# FEMA/Assistance to Firefighter Grants (AFG)

# Research and Development Grants (2006-2007)

## *Clinical and Behavioral Studies*

### Physical and Emotional Stress, James Brown, PhD, University of Indiana, with Indianapolis Fire Department (Clinical, FY06)

**This 1 year project will be the first to track firefighter physiological and psychological responses to actual work conditions.**

This research will measure firefighter physiology during real fireground activity. Firefighter participants will wear the Life Shirt device system at the beginning of each duty shift and continue to wear it throughout their 24-hour shift.

In addition to monitoring the internal state of the firefighters, the project will monitor the fire scene to determine aspects of the work environment that affect physical and emotional responses.

Data analysis will provide a thorough understanding of the interaction between the fire scene and firefighter physiology. Results will enable us to describe the range of firefighter responses to work stress. With this improved understanding of the biomedical needs of firefighters, we will be able to develop better physical training programs for firefighters and reduce the number of line of duty deaths.

As a result of this research, the primary influences on firefighter physiology will be identified. The resulting model will enable instructors and command personnel to predict firefighter responses to different fire scene scenarios.

### Risk Factors for Firefighter Cardiovascular Disease, Jeff Burgess, MD, and Eyal Shahar, MD, University of Arizona (Clinical, FY07)

**This 2-year study will evaluate carotid intimal-medial thickness as a screening test for atherosclerotic disease and will determine the effects of fire suppression activities and rehabilitation methods on biomarkers for cardiac injury.**

A total of 500 firefighters who have at least 5 years of firefighting service and are without known cardiovascular disease will participate in a non-invasive test, carotid intimal-medial thickness measurement, to assess for early atherosclerotic disease. Also, new blood tests, in conjunction with traditional risk factors for cardiovascular disease, will be analyzed to determine their ability to predict carotid artery thickening.

The effect of fire suppression activities on biomarkers for cardiac injury also will be evaluated. Specific factors will be considered: exposures to combustion products, core body temperature, and workload based on increased heart rate. Also, the effectiveness of aggressive cardiac rehabilitation, using a cooling glove at the fire scene, will be tested. The study will determine whether this method of active cooling impacts biomarker changes.

Given the prevalence of early atherosclerotic disease in asymptomatic individuals in the general population, we expect to find a range of carotid intimal-medial thickening in firefighters. If this is true, then it will be important to evaluate use of this test in annual medical surveillance examinations.

## Comprehensive Firefighter Fatigue Management Program, Charles Czeisler, PhD, MD, and Steven Lockley, PhD, Brigham & Women's Hospital (Clinical, FY07)

**The public expect firefighters to be available around-the-clock and to perform flawlessly when called upon. This 3-year study addresses health and safety risk due to sleep disorders.**

Firefighters work frequent extended shifts and long work weeks which lead to acute and chronic sleep deprivation. Firefighters are also susceptible to other sleep disorders. For instance, obstructive sleep apnea is a serious disease caused by obstruction of breathing during sleep that leads to repeated awakenings, disrupted sleep and daytime fatigue. Sleep deprivation and sleep disorders also adversely affect personal health longer-term, increasing the risk of hypertension, stroke and cardiovascular disease, and impairing glucose metabolism, increasing the risk of obesity and diabetes.

Sleep deprivation, due to any reason, significantly degrades cognition, alertness, reaction time and performance and leads to an increased risk of injury due to motor vehicle crashes and accidents which are an important occupational risk for firefighters. Motor vehicle crashes and heart attacks are the two leading causes of death in firefighters. Sleepiness and sleep disorders have been shown to increase the risk of both. The goals of this program are to reduce the adverse consequences of fatigue on firefighters' health, safety, and performance.

The overall method of our team will be to develop and test the effects of a sleep health and sleep disorder detection and treatment program "operation healthy sleep" specifically designed for firefighters that can be disseminated to practitioners, policymakers and researchers nationwide to reduce firefighter fatigue, stress and disease; treat serious undiagnosed sleep disorders; enhance the ability of firefighters and their families to cope with difficult work schedules; and ultimately improve the health, safety and performance of firefighters, and improve the safety of the public whom they serve.

