Monday, October 17

Presentations on Disaster Response Management

National Firefighter Technology Resource Center
***Thomas J. Kennedy**, Center for Technology Commercialization – Public Safety Technology Center*

First responders from State and local public safety agencies rely on assets of Federal agencies for training and technology support. However, prior to FFY 2005, there was no single facility dedicated to the research and development, and test and evaluation of technology products and services for the fire community.

The Department of Homeland Security Science & Technology Directorate will fund the Public Safety & Security Institute for Technology (PSITEC) to develop a center. Center for Technology Commercialization, Public Safety Technology Center (CTC-PSTC), working in conjunction with PSITEC, is working to establish a National Firefighter Technology Resource Center (NFTRC) that will stimulate and enable research and development, test and evaluate and use of advanced technologies for the fire community, in an effort to help better protect both fire fighters and the public.

As a first step towards the development of the center, Public Safety Technology Center developed a comprehensive inventory of firefighter needs based on after action, existing needs assessment, lessons learned and technology reports. The goal of this research project was to create a national needs assessment for the fire service community to be utilized by the National Firefighter Technology Resource Center.

CTC, Public Safety Technology Center analyzed a total of fifty-four (54) after action, technology/equipment, lessons learned, and needs assessment reports that were completed by government and industry organizations during the time period of 1991 to 2004. Priority areas were extracted from the literature and entered into a matrix. The analysis provided for a total of 672 recommendations for firefighter needs and 210 specific technology categories. Fifteen major technology categories were identified by the frequency of the recommendations. A common linkage was identified from the recommendations between after action, lessons learned and needs assessment reports on policy, technology and training.

PSTC completed the research project and achieved the following outcome:

1. Created a matrix "inventory" of need requirements that categorizes and tracks the highest to lowest priority needs as determined by the frequency that they were identified in the reports. The matrix illustrates the top broad category needs and the top specific technology needs.

The analysis illustrates that 71% of all recommendations identified fall within the top five major categories; pre-planning, incident management, personal protective equipment, communications, training.

The National Firefighter Technology Resource Center will work with the fire service community to facilitate partnerships, stimulate research & development, and evaluate new technology to eliminate the gaps identified.

Bio: Thomas J. Kennedy, CEO and Director, CTC Public Safety Technology Center As CEO of CTC he's charged with providing service to public safety. His background in Law Enforcement makes him uniquely qualified to lead this major CTC initiative, bringing cutting-edge technology to this unique arena. Prior to joining CTC, Lieutenant Colonel (ret.) Kennedy was the Deputy Superintendent, Massachusetts State Police, where he initiated major programs including the Training Academy, state-of-the-art crime lab, community policing initiatives, new communications systems and regional dispatch centers, traffic safety and intelligent traffic system programs, and a Total Quality Management program. Mr. Kennedy had fiscal oversight of projects and configured systems to address the accounting needs of the department. Mr. Kennedy earned a B.S. from Northeastern University, a M.A. in Criminal Studies from The American International College, and a MBA from Anna Maria College. He was an Adjunct Professor, Criminal Justice Program, at Anna Maria College.

Protecting Public Safety and Rescue Personnel from Vaccine-Preventable Hepatitis
Gerald M. Dworkin, *Lifesaving Resources, Inc.*

The term, Body Substance Isolation (BSI) Protocols, represents the Standard of Care for the response to EMS incidents as well as disaster response to natural or man-made disasters. Organizations, such as the Centers for Disease Control (CDC), Federal Emergency Management Agency (FEMA), International Association of Firefighters (IAFF) and International Association of Fire Chiefs (IAFC), and the American Red Cross have been advocating BSI protocols as infectious disease risk reduction strategies. However, in order to reduce or prevent infectious disease risk, a two-pronged effort must be deployed that includes, not only the BSI Protocols, but also immunization against vaccine-preventable diseases.

Although most Public Safety and Rescue personnel are vaccinated against Hepatitis B, very little attention has been given to Hepatitis A. This educational session focuses on the need for vaccinations against Hepatitis A and B and discusses Vaccine Preventable Hepatitis in detail with a focus on EMS, Disaster, and Water Rescue response to incidents.

Bio: Gerald Dworkin is a professional Aquatics Safety and Water Rescue Consultant for Lifesaving Resources and regularly consults as an Expert in drowning, aquatic injury, and pre-hospital EMS litigation. Dworkin has published over 30 articles and several

textbooks, and has been actively involved in Public Safety and Rescue as a Firefighter and EMT for over 30 years.

