2009 BFRL Project Description

Project Title: Tactical Decision Aids for First Responders

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BFRL Program: Advanced Fire Service Technologies

Objectives: To develop methods that will provide highly reliable information about conditions within residential and commercial buildings to emergency responders in advance of their arrival at a building emergency and throughout the event. Provide emergency responders with displays and tools that provide real-time information to improve situational awareness and response.

Problem:

What is the problem? There are no standards for what type of information or situational awareness, such as alarm or sprinkler activation and location, that must available or displayed before or after the emergency responders arrive at a commercial or residential structure. For commercial structures including office buildings, emergency responders proceed to an annunciator panel or fire control room to access the type of alarm and the approximate location of the alarm, usually just the floor and zone. Fire fighters must still proceed to the location to verify the alarm. Without detailed information or situational awareness, they have no knowledge of the environment, if there is smoke, a flaming fire, or a smoldering fire, until they get to the alarm location. For a police officer, they must also enter a building to physically check the status of an alarm. As an emergency incident unfolds, additional information such as operational status of ventilation fans, exit doors, and elevators, would also be extremely valuable to emergency responders as they monitor and respond to the evolving conditions.

Improved measurement science would enable situational awareness by allowing standard information such as smoke, heat, and motion alarm location and status, sprinkler activations, and temperature, to be displayed in a standard format for both commercial and residential structures. This information or awareness of conditions may be provided to the fire service as the apparatus is enroute to the scene or after arrival. The data could be provided at a control panel inside a commercial building or could be linked to the on-scene incident command center.

Currently there are no standards on prioritizing the data that is being displayed. Simply providing the data without identifying the priority or importance of the building data will overwhelm the incident commanders. Since the sprinkler activation would be a direct indication of fire growth, sprinkler operations might have a higher priority than the operational status of a ventilation fan or an exit door. The available data need to be displayed in prioritized manner in order to allow the emergency responders to utilize the information effectively.

The lack of adequate measurement science directly impacts the ability of the fire service to be alert to conditions or to make informed decisions on the fire scene. Tactical decision aid technology is utilized by the over one million fire fighters in over 32,000 fire departments in the

US. The National Fire Research Agenda Symposium,[i] which was attended by over 50 organizations, including the fire service, IAFC,[ii] IAFF, and NVFC, manufacturers, DHS, & USFA, identified and prioritized research needs for fire fighters. "Urgent and critical issues" included situational awareness technology and tactical decision aids. Research needs that were deemed "less urgent, but still highly important issues" included structural collapse prediction. Workshops conducted by NIST in San Antonio, TX and Emmitsburg, MD, also identified tactical decision aids, protective clothing, and locator systems as critical research needs for the fire service.[iii] [iv]

Why is it hard to solve? The measurement science problems are hard to solve because the amount of building information is limited and the emergency responders lack the understanding as to how building data could be used. In commercial structures, building data may be limited to floor and zone of alarm activation, while in most single family residential structures, no data on smoke alarm activation or location is provided. Fire service culture traditionally emphasizes experience and has not been able to take full advantage of emerging technology. Additional information needs to made available to emergency responders, that information needs to be provided in a format that is readily usable by the responders.

How is it solved today, and by whom? The problem is not solved. The fire service currently relies on the experience of fire officers and fire fighters to assess the fire ground conditions. Unknown conditions inside structures make it difficult for responders to make tactical decisions. Without the ability to access and make use of building information, entering a structure poses significant risks to emergency responders. European fire departments often utilize more defensive tactics that involve protecting surrounding structures rather than entering the burning building itself. Locating and rescuing building occupants, locating the fire, and quickly suppressing the fire can be more effectively accomplished by entering a structure.

Why NIST? BFRL is an international leader in measurement science and predictive tools for the fire safety and investigation community. This project requires advanced fire measurement, analysis and modeling techniques which are central to one of BFRL's Core Competencies of fire protection and fire spread within buildings, and aligns with the BFRL Strategic Priority using measurement science for innovative fire protection.

Approach:

What is the new technical idea? Provide emergency responders with currently available building information in a standard format. Combine the building information with fire growth models to predict how the fire will grow and spread. Initially, this information would include smoke, heat, and motion alarm location and status, sprinkler activations, and temperatures, but eventually, location of building occupants and emergency responders and other building data could be incorporated. Currently building data is provided at the annuciator or fire control panel for commercial buildings. This information may be provided to the fire service as the apparatus is enroute to the scene or after arrival. Eventually, the data as well as the model predictions for fire growth would be linked to the on-scene incident command center for both commercial and residential structures.

