

INTERNATIONAL FIRE SERVICE JOURNAL OF LEADERSHIP AND MANAGEMENT



Journal Team

Editor

Dr. Robert E. England
Fire Protection Publications
Oklahoma State University

Managing Editor

Eric R. England
Fire Protection Publications
Oklahoma State University

Production Manager

Ann Moffat
Fire Protection Publications
Oklahoma State University

Journal Webmaster

Jiejia Wang
Fire Protection Publications
Oklahoma State University

Associate Editor

Mike Wieder
Fire Protection Publications
Oklahoma State University

Copy Editor

Barbara Adams
Fire Protection Publications
Oklahoma State University

Layout & Design

Ben Brock
Fire Protection Publications
Oklahoma State University

Subscriptions & Permissions

Coordinator
Mike Wieder
Fire Protection Publications
Oklahoma State University

Editorial Board

Dr. David N. Ammons
Albert Coates Professor of
Public Administration and Government
University of North Carolina at
Chapel Hill

Ms. Meri-K Appy
President
Safe Kids USA
Washington, DC

Dr. Shawn Bayouth
Assistant Professor & Collaborator
Iowa State University
Fire Chief, Ames, Iowa

Roxanne V. Bercik
Los Angeles Fire Department
(ret. 2014) Deputy Chief
Bureau of Training and Support
Services

Dr. David Billeaux
Professor and Associate Vice-President
for Academic Affairs
Texas A&M University at
Corpus Christi

Dr. Anthony Brown
Associate Professor Emeritus of
Political Science
Oklahoma State University

Vivienne Brunsden
CPSychol CSci
Head of the Emergency Services
Research Unit
Nottingham Trent University
United Kingdom (UK)

Dr. Harry R. Carter
Chairman, Board of Fire
Commissioners
Howell Township (New Jersey)
Fire District # 2

Dr. N. Joseph Cayer
Professor Emeritus
Arizona State University

Dr. Larry R. Collins (ret.)
Associate Dean
School of Safety, Security,
and Emergency Management
Eastern Kentucky University
and International Fire Service Training
Association Executive Board

Chief Dennis Compton
Chairman of the Board of Directors
National Fallen Firefighters Foundation

I. David Daniels
Deputy Fire Chief/Chief Safety Officer
Safety and Response Operations
Section, Department of Fire
and Emergency Services
City of Richmond, Virginia

Dr. Jeff G. DeGraffenreid
Fire Chief
City of Olathe (KS) Fire Department

John J. Delorio, II
Deputy Chief
Ocala (FL) Fire Rescue

Dr. Edward T. Dickinson, MD
Professor and Director of
EMS Field Operations
Department of Emergency Medicine
Perelman School of Medicine
University of Pennsylvania

Steven T. Edwards
Director
Maryland Fire and Rescue Institute
University of Maryland

Dr. Anne Eyre
Independent Consultant, Trauma
Training, Coventry, United Kingdom
(UK)

Dr. Richard B. Gasaway
Executive Director, Center for the
Advancement of Situational
Awareness & Decision Making
Chief Scientist: Public Safety
Laboratory

Dr. John A. Granito
Professor and Vice President
Emeritus
State University of New York
Binghamton and
Fire and Emergency Services
Consultant

Craig Hannan
Director
Fire Protection Publications
Oklahoma State University

Rowena Hill
Senior Lecturer in Psychology
Nottingham Trent University
United Kingdom (UK)

Jeffrey L. Huber
Public Service Careers Department
Fire Science Program
Lansing (MI) Community College

Dr. Owen E. Hughes
Dean of Students
RMIT University
Melbourne, Australia

Dr. Sara A. Jahnke
Principal Investigator & Director
Center for Fire, Rescue, & EMS Health
Research
Institute for Biobehavioral Health
Research
National Development & Research
Institutes

Dr. William (BJ) Jetter
Fire Chief Sycamore Township (Ohio)
Professor, University of Cincinnati
Cincinnati State College

Mark Jones
Director, Strategic Reform Agenda
Emergency Services Agency
ACT Government
Canberra, Australia

Dr. Bill Lowe, EFO & EMT-P
Associate Professor of Emergency
Management
Jacksonville (AL) State University

Dr. Susan MacManus
Distinguished University Professor
Department of Government and
International Affairs
University of South Florida

Dr. R. Jeffrey Maxfield
Associate Dean
School of Public Services
Utah Valley University

Dr. David P. Milen
Professor of Public Policy and
Administration
Walden University

Dr. Susan Miller
Assistant Professor, Political Science
University of South Carolina

Dr. Bruce J. Moeller
Director
Pinellas County (FL)
Public Safety Services

Dr. Lori Moore-Merrell
Assistant to the General President
International Association of Fire
Fighters
Washington, DC

Dr. John M. Moschella
Adjunct Professor
Department of Fire Science
Anna Maria College
Paxton, MA

Chief (ret.) Christopher Neal
Fire and Public Safety Consultant

Dr. William L. Pessemier
Director
Summit County (CO)
Communications Center

Chief (ret.) William E. Peterson
Fire and Public Safety Consultant

Dr. Richard L. Resurreccion
Consultant to Training Division
Long Beach Fire Department
Professor Emeritus
Occupational Studies
California State University
Long Beach, California

Dr. Kim Coffman-Romero
Dean of Instruction
Ottawa University
Phoenix, Arizona

Dr. Peter Rudloff
Assistant Professor
Political Science
Oklahoma State University

Chief Douglas R. Schrage
Fire Chief
University of Alaska (Fairbanks)
Fire Department

Dr. Terry Shevels
Chartered Psychologist (CPSychol.)
Course Leader MBA Programs
Newcastle College, MBA Centre
Sandyford, Newcastle
United Kingdom (UK)

Chief Ronald Jon Siarnicki
Executive Director
National Fallen Firefighters Foundation
Emmitsburg, Maryland

Dr. Qingsheng Wang
Assistant Professor
Department of Fire Protection & Safety
Department of Chemical Engineering
Oklahoma State University

William M. Webb
Executive Director
Congressional Fire Services

Michael A. Wieder
Associate Editor, *International Fire
Service Journal of Leadership and
Management*
Associate Director, Fire Protection
Publications
Executive Director, International Fire
Service Training Association
Oklahoma State University

Dr. B. E. (Bernie) Williams
Associate Professor
Faculty of Management
University of Lethbridge, Canada



The *International Fire Service Journal of Leadership and Management (IFSJLM)* is composed of peer-reviewed articles focusing exclusively on fire leadership and management topics. **To our knowledge, it is the only academic journal with this focus in the world.** *IFSJLM* is published by Fire Protection Publications (FPP) at Oklahoma State University (OSU). FPP is part of the College of Engineering, Architecture, and Technology at OSU and is the leading publisher in the world of fire-related education and training materials.

IFSJLM would not be possible without the financial support of the Dean of the College of Engineering, Architecture, and Technology and FPP. Their support represents a commitment to the continued professionalization of the American fire service.

As a further indication of the support of FPP to the international fire community, all issues of the *IFSJLM*, except the two most recent years, are available for reading **free of cost** at the Journal's website. Please go to <http://www.ifsjlm.org/PastEditions.htm> to read and/or download previous issues of the Journal.



The Dr. Granito Award

Dr. John Granito Award for Excellence in Fire Leadership and Management Research 5

Message from Dr. Robert England 6

Keynote Addresses

The Value of Research to Fire-Rescue Officers

Dr. John Granito 7

LODD Reduction: Stories, Science, Statistics, and Solutions

Dr. Denis Onieal 11

Report on Residential Fireground Field Experiments

Dr. Lori Moore-Merrell 15

Is There a Doctor in the (Fire) House?

Dr. Edward T. Dickinson 23

Fire Dynamics: The Science of Fire Fighting

Daniel Madrzykowski 27

The Making of a Hero: An Exploration of Heroism in Disasters and Implications for the Emergency Services

Dr. Anne Eyre 37

Do Current Fire-Service Issues Offer Political and Operational Leadership Challenges?