## Effect of Fitness on Recovery from Firefighting Activities, Patricia Fehling, PhD, and Denise Smith, PhD, Skidmore College (Clinical, FY07)

**This 2-year study will examine the role of different types of fitness – strength training and cardiovascular training -- on physiological recovery from firefighting activities. At the conclusion of the research, the study team will produce recommendations for best practices in fire service physical fitness training programs to mitigate the risks of sudden cardiac death in Firefighters.**

Cardiac death among firefighters with underlying cardiovascular disease is likely triggered through a combination of factors, including:

- Adrenaline surge (sympathetic nerve stimulation)
- Neurohormonal responses to exertion
- Hyperthermia

We will investigate different types of physical fitness on physiological responses to and physiological recovery from firefighting activities, - that is, we will study the crucial period following firefighting activity when many cardiac events occur.

A field based study will be used to describe firefighter's response to firefighting activity. Physiological variables will be monitored with a wireless physiologic status monitor. The physiologic status monitor will be worn by firefighters during their entire 24 hr work shift. Physiological data will be examined in relation to specific firefighting activities, including responding to an alarm, fire suppression, rehab, and recovery.

In parallel, a controlled laboratory study will be conducted to focus on cardiovascular recovery from the combination of physical work and hyperthermia (working in PPE), specifically targeting vascular function, neurohormonal changes, coagulatory potential and autonomic nervous system function.

## Measuring Code Compliance Effectiveness for Fire-Related Portions of Codes, Casey Grant, MS, PE, Fire Protection Research Foundation (Clinical, FY06)

**This 1 year project targeted code compliance issues.**

For this activity, NFPA's Fire Research and Analysis unit provided leadership and also a technical advisory panel was formed. The aim was to develop and disseminate widely an evaluation tool that measures how fire prevention activities carried out by fire safety enforcement organizations can reduce community level fire risk. On site interviews were carried out in nine communities and a leadership component was developed. Numerous presentations and scientific papers have been delivered to disseminate results.

## Reducing Occupational Hearing Impairment in Firefighters, Oisaeng Hong, PhD, RN, and Stephen Vogel, MD, University of California, San Francisco; OMEGA North Shore University Health Systems (Clinical, FY07)

**This 3-year study aims to reduce firefighter's noise-induced hearing loss. In addition to impaired quality of life, hearing loss may put firefighters at risk for other types of injuries by reducing their ability to hear warnings.**

Noise-induced hearing loss is a significant occupational injury for firefighters, developing slowly over several years as a result of exposure to loud noise. This is a preventable but irreversible condition for which there is currently no effective medical treatment because hair cells, once damaged, do not regenerate. Approximately one in five firefighters suffers hearing loss that results from intermittent noise exposure on the job.

This study aims to develop and evaluate a theory-driven, tailored, internet-based hearing protection intervention (NOISE-e) to prevent noise-induced hearing loss in firefighters. The study seeks to explore the relationship between noise exposure and hearing loss and occupational injuries in firefighters.

This project will be conducted, with about 500 firefighters, in three phases over three years:

- Intervention development includes collection of qualitative data on firefighter's perceptions, opinions, and attitudes on use of hearing protection devices, using focus groups, expert panel reviews, and pilot testing

- A randomized, pretest/posttest, experimental and control group design will test the effectiveness of NOISE-e

- Post-study evaluation of intervention will include evaluation of the intervention post-test and data analysis

## Cardiovascular Function as a Result of Prolonged Firefighting, Gavin Horn, PhD, and Denise Smith, PhD, University of Illinois, with Illinois Fire Service Institute (Clinical, FY07)

**This 2-year study examines changes in firefighter's cardiovascular function associated with prolonged firefighting and whether they can be modified by preloading with Vitamin C.**

Cardiac events are responsible for the highest percentage of line of duty deaths each year. These cardiovascular deaths are routinely attributed to overexertion. It is unclear how overexertion leads to sudden cardiac events and why some individuals are vulnerable to overexertion while others are not. The University of Illinois team will employ an intervention, preloading with Vitamin C, to determine its impact on cardiac risk.