Emergency Planning and Response in a University Environment
Zack Adams, *Virginia Tech Environmental Health and Safety Services (EHSS)*

Emergency response organizations recognize that the college or university in their community represents a large population. They may understand that we do something called 'research'. What may not be realized, however, is that our diverse population, composed of many nationalities speaking many languages and representing many religious and ethnic groups, presents unique challenges; our research activities can themselves present extreme risks to first responders; our daytime population may exceed the population of the surrounding community; and, finally, we are a business with two primary missions--education and research--and this sets the focus for our emergency planning.

During this presentation we will discuss emergency planning at colleges and universities, and emphasize why there needs to be an interactive discussion between the locality, response organizations, and the educational institution on expectations, roles, capabilities, and priorities. We will highlight the potential hazards associated with research activities, and provide recommendations on how you should interact with the research community to assure your safety. Finally, we will discuss other activities that may occur on a college campus and the risks these may present to first responders.

Bio: Zack Adams is Co-Director with Environmental, Health and Safety Services at Virginia Tech; in his role he oversees fire safety and occupational safety programs, and serves as emergency planner for the university. He has more than 20 years experience in the safety and health arena, and is a licensed Professional Engineer, Certified Safety Professional, and Certified Industrial Hygienist.

Presentations on PPE Standards for Emergency Responders

NFPA Fire and Emergency Services Protective Clothing and Standards Program
Bruce Teele, *National Fire Protection Association (NFPA)*

What Has Changed in the NFPA Hazardous Materials Protective Clothing Standards?
James P. Zeigler, *DuPont Personal Protection*

The NFPA standards on hazardous materials (NFPA 1991 and NFPA 1992) and CBRN response (NFPA 1994) protective clothing have completed 5 year revisions cycle. In addition, CBRN have been added to Structural Firefighting Ensembles (NFPA 1971) and

Urban Search and Rescue (NFPA 1951) garments in their 5 year revisions. We will summarize the changes in these standards and the process by which these changes were adopted.

NIOSH Best Practices Functional Safety Guidance: What is it and How Does it Apply to Personal Protective Equipment?
Joe Waters, Tom Fisher, Janet Flynt, *Underwriters Laboratories, CDC/NIOSH/NPPTL, Safety Requirements, Inc.*

Advanced Personal Protection Equipment and Systems (PPES) incorporate product-ready technology in electrical, electronic, and programmable electronics. Use of newer materials, software, and wireless communications reduces life safety risks. Experience has shown though, that these technologies may fail to function in ways not previously anticipated.

To proactively address the potential for failure and to work toward reducing future risk to life safety professionals, NIOSH-NPPTL has led the development of a nine-part series of best practice recommendations for achieving functional safety. The guidance is currently being considered by the NFPA Electronic Safety Equipment Committee. Achieving functional safety for advanced personal protective equipment requires a system design approach that addresses hardware, software, human behavior, and the operating environment over the equipment's life cycle. It involves more than performance testing of the finished equipment and software.

The paper summarizes each of the nine parts of the NIOSH Best Practices Functional Safety Guidance and documents their status. It addresses why best practices are needed and how the guidance documents relate to existing IEC and UL standards. By reviewing the best practices guidance, manufacturers of PPES will be able to baseline existing practices against the recommendations. First responders will be able to address adding functional safety requirements to purchasing specifications.

A Practical Tool for Heat Stress Risk Assessment and Planning
James P. Zeigler, *DuPont Personal Protection*

The Wet Bulb, Globe and Temperature (WBGT) Method is the accepted method of civilian and military heat stress management. The method utilizes the key factors that control heat stress – heat, humidity, work level, clothing and end-user health – to assess heat stress risk. Both the American Congress of Governmental Industrial Hygienists (ACGIH) and US Army continue to support and upgrade this method. OSHA recommends this method for heat stress management. We have added psychrometry, historical weather data and updated clothing factors to enhance the utility of this method for first responder resource and response planning. This allows an assessment of the 24/7/365 impact of heat and humidity on manpower availability and on heat stress risk for various tasks and levels of PPE.