Chief Dennis Compton 47

Understanding and Preventing Sudden Cardiac Events in the Fire Service

Dr. Denise L. Smith 51

Journal and Subscription Information 59

*Previous Recipients of the Dr. John Granito Award for
Excellence in Fire Leadership and Management Research*

Research Symposium 2008 (RS08)

Dr. John Granito

Professor Emeritus and Retired Vice President Emeritus
for Public Service and External Affairs
State University of New York Binghamton and Public Safety
Management Consultant

Research Symposium 2012 (RS12)

Daniel Madrzykowski

Fire Protection Engineer
National Institute of Standards and Technology (NIST)

Research Symposium 2009 (RS09)

Dr. Denis Onieal

Deputy U.S. Fire Administrator

Research Symposium 2013 (RS13)

Dr. Anne Eyre

Independent Consultant, Trauma Training,
Coventry, United Kingdom (UK)

Research Symposium 2010 (RS10)

Dr. Lori Moore-Merrell

Assistant to the General President
International Association of Fire Fighters (IAFF)

Research Symposium 2014 (RS14)

Chief Dennis Compton

Chairman of the Board of Directors of the
National Fallen Firefighters Foundation

Research Symposium 2011 (RS11)

Dr. Edward T. Dickinson, MD

Professor of Emergency Medicine
Perelman School of Medicine, University of Pennsylvania

Research Symposium 2015 (RS15)

Dr. Denise Smith

First Responder Health and Safety Laboratory, Department
of Health and Exercise Sciences, Skidmore College and
Research Scientist University of Illinois Fire Service Institute,
Champaign, Illinois

Research Symposium 2016 (RS16)

Dr. Sara A. Jahnke

Director and Principal Investigator,
Center for Fire, Rescue & EMS Health Research,
Institute for Biobehavioral Health Research,
National Development and Research Institutes,
Leawood, Kansas

***Dr. John Granito Award for
Excellence in Fire Leadership and Management Research***

The Dr. Granito Award

Fire Protection Publications (FPP) and the *International Fire Service Journal of Leadership and Management (IFSJLM)* headquartered on the campus of Oklahoma State University (OSU) are proud to announce the creation of the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research (the Dr. Granito Award)**. The award will be presented at the *IFSJLM* Research Symposium that supports the *Journal* held annually in July at the IFSTA Validation Conference. The award honors Dr. John Granito. John has been one of the premier fire and public safety consultants in the United States. Just a few of his many Fire, Rescue, and Emergency Services research projects include: Oklahoma State University-Fire Protection Publications Line of Duty Death Reduction project (3 years); Centaur National Study (3 years); Research Triangle Institute/National Fire Protection Association/International City/County Management Association project (4 years); Fire Department Analysis Project (FireDAP) of the Urban Fire Forum (13 years); *Combination Department Leadership* project, University of Maryland, Maryland Fire & Rescue Institute (4 years); Worcester Polytechnic/International Association of Fire Fighters/International Association of Fire Chiefs/National Institute for Occupational Safety and Health *Fire Ground Performance Study*. He has participated in more than 400 fire department studies. John also has strong ties to academia. He served in a number of academic positions for almost 30 years, including 16 years at the State University of New York at Binghamton. He is Professor Emeritus and Retired Vice President for Public Service and External Affairs at SUNY Binghamton, which is consistently ranked in the top public universities by *U.S. News and World Report*. John has published numerous articles, chapters, and technical papers, served as co-editor of the 2002 book published by the International City/County Management Association entitled, *Managing Fire and Rescue Service*, and is a Section Editor of the NFPA® 2008 *Fire Protection Handbook*. Dr. Granito was the first recipient of the award that honors him and his service to the fire service and to academia. Each year the recipient of the Dr. Granito Award presents the Keynote Address at the annual *IFSJLM* Research Symposium. The Keynote Address is subsequently published as the lead article in the following year's volume of the *IFSJLM*.

Nomination Form

Fire Protection Publications (FPP) and the *International Fire Service Journal of Leadership and Management (IFSJLM)* headquartered on the campus of Oklahoma State University (OSU) are accepting nominations for the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research (the Dr. Granito Award)**. The award is presented at the Research Symposium that supports the *International Fire Service Journal of Leadership and Management (IFSJLM)* held annually in July at the IFSTA Validation Conference.

The nominee should have made a significant contribution to the advancement of fire leadership and management through his/her scholarly/academic writing. The Dr. Granito Award is not necessarily a life-time achievement award, although such individuals certainly should be in a prominent position to be nominated. The nominee can be a person who,

although early in their career as a practitioner/scholar or academic, has made a seminal contribution to the fire leadership and management literature.

To nominate an individual for the Dr. Granito Award, please submit by 15 November of the current year: (1) this form (or a copy of it), (2) no more than a one-page single-spaced letter explaining why you believe the person is deserving of the award, and (3) a copy of the nominee's resume or curriculum vitae. Please send required materials in hard copy to: Dr. Granito Award, C/O Dr. Robert E. England, Founding Editor, *International Fire Service Journal of Leadership and Management*, P. O. Box 720846, Norman, Oklahoma 73070. Or, if you prefer, scan and complete the nomination form and send all materials electronically to: bob.england@okstate.edu.

I nominate _____ for the **Dr. John Granito Award for Excellence in Fire Leadership and Management Research**. To support the nomination, I have included a letter of recommendation and a resume or curriculum vitae (CV) of the nominee. (A nomination is not accepted without the supporting letter and resume/CV.)

Nominator Name: _____

Address: _____

Zip/Postcode: _____

Contact Information:

Telephone: _____

Email: _____

Message from Dr. Robert E. England

Founding Editor, *International Fire Service Journal of Leadership and Management (IFSJLM)*, Fire Protection Publications, Oklahoma State University

Welcome to this special “Highlights” edition of *IFSJLM*. In order to celebrate the publication of Volume 10 of the *Red Journal*, we decided to offer a compilation of the Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Addresses presented at the Research Symposium held annually in July at the International Fire Service Training Association Validation Conference.

The “Granito Award” honors Dr. John Granito, one of the premier fire and public safety consultants in the United States. John served in a number of academic positions for almost 30 years, including 16 years at the State University of New York at Binghamton. In 2008

(at Research Symposium 2008, but published in 2009 in Volume 3 of the *IFSJLM*), Dr. Granito was the first recipient of the award. The title of his presentation was aptly entitled, “The Value of Research to Fire-Rescue Officers.”

This Volume 10 of the *IFSJLM* includes seven previously published Granito Award Keynote Addresses (found in Volumes 3 to Volume 9) and one previously unpublished Keynote Address presented at Research Symposium 2015 by Dr. Denise Smith. The 2016 Granito Keynote Address presented this past July by Dr. Sara A. Jahnke will appear as the lead article in Volume 11 of the *International Fire Service Journal of Leadership and Management* scheduled for release in September or October of 2017.

We hope you enjoy this “Highlights” Volume 10 of *IFSJLM*.

Dr. Granito Keynote Address Volume 3 (2009)

First Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address.

Dr. John Granito, Professor and Vice President Emeritus, State University of New York Binghamton and Public Safety Management Consultant

The Value of Research to Fire-Rescue Officers

Introduction

The intent of this paper is twofold: (1) to present to senior fire/rescue officers and other fire-service officials a few thoughts concerning the value of additional and more rigorous research in the areas of management and leadership and (2) to comment on how research can contribute significantly to professionalization and better public protection. Over the years, most fire-service research has focused on technical issues and field operations, an example being widespread concern over the most effective tactics for combating high-rise fires. Yet, a high percentage of the challenges today are created and driven by economic and social issues rather than a lack of technology or engineering. While technical advancements may ease certain of the economic and social problems that fire/rescue organizations face, more effective management and more inspiring leadership certainly are necessary if the required levels of community-service delivery are to continue across our nation, provided by viable fire/rescue departments.

It is, perhaps, this challenge of continuing viability for fire/rescue departments that cries the loudest for more skilled and sensitive management and for more forthright and vigorous leadership. I believe that the *International Fire Service Journal of Leadership and Management* and the annual recognition of worthy researchers will contribute greatly to meeting the needs I describe. I mean to strongly encourage both experienced and newer researchers to contribute the reports of their inquiries on an ongoing basis. The *Journal* fills an important need, one that is not filled by any other fire-service publication, and its support by the College of Engineering, Architecture, and Technology of Oklahoma State University (OSU) and OSU's Fire Protection Publications (FPP) unit is commendable.

Note that I have attempted to distinguish between the conduct of research and the reporting of that research. We need both very much, since unreported research obviously has very limited benefit. Simply think of the vast service provided by publications such as the *New England Journal of Medicine* or the *Journal of the American Medical Association* or the United Kingdom's (UK's) *The Lancet*. My hope is that our *Journal*, with your efforts, will go on to provide practitioners with a similar high level of research coverage.

Some Needed Types of Research

Research often is defined as studious inquiry and examination to discover new or revised knowledge. It

occurs to me that the following types of research are among those needed to serve as the foundation for improved fire-service management and leadership:

- ***The identification and application of findings in a variety of disciplines such as political science, sociology, psychology, statistics, organizational behavior, economics, and business management that have useful transferability*** — Examples are the adoption by the fire service from economics of special-service cost transferability to the private sector, such as hazardous materials response charges, and the provision of critical incident stress debriefing by trained psychologists.
- ***The transfer of computer applications to enhance information management, and thus fire/rescue officer decision making*** — An example is the sorting of response data to identify the daily volume of simultaneous alarms that would affect Emergency Medical Services (EMS) response capacity with existing resources — the New Orleans post-Katrina project.
- ***Controlled research projects that examine historical data or that generate new data in order to draw conclusions concerning service delivery*** — Examples are code-enforcement progress in retail, warehouse, high-rise, and other occupancies contrasted with numbers of inspectors — the KPMG/MMA Chicago study, and the National Fire Protection Association (NFPA®) Fire Department Analysis Project (FireDAP).
- ***Research projects that test conventional wisdom or that seek to learn firefighter and other perceptions of accepted practice*** — Examples are found in the OSU, Department of Energy (DOE), New York City/Anchorage, and DOE National Laboratories studies that seek to discover accurate and useful understandings of organizational safety climate.
- ***Large scale, broad-based examinations of both historical data and current findings in order to establish benchmarks and improvement steps*** — Examples are the International Association of Fire Fighters (IAFF) Fire Fighter Injury Study, the OSU Line-of-Duty Deaths (LODD) Database Reduction through Best Practices Phase 1 Project, and the ongoing

National Institute of Standards and Technology (NIST)-IAFF-International Association of Fire Chiefs (IAFC)-Center for Public Safety Excellence (CPSE)-Worcester Polytechnic Institute (WPI) Project on Response System Design.