The study examines:

- Changes in cardiovascular function (specifically heart function, vascular function, hemostatic balance, and inflammatory/vascular biomarkers that mediate the interaction of cardiovascular variables) as a result of prolonged fire fighting activities

- The ability of individual resting cardiovascular measures (e.g.carotid intimal thickness, endothelial function) to predict firefighters who will have an exaggerated/high risk cardiovascular response to firefighting activity

- The effectiveness of preloading with Vitamin C to improve cardiovascular function and lower cardiovascular risk at rest and following firefighting activity

## Fireground Rehabilitation Evaluation (FIRE) Trial, David Hostler, PhD, University of Pittsburgh, with Guyasuta Volunteer Fire Department and Allegheny County Fire Academy (Clinical, FY06)

**This two year project is to study how heat stress combined with the current state of fireground rehabilitation may result in impaired cognition leading to injury.**

In general, research studies have shown that:

- Replacing fluid losses from sweating is an essential element to fireground rehabilitation. For work over 20 minutes in duration, commercial sports drink preparations are likely superior to plain water, but this is untested in firefighters.

- Oral fluids must be absorbed from the gastrointestinal tract resulting in delayed bioavailability. Complete fluid restoration requires the firefighter to consume more than 100% of the fluids lost which may take longer than three hours. Oral rehydration is further complicated by increased urine output.

- Intravenous rehydration has been examined and found to be equivalent to oral rehydration in terms of performance. These studies, however, were carried out with highly trained athletes.

Further studies point to injury outcomes:

- It is well known from military research that heat and physiological stress impair decision-making capacity. Sleep deprivation, heat stress and dehydration are inevitable aspects of firefighting and shift work. Half of fireground injuries are attributed to slips, falls, jumps, overexertion and strains forcing us to wonder if impaired decision-making and reaction time significantly contribute to this statistic.

- Heat stress and loss of body mass from dehydration is also known to cause fatigue and increase cortisol level. A study of soldiers demonstrated that sleep loss, heat and dehydration caused severe decrements in cognitive function including reaction time. In this group of subjects reaction time at the end of a field exercise was four times worse than if the subjects suffered from a blood alcohol level of 0.10 and two times worse than if suffering hypoglycemia.

In summary, while multiple cooling modes are commercially available for fireground rehab, none has been rigorously tested in the firefighter population. The potential connection between physiological stress and cardiovascular disease and fireground injuries makes it imperative that fireground rehabilitation programs be selected and implemented based on the ability to reduce cardiovascular strain, reduce or prevent the rise in core body temperature and improve firefighter cognition. This study has added value by assessing inflammation, coagulation and vascular reactivity, providing insight into future investigations of firefighter health and safety.

## Firefighter Assessment and Screening, Ben Hurley, PhD, and Angela L. Bennett, MS, University of Maryland College Park, with Maryland Fire Rescue Institute (Clinical, FY06)

**This 1-year study examines fitness and body composition to determine which is most important for optimal performance.**

The primary aim of the Firefighter Assessment and Screening project is to improve screening procedures of candidate firefighters on a national level as a means to:

- Reduce the number and severity of injuries and death

- Improve the quality and safety of performance in firefighter recruits

- Develop better screening procedures for recruits

- Provide better information to recruits and trainers concerning the physical attributes most important for firefighting

- Establish a scientific basis for individualized exercise training programs for recruits and experienced firefighters

- Reduce the cost of screening and training recruits

The overarching goal is to see a reduction in the number of firefighter deaths and injuries in the United States.

## Predicting Cardiovascular Risk and Fitness in Firefighters, Stephanos Kales, MD, Harvard School of Public Health (Clinical, FY06)

**This 3 year study examines cardiovascular risk among firefighters across the US.**

Cardiovascular disease is the primary cause of on-duty and lifetime mortality in firefighters and likely accounts for several thousand disability retirements each year.