Presentations on Human/PPE Interface: Issues and Solutions

Physiological Changes Associated with Fire Exposure in Firefighters

Jonathan Kaufman, *Naval Air Systems Command Pax River*

Heat stress is widely recognized as a major threat to firefighter (FF) health, contributing to diminished judgment while performing operational tasks and incidents of heart failure when combined with high physical demands. Efforts to characterize FF thermal burdens have generally been limited to laboratory assessments, though a few investigations in more operationally-relevant settings have been undertaken. The present study assessed physiological responses among professional FFs (n=6, average experience = 22.2 years) while exposed to fire (approximately 1 MW) in standard turnout gear. Physiological measures included core temperature, heart rate, and skin temperature (20 skin sites to assess asymmetric heating). External PPE conditions were quantified with two thermocouples (Tcs) and four heat flux transducers mounted on the helmet. Room conditions were characterized by four poles on which 5 Tcs were mounted at 2 foot intervals (1-9 ft). Subjects were located approximately at distances approximately 5 and 12 feet from the fire and remained in place for 11 minutes while kneeling. During this time, FFs struck a board with a fire ax 75 times to produce a physical workload. Air temperature exceeded 250°C five feet above the floor with external helmet temperatures > 100°C. Localized skin temperatures were >40°C among upper body sites and increased by > 10°C over the course of exposures. Core temperature changes were minimal while peak heart rates exceeded 200 beats/min. Study results provide insight into physiological changes associated with direct exposure to fire.

Ergonomics Protocol for Next Generation Structural Firefighter Personal Protective Equipment Evaluation

Steven L. Johnson, *University of Arkansas*

There have recently been dramatic changes in the range of scenarios that firefighters, as first responders, might face. The potential for chemical or biological agents being encountered during is increasingly being recognized and is receiving significant attention at the national, state and local levels. One component of this attention is the desire to provide the fire fighters with structural firefighting ensembles that provides additional protection from chemical and biological agents.

The protocols for reliable and valid evaluation of HAZMAT ensembles have been relatively well developed, although they are continually being improved. There are significant challenges involved with the development of an ensemble that protects the firefighters from chemical and biological agents, while simultaneously providing the necessary protection from the traditional physical risks (i.e., heat). Similarly, the protocol necessary to evaluate alternative designs from an ergonomics perspective is distinct from

protocols that have previously been developed to test either HAZMAT or structural firefighting ensembles.

The physical and physiological effects of personal protective equipment (PPE) have been extensively studied. There have also been a number of national and international studies of the anthropometric considerations involved with firefighter ensembles. However, there has been much less attention devoted to the ergonomics of ensemble design and use in the public literature. Much of that literature relates to "preference" and user acceptance, rather than addressing objective assessments of "performance" when using wearing the PPE.

The paper presents a protocol to evaluate alternative structural firefighter ensemble designs with respect to physical, as opposed to the physiological, capacity limitations when wearing the ensembles. The objectives of the protocol are to provide an evaluation tool, as well as delineate areas of potential improvement that could increase the ability of the firefighter to perform their required tasks when wearing the ensemble.

The protocol development was initiated with a task analysis of firefighter's activities when fighting a fire with the potential for chemical and biological agents. A number of methodological issues are addressed in the paper. For example, issues such as the "learning curve" for donning and doffing new ensembles and operational definitions of performance that are internally and externally valid are discussed.

From the task analyses, "relevant scenarios" were developed that represent the wide variety of activities performed by firefighters. These scenarios were translated into four categories:

* `Static range of motion (i.e., elbow flexion, shoulder abduction, etc.)
* General dynamic motions (i.e., kneel and arise, body bend, forward reach, etc.)
* Job specific dynamic motions (climb ladder, crawl with one hand on wall, etc.)
* Material handling (pulling hose, manipulating drum and hand truck, etc.)

As with any protocol that is to be completed by operational personnel, there is a trade-off between the number of participants, the number of tasks and the time required to complete the evaluation. The paper presents the protocol and the rational for the decision that were made during the development.

Developing PPE Systems: Salient Issues Faced by Small and Large Manufacturers
Jeff A. Lancaster, John G. Casali, Atul Deshmukh, *Virginia Tech*

Dissipation of Oxygen from Outward Leak of Closed-Circuit Breathing Device
Kathryn M. Butler, Rodney A Bryant, John G. Kovac, *NIST/NPPTL*

Closed-circuit breathing devices recycle exhaled air after scrubbing carbon dioxide and adding make-up oxygen from a tank of pure oxygen. Use of this equipment allows first

responders to work for up to four hours without swapping out cylinders. Firefighting situations in which these devices would be useful include tunnels, mines, ships, high-rise buildings, and environments contaminated with biological or chemical toxins. A risk perceived by firefighters entering environments containing open flame and high radiant heat is the possibility of fire ignition in the vicinity of the respirator caused by the outward leakage of oxygen around the face piece.

This paper presents the results of a computational fluid dynamics (CFD) study of oxygen dissipation into the environment surrounding a respirator facepiece. Actual heads and masks were scanned into a 3D data set for entry into the CFD software, providing a physical boundary for the problem to be solved. Leak geometries representing an imperfect seal were defined. Oxygen concentration fields and flow streamlines are presented for multiple leak geometries and for both normal and high stress breathing patterns. Model results will be compared to planned experimental work.