- **Research conducted to satisfy cognitive curiosity, remembering Robert Oppenheimer's statement that "... the deep things in science are not found because they are useful; they are found because it was possible to find them."** (as quoted in Rhodes, 1988, p. 11) — One great value of curious findings, of course, is that they provide springboards or stepping stones to functionality for the next researcher.
- **Reviews of relevant literature, but with the necessary addition of new concepts stemming from a rethinking or a re-juxtapositioning of existing knowledge.**

What Research is Not

Like true love or a junior aerial, research may be described best by what it is not. Research is not any of the following:

- The exposition of "How I did it." While these may add to your repertoire, situational leadership tells us, as Heraclitus pointed out, that you can't stick your toe in the same river twice.
- "Lessons learned" unless presented in a highly formalized and sophisticated way, with eminent transferability.
- A compilation of close-call descriptions, although these could lead to a useful research construct.
- A description of what the writer might believe to be the best way to handle a given situation, although these descriptions may stimulate thought.
- The arrangement of data in order to demonstrate that what you already believe is correct.
- An article that recites or summarizes existing knowledge learned by the writer in a recent college class.
- An autobiography, no matter how exciting and well written.

Earmarks to Consider

What, then, are some earmarks of sound and useful research? Consider the following items:

- Research that leads to an unbiased extension of what is already part of a formal body of knowledge, generally widely accepted by practitioners
- Research leading to conclusions that can be duplicated through repeated trials

- New or extended knowledge that makes sense in real-world operations or that leads to acceptance after testing by practitioners
- Controlled experiments that test null hypotheses
- Research that recognizes variables and controls for them
- Research that has a large enough sample size (N) to have reasonable validity or that sets a framework for continued trials with larger populations
- Research that recognizes that a stratified or select population limits conclusions
- Research that, if it concludes that additional study is needed, at least provides a sample structure and process framework for consideration
- Research that, if grounded in statistics, uses the proper treatment of data. Dave McCormack often pointed out that statistically speaking the average man has fewer than two arms, yet shirt manufacturers never use that statistic

The Value of Research to the Profession

Fire and rescue officers and officials, whether career or volunteer, will benefit from membership in a recognized profession; but for fire/rescue officership to become a recognized profession, a sufficient research endeavor is necessary. The basis for professionalization of the fire-service management discipline must, of course, consist of several additional key elements in addition to a healthy research component. Some of these elements will be mentioned later in this article.

It appears doubtful that those outside our interest area (which likely is considered by many to be an occupational specialty rather than a "profession") will view us as a recognizable profession until we can demonstrate to their satisfaction that we really do "know what we're doing." I judge that a body of knowledge specific to the effective and efficient management of community protection is required for that demonstration. Of course, I am not proposing that we attempt to emulate physicians. I do, though, believe that our "profession" has a considerable distance to go before it will no longer be whipsawed by numerous municipal administrators and voters who have little confidence in our resource requests and other judgments. To measure our current professional impact, simply consider where we are with widespread sprinkler legislation, for example, or with code-improvement requests or with minimum staffing standards.

Simply stated, services that are perceived by the public as being conducted and delivered by professionals typically are better supported than those that are not. Even worse, I note with chagrin that my neighbors accept with no question the recommendations of our local plumber, but pay little attention to the *FIREWISE*

material distributed by our local fire department. I hope you will agree that there are distinct advantages to professionalization.

The Earmarks of a Profession

Professions are often defined as callings requiring specialized knowledge, intensive and frequently long preparation including instruction in skills and methods, in addition to having a body of scientific, historical, or scholarly principles underlying the skills and methods. High standards of achievement and conduct plus continuing education are required and scrutinized by peers. The type of work generally has the rendering of public service as its prime purpose. Earmarks typically include the following items:

- A distinct and contributing body of knowledge that is ever-enlarging and being tested
- A body of relevant literature that contains the required body of specialized knowledge, which is growing, and which conveys that knowledge to practitioners through written, graphic, oral, and other means
- Focused and continuing study with recognized certifications
- A formalized research program with the distribution of research findings
- Maintenance and scrutiny of practitioner standards, and policing by professional associations using a quality-assurance program
- Clearly identified professional organizations with provisions for continuing education
- A strong focus on improved public service

To carry the concept of professionalism to our own field of interest, several key questions should be posed. These questions include whether a profession can include the categories of supervisor, manager, administrator, and leader, and whether all workers — career or volunteer — necessarily have to be professionals? The statement sometimes voiced by career firefighters that, “I’m a professional firefighter” has, of course, a different meaning and intent. However, it does seem reasonable to assume that the full range of department officers, given the right circumstances, can be professionals, although not all persons in a given field need to be. Part of the difficulty in dealing with these questions has to do with the changing definition of the word *profession*. While historically the *learned professions* have been identified as theology, law, and medicine, we now have many “subprofessions” in the health field, for example, and many thousands who would term themselves as health professionals who are not physicians.

For discussion purposes, this article will consider fire/rescue officers as belonging to a “specialty” in order to test how close the specialty is to having the

characteristics of a widely recognized profession.

As a hurdle to professionalization, consider that some members of the specialty may have the following deficiencies:

- May not be certified
- May not have a demonstrated mastery of the body of knowledge and skills required
- May not function well, or at all, as a supervisor, manager, or leader
- May not have had formal training
- May not be aware of shortcomings in knowledge and skills
- May not be aware of best operational practices
- May evidence obvious managerial and leadership failures

We know, however, that a high percentage of specialty members (career and volunteer) are certified, well trained, knowledgeable, and skilled in the specialty and keep well abreast of the most up-to-date information. Unfortunately, there still exist many fire/rescue departments (both career and volunteer) where chief-level officers are not selected on merit, and so we have a pronounced slope on the “where do we stand” graph. I believe it is important to note that without rigorous and on-going research efforts, plus the widespread dissemination of findings to practitioners, widely recognized professionalization cannot be achieved.

The Professional Status of Fire/Rescue Officers

Despite the distance some officers appear to be from professional status, there are many positive vectors present in the specialty and a significantly high and growing number of officers who are as “professional” as one can get at this time in the specialty. Without question, many would say (and I would hesitate to argue) that they *do* belong to a profession. I add only that the necessary research and dissemination programs are only now beginning to appear.

We *do* have certification, accreditation, and a fully operational Center for Public Safety Excellence. We have strong and effective professional associations and organizations such as IAFC, IAFF, NFPA®, and others, and we have had for some time fully accredited college-level degree programs. There is an overarching federal organization — United States Fire Administration (USFA) — with a national training academy, plus related programs with a recommended curriculum. We have various categories of “professional qualifications” plus a standardized testing program. We have bodies of knowledge well published as training documents — although mostly related to technical and field operations. We do, indeed, have much that contributes to professionalization. But as the old show tune asks, “What ain’t we got?” Well, we don’t have a very active and productive research program that visibly

contributes to the practice of management and leadership. Fortunately, however, we now have an academically based refereed journal that stimulates research, publishes peer-reviewed research articles, and has the potential for widely based distribution of those articles. Further, it brings together both experienced and newer researchers for an annual symposium.

I expect that through the good work of the researchers here today and others, the *Journal* will serve an expanded and much-needed role in our nation as the UK publications do there. Good management and leadership research provides clarity, confirmation or denial; newer and more productive ways of viewing challenges; and a springboard to obtaining local answers.

If I were to title an article about today's typical chief officer, I think I'd borrow the one William Moore used as a book title in 1971, *Blind Man on a Freeway*; or perhaps I'd lean toward Wendell Johnson's 1946 book, *People in Quandaries*. Anyway, here is my list of a few of today's challenges that cry for some genuine research in administration and leadership:

- Discovering methodologies to use in functional consolidation, merging, and combining
- Identifying operational-performance measures
- Determining response-crew staffing requirements
- Managing and leading combination departments
- Maintaining effective volunteerism
- Identifying results of combining fire and police services
- Preparing and presenting viable long-range plans
- Downsizing methodologies
- Managing growth
- Creating and maintaining productive labor-management relations
- Creating and then managing diversity

- Adding to the service-delivery package
- Creating a safety-oriented organizational climate
- Building and using an information-management system
- Creating a meritocracy in testing and promotions
- Entering and surviving the political process
- Organizing and managing a fire-based EMS delivery organization
- Increasing department income options
- Leading emergency management and military officials
- Managing a Balkanized fire/rescue service
- Maintaining personal growth and development
- Assigning resources effectively
- Avoiding legal and related traps
- Creating and maintaining firefighter wellness

I close by emphasizing that both community fire protection and the fire/rescue organizations that provide these services are enhanced by professional leadership. Research is a vital component of professional vitality and viability, and America's fire/rescue services need to be supported and strengthened by it. Our *Journal* — whose motto is "Building Theory to Impact Practice" — is the best stimulus for, and the most effective distributor of, those research findings. I encourage you as individuals, as students in higher education, as organizational leaders, as members of the Executive Fire Officer program, and as college and university faculty members to push your own and other research efforts in management and leadership and to use the *Journal* to its fullest.