This project will include the dietary and medical history; body composition and blood pressure; metabolic profiles; inflammatory cardiovascular markers and exercise stress testing of firefighters. The information collected will determine:

- Baseline predictors for results of exercise stress test

- How exercise stress test results predict health and employment consequences

Findings will consider cardiovascular risk factors; correlation between current physical exams, lab results and novel inflammatory markers and current maximal exercise tolerance, blood pressure response and heart rate recovery; and correlation of current dietary intake, body composition, lipid profiles, glucose and inflammatory markers.

This research will help decrease the burden of cardiovascular disease by examination of effects of:

- Restricting firefighters found at high risk for on-duty events from certain emergency operations

- Targeting others for further evaluation to better determine their fitness for duty

- Identifying symptomatic and asymptomatic firefighters needing intense risk reduction interventions designed to prevent future events

## Enhancing Health of Volunteer Firefighters in Maryland - Keshia Pollack, PhD, MPH, with the National Volunteer Fire Council (Clinical, FY07)

**The goal of this 3-year project is to explore the culture of fitness and wellness for firefighters and identify modifiable barriers to implementing health and wellness interventions in firefighters.**

Heart attacks are a leading cause of on-duty deaths for firefighters in the U.S.. Reducing firefighter fatalities from preventable cardiovascular conditions is a public health priority. This research includes three distinct but complementary projects:

- Identifying barriers to implementing wellness and fitness interventions among firefighters and fire departments
- Developing, testing and evaluating a pilot intervention
- Creating a database system to facilitate the longitudinal collection of health and injury-related measures for firefighters.

We will target our efforts to volunteer firefighters—a segment of the workforce whom we believe not only require carefully crafted and innovative wellness interventions, but also have received limited research attention in this area. Translation and dissemination for this project includes process evaluation metrics and conveying findings to firefighters, fire prevention partner agencies, fire leadership and policymakers.

## Cardiovascular and Biomechanical Responses to Firefighting and PPE, Denise Smith, PhD, and Gavin Horn, PhD, University of Illinois, with Illinois Fire Service Institute (Clinical, FY06)

**This 1 year project is the first systematic study of firefighting activities on cardiovascular and biomechanical function.**

More firefighters die in the line of duty from heart attacks than from any other cause; and more firefighters are injured by slips, trips and falls than from any other cause.

While the origins of heart attacks and slips, trips and falls may appear unrelated, previous research suggests that heat stress may be a common causal factor in both heart attacks and falls. The proposed research project will:

- Investigate changes in body temperature, cardiovascular function and biomechanics following strenuous firefighting activity
- Develop enhanced personal protective equipment, incorporating currently available technology and novel concepts

- Compare enhanced personal protective equipment (PPE) to standard PPE to determine if modified PPE can minimize these dangerous changes associated with firefighting

- Distribute findings and recommendations broadly through strategic partnerships with major fire service organizations in order to decrease fatalities and injuries and improve firefighter safety and performance

The overarching goal of this research project is to decrease the number of firefighter fatalities and injuries. Results from our study will provide scientific evidence regarding the extent to which "enhanced personal protective equipment" can minimize detrimental changes in cardiovascular and biomechanical variables related to heart attacks and slips, trips, and falls.

## Coronary Heart Disease, Robert Superko, MD, St. Joseph's Hospital, with Gwinnett County Fire Department (Clinical, FY06)

**This 3 year study examines cardiovascular risk among firefighters across the US.**

The primary purpose of this study is to improve firefighter health and life safety through the elucidation of metabolic, genetic and environmental issues that contribute to the unusually high incidence of coronary heart disease in firefighters.

This study aims to:

- Determine the prevalence of undiagnosed coronary heart disease and carotid artery atherosclerosis in firefighters

- Consider whether cardiovascular disease in firefighters is linked to metabolic disorders, genetic attributes or environmental issues

- Determine how these factors impact firefighter's health and safety

The results of this project will provide the foundation from which a scientific heart disease detection and prevention program will be developed that is specific to all firefighters.

