2009 BFRL Project Description

Project Title: Performance Metrics for Critical Electronic Equipment for Emergency Responders

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Co-Investigator(s):

BFRL Program: Advanced Fire Service Technologies

Objective: To develop an apparatus and measurement mechanism to provide controlled smoke supply to test the combination of smoke and elevated temperatures on electronic equipment for development of equipment performance metrics.

Problem:

What is the problem? The fire fighting environment exposes electronic equipment including thermal imaging cameras, gas analyzers, and radios, to severe conditions including extreme heat and smoke. Most of the electronic equipment has some type of seal to keep out dust, smoke and other particulates; however, testing of the equipment at elevated temperatures has shown that many of the components melt and warp during these exposures, and the seals could be compromised. Smoke is of particular concern due to its mobility and its frequent abundance in fire fighting environments.

Performance metrics regarding the operation of electronic equipment in environments with both smoke and elevated temperatures are needed by the fire industry. For some equipment, existing standards are inadequate because they fail to address impacts from the combination of heat and smoke, such as buoyancy of a heated smoke plume. For other equipment, such as portable radios and the developing ad hoc networks, no universal performance standards exist. In order to develop these performance metrics we need to have the capability to simulate a heated and smoke filled environment in a way that is measured, controlled and repeatable.

Why is it hard to solve? The problem is hard because equipment must be designed to provide simultaneous heat and smoke that is well characterized, controlled, and repeatable. They must be provided at levels that are representative of fire environment exposures. The heat and smoke exposure must be accurately measured, and effects of different types of smoke must be considered. The task of developing performance standards will also be challenging because the experimental results of laboratory tests will need to be combined with research of expected fire environment exposures to determine appropriate metrics for the equipment.

How is it solved today, and by whom? Some NFPA codes call for testing of equipment with particulate exposure, but at temperatures below those encountered in fire environments.

Many electronic devices used by firefighters do not currently have any NFPA standards. It is left to manufacturers to develop their own standards, and most do not test for smoke exposure at or after elevated temperature exposure.

Why NIST? This project is aligned with BFRL's mission and vision by creating tools and developing measurement science methods to be used for the development of performance based standards for the Fire Safety Industry. This project is aligned with BFRL's strategic priority of Measurement Science for Innovative Fire Protection because it enables the advancement of equipment used by the fire services through better equipment performance metrics. It supports the core competency of fire protection and fire spread within buildings and communities by allowing for the development of unbiased, scientifically based standards. The impact of this work is improved life safety for all US firefighters. NIST is ideally positioned to develop these standards based on our extensive experience in fire research and our ability to providing sound scientific results.

Approach:

What is the new technical idea? The new technical idea is to add smoke exposure capabilities to the large, heated recirculating flow loop, and to then test the impact of smoke in combination with elevated temperatures on various electronic devices. A smoke generation apparatus and delivery system will be developed and built to provide controlled smoke input and flow into the testing section of the flow loop. This will provide the capability to test items for simultaneous exposure to elevated temperatures and smoke. The tunnel will be able to reach elevated temperatures beyond those of existing smoke chambers. The recirculating feature of the testing tunnel will allow simulation of increasing or repeated smoke exposures and possible soot build-up within the equipment.

Why can we succeed now? The heated recirculating flow loop has been shown to be an effective tool for testing electronic equipment, and the results have been used for development and modification of NFPA standards. The new flow loop is an ideal candidate for the addition of smoke exposure capabilities because it has the space and versatility to accommodate needed modifications, such as opposing viewing windows for smoke measurements. In addition, the BFRL staff has the expertise, technical know-how, and experience with smoke, heat, and flow measurements to successfully create the equipment needed for the development of the performance metrics.

What is the research plan? The emphasis for FY2009 will be the design, fabrication, and testing of an apparatus that can deliver carefully controlled and measured amounts of smoke to the testing section of the heated flow loop tunnel. In future years, the smoke system will be used to test the operation of firefighter electronic equipment during exposure to smoke and elevated temperatures. The data will be used to develop performance metrics for the electronic equipment.

In order to provide realistic smoke exposure conditions, information about the smoke conditions in real firefighting environments will be needed. Research into available fire data will be performed to determine appropriate smoke conditions to use. Different types of fuels and their smoke properties will be considered to determine which types are most suitable for these

tests. A smoke generating apparatus will be designed, likely consisting of a burner with a measured fuel supply, and a flow system for delivering smoke to the testing chamber of the flow loop. Laser extinction measurements will be used to measure smoke concentrations in the test section of the tunnel.

Once the apparatus is fully operational, it will allow for controlled, repeatable smoke supply to the testing section of the flow tunnel. This will allow for items to be tested for exposure to a combination of smoke and elevated temperatures. In the years following, a variety of firefighter electronic equipment, including PASS, SCBA, portable radios, and ad-hoc network systems will be tested for smoke exposure in order to develop performance metrics for the equipment.

Recent Results:

Outcome: Capability to expose small electronic equipment to temperatures up to 300 C while monitoring functionality.

Output: Donnelly, M.K., "Performance of Thermal Imaging Cameras in High Temperature Environments", NIST Technical Note 1491, National Institute of Standards and Technology, Gaithersburg, MD 14 p. November 2007.

Standards and Codes: The ability to test firefighter electronic equipment exposed to both heat and smoke will result in data useful to the committees that develop the NFPA standards. BFRL staff will participate on NFPA standards committees directly related to electronic equipment, and have been instrumental in relaying our results to the NFPA.