Reference

Rhodes, R. (1988). *The making of the atomic bomb*. New York: Simon and Schuster.

Dr. Granito Keynote Address Volume 4 (2010)

Second Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address. **Dr. Denis Onieal**, Superintendent, National Fire Academy. (Dr. Onieal is currently Deputy Fire Administrator, United States Fire Administration.)

LODD Reduction: Stories, Science, Statistics, and Solutions

...We've arranged a civilization in which most crucial elements profoundly depend on science and technology. We have also arranged things so that almost no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces Carl Sagan

This presentation about firefighter Line-of-Duty Deaths (LODDs) will ask and attempt to answer the following four questions surrounding LODDs:

1. We are all great at *Stories*, but how good are we at *Science* and *Statistics*?
2. What is *federalism*; what is *devolution*?
3. What has worked and what never does work?
4. What is the *Solution*; what are we all going to *DO*?

(Editor's Note: Take the time to find an Internet connection and watch this short video. It provides an excellent context for Dr. Onieal's presentation.)

Video presentation by Michael Shermer on what constitutes Science: http://www.ted.com/talks/michael_shermer_on_believing_strange_things.html

How good are we at science and statistics? Mike Shermer showed you what *is* and *is not* science and explains the differences in a pretty funny way. We are not good scientists, and human beings are equally poor as intuitive statisticians. It is hard for us to discover the truth when we just do not ever figure the odds. It is common for people to believe that they have a good chance of winning the lottery, but at the same time believe they will not get into a vehicle accident because they are *good drivers*. On the face of it, the odds are in favor of the accident and against the lottery, but indeed people do think that way. Hope springs eternal!

In much the same way, people believe fire fighting LODDs occur because fire fighting is dangerous — that is the *story*; but the science and the statistics tell us that roughly 75 percent of the 100 or more annual LODDs are caused by firefighter-controlled behaviors. About 50 percent of the current LODDs are caused by heart-related events and 25 percent by vehicle accidents. Fires and other causes result in about 25 percent of the LODDs.

If you look at the science, the *New England Journal of Medicine* article by Dr. Stephanos Kales, et al. entitled "Emergency Duties and Deaths from Heart Disease Among Firefighters in the United States" identifies the following four personal cardiovascular risk factors in his analysis of LODDs:

1. Poor exercise tolerance
2. High prevalence of obesity and high cholesterol
3. Hypertension (often untreated)
4. Lack of regular periodic examinations

In this and another article in the *American Journal of Cardiology*, Kales identified the odds of a cardiac-related firefighter LODD as follows:

1. 40 percent of LODDs are caused by smokers who have heart attacks.
2. A LODD is:
 - 35 times greater for those with a known diagnosis of some form of heart disease
 - 12 times greater for those with hypertension
 - 6½ times greater for those more than 50 years old

Additional risk factors include obesity; and as a part of society, firefighters are not immune to this alarming trend. Obesity is defined as a Body-Mass Index (BMI) of over 30; a BMI of 25–30 is considered overweight. America's growing obesity problem over the past 18 years is graphically demonstrated on the Centers for Disease Control and Prevention (CDC) website: www.cdc.gov.

In research tangential to one of the Kales' identified risk factors (regular periodic examinations), Walter Malo and John Delorio published their findings in the *International Fire Service Journal of Leadership and Management*, "Getting to the Heart of the Matter: Reducing Firefighter Line of Duty Deaths." Their research found the following information:

- 64 percent of fire departments who responded to their survey required annual incumbent physicals.
- 22 percent of fire departments responding performed no periodic physicals.
- Of those departments that reported that they conducted physicals:

- Half of the physicals were (and the other half were not) conducted by occupational medicine physicians.
- Only half of those occupational medicine physicians were familiar with National Fire Protection Association® (NFPA®) 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*.

- 84 percent of the respondents did not include obesity as a determining factor in *fit for duty*.

It is clear from the scientific evidence that previously diagnosed heart disease, age, and obesity are significant contributing factors to heart-related LODDs. While Malo and Delorio's research is probably too small a sample to be definitive, it does identify some opportunities to address the issues through annual medical screening conducted by trained occupational physicians using NFPA® standards. It is a start toward a workable solution to reducing cardiac-related LODDs.

What is federalism, and what is devolution — and how do they relate to efforts to reduce LODDs? In a nutshell, *federalism* defines the role of the federal government versus state government. Unless specifically reserved for the federal government in the United States (U.S.) Constitution, most authorities are *devolved* to reside with the states. The federal government reserves the right to coin or print money, sign treaties with foreign governments, declare war, and regulate interstate commerce. Other authorities like issuing drivers' or medical licenses, regulating voting, issuing marriage licenses and divorce decrees, establishing and sustaining a National Guard, and regulating property-transfer rules and requirements belong to the states. Some authorities are shared efforts — family assistance, education, road construction, and road maintenance are but a few. In governance, certain authorities are centralized in the federal government, but most are devolved locally.

An extraordinary example of centralized authority versus devolved authority that this writer once examined is military veterans' benefits. Before discussing this issue any further, I want to state that I have three family members who are disabled veterans — an uncle from World War II, a cousin from Vietnam, and my son from Iraq. Each receives extraordinary treatment from the Veterans Health Administration (VHA) medical system (part of the U.S. Department of Veterans Affairs [VA]); the men and women who work for the VA are remarkable — you will only hear me singing their praises.

After World War II, the Korean War, and the Vietnam War, the government took two distinct approaches to veterans' benefits, and the differences can be used to demonstrate centralized versus devolved services. In one case, the government told the veterans:

Thank you for your service, and the time you took from your life to defend democracy. We

want to help you get back with your life by helping you with a college education. You can study whatever you would like, and attend any college or university as long as it is accredited. We will give you funds to pay for your tuition and some living expenses.

And the VA did just that. As a result, we took an entire generation of lower economic status people (which most draftees were) and educated them into the tax-paying middle class. The government devolved the decision, provided general guidance and resources, and let the system work. Our country experienced tremendous economic growth because of the education these veterans received, and we continue to reap the benefits.

To the returning veterans who were injured and disabled they also said:

Thank you for your service, and the time you took from your life to defend democracy. We are sorry you were injured, and we will help you get back with your life by treating your medical condition. We will build and manage the hospitals, hire the doctors and the nurses, cook the food, sweep the floors and manage the laboratories.

In the process, the VA built one of the largest health-care systems in the world.

I happen to think that the VA is very good, but that is my experience; and others have a different opinion. However, I often wonder what the healthcare system in the U.S. would be today had the VA decided to devolve the health benefits for disabled veterans the same way they devolved the education benefits — that disabled veterans could receive healthcare in their local communities rather than a centralized system. Of course, we will never know, but the question is intriguing.

In the case of LODDs, my concern is that the efforts to reduce LODDs are becoming centralized rather than devolved and that the solutions are too far from the problems.

There are a number of activities associated with the attempt to reduce LODDs. The National Fallen Firefighters Foundation (NFFF) has embarked upon an ambitious program to reduce LODDs. The program was developed during a Firefighter Life Safety Summit held in Tampa, Florida, in March, 2004. The Summit produced 16 major initiatives that give the fire service a blueprint for making the necessary organizational changes to reduce LODDs. The work of the NFFF is remarkable — from helping the families of the fallen, to providing scholarships for their survivors, and then conducting the annual Memorial event each October.

While there is widespread recognition of their tremendous efforts, my concern is that the LODD reduction efforts are increasingly viewed as the responsibility of the NFFF rather than the responsibility of the individual or local fire department. In just about every conversation I have on campus (National Fire Academy), the Foundation is mentioned as being the impetus for,

or the solution to, the problem. The concern is that the LODD reduction effort is becoming centralized in the NFFF rather than decentralized to the local fire department where the problem is. Solutions there would have a much greater impact.

So, what are we going to DO? I believe that the LODD efforts must be devolved into local fire departments; the solutions must be placed closer to the problem. The NFFF must provide local fire chiefs the tools they need to reduce LODDs — heart attacks and vehicle accidents. NFPA® 1582 should be used and enforced by local fire departments if we are ever going to successfully deal with cardiac and obesity issues. The local fire chief should have model documents at her or his disposal to help enforce NFPA® 1582 along with model programs to help implement the standard. Fire department physicians should be as equally familiar with the standard as the fire chief.