## *Database Studies*

### Database for Health and Fitness, Carrie Dorsey, MD, MPH, and Melissa McDiarmid, MD, MPH, University of Maryland; Don Stewart, MD, MS, Fairfax County Fire and Rescue (Database System, FY07)

**This 1-year study aims to design a health, wellness and fitness minimum data set that can be used to improve firefighter safety and wellness.**

A web-based, centralized data set will be designed and implemented to enable tracking of medical, work-related, and fitness factors in relation to health outcomes, injury, and disease occurrence in firefighters. All protections used in medical and computer practice will be built into this system that will be developed and implemented in collaboration with the International Association of Fire Fighters.

This study aims to refine the International Association of Fire Fighters' Wellness Fitness Initiative data set. Pilot tests will be conducted with two participating fire departments. Focus groups will be carried out to help researchers further refine the process of data collection. Participating fire departments will work with Information Technology specialists to finalize their data collection system within their existing Medical Information System and build compatible interfaces. Interfaces will be constructed between these upstream systems and the central database. In addition, interfaces will be available for future data transfer from the central database to downstream uses such as specific registries for injury, cancer, cardiovascular and infectious disease.

The study aims to demonstrate: (a) what can be accomplished with fire departments; and (b) how national implementation might be conducted. When established, such a data set would allow a wide variety of clinical and cost/benefit studies to be conducted by investigators inside and outside of the fire service for the purpose of preventing injury and promoting the wellness of firefighters.

### Health Behavior Risk for Injury among Firefighters, Sara Pyle, PhD, Richard Suminski, PhD, Keith Haddock, PhD, Carlos Poston, PhD, Kansas City University of Medicine and Bio-Sciences, with Missouri Valley Fire Departments (Database System, FY07)

**The purpose of this 2-year study is to examine key risks for cardiovascular disease and line of duty injury in order to determine "fitness for duty" service.**

The study will develop a health surveillance tool for the fire service that will focus on risk factors for high cholesterol, high blood pressure, cardiovascular disease co-morbidities and injury. This study will examine:

- Behavioral risk factors, including lifestyle, body composition, fitness, depression, sleep, tobacco and alcohol use

- Factors associated with the departmental environment, such as type of department, call rate, health policies, food and physical activity

- Line-of-duty factors, such as types of calls, exposures and safety equipment

These behavioral, departmental, and line-of-duty factors will be used to establish a profile for "fitness for duty". A final set of factors might include, for example, levels of excess body fat, current cigarette smoking, low aerobic power, fire department food and physical activity. Data from randomly selected fire departments will be used to establish a profile for "fitness for duty" for firefighters.

## Firefighter Safety and the Deployment of Resources, Tom Wieczorek, MPA, Center for Public Safety Excellence, Lori Moore, PhD, International Association of Fire Fighters, and Kathy Notarianni, PhD, Worcester Polytech Institute (Database System, FY06)

**This 1 year study develops and tests a model and methods to support decision making about resource deployment in a risk filled environment.**

**T**oday, the level of service demands and public expectations placed upon local fire departments continues to rise with threats to communities coming from both natural and man-made disasters including terrorism.

The project team, with an expert technical panel, developed a robust theoretical model, designed and tested a survey instrument, and developed and implemented a strategy to sample needs and resources of fire departments. Over four hundred fire departments across the country registered to participate in the study.

Further project activity includes:

- Software development, model verification and testing, model validation, documentation, and dissemination.

- Field experiments will be carried out to assess resource deployment including crew size and time to task.

- Departments will evaluate situations to assess how well they match their community risk level to resources deployed.

The completion of this project will enable fire departments, cities, counties, and fire districts to design an acceptable level of resource deployment based upon community risks and service provision commitment.