Why can we succeed now? In the past, the fire service has depended on gaining experience by responding to a large number of fires. But, as the overall number of fires decrease and the more experienced fire fighters and officers retire, they are being replaced with younger, less

experienced personnel who are more accepting of new and innovative technology. In addition to a fire service that is more receptive to new technology, tactical decision aid technologies are just being developed. BFRL has the unique mix of expertise with building information, fire models, and measurement science to enable tactical decision aid technology for emergency responders.

What is the research plan? In previous years, the Tactical Decision Aid Project has focused on information currently available at the annunciator or fire control panels. Progress has been made in developing standard display icons and incorporating fire growth models with alarm panel displays. NEMA SB30-2005 demonstrated the standardization of display icons for building fire panels[v], but only for in-building displays, not for laptop computers or mobile displays. Enhancement of the Virtual Cybernetic Building Testbed included the incorporation of a zone fire model with heating, ventilation, and air conditioning components[vi], but did not incorporate a fire model for a wider range of commercial buildings. A field demonstration at a hospital in Kinston NC, did identify the issues with command authority & control of building systems, the need to update "static" information in a timely fashion, and the need to provide a traffic control system.[vii] These issues clearly pointed toward a need to prioritize how and in what format information must be made available to the first responder.

In order to expand the display standardization, information prioritization, and fire model prediction into a wider range of commercial structures and residential structures, the research plan includes the following components:

- Host workshop to determine feasibility of new innovative technologies such as locator/tracking, fire environment, or body worn networks.
- Incorporate building data into fire models to predict fire growth and spread in a wider range of commercial buildings and in residential buildings.
- Develop prioritization criteria for display of commercial building information to alert emergency responders to critical situations.
- Develop standard format for display of commercial building information on portable devices such as laptop computers or mobile data displays.
- Develop prioritization criteria for display of commercial building information to alert emergency responders to critical situations.
- Develop standard format for display and prioritization of residential building information on laptop computers or mobile data displays.
- Develop protocols for incorporating building data from innovative technologies in future displays for emergency responders.

Improved measurement science would enable situational awareness by displaying standard information in a standard format for both commercial and residential structures. Initially, this information would include smoke, heat, and motion alarm location and status, sprinkler activations, and temperatures, but eventually, location of building occupants and emergency responders, structural integrity, and other building data could be incorporated. This information may be provided to the fire service as the apparatus is enroute to the scene or after arrival to the incident command center.

Recent Results:

Output: C. Park, P.A. Reneke, M.A. Galler, S.T. Bushby, and W.D. Davis, "Enhancement of the Virtual Cybernetic Building Testbed to Include a Zone Fire Model with HVAC Components", NISTIR 7414, 50 p. April 2007.

Output: Demonstration conducted in Wilson N. C. in September, 2005 (Davis, William D., Holmberg, David, Reneke, Paul, Brassell, Lori, Vettori, Robert, "Demonstration of Real Time Tactical Decision Aid Displays", NISTIR 7437, 25 p. August 2007).

Output: W. D. Davis, "Intelligent Building Response", *Fire Protection Engineering*, pp 30-36, Winter 2007.

Standards and Codes: Dissemination of results and technology transfer will occur through several means including: the NPFA Technical Committee on Electronic Safety Equipment, the National Fire Academy Technology Transfer Program, International Fire Service Training Association.

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[i] National Research Agenda Symposium Report of the National Fire Service Research Agenda Symposium June 1 – 3, 2005 Emmitsburg, Maryland

[ii] International Association of Fire Chiefs (IAFC), International Association of Fire Fighters (IAFF), National Voluntary Fire Council (NVFC), Department of Homeland Security (DHS), United States Fire Administration (USFA)

[iii] Walton, W.D.; Bryner, N.P.; Madrzykowski, D.; Lawson, J.R.; Jason, N.H., "Fire Research Needs Workshop Proceedings, San Antonio, Texas, October 13-15, 1999", NISTIR 6538; National Institute of Standards and Technology, Gaithersburg, MD, 47 p. July 2000.

[iv] Walton, W.D.; Bryner, N.P.; Jason, N.H., "Fire Research Needs Workshop Proceedings, Emmitsburg, Maryland, October 20, 1999", NISTIR 6539; National Institute of Standards and Technology, Gaithersburg, MD, 19 p. July 2000.

[v] NEMA SB30-2005 was published, which provides standardization of displays for building fire panels. This display standard was included in NFPA 72 at the June 2006 meeting as Appendix F.

[vi] C. Park, P.A. Reneke, M.A. Galler, S.T. Bushby, and W.D. Davis, "Enhancement of the Virtual Cybernetic Building Testbed to Include a Zone Fire Model with HVAC Components", NISTIR 7414, 50 p. April 2007.

[vii] W. D. Davis, "Intelligent Building Response", *Fire Protection Engineering*, pp 30-36, Winter 2007.