, also is included on the disk. Fire department training officers are using the CD- ROM to demonstrate how rapidly conditions can change in a house fire. More than 12,000 copies of the CD-ROM have been distributed. If you would like a copy of the CD-ROM, please e-mail your request to: daniel.madrzykowski@nist.gov.

Burning Structures Provide Data to Understand Urban Fires, cont.

The 5 m x 6.2 m single story structure, covered with asphalt based shingles and siding, was ignited by burning vegetation. It burned rapidly, being consumed in 7 minutes. Data from this field test are being combined with laboratory measurements of burning properties of the wall and roof materials to estimate the total heat release rate of the structure. Other opportunities to make measurements on different types and sizes of structures fully involved in fire are being sought to expand the database.

For additional Information contact: Dave Evans, telephone: (1) + 301-975-6897, e-mail: dave.evans@nist.gov.

Reducing Number of Sailors Needed for Shipboard Firefighting

Historically, the Navy has relied on damage control teams, consisting of 20-25 sailors, to combat accidental fires and battle damage. On large ships, there may be up to eight damage control repair parties.

However, part of the Navy's strategic planning is to reduce overall shipboard manning by up to two-thirds. Since present shipboard damage control and firefighting capabilities rely heavily on sailors, alternatives need to be developed. The Damage Control-Automation for Reduced Manning (DC-ARM) Program was initiated by the Office of Naval Research and conducted by the Naval Research Laboratory and Hughes Associates, Inc. The objective is to demonstrate the viability of automating the elements of the damage control related to fire protection and fluid systems control. DC-ARM focused on the use of integrating intelligent sensor arrays with automated reasoning and casualty response technologies. This technology will allow the firefighting response to focus on maintaining tenability in unaffected areas, and over time recover the damaged areas. Even though firefighting personnel will be reduced, their safety may actually be improved as fewer sailors will need to be exposed to extremely dangerous conditions and more rapid automated response to fires and damage is possible.

Ex-USS Shadwell Damage Control Central (DCC) with Intelligent Supervisory Control System (SCS)

The key technical component in this strategy, the capability to reliably automate sensing, decision-making, and control technologies, was demonstrated over a four-year period. Tests were conducted with a full complement of sailors organized in a traditional damage control repair party. Standard manual firefighting techniques were used in response to a simulated multi-deck, multi-compartment fire that could result from combat induced damage. Limitations of current firefighting tactics/procedures were identified. In particular, the "situational awareness" of firefighters was limited, that is, the knowledge of when and where to allocate personnel to prevent fire and smoke spread beyond the initial area of damage.

A second series of tests was conducted using "remote-manual" capabilities. Installed detection, suppression and valve-control technologies were implemented.

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Reducing Number of Sailors Needed for Shipboard Firefighting, cont.

These systems advanced the current state-of-the-art in fire protection:

- Installed water mist fire suppression systems were optimized using high pressure/ low flow techniques;

- "Smart" valve technology was implemented in fluid piping systems to automatically detect and isolate ruptures, and redirect fluid flow through intact segments; and

- Early warning fire detection systems used multi-criteria sensing elements and associated algorithms to reduce detection time and prevent nuisance alarms.

These systems were activated and responders were directed from a centralized command center, headed by a Damage Control Officer. The systems provide much better capability in isolating the fire/damage incident, but the Damage Control Officer suffered from "information overload." Next, in the third test series, installed systems were more fully automated using a supervisory control system. This system was programmed to automatically track damage via intact sensors, isolate ruptured systems, and activate suppression systems to contain fire damage. A reduced number of personnel was used to check on the systems and assure that boundary conditions were stable. A relatively small damage control party then made an indirect firefighting attack to ultimately control the major fire in the damaged space.

The concept continues to evolve. The aggressive, personnel-intensive direct firefighting attack will give way in the future to a more measured, preplanned response utilizing sensors, advanced fire suppression systems, and automated isolation and reconfiguration of systems.

For information, contact Frederick W. Williams, telephone: (1) + 202-767-2476, e-mail: fwilliams@ccs.nrl.navy.mil or Joseph L. Scheffey, telephone: (1) + 410-737-8677, e-mail: joe@haifire.com.

Ex-USS Shadwell (LSD 15)

Canadian Research Has Implications for Smoke Detectors in Homes

Working with the Underwriters' Laboratories of Canada, researchers in the Fire Risk Management Program of the National Research Council of Canada's Institute for Research in Construction have demonstrated through full-scale experiments that combined ionization-photoelectric smoke detectors, can be, in some cases, more effective than ionization or photoelectric detectors used alone in homes. This research was part of an ongoing effort in the fire protection community to maximize the benefit of current smoke detector technologies to improve residential fire safety.