## *Technology Studies*

### Firefighter Accountability Technology, Gilmer Blankenship, PhD, University of Maryland College Park, Steve Edwards, Director, Center for Firefighter Safety Research and Development, with Carole Teolis, PhD, TRX Systems Inc. (Technology, FY07)

**This 1-year study builds upon the original development of the firefighter tracking system to develop the integration of its several separate elements and the conduct of field testing in real world scenarios.**

This study extends U MD's research in this area of firefighter tracking with physiological health status monitoring. The aim is to bring to market an affordable system that is able to accurately determine the position and physiological condition of each firefighter at an incident scene and monitor environmental factors through development of new technologies.

### Firefighter Tracking System, Marino Di Marzo, PHD University of Maryland College Park, with Maryland Fire and Rescue Institute (Technology, FY06)

**This 1-year study develops interoperable firefighter accountability location and monitoring devices.**

Resource tracking, scene surveillance and physiological and special monitoring of personnel are identified as areas that must be integrated into the incident management process and made available to all fire departments and officials:

This study aims to develop a system to continuously monitor the location and physiological status of firefighters and transmit that data from the firefighters inside buildings to incident commanders at remote locations.

This system will provide the fire service on a national level with a reliable way to reduce the number and seriousness of fire ground related injuries and deaths. In addition, the tools developed through this research will provide the means to physically rescue at-risk firefighters from demanding emergency response activities as quickly as possible

## Integrated Firefighter Locator and Physiological Status Monitoring, James Duckworth, PhD, and David Cyganski, PhD, Worcester Polytechnic Institute, with Worcester Fire Department (Technology, FY06)

**This one year study is to develop a 3-D precision location/tracking device and physiological stress monitoring system.**

WPI and Foster Miller, Inc. will jointly develop a unique proof-of-concept 3-D location system with integrated wearable physiological stress monitoring. The proposed system will permit firefighter commanders to wirelessly locate, track and monitor individual crew members throughout multi-story structures in real time using a laptop computer with an intuitive graphics display showing each firefighter position. In addition, physiological information from the tracked firefighters will be continuously transmitted and displayed on the command console. Location and monitoring performance will be evaluated for various types and sizes of buildings and the integrated display will be evaluated by firefighters from the Worcester Fire Department. Goals include testing the viability of the technology and identifying any challenges that must be met before commercialization is feasible.

## Performance of Special Extinguishment Agents for Firefighter Use, Pravinray Gandhi, PhD, and Robert Backstrom, MS, Underwriter's Laboratories, Inc. (Technology, FY 06)

**This 1-year study evaluates the fire performance and effectiveness of special extinguishment agents in firefighting of residential structural fires.**

This research project evaluated the fire performance of various special agents including wetting agents and Class A foams and compared their performance to that of a baseline, traditional water application. A series of fully instrumented fire tests were conducted using a standardized fuel package that was designed to simulate a residential living area and hallway fire setting to evaluate the effectiveness of each extinguishing agent in controlling the fire. Additionally, the room temperature and smoke environment experienced by the firefighter was evaluated to determine safety conditions when special agents are used. The data collected and the video recordings from these tests was used to design and construct an educational course using a stand-alone web-based training module approach that was disseminated to fire services nationwide. The fire service can immediately transfer the test results into a) special extinguishing agent purchasing decisions and b) firefighting tactics related to use of special agents to increase the level of firefighter safety when special extinguishing agents are in use.

## Structural Stability of Engineered Lumber in Fire Conditions, Pravinray Gandhi, PhD, and Robert Backstrom, MS, Underwriter's Laboratories, Inc., with Chicago Fire Department (Technology, FY06)

**This 1-year study determines characteristics of engineered lumber assemblies.**

This was a problem-focused fire research study to enhance understanding of hazards to firefighters posed by use of light-weight construction of wood trusses and engineered lumber in roof and floor designs that are increasingly replacing conventional solid joist construction in residential structures. The project investigated and compared the fire performance of conventional solid joist lumber and light-weight lumber as used in floor and roof construction; and as correlated with fully instrumented fire tests. The fire tests in combination with fire performance data on lumber allow fire professionals to better interpret fire hazards and assess risk for life safety of building occupants and firefighters. UL transferred the knowledge gained through the research to the fire service community by creating a web-based training module approach that has been disseminated to fire services nationwide and can be used to enhance firefighter preparedness and safety. Results provide substantiation for code requirements for fire rating of light-weight construction in residential structures to further enhance firefighter safety.

