National Institute of Standards and Technology
Homeland Security

FIRE.GOV

Better fire fighting through research

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From the Editor

Measuring Fire-Induced Vibrations in Burning Structures

Harvey Mudd College has been working on the development of a sensor which can be used by the fire service to monitor the structural integrity of a building during a fire. The sensor would alarm to provide a warning for firefighters to evacuate the building prior to collapse. Another step forward was made during some recent burn tests in an acquired structure. The structure tested was a classroom-type structure, approximately 35 feet wide and 165 feet long, constructed using wood frame members covered with stucco and brick veneer. The anticipated collapse events included the collapse of the cantilevered overhang along the east side of the building and the collapse of two locations on the roof loaded with approximately 1200 pounds. Roof loading was achieved using five 30 gallon steel trash cans filled with sand.

Instrumented classroom burned to collect data on fire-induced vibration. Sand filled cans provide mass load on roof during burn experiment on classroom structures.

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First Responders Thermal Imaging Research Needs

The potential benefits of thermal imaging or infrared (IR) imaging to fire fighters became evident in the early to mid 1990s. Since then IR technology for first responder applications has matured to the point that most emergency response organizations either have purchased or are considering the purchase of thermal imaging cameras (TICs.) Thermal imagers are a significant tool for the fire service, enabling fire fighters to locate fires and victims, find their way out of burning structures, provide guidance to fire attack teams, and perform overhaul operations and fire investigations more effectively.

The National Institute of Standards and Technology (NIST) held a workshop to provide a forum to discuss strategies, technologies procedures, best practices, and research and development that could greatly improve thermal imaging technology for the first responder community. The goal of the workshop was to identify barriers that impede advances in the application of thermal imaging technology to emergency response. Four communities were represented: experts from the first responder community, thermal imaging camera and component manufacturers, firefighter trainers, and those doing research on thermal imaging.

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Measuring Fire-Induced Vibrations in Burning Structures, cont.

Vibration sensors were installed on the cantilevered overhang and at various locations around the perimeter of the structure. The latest fire sensor design, which is Micro-Electro-Mechanical Systems (MEMS) based, was used during the tests. A research grade sensor was co-located for evaluation purposes. Fire induced responses were acquired for a little more than 80 minutes.

Significant outcomes from these tests included the ability to extract a real-time indicator that tracked weakening conditions in the burning structure.

The MEMS sensors may be a practical approach to fire-induced vibration monitoring, and will contribuute to a field-ready prototype.

See "*Tiny Vibrations Provide Warning of Collapse*" in issue 4 of FIRE.GOV, for the previous report on this project. For additional information, contact Dr. Ziyad H. Duron via e-mail: ziyad_duron@hmc.edu.

First Responders Thermal Imaging Research Needs, cont.

Workshop identifies first responder research needs for thermal imagers.

Three breakout groups discussed TIC technology and develop separate lists of issues. When the groups reconvened, a similarity of interests was noted, and the prioritization voting reflected a combination of issues. Image quality (research, performance metrics, and standards) was the priority issue in all three groups. Durability of the TIC, and training and certification for personnel were also of high priority to the groups.

The publication, "Thermal Imaging Research Needs for First Responders: Workshop Proceedings," by Francine Amon, Nelson Bryner and Anthony Hamins (NIST Special Publication 1040), June 2005, contains the presentations and group summaries identifying research needs. To obtain the complete report, it may be downloaded from http://fire.nist.gov/bfrlpubs/fire05/PDF/f05036.pdf. For additional information, contact Francine Amon via e-mail: francine.amon@nist.gov.

UK Tests Protective Clothing for Operational Effectiveness

Firefighter protective clothing is tested to very similar standards throughout the world. The European and International standards as we know them today for personal protective equipment (PPE) have been developed within the last ten years. However, many nations, e.g., the United Kingdom, the United States, have their own standards. The current performance standard for structural firefighting in Europe is "Protective Clothing for Firefighters", EN 469. This standard characterizes garments for resistance to radiant and convective heat.

The physical protection afforded by PPE against various forms of hazard exposure has been extensively researched, but until recently the impact of the PPE on the firefighter has not received the same level of attention. Wearer heat-stress has now become an issue of considerable concern not only in European climates but, more particularly, in warmer and more humid climates. The emphasis has turned to developing lighter-weight garments, which place less strain and reduced internal heat build-up on the wearer during prolonged use while not compromising the performance integrity of the clothing. "Firefighters' Clothing: National and International Performance Standards" by Asia Pacific Magazine, Issue 12, December 2004, pp. 58-59, (http://www.apfmag.com/content/artic-fs.htm) discusses a series of tests that were performed to better understand the wear-ability issues firefighters face.

A week-long series of physiological tests were conducted, on behalf of Briston Uniforms Ltd., by Human Vertex Ltd. and then modified to develop the next level of trials that would result in realistic tests. Six firefighters were selected and approved for the study by their Occupational Health Advisor. The subjects underwent ten separate treadmill exercises in an environmentally controlled laboratory over a four day period. Neither volunteers nor testers were given details of the fire clothing being tested.

Data collected included core and skin temperature, heart rate and total body weight loss. An ergonomic assessment was also obtained using a drill, which included walking, crawling, stair climbing and reaching exercises conducted over a period of approximately six minutes. Individual experiences were recorded in questionnaires on comfort, fit, and overall ease of movement. These responses were collected both before and after the exercise drills, the treadmill tests and after trying on and removing the different types of ensembles.

