2009 BFRL Project Description

Project Title: Evaluating Positive Pressure Ventilation in Large Structures

September 15, 2008

Principal Investigator: Stephen Kerber

Co-Investigator(s): NA

BFRL Program: Advanced Fire Service Technologies

Objective: Work with first responders and positive pressure fan manufacturers to refine guidelines for effective positive pressure ventilation, and transfer knowledge of positive pressure ventilation (PPV) fan performance, to stakeholders and standards developing organizations.

Problem:

What is the problem? When properly used, positive pressure ventilation (PPV) tactics can provide a safer environment for occupant egress and fire fighting operations in all structures. PPV can improve the effectiveness of fire fighting tactics and reduce the number of fatalities and injuries on the fire ground. NIST research has recently developed science-based methodology to evaluate the effectiveness of the positive pressure ventilation (PPV). The improved understanding of PPV and the recently developed measurement science now needs to be transferred to the fire service and to standards development organizations.

The lack of adequate measurement science directly impacts the effective use of positive pressure ventilation tactics in each of the over 32,000 fire departments in the US. The National Fire Research Agenda Symposium,[1] which was attended by over 50 organizations, including the fire service, IAFC,[2] IAFF, and NVFC, manufacturers, DHS, & USFA, identified and prioritized research needs for fire fighters. "Urgent and critical issues" included strategies that would reduce injuries and fatalities. Workshops conducted by NIST in San Antonio, TX and Emmitsburg, MD, also identified suppression and ventilation as critical research needs for the fire service.[3] [4]

Why is it hard to solve? There are many variables that impact PPV fan effectiveness, many different types of structures they can be used on and the fire service needs guidance on how to adapt their tactics to provide a successful outcome based on the variables presented. The fire service as a whole is not openly receptive of new tactics and tools unless they have a lot of supporting evidence and data.

How is it solved today, and by whom? It is not solved. The fire service has resorted to trial and error on emergency scenes which is extremely dangerous to both the fire service and the public. The past effort by BFRL has resulted in preliminary recommendations to the fire service that will be strengthened by the continuing work.

Why NIST? This project fits the BFRL mission and vision. It anticipates and meets the need to develop measurement tools to evaluate the impact of positive pressure ventilation in structure fires thus improving the safety and effectiveness of fire fighting. It provides knowledge in the form of computer model and experimental results that enable the selection and placement of fans for positive pressure ventilation. By providing the measurement science to improve safety for the fire service, this project is well aligned with the BFRL strategic priority of Measurement Science for Innovative Fire Protection, as well as BFRL's core compentency in fire protection and reducing fire spread within buildings and communities. BFRL has the ability to provide the knowledge through measurement science of the use of this solution-enabling tool to the fire service worldwide.

Approach:

What is the new technical idea? While working with positive pressure ventilation fan manufacturers and first responders, a set of tactical guidelines and test methods have been developed that directly relate to the operating environment and tasks performed by first responders. Utilizing all the performance data collected in the previous series of full-scale experiments, the tactical guidelines and test methods now will be transferred to the stakeholders and standards organizations.

Why can we succeed now? There is a significant increase in demand from the fire service due to our current accomplishments and outputs.

What is the research plan? This project has been ongoing for ten years supported by both internal (2 years) and external (10 years) funds; it provided the scientific foundation for developing guidelines for the effective use of positive pressure ventilation. The research plan includes:

- Complete documentation of existing full-scale experiments. This includes examining the PPV component that was added onto the front end of the wind driven fire experiment on Governor's Island, compiling the pressure results from Toledo, Chicago, Delaware County and New York, and to develop further PPV guidance as to number and size of fans needed dependent upon building height and foot print.
- Explore additional computer modeling of high-rise experiments. The experiments from Chicago and Toledo should be modeled using FDS and CONTAM. These experimental results are rare and provide a good check for both CFD models and node models.
- Transfer guidelines to first responders. The PI is a member of the International Fire Service Training Association (IFSTA) committee tasked with writing a high-rise firefighting training manual. All of this work will be incorporated. There is also coordination internationally with an International Fire Instructor Group to implement knowledge of improved ventilation procedures. More than 10,000 DVD's of our research on positive pressure ventilation have been requested by the fire service and they will continue to be distributed to improve the fire services knowledge of the topic and improve their standard operating procedure development. Presentations will also be

made at the Fire Department Instructor's Conference (FDIC) and the annual NFPA World Safety Conference.

- Transfer research results to standards development organizations. The PI is a member of the NFPA committee for fire fighter training. The results would be introduced to standards and guidelines for fire service training.

Recent Results:

Output: Kerber, S., Madrzykowski, D., Stroup, D. "Evaluating Positive Pressure Ventilation In Large Structures: High-Rise Pressure Experiments." National Institute of Standards and Technology, NISTIR 7412, 2007.
Output: Kerber, S., Madrzykowski, D., "Evaluating Positive Pressure Ventilation In Large Structures: High-Rise Fire Experiments." National Institute of Standards and Technology, NISTIR 7468, 2007.
Output: Kerber, S., Madrzykowski, D., "Evaluating Positive Pressure Ventilation In Large Structures: School Pressure and Fire Experiments." National Institute of Standards and Technology, NIST TN in review, 2008.
Output: Kerber, S., and Madrzykowski, D., Fire Fighter Tactics under Wind Driven Conditions Workshop, April 14-15, 2008, NIST, Gaithersburg, MD.
Output: Positive Pressure Ventilation Research: Videos and Reports. 2 DVD Set available to the fire service with guidelines for the use of PPV.

Outcome: The standard operating guidelines of many fire departments have been improved as a result of our research including the two largest fire departments in our country, Fire Department of New York and Chicago Fire Department.

Standards and Codes: As each fire department understands the potential impact of positive pressure ventilation, each department will incorporate positive pressure tactics and operating guidelines into their department's standard operating procedures (SOPs). These SOPs are tailored to the specific needs and resources of each department. These research results have also been presented to NFPA 1410 Committee, Standard on Training for Initial Scene Operations and the committee agreed that the results need to be incorporated into the training standard.

---

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

[2] 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)

[3] 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.

Walton, W.D.Fire Service Needs Workshop Proceedings, San Antonio, Texas, October 13-15-1999

[4] 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.