## Firefighter Exposure to Smoke Particulates, Pravinray Gandhi, PhD, Tom Fabian, PhD, and Robert Backstrom, MS, Underwriter's Laboratories Inc. (Technology, FY07)

**This 1-year study will investigate the exposure and effect of smoke particulates on firefighters during fire suppression and overhaul.**

This is a problem-focused fire research study to enhance understanding of hazards to firefighters posed by exposure to smoke particles. These particles may be contributing to increased risk of firefighter cancer.

This project investigates the chemical composition of smoke particles encountered by first responders, including in the air and on protective clothing.

The study will include the following phases:

- Small scale tests to determine material characterization, smoke, ignition and combustibility characteristics
- Laboratory tests to evaluate smoke during planned, scenario-based, fire events
- Data collection from field fire events
- Comparative analysis of the data collected

- Assessment of potential epidemiological hazards from the data collected

The resulting data may be used by researchers to better understand long-term exposure to chemical-laden smoke that increases cancer and other disease risk to firefighters; to highlight the importance of decontaminating the firefighter's skin after exposure; and to develop guidance on frequency of firefighting garment cleaning.

## Fire Fighting Tactics under Wind Driven Conditions, Casey Grant, MS, PE, Fire Protection Research Foundation (Technology, FY06)

**This 1 year study examined ways firefighters can manage wind driven fires.**

NIST's Building and Fire Research Laboratory served as lead investigator team for a series of 8 full scale laboratory tests to explore various ventilation conditions and the impact of various techniques, such as fire blankets. Results will provide guidance on appropriate tactical options for use under wind driven conditions in the form of both video and technical report**.**

## Thermal Capacity of Fire Fighter Protective Clothing, Casey Grant, MS, PE, Fire Protection Research Foundation (Technology, FY06)

**This 1 year laboratory-based project tested the thermal radiation/compression properties of materials that may be considered for use in protective clothing.**

Significant numbers of firefighters sustain burn injuries when energy stored within the layers of protective equipment are suddenly transferred to the firefighter. Current standardized test protocols do not adequately evaluate the risk caused by this stored energy.

In this activity, the Foundation formed a technical advisory panel, and had leadership from NIOSH's Personal Protective Technology Laboratory, NIST's Building and Fire Research Laboratory, and North Carolina State University in the efforts to calibrate a test method and implement that method to examine 24 different materials.

Results will provide helpful information to those who select materials for protective clothing so that potential for low heat flux burn injury may be decreased. Results also will be considered in standards development activities underway at NFPA and ASTM.

## Alternative Strategic Approaches to Wind Driven High Rise Fires, Sunil Kumar, PhD, New York University – Polytechnic, with FDNY (Technology, FY06)

**This three year project is to study the effectiveness of positive pressure ventilation in high rise buildings.**

This effort will focus on validating the effectiveness of positive pressure ventilation for fire suppression in high rise buildings and will develop optimal approaches to pressurization. In addition, alternative strategies will be developed that utilize thermal blankets and aim-able water nozzles to enhance the effectiveness of positive pressure ventilation and to facilitate fire-fighting operation in high rise buildings. The study will consist of the following specific tasks:

- Parameter identification
- Characterization of nozzles and thermal blankets
- Characterization of wind conditions
- Positive pressure ventilation optimization
- Optimal implementation of thermal blankets
- Live burn tests and data analysis
- Dissemination

High rise fires are among the most technically complex and deadly operations for firefighters and the public. Results will enable firefighters to improve operational effectiveness and safety.