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UK Tests Protective Clothing for Operational Effectiveness, cont.

While the physiological tests indicated no significant differences between the different ensembles tested, there were some highly significant differences in the subjective analysis, which clearly allowed the ensembles to be ranked form 'worst' to 'best'. Sufficient consistency prevailed to allow the best three and worst three ensembles to be clearly identified. For future trials, it is suggested that different scales be selected to allow more robust ranking data to be generated, e.g., a simple sweat scale might be used. Recognizing the deficiencies of the old standard, the new EN469:2005, which has just been published, omits any reference to physiology. It is understood that further work is now being done to provide more appropriate guidance which could become embodied in a new annex in due course.

To obtain additional information, contact Ivan Rich by email, ivan.rich@bristoluniforms.co.uk

Turnout Gear Examined For Heat Stress and Operational Effectiveness.

Power Transformer Room Protected by Fixed Water Mist System Studied

Spontaneous re-ignition in a power transformer room was studied to see if there was a difference between a high- or low-pressure water mist system. Full-scale suppression tests were performed for six different fire scenarios: two spray fires, three pool fires, and one cascade fire. Three reduced-scale models were used to estimate the cooling characteristics required for the power transformer and to calculate the discharge time for the water mist to prevent spontaneous re-ignition. The power transformer occupied about 7% of a 10 m x 10 m x 10 m fire test room.

Fire suppression test results demonstrated that the high-pressure system was superior to the low-pressure system, especially considering oxygen depletion and the ambient temperature distribution. In the cooling tests, the discharge time required to prevent spontaneous re-ignition was estimated to be about 12 hours for both the high- and low-pressure systems.

In addition to power transformer rooms, high-pressure water mist system also has potential to be used in other environments, e.g., computer rooms, telecommunication rooms. The effectiveness of water mist systems in other environments needs to be studied further. Gaseous suppressions systems are good for suppressing fires, but they do not prevent the re-ignition that could occur when the fire source has a large latent heat capacity.

This work is described in the paper, "Application of a Fixed Water Mist System in a Power Transformer Room" by Yougshik Han, Byungil Choi, and Myungbae Kim, presented at the 8th International Symposium on Fire Safety Science, Beijing, China, September 12-18, 2005.

For additional information, contact Byung Il Choi, e-mail: chisey@kimm.re.kr, telephone: (82) + 42-868-7405; fax: (82) + 42-868-7355.

Water Mist System Tests for Power Transformer Room Fires.

Passenger Train Full-Scale Fire Experiment

To achieve better understanding of how large fires develop and spread in a rail passenger vehicle and to increase understanding of the relationship between material flammability properties and total fire size, the Commonwealth Scientific and Industrial Research Organization (CSIRO) Fire Science and Technology conducted a full-scale fire test on a typical Australian passenger train car. The fire was allowed to become fully developed involving all combustible materials within the train car. In addition to the fully developed fire test, nine ignition experiments were conducted on one corner of the passenger train car.

The purpose was to better understand the fire size resulting from a variety of ignition sources of different severity.

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Passenger Train Full-Scale Fire Experiment, cont.

In addition, the mechanisms of fire growth from localized ignition source fire to a large, fully developed fire also were investigated.

For these tests, the carriage and materials tested were selected from scrap stock representative of a typical Australian suburban rail passenger vehicle. The following measurements were made: temperature, flow, heat flux, and gas composition. In this experiment, the behavior of the ceiling and upper wall linings was more important than that of the seats and lower wall linings in predicting the occurrence of flashover and time to untenable conditions in a typical rail passenger vehicle.

The results of this work by Nathan White, Vince Dowling, and Jonathan Barnett in the paper, "Full-scale Fire Experiment on a Typical Passenger Train", presented at the 8th International Symposium on Fire Safety Science, Beijing, China, September 12-18, 2005.

For more information about these fire experiments, contact Nathan White, nathan.white@csiro.au or CSIRO (Australian Commonwealth Scientific and Industrial Research Organization, http://www.csiro.au/)

Full scale fire experiments conducted on passenger rail cars.

From the Editor

Welcome to Meredith Lawler, USFA Fire Program Specialist, who will be assuming the responsibility of reviewing FIRE.GOV issues for USFA. In 1997, Ms. Lawler began her Federal government career as an analyst for the FEMA's Office of Inspector General where she reviewed numerous government programs including the Assistance to Firefighters Grants Program.

In November 2004, Ms. Lawler joined USFA's National Fire Data Center where she currently manages behavioral mitigation and fire department operations technology research projects and is actively involved with the support and implementation of the National Fire Incident Reporting System. We look forward to a long and rewarding relationship with Meredith.

We extend a fond farewell to Bob McCarthy as he leaves USFA/FEMA to enjoy his retirement. Mr. McCarthy was a Caption with the Jersey City Fire Department from 1968-1983. In 1983, he took a position with the USFA where he managed many programs and initiatives in firefighter health and safety. Most recently, before his retirement in August 2005, Mr. McCarthy was responsible for a variety of research activities, including those involving firefighter personal protective equipment, detection systems, and suppression technology. Bob has been a faithful reviewer and USFA contact from the very first issue of FIRE.GOV in Spring 2001. We wish you all the best, Bob!

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