The solution to 25 percent of the LODDs related to vehicle accidents is not rocket science. Mandatory seatbelt use and increased driver qualifications and training are the answers. One of the fire service's best instructors happens to be a retired police officer, Gordon Graham. If you have never heard Gordon speak, do not miss the next opportunity. If you have heard him speak, then you are probably like me — whenever and wherever, I am in the audience.

One of the stories he tells is about truck accidents. He usually asks his audience to raise their hand if they have ever seen a vehicle accident involving a truck. Of course, every hand in the audience goes up. Then he asks if anyone has ever seen a truck accident involving a United Parcel Service (UPS) truck. In all his audiences, very few hands ever go up on that question, and frequently none are raised. Gordon goes into a great explanation as to why UPS is so successful at

accident reduction — but there is no magic to it. It is careful screening and training, training, training. There are rules, everyone knows the rules and everyone knows that the rules are enforced. There are consequences for breaking the rules. There is no reason at all that the same cannot be done in the local fire department. What is rewarded is repeated; what is punished does not.

In closing, firefighter LODD reduction is not a gamble with the odds; it is not Las Vegas and it is not the jumbo lottery. It is science; it is data. We have talked it and *PowerPointed* it to death; now is the time for action. The science and the statistics are telling us to work with the best odds. The science and statistics are telling us that it is heart attacks and vehicle accidents that are causing 75 percent of the LODDs. The biggest impact on LODD reduction is in these two areas — *and we control the variables!*

If we are serious about LODD reduction, we must place the solution next to the problem — at the local level. The local fire chief is the most effective change agent and must have the tools, the models, the examples, and the best practices to implement NFPA® 1582 or an equivalent health and fitness program. If we are serious about reducing vehicle-related LODDs, the local fire chief must have model driver training programs, model safe driver and passenger policies, and examples of enforcement. It is time that we expose, rather than comfort and shield, officers who suffer and permit unsafe practices to flourish in their departments.

In closing, I want to once again recognize one of my heroes, Dr. John Granito for whom this award is named for all that he has done for America's Fire and Emergency Services. We are all better because of Dr. Granito's leadership and vision.

Dr. Granito Keynote Address Volume 5 (2011)

Third Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address, **Dr. Lori Moore-Merrell**, Assistant to the General President of the International Association of Fire Fighters.

Jason D. Averill, National Institute of Science and Technology
Dr. Lori Moore-Merrell, International Association of Fire Fighters
Adam Barowy, National Institute of Science and Technology
Robert Santos, Urban Institute
Richard Peacock, National Institute of Science and Technology
Dr. Kathy A. Notarianni, Worcester Polytechnic Institute
Doug Wissoker, Urban Institute

Report on Residential Fireground Field Experiments

Abstract

Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism have steadily increased. However, local decision-makers are challenged to balance these community-service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.

For the first time, this study investigates the effect of varying crew size, first-apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed, and robust research methods were used. The results and conclusions will directly inform the National Fire Protection Association® (NFPA®) 1710 Technical Committee, who is responsible for developing consensus industry-deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire — a low-hazard residential structure fire. For the fireground experiments, a 2,000 ft² (186 m²), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, Maryland. Fire crews from Montgomery County, Maryland, and Fairfax County, Virginia, were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environments inside the structure were measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus-arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.

Background

The fire service in the United States (U.S.) has a deservedly proud tradition of service to community and country dating back hundreds of years. As technology advances and the scope of service grows (e.g., more Emergency Medical Services [EMS] obligations and growing response to natural disasters, hazardous materials incidents, and acts of terrorism), the fire service remains committed to a core mission of protecting lives and property from the effects of fire.

Fire fighting is a dangerous business with substantial financial implications. In 2007, U.S. municipal fire

departments responded to an estimated 1,557,500 fires. These fires killed 3,430 civilians (nonfirefighters) and contributed to 17,675 reported civilian fire injuries. Direct property damage was estimated at \$14.6 billion dollars (Karter, 2008). In spite of the vigorous nationwide efforts to promote firefighter safety, the number of firefighter deaths has consistently remained tragically high. In both 2007 and 2008, the U.S. Fire Administration (USFA) reported 118 firefighter fatalities (USFA, 2008).

Although not all firefighter deaths occur on the fireground — accidents in vehicles and training fatalities add to the numbers — every statistical analysis of the fire problem in the United States identifies residential structure fires as a key component in firefighter and civilian deaths as well as direct property loss. Consequently, community planners and decision-makers need tools for optimally aligning resources with the service commitments needed for adequate protection of citizens.

Despite the magnitude of the fire problem in the United States, there are no scientifically based tools available to community and fire-service leaders to assess the effects of prevention, fixed sprinkler systems, fire-fighting equipment, or deployment and staffing decisions. Presently, community and fire-service leaders have a qualitative understanding of the effect of certain resource-allocation decisions. For example, a decision to double the number of firehouses, apparatus, and firefighters would likely result in a decrease in community fire losses, while cutting the number of firehouses, apparatus, and firefighters would likely yield an increase in the community fire losses, both human and property. However, decision-makers lack a sound basis for quantifying the total impact of enhanced fire resources on the number of firefighter and civilian lives saved and injuries prevented.

Studies on adequate deployment of resources are needed to enable fire departments, cities, counties, and fire districts to design an acceptable level of resource deployment based upon community risks and service-provision commitment. These studies will assist with strategic planning and municipal and state budget processes. Additionally, as resource studies refine data-collection methods and measures, both subsequent research and improvements to resource-deployment models will have a sound scientific basis.

Project Overview

This project systematically studies deployment of fire-fighting resources and the subsequent effect on both firefighter safety and the ability to protect civilians and their property. It is intended to enable fire departments and city/county managers to make sound decisions regarding optimal resource allocation to meet service commitments using the results of scientifically based research. Specifically, the residential fireground experiments provide quantitative data on the effect of crew size, first-due engine arrival time, and subsequent apparatus stagger on time-to-task for critical steps in response and fire fighting.

The first phase of the multiphase project was an extensive survey of more than 400 career and combination fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented

in this report, which is limited to the experimental phase of the project, but they will constitute significant input into future applications of the data presented in this document.

This report describes the second phase of the project, divided into the following four parts:

- **Part 1** — Laboratory experiments to design the appropriate fuel packages to be used in the burn facility specially constructed for the research project
- **Part 2** — Field tests for critical time-to-task completion of key tasks in fire suppression
- **Part 3** — Field tests with real furniture (room and contents experiments)
- **Part 4** — Fire modeling to apply data gathered to slow-, medium-, and fast-growth-rate fires

The scope of this study is limited to understanding the relative influence of deployment variables on low-hazard, residential structure fires, similar in magnitude to the hazards described in National Fire Protection Association® (NFPA®) 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. The standard uses as a typical residential structure a 2,000 ft² (186 m²) two-story, single-family dwelling with no basement and no exposures (nearby buildings or hazards such as stacked flammable materials).

The limitations of the study, such as firefighters' advance knowledge of the facility constructed for this experiment, invariable number of apparatus, and lack of experiments in extreme temperatures or at night, will be discussed in a later section of this report. It should be noted that the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, and response to hazardous material incidents, acts of terrorism, and natural disasters, or other technical responses has not been assessed and should not be extrapolated from this report.

Literature Review

Research to date has documented a consistent relationship between resources deployed and firefighter and civilian safety. Studies documenting engine- and ladder-crew performance in diverse simulated environments as well as actual responses show a basic relationship between apparatus staffing levels and a range of important performance variables and outcome measurements such as mean on-scene time, time-to-task completion, incidence of injury among fire-service personnel, and costs incurred as a result of on-scene injuries (Cushman, 1982; McManis Associates & John T. O'Hagan and Associates, 1984; Morrison, 1990; Phoenix [AZ] Fire Department, 1991).

Reports by fire-service officials and consulting associates reviewing fire suppression and emergency response by fire crews in U.S. cities were the first publications to describe the relationship between adequate staffing levels and response time, time to completion of various fireground tasks, overall effectiveness of fire suppression, and estimated value of property loss for a wide range of real and simulated environments. In 1980, the Columbus (OH) Fire Division's report on firefighter effectiveness showed that for a predetermined number of personnel initially deployed to the scene of a fire, the proportion of incidents in which property loss exceeded \$5,000 and horizontal fire spread of more than 25 ft² (2.3 m²) was significantly greater for crews whose numbers fell below the set thresholds of 15 total fireground personnel at residential fires and 23 at large-risk fires (Backoff, 1980). The following year, repeated live experiments at a one-family residential site using modern apparatus and equipment demonstrated that larger units performed tasks and accomplished knockdown more quickly, ultimately resulting in a lower percentage of loss attributable to factors controlled by the fire department. The authors of this article highlighted that the fire company is the fire department's basic working unit and further emphasized the importance of establishing accurate and up-to-date performance measurements to help collect data and develop conclusive strategies to improve staffing and equipment utilization (Gerard & Jacobsen, 1981).