Presentations on Novel PPE Ensembles

A Lightweight Self-Contained Breathing Apparatus with Integrated Full Body Cooling

Harold L. Gier, *Supercritical Thermal Systems, Inc.*

A new type of self-contained breathing apparatus (SCBA) has been developed on the US Government's Small Business Innovative Research (SBIR) program for NASA and the Air Force. This is an open-cycle SCBA which uses cryogenic air rather than compressed air. The side advantage of the cryogenic air is that the air breathed becomes a heat sink for the metabolic heat produced by the user and the environmental heat absorbed through the protective garment.

The use of cryogenic air allows a much lower pressure storage in the backpack than does compressed air, and simultaneously increases the storage density. The result of these factors is an air bottle (dewar) which is both smaller and lighter than a compressed air bottle containing the same quantity of air. In addition the air contained in the dewar is at a temperature of approximately -300 degrees F. In bringing the air temperature up to a comfortable breathing temperature considerable heat is absorbed from the user's body and from the environment.

Bio: Harold Gier received his B.S. and M.S. from Caltech and his Ph.D from the Univ. of Colorado in Aerospace Engineering Science. He worked as a test engineer in rocket engine heat transfer at the Jet Propulsion Laboratory, Pasadena, Calif. He taught Aerospace Engineering at the Univ. of Wyoming. He worked at Beech Aircraft, Boulder, Colo in spacecraft cryogenics. When Beech sold its Boulder Division, he started his own engineering company from which the breathing/cooling apparatus is one of the significant developments.

Advanced Chemical/Biological Protective Firefighter Turnout Suit
Roger L. Barker, Anthoney S. Deaton, *North Carolina State University*

Researchers at North Carolina State University, in partnership with Globe and DuPont, are developing a prototype next generation firefighter turnout that provides protection from heat and flame, as well as toxic chemical and biological agents. This project, awarded by the Department of Homeland Security and the Technical Support Working Group (TSWG), is achieving new levels of performance using advanced materials and turnout design. The turnout incorporates advanced materials technologies, including a selectively permeable membrane that allows sweat evaporation and body heat to escape while blocking harmful agents and a new nonwoven thermal liner developed at NC State. Innovative garment design has resulted in improved ergonomics and enhanced functionality, with an emphasis placed on seams, interfaces, and closures. The new suit has been designed for ease of use in structural firefighting. Materials and garment performance, including thermal protection, protection for CB agents and TICs, and heat stress has been evaluated using state of the art procedures. The design validation process has relied heavily on input from fire fighters.

Next Generation Structural Firefighting PPE with Chemical/Biological Protection
Jeffrey O. Stull, Richard M. Duffy, *International Personnel Protection, International Association of Fire Fighters (IAFF)*

One lesson of 9/11 was clear, the world has changed and firefighters will be among the most impacted. Today, we now understand that a fire may be caused by improvised explosive devices designed to distribute chemical/biological weapons of mass destruction. Firefighters responding on a "fire call" may now find that they are also exposed to chemical and biological toxins. Protective clothing for structural firefighting (i.e. bunker gear) has been designed to provide protection from fire and heat, but not these new challenges. HazMat suits exist but are cannot meet the demands of normal firefighting calls, especially by being available and in place when needed.

The International Association of Fire Fighters (IAFF), as part of their "Project HEROES" (Homeland Emergency Response Operational and Equipment Systems) initiative, received a federal government contract by the Technical Support Working Group (TSWG) with funding from the Department of Homeland Security (DHS). Through this project they have rapidly developed and tested a new structural fire fighting PPE ensemble with enhanced chemical, biological, radiological, and nuclear (CBRN) protective qualities to account for today's new threats. This protective ensemble is nearly indistinguishable from current structural fire fighting gear, but still offers improved chemical, biological, radiological and nuclear protections, without sacrificing thermal protection, comfort and functionality.

The team led by the IAFF, and including the International Association of Fire Chiefs (IAFC), Morning Pride Manufacturing, the National Personal Protection Technology

Laboratory, and International Personnel Protection, has developed an ensemble which provides the following features:

* The traditional moisture barrier is replaced with a chemical/biological barrier that provides the same level of breathability as current fire fighter clothing moisture barriers.
* A variety of outer shell and thermal barrier materials are permitted to allow department choices in composites.
* The design addresses the entire ensemble with modifications to the garments, hood, gloves, and footwear to ensure complete body protection when worn with a CBRN SCBA
* Unique interface designs are provided that function to provide passive CBRN protection when needed (the fire fighter does not have to do anything special to activate this protection)
* Some of new features actually enhance structural fire fighting protection

This paper will provide a detailed description of the ensemble, the materials used in its construction, and the process by which it was developed and evaluated.