## Situational Awareness for Firefighters, Sharad Mehrotra, PhD, and Jay Lickfett, MS, University of California, Irvine (Technology, FY07)

**Emergency responders must process information, make critical decisions, take appropriate actions, and communicate effectively with others around them.**

This 2-year study is to achieve a high level of situational awareness which would allow more informed decisions to be made, resulting in much more effective actions and better management of risks. The study will include technology to record, store and replay fire site sensors data during training.

Today, a number of factors work against maintaining situational awareness in the context of fire response. These include incomplete, inaccurate, or uncertain information, as well as lack of clear priorities about information, incomplete sharing of information, and cultural factors.

The Situational Awareness for Firefighters study includes a plan for the research, development, and evaluation of a next-generation, end-to-end situational awareness system. This system aims to empower individual firefighters, incident commanders and emergency/department operations center staff to make effective decisions in dynamic environments. By using the Fire Incident Command Board, the user can establish and maintain situational awareness utilizing a wide range of sensor and data streams from the field, as well as existing centralized information systems such as computer-aided dispatch and geographical information systems.

The study would build substantially on the RESCUE Project led by the University of California, Irvine. RESCUE is an interdisciplinary, National Science Foundation funded project that explored how it can be used to empower first responders to make more informed decisions. Expected research contributions of SAFIRE include the Fire Incident Command Board, radio transcript interpretation, sensor data collection, and situation data management.

## High Performance Fire Blankets for Suppression and Protection, Fumiaki Takahashi, PhD, and James T'ien, PhD, Case Western Reserve University (Technology, FY07)

**The proposed new uses of fire blankets to protect structures in wildland-urban interface fires and for suppression of aviation fuel fires may revolutionize firefighting strategies in these catastrophic fire scenarios.**

> **Wildland-Urban Interface Fires** – If a large sheet or fire blanket made of suitable materials is developed with an appropriate deployment system, the probability of destruction of high-valued homes can be reduced.
>
> **Aviation/Tank Truck/Storage Tank fires** - Aviation fuel pool fires occur on the ground at airports as a result of fuel leakage from aircraft, a tank truck, or a storage tank. These occurrences may be accidental (mechanical failure, overruns, or ground collisions), or manmade (maintenance error or terrorism). If multiple sheets of fire blankets suitable for liquid fires are deployed quickly, the hot fuel surface can be covered and separated from air, the fire underneath the fuel tank can be controlled and suppressed, and thus a further disaster can be prevented.

This 3-year study consists of two phases: (1) surveying and developing fire blanket materials in combination with testing; and (2) designing and fabricating the deployment system prototypes for the two applications. The experimental work consists of: (1) flammability and heat-transfer tests of sample materials in combination with using standard test procedures; (2) fire protection tests; and (3) fire suppression tests. The instrumentation includes, visible and IR thermography video recording, time-resolved radiometer, temperature, and heat-flux measurements.

## Effectiveness of Pre-Applied Wetting Agents in Prevention of Urban Wildland Interface Fire Spread to Structures, Jozef Urbas, PhD, and Aixi Zhou, PhD, University of North Carolina at Charlotte (Technology, FY07)

**This 3-year study will test the use of pre-wetting agents on vegetation, dead fuels and structures found efficient in implementing ignitions and the spread of fires.**

Wildland Urban Interface fire threats have become a serious problem in the U.S. Fatalities and injuries most often occur from exertion and stress in situations when firefighters are trapped by fire progress. Successful pre-wetting agents delivered prior to firefighter arrival can be extremely valuable for mitigating fires. But this is so only if the performance and efficiency of these agents is systematically examined and understood.

"Pre-wetting" has been found efficient to prevent the spread of fires and reduce firefighter casualties and injuries. This study will examine; (a) water, (b) class A foams, and (c) gels. We will use study results to:

- Develop a database of performance and effectiveness of the three wetting agents
- Develop a testing standard for evaluating urban wildland interface wetting agents
- Design and construct an educational module that will be disseminated to fire services nationwide

Fire service and building owners can immediately transfer the research results into purchasing decisions for special extinguishing agents.