Subsequent reports from the USFA and several consulting firms continued to provide evidence for the effects of staffing on fire crews' ability to complete tasks involved in fire suppression efficiently and effectively. Citing a series of tests conducted in 1977 by the Dallas (TX) Fire Department that measured the time it took three-, four-, and five-person teams to advance a line and put water on a simulated fire at the rear of the third floor of an old school, officials from the USFA underscored that time-to-task completion and final level of physical exhaustion for crews markedly improved not after any one threshold, but with the addition of each new team member. This report went on to outline the manner in which simulated tests exemplify a clear-cut means to record and analyze the resources initially deployed and finally utilized at fire scenes (National Fire Academy [NFA], 1981). A later publication detailing more Dallas (TX) Fire Department simulations — 91 runs each for a private residential fire, high-rise office fire, and apartment-house fire — showed again that increased staffing levels greatly enhanced the coordination and effectiveness of crews' fire-suppression efforts during a finite time span (McManis Associates & John T. O'Hagan and Associates, 1984). Numerous studies of local departments have supported this conclusion using a diverse collection of data, including a report by the National Fire Academy (NFA) on fire-department staffing in smaller

communities, which showed that a company crew staffed with four firefighters could perform rescue of potential victims approximately 80 percent faster than a crew staffed with three firefighters (Morrison, 1990).

During the same time period that the impact of staffing levels on fire operations was gaining attention, investigators began to question whether staffing levels could also be associated with the risk of firefighter injuries and the cost incurred as a result of such injuries at the fire scene. Initial results from the Columbus (OH) Fire Division showed that "firefighter injuries occurred more often when the total number of personnel on the fireground was less than 15 at residential fires and 23 at large-risk fires" (Backoff, 1980). Mounting evidence has indicated that staffing levels are a fundamental health and safety issue for firefighters in addition to being a key determinant of immediate-response capacity. One early analysis by the Seattle (WA) Fire Department for that city's Executive Board reviewed the average severity of injuries suffered by three-, four-, and five-person engine companies, with the finding that "the rate of firefighter injuries expressed as total hours of disability per hours of fireground exposure were 54 percent greater for engine companies staffed with three personnel when compared to those staffed with four firefighters, while companies staffed with five personnel had an injury rate that was only one-third that associated with four-person companies" (Cushman, 1982). A joint report from the International Association of Fire Fighters (IAFF) and Johns Hopkins University (JHU) concluded, after a comprehensive analysis of the minimum staffing levels and firefighter-injury rates in U.S. cities with populations of 150,000 or more, that jurisdictions operating with crews of less than four firefighters had injury rates nearly twice the percentage of jurisdictions operating with crews of four-person crews or more (IAFF & JHU, 1991).

More recent studies have continued to support the finding that staffing per piece of apparatus integrally affects the efficacy and safety of fire department personnel during emergency response and fire suppression. Two studies in particular demonstrate the consistency of these conclusions and the increasing level of detail and accuracy present in the most recent literature by looking closely at the discrete tasks that could be safely and effectively performed by three- and four-person fire companies. After testing drills comprised of a series of common fireground tasks at several fire-simulation sites, investigators from the Austin (TX) Fire Department assessed the physiological impact and injury rates among the variably staffed fire crews. In these simulations, an increase from a three- to four-person crew resulted in marked improvements in time-to-task completion or efficiency for the two-story residential fire drill, aerial-ladder evolution, and high-rise fire drill, leading the researchers to conclude that loss of life and property increases when a sufficient number of personnel are not available to conduct the required tasks efficiently, independent of

firefighter experience, preparation, or training. Reviews of injury reports by the Austin (TX) Fire Department furthermore revealed that the injury rate for three-person companies in the 4 years preceding the study was nearly one-and-a-half that of crews staffed with four or more personnel. In a sequence of similar tests, the Office of the Fire Marshal of Ontario, Canada, likewise found that three-person fire companies were unable to safely perform deployment of backup protection lines, interior suppression or rescue operations, ventilation operations that required access to the roof of the involved structure, use of large hand-held hoselines, or establishment of a water supply from a static source without additional assistance and within the time limits of the study. Following these data, Fire Marshal officials noted that three-person crews were also at increased risk for exhaustion due to insufficient relief at fire scenes and made recommendations for the minimum staffing levels per apparatus necessary for suppression and rescue-related tasks (Office of the Fire Marshal of Ontario, 1993).

The most comprehensive contemporary studies on the implications of fire-crew staffing now include much more accurate performance measures for tasks at the fireground in addition to the basic metric of response time. They include environmental measures of performance, such as total water supply, which expand the potential for assessing the cost-effectiveness of staffing not only in terms of fireground personnel injury rates but also comparative resource expenditures required for fire suppression. Several examples from the early 1990s show investigators and independent fire departments beginning to gather the kind of specific, comprehensive data on staffing and fireground tasks such as those suggested and outlined in concurrent local government publications that dealt with management of fire services (Coleman, 1988). A report by the Phoenix (AZ) Fire Department laid out clear protocols for responding to structure fires and response evaluation in terms of staffing, objectives, task breakdowns, and times in addition to outlining the responsibilities of responding fire department members and the order in which they should be accomplished for a full-scale simulation activity (Phoenix [AZ] Fire Department, 1991). One attempt to devise a prediction model for the effectiveness of manual fire suppression similarly reached beyond response-time benchmarks to describe fire operations and the step-by-step actions of firefighters at incident scenes by delineating the time-to-task breakdowns for size-up, water supply, equipment selection, entry, locating the fire, and advancing hoselines, while also comparing the predicted time-to-task values with the actual times and total resources (Menker, 1994). Two separate studies of local fire department performance, one from Taoyuan County in Taiwan and another from the London Fire Brigade, have drawn ties between fire crews' staffing levels and total water demand as the consequence of both response time and fire severity. Field data

from Taoyuan County for cases of fire in commercial, business, hospital, and educational properties showed that the type of land use as well as response time had a significant impact on the water volume necessary for fire suppression, with the notable quantitative finding that the water supply required on-scene doubled when the fire department response increased by 10 minutes (Chang & Huang, 2005).

Response time as a predictor of residential fire outcomes has received less study than the effect of crew size. A Rand Institute study demonstrated a relationship between the distance the responding companies traveled and the physical property damage. This study showed that the fire severity increased with response distance, and therefore the magnitude of loss increased proportionally (Rand Institute, 1978). Using records from 307 fires in nonresidential buildings over a 3-year period, investigators in the United Kingdom correspondingly found response time to have a significant impact on final fire area, which in turn was proportional to total water demand (Sardqvist, 2000).

Recent government and professional literature continue to demonstrate the need for more data that would quantify in depth and illustrate the required tasks, event sequences, and necessary response times for effective fire suppression in order to determine with accuracy the full effects of either a reduction or increase in fire-company staffing (Karter, 2008). A report prepared for National Institute of Standards and Technology (NIST) stressed the ongoing need to elucidate the relationship between staffing and personnel injury rates, stating that "a scientific study on the relationship between the number of firefighters per engine and the incidence of injuries would resolve a long-standing question concerning staffing and safety" (TriData Corporation, 2005). While not addressing staffing levels as a central focus, an annual review of fire department calls and false alarms by the NFPA® exemplified the need to capture not only the number of personnel per apparatus for effective fire suppression but also to clarify the demands on individual fire departments with resolution at the station level (NFPA®, 2008).

In light of the existing literature, there remain unanswered questions about the relationships between fire-service resource deployment levels and associated risks. For the first time, this study investigates the effect of varying crew size, first-apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical advisors involved. Additionally, the structure used in the field experiments included customized instrumentation for the experiments; all related industry standards were followed; robust research methods were used; and the results and conclusions will directly inform the NFPA® 1710 Technical Committee as well as public officials and fire chiefs.¹

Discussion

Both the increasing demands on the fire service — such as the growing number of EMS responses, challenges from natural disasters, hazardous materials incidents, and acts of terrorism — and previous research point to the need for scientifically based studies of the effect of different crew sizes and firefighter-arrival times on the effectiveness of the fire service to protect lives and property. To meet this need, a research partnership of the Commission on Fire Accreditation International (CFAI), International Association of Fire Chiefs (IAFC), IAFF, NIST, and Worcester Polytechnic Institute (WPI) was formed to conduct a multiphase study of the deployment of resources as it affects firefighter and occupant safety. Starting in FY 2005, funding was provided through the U.S. Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA) Grant Program Directorate for Assistance to Firefighters Grant Program — Fire Prevention and Safety Grants. In addition to the low-hazard residential fireground experiments described in this report, the multiple phases of the overall research effort include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and on property losses.

The first phase of the project was an extensive survey of more than 400 career and combination (both career and volunteer) fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project. The survey results will constitute significant input into the development of a future software tool to quantify the effects of community risks and associated deployment decisions on resultant firefighter and civilian injuries and property losses.