Two houses in the now deserted town of Kemano, British Columbia, served as test sites for the experiments: a 900-square-foot one-story house and a 1400-square-foot two-story house. In both dwellings, the researchers installed groupings of three types of detectors-photoelectric, ionization and combined photoelectric-ionization to determine the response time to various fires set in the structures.

In general, the results of the experiments were not surprising. Combined ionization-photoelectric detectors responded at the same time, or in some cases, sooner in detecting fires than ionization detectors or photoelectric detectors alone. Surprisingly, however, smoke detectors installed in the "dead air space" (the triangular area 10 cm from ceiling and wall joints in each direction) were among the first to detect fires. Theoretically, smoke detectors should not alarm rapidly or work in this space, and Canadian standards for placement of smoke detectors require that this space be avoided.

The new results relative to detection in the "dead air space" deserve further study to determine to what extent, if any, they were influenced by the temperature in the unconditioned houses (the ambient temperature was around 12°C). **Kemano Fire Studies—Part 1: Response of Residential Smoke Detectors** will soon be available for downloading: http://irc.nrc-cnrc.gc.ca/fulltext/rr108/ .

Specific questions can be directed to Dr. Joseph Su at (1) + 613-993-9616, fax (1) + 613-954-0483, or e-mail joseph.su@nrc.gc.ca

Installing different technology smoke detectors in house.

Twenty sheets of newspaper transition from smoldering to flaming during tests.

Reducing Volunteer Firefighter Life Loss

Addressing the loss of life among volunteer firefighters, the U.S. Fire administration (USFA) and the National Volunteer Fire Council (NVFC) initiated a partnership and established the Volunteer Fire Service Fitness and Wellness Project. The goal is to reduce loss of life from heart attack and stress.

The partnership effort will involve researching and developing effective examples of health and wellness programs aimed at the needs of the volunteer firefighter. These programs will address fitness and exercise (aerobic, flexibility, strength training, etc.); diet; smoking cessation; and other areas that will have a positive impact on the volunteer fire service community. This project also will develop information on how volunteer fire departments can enhance compliance with appropriate National Fire Protection Association (NFPA) Firefighter Health and Safety Standards such as NFPA Standard 1583, *Health Related Fitness Programs For Fire Fighters*. This project complements existing USFA firefighter wellness and fitness partnerships with the International Association of Fire Chiefs (IAFC) and the International Association of Fire Fighters (IAFF) to support the expansion of the IAFF and IAFC *Fire Service Joint Labor Management Wellness-Fitness Initiative* to additional fire departments.

Further information about the Volunteer Fire Service Fitness and Wellness Program as well as other USFA fire service fitness and wellness partnerships may be found on the USFA web site at: http://www.usfa.fema.gov/dhtml/inside-usfa/fitness.cfm.

Volunteer Firefighter, ***Damascus Volunteer Fire Department****, Maryland.*

New Program Helps Communities To Be Wildfire Wise

The National Wildfire Coordinating Group's Wildland/Urban Interface Working Team, a consortium of wildland fire organizations and federal agencies that are responsible for wildland fire management in the United States, has developed a new program to inform the public about how fire-prone communities can raise their resistance to wildfire threats. Firewise Communities/USA is a nationwide initiative that will recognize individual communities for implementing strategies to protect people and properties from the dangers of wildfire. A videotape is available that explains the process by which small geographically defined organizations of homeowners can come together to take actions and be recognized for their efforts in wildfire safety. Currently there are 12 communities recognized as part of the Firewise Communities/USA program.

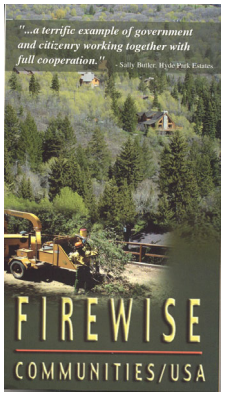
The videotape explains the standards for recognition that must be met by participants and describes the efforts of several communities that have been successful in gaining and maintaining this recognition.

An introduction to the wildfire problem in the U.S. is contained in the videotape; it may be downloaded and then viewed by clicking on the link under the cover photo at the right.

For additional information, check the website http://www.firewise.org/usa or contact Michele Steinberg at (1) +617-984-7487, e-mail: msteinberg@nfpa.org.

To obtain copies of the videotape, visit the Publications Catalog online at http://www.firewise.org/.

VHS video, Click to view Introduction to FIREWISE



Contact Information:

National Institute of Standards and Technology
100 Bureau Drive, MS 8660
Gaithersburg, MD 20899

David Evans
Email: editor@fire.gov
Phone: 301-975-6897
Fax: 301-975-4052

U.S. Fire Administration
16825 S. Seton Avenue
Emmitsburg, MD 21727

Bob McCarthy
Email: Bob.McCarthy@fema.gov
Phone: 301-447-1130
Fax: 301-447-1093

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Editor: David Evans
Associate Editor: Nora Jason
Design and Layout: Kellie Beall