The following research questions guided the experimental design of the low-hazard residential fireground experiments documented in this report:

1. How do crew size and stagger affect overall start-to-completion response timing?
2. How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the 22 critical fireground tasks?
3. How does crew size affect elapsed times to achieve the following three critical events that are known to change fire behavior or tenability within the structure?

- a. Entry into structure
 - b. Water on fire
 - c. Ventilation through windows (three upstairs and one back downstairs window and the burn-room window)
4. How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene vary between crew sizes of four and five?

In order to address the primary research questions, the research was divided into the following four distinct, yet interconnected parts:

- **Part 1** — Laboratory experiments to design appropriate fuel load
- **Part 2** — Experiments to measure the time for various crew sizes and apparatus stagger (interval between arrival of various apparatus) to accomplish key tasks in rescuing occupants, extinguishing a fire, and protecting property
- **Part 3** — Additional experiments with enhanced fuel load that prohibited firefighter entry into the burn prop — a building constructed for the fire experiments
- **Part 4** — Fire modeling to correlate time-to-task completion by crew size and stagger to the increase in toxicity of the atmosphere in the burn prop for a range of fire-growth rates

The experiments were conducted in a burn prop designed to simulate a low-hazard fire in a residential structure described as typical in NFPA® 1710. NFPA® 1710 is the consensus standard for career firefighter deployment, including requirements for fire department arrival time, staffing levels, and fireground responsibilities.

Limitations of the study include firefighters' advance knowledge of the burn prop, invariable number of apparatus, and lack of experiments in elevated outdoor temperatures or at night. Further, the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, hazardous materials, or other technical responses has not been assessed and should not be extrapolated from this report.

Primary Findings

Of the 22 fireground tasks measured during the experiments, results indicated that seven factors had the most significant impact on the success of fire-fighting operations. All differential outcomes described in the following sections are statistically significant at the 95-percent confidence level or better.

Overall Scene Time

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) 7 minutes faster — nearly 30 percent — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 percent — than the three-person crews. On the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and is recognized in industry standards.²

Time to Water on Fire

There was a 10-percent difference in the *water-on-fire* time between the two- and three-person crews. There was an additional 6-percent difference in the *water-on-fire* time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16 percent faster than two-person crews). There was an additional 6 percent difference in the *water-on-fire* time between the four- and five-person crews (i.e., five-person crews put water on the fire 22 percent faster than two-person crews).

Ground Ladders and Ventilation

The four-person crews operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 percent faster than the two-person crews and 25 percent faster than the three-person crews.

Primary Search

The three-person crews started and completed a primary search and rescue 25 percent faster than the two-person crews. The four- and five-person crews started and completed a primary search 6 percent faster than the three-person crews and 30 percent faster than the two-person crew. A 10-percent difference was equivalent to just over 1 minute.

Hose-Stretch Time

In comparing four- and five-person crews to two- and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to the two-person crews, the differences are more distinct. Two-person crews took 57 seconds longer than three-person crews to stretch a line. Two-person crews took 87 seconds longer than four-person crews to complete the same tasks. Finally, the most notable comparison was between two-person crews and five-person crews — more than 2 minutes (122 seconds) difference in task-completion time.

Industry Standard Achieved

As defined by NFPA® 1710, the *industry standard achieved* time started from the first-engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.³ An effective response force was assembled by the five-person crews 3 minutes faster than the four-person crews. Based on the study protocols modeled after a typical fire department apparatus-deployment strategy, the total number of firefighters on scene in the two- and three-person crew scenarios never equaled 15; and therefore the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue

Three different standard fires were simulated using the Fire Dynamics Simulator (FDS) model. Characterized in the *Handbook of the Society of Fire Protection Engineers* as slow-, medium-, and fast-growth rate,⁴ the fires grew exponentially with time. The rescue scenario was based on a nonambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue, depending on arrival times for all crew sizes. Occupants rescued by early-arriving crews had less exposure to combustion products than occupants rescued by late-arriving crews. The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting them to an increasingly toxic atmosphere.

For a slow-growth-rate fire with two-person crews, the FED was approaching the level at which sensitive populations such as children and the elderly are threatened. For a medium-growth-rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the general population. For a fast-growth-rate fire with two-person crews, the FED was well above the median level at which 50 percent of the general population would be incapacitated.

Larger crews responding to slow-growth-rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth-rate fires. The result for late-arriving (2 minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth-rate fires. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

Conclusion

More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies

the effects of changes to staffing and arrival times for residential fire-fighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public-policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors, including geography, local risks and hazards, and available resources as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire-service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in NFPA® 1710. The results also provide valid measures of total effective response-force assembly on scene for fireground operations as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires. Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities and responses to large-scale nonfire incidents or technical-rescue operations.

References

- Backoff, R. W. (1980). *Firefighter effectiveness — A preliminary report*. Columbus: Ohio State University, Columbus Fire Division.
- Chang, C. & Huang, H. (2005). A water requirements estimation model for fire suppression: A study based on integrated uncertainty analysis. *Fire Technology*, 41(1), 5.
- Coleman, R. J. (1988). *Managing Fire Services* (2nd ed.). Washington, DC: International City/County Management Association.
- Cushman, J. (1982). *Report to executive board: Minimum manning as health and safety issue*. Seattle: Seattle (WA) Fire Department.
- Gerard, J. C., & Jacobsen, A. T. (1981). Reduced staffing: At what cost? *Fire Service Today*, p. 15.
- International Association of Fire Fighters (IAFF) & Johns Hopkins University (JHU). (1991). *Analysis of firefighter injuries and minimum staffing per piece of apparatus in cities with populations of 150,000 or more*. Washington DC: IAFF/JHU.
- Karter, M. J. Jr. (2008). U.S. fire loss for 2007. *NFPA Journal*. September/October.
- McManis Associates & John T. O'Hagan and Associates (1984). *Dallas fire department staffing level study*. June, pp. I-2 and II-1 through II-7. Dallas: McManis Associates and John T. O'Hagan and Associates.
- Menker, W. K. (1994). *Predicting effectiveness of manual suppression* (unpublished master's thesis). Worcester Polytechnic Institute, Worcester, MA.
- Morrison, R. C. (1990). *Manning levels for engine and ladder companies in small fire departments*. Emmitsburg, MD: National Fire Academy (NFA).
- National Fire Academy (NFA). (1981). *Fire engines are becoming expensive taxi cabs: Inadequate manning*. Emmitsburg, MD: National Fire Academy (NFA) and United States Fire Administration (USFA).

National Fire Protection Association® (NFPA®). (2008). *Fire Protection Handbook* (20th ed.). Quincy, MA: National Fire Protection Association®.

Office of the Fire Marshal of Ontario. (1993). *Fire ground staffing and delivery systems within a comprehensive fire safety effectiveness model*. Toronto, Ontario, Canada: Ministry of the Solicitor General.

Phoenix (AZ) Fire Department. (1991). *Fire department evaluation system* (FIREMAP). December, p. 1. Phoenix: Phoenix (AZ) Fire Department.

Rand Institute. (1978). *Fire severity and response distance: Initial findings*. Santa Monica, CA: B. Roberts.

Sardquist, S. & Holmsted, G. (2000). Correlation between firefighting operation and fire area: Analysis of statistics. *Fire Technology*, 36(2), 109.

TriData Corporation. (2005). *The economic consequences of firefighter injuries and their prevention: Final report*. Gaithersburg, MD: National Institute of Standards and Technology, U.S. Department of Commerce.

United States Fire Administration (USFA). (2008). *Firefighter fatalities in the United States in 2007* (Prepared by C2 Technologies, Inc. for USFA, Contract Number EME-2003-CO-0282). Washington, DC: USFA.

United States Fire Administration (USFA)/National Fire Data Center. (2005). *Fatal fires. Topical Fire Research Series*, Volume 5, Issue 1, March 2005.

Endnotes

¹ NFPA® is a registered trademark of the National Fire Protection Association®, Quincy, Massachusetts. NFPA® 1710 defines minimum requirements relating to the organization and deployment of fire-suppression operations, emergency medical operations, and special operations to the public by substantially all career fire departments. The requirements address functions and objectives of fire department emergency-services delivery, response capabilities, and resources. The purpose of this standard is to specify the minimum criteria addressing the effectiveness and efficiency of the career fire department fire-suppression operations, emergency medical services, and special-operations delivery in protecting the citizens of the jurisdiction and the occupational safety and health of fire department employees. At the time of this experiment, the 2004 edition of NFPA® 1710 was the current edition.

² NFPA® 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*: Section 5.2.1 Fire Suppression Capability and Section 5.2.2 Staffing.

³ NFPA® 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*: Section 5.2.1 Fire Suppression Capability and Section 5.2.2 Staffing.

⁴ As defined in the *Handbook of the Society of Fire Protection Engineers*, a fast fire grows exponentially to 1 MW in 150 seconds. A medium fire grows exponentially to 1 MW in 300 seconds. A slow fire grows exponentially to 1 MW in 600 seconds. A 1 MW fire can be thought of as a typical upholstered chair burning at its peak. A large sofa might be 2 to 3 MW.

About the Authors

Jason D. Averill is the leader of and a supervisory fire protection engineer in the Engineered Fire Safety Group of the Fire Research Division (FRD) of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST).

Lori Moore-Merrell is an Assistant to the General President of the International Association of Fire Fighters (IAFF) in charge of Research and Technical Assistance for Fire and EMS Operations, Labor Issues and Collective Bargaining, Pension Resources, and IAFF Field Services.

Adam M. Barowy is a fire protection engineer in the Fire Fighting Technology Group of the Fire Research Division (FRD) of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST).

Robert Santos is the Senior Institute Methodologist at the Urban Institute and heads the Institute's Statistical Methods Group.

Richard D. Peacock is a chemical engineer in the Engineered Fire Safety Group of the Fire Research Division (FRD) of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST).

Kathy A. Notarianni is the Head of the Department of Fire Protection Engineering at Worcester Polytechnic Institute (WPI).

Doug Wissoker is an economist and Senior Research Associate in the Statistical Methodology Group at the Urban Institute.

Fourth Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address.
Edward T. Dickinson, MD, Professor of Emergency Medicine in the Perelman School of Medicine of the University of Pennsylvania.

Is There a Doctor in the (Fire) House?

Introduction

The unique and traditionally independent realms of the fire service and medicine are now forever intertwined. The interface of medicine and the modern fire service includes medical direction and oversight of emergency medical services (EMS) operations, responder education, field response, health and safety, occupational medicine, research, and a broader interaction with the civilian medical community. But what specifically can (and should) an individual physician bring to the fire service in 2012? The answer is — they should do what they do best.

Few, if any, doctors can be all things to all fire departments. This is a very important reality check for both the physician and the fire department. The fund of knowledge necessary for a single physician to effectively orchestrate all potential department needs (EMS oversight, responder education, field response, health and safety, occupational medicine, research, and as a liaison with the civilian medical community) would require both extensive formal training and extraordinary talent. It is best if all parties come to terms with this limitation at the outset of their relationship. For some physicians, this may require some judicious ego attenuation. At the end of the day, the most solid foundation of the physician/fire department relationship is built upon a clear delineation of the specific duties that an individual physician will perform for the fire department.

I count myself fortunate that my own career in emergency services actually began 33 years ago in the volunteer fire service. Indeed, it was my intense involvement in fire, rescue, and EMS during my college years that changed my career path from law to medicine. My own experiences as a firefighter, paramedic, training officer, and assistant fire chief, coupled with my love and respect for the fire service and its traditions, have unquestionably shaped my own beliefs and biases as to what physicians can offer the fire service in 2012. Similarly, my experience has humbled me to understand that even as a doctor who “grew up” in the fire service, I too have limitations as to what service I can provide to my fire departments. My personal approach is to do what I do well and what I can consistently deliver to my department members (EMS medical oversight, provider education, field response, and research), and delegate to other health professionals those responsibilities that I know they can do better than I can.

Medical Direction and EMS Oversight

The most common physician interaction with the modern fire service is the role of department medical director and the provision of medical oversight of EMS operations. A physician medical director is ultimately responsible for the depth, breadth, and quality of patient care provided by an agency’s emergency medical technicians (EMTs) and paramedics. In most cases, local or state regulations mandate that each department have a medical director. Beyond this letter of the law, it is the ethical, moral, and professional duty of an EMS medical director to assure that the patient care provided by those working under the delegated authority of his or her medical license is not only good, but **excellent**. The ultimate subjective measure of the EMS system is that you as the medical director would be comfortable with any of your department members caring for your own family members in a life-threatening medical emergency.

Although most fire departments that provide emergency medical services already have a relationship with a medical director, that relationship can almost always be made better. There are several classic pitfalls that can occur in the relationship between an EMS medical director and a fire department. It is the responsibility of the department to properly orient the EMS medical director to the unique aspects of a given fire agency as well as enlightening the doctor as to the fundamental “culture” of the fire service in general. Failure to do so runs the risk of having a medical director who lacks adequate engagement and the necessary commitment to give a fire department.

The worse-case scenario for a department EMS medical director is “Dr. Rob R. Stamp” (also known as doctor rubber stamp). Shamefully, there are both physicians and fire departments who want their relationships to be no more than the provision of signatures on necessary documents to fulfill some legal obligations. This practice must be eradicated just like the use of booster lines on car fires, because it too places lives at risk.

I am honored that I was recently asked to be involved in the development of a new and concise publication recently published by the Department of Homeland Security and the Federal Emergency Management Agency under a contract with the International Association of Fire Chiefs that should serve as an invaluable resource for both the physician EMS medical director and the hierarchy of the fire

department. The *Handbook for EMS Medical Directors* is a **must** read for all EMS medical directors in the United States. It provides a wealth of both general and specific information that will be of help to both the neophyte and experienced physician EMS medical director. The document also provides agency officers and administrators an insight into the potential benefits of an optimally engaged medical director.

Provider Education

A fire-based physician must understand that opportunities to educate department members occur not only in the classroom but also at 6:45 a.m. with a cup of coffee in your hand sitting in the station's day room discussing the last tour's interesting calls with two paramedics. Both venues are equally valuable to the physician and the department members. The classroom or didactic settings allow for the necessary uniform dissemination of information to many members at one time.

The value of the informal, spontaneous small-group setting is that it is here where some of the most effective case-based teaching occurs. It is also in this setting where the physician medical director has the opportunity to detect gaps in provider knowledge and then make sure that those gaps are not only closed with the couple of providers in the small group but are incorporated in department-wide education. The other benefit of the small informal educational interaction is that it can be a source of instant information about emerging clinical situations on the streets that may necessitate an urgent need to educate the entire membership.

Physician Field Response

Many EMS medical directors ride with their units in the field on a regular basis as part of their administrative and supervisory duties. Not all physicians are initially comfortable in the out-of-hospital environment. However, an increasing number of EMS physicians were themselves EMTs, firefighters, or paramedics before attending medical school and completing their residency training. No physician should be simply thrown into the field. For a physician to be an asset rather than a liability to a fire department in emergency field operations, he or she must be fully trained, oriented, and equipped to the function as part of the fire department within the incident command system. It has been the experience of many EMS agencies that well-trained prehospital physicians are particularly beneficial in complex, prolonged rescue situations, multiple-casualty incidents, and large-scale rehab operations.

In the next several years the fire service and all other EMS providers in the United States are going to see an increased presence of trained EMS physicians extending true medical practice into the field. In 2010, "Emergency Medical Services" was approved by the

American Board of Medical Specialists as the newest medical subspecialty. Thus, in the "house of medicine," the provision of prehospital oversight and the actual delivery of hands-on prehospital care by a physician are now recognized at the same level of medical subspecialization as an oncologist or a cardiologist. Beginning in 2013, physicians who complete either an approved EMS fellowship or who can demonstrate pre-existing, long-standing expertise and practice experience as an EMS medical director will be eligible to take the subspecialty exam in EMS that will be administered by the American Board of Emergency Medicine. This is going to be a win-win situation for both dedicated EMS physicians and fire departments and other EMS agencies that they serve as medical directors.

Research

It is the responsibility of a fire-service physician to not only foster and encourage participation in research in his or her department, but also to assure that both internal and exogenous research (especially medical research) is appropriately interpreted and integrated into the relevant practices of the department. It is not that physicians are better than others conducting research. Rather, they bring a different perspective and a critical eye to research based on constant exposure to the peer-review process of the medical literature. By their nature, academic physicians are particularly dogmatic in their evaluation and interpretation of research.

There are several truisms about research. First, research is a remarkably powerful tool with profound political, funding, logistical, and patient-care ramifications for the fire service. The second reality is that there is both good research (controlled, objective, and relevant) and bad research (sloppy, uncontrolled, biased, and irrelevant). If good research is the basis for change, then most often good and appropriate change can occur. However, if bad research is the basis for change, then beware — garbage in-garbage out.

The statement "We're going to do 'X' because that is what the research says" used to be confined to traditional medicine. Now the statement is commonly heard in the firehouse, not just in regards to medical interventions but also as it relates to advances in rescue and fire-suppression techniques. This is the age of "evidenced-based practice." The premise of evidenced-based practice is that we should base our standard operating procedures (SOPs), protocols, and guidelines upon those things that research has demonstrated is the best, most effective intervention. When evaluating the relevance of "evidence-based research," there are two quotes that must always be considered:

1. "Don't try to outsmart your common sense." (Lee Brice)
2. "Just because it has not been studied, does not always mean it's bad." (Ed Dickinson)

These two quotes are in fact linked. The first quote speaks for itself. The second may be less obvious, but here is an example and the linkage with common sense. For years it has been taught that the sequence to control extremity bleeding has been to apply direct pressure on the wound, elevate the limb, and use a tourniquet if the bleeding remains uncontrolled. Direct pressure is such common sense that it has not been challenged as the first intervention to control bleeding. Recent combat data has shown that modern tourniquets are highly effective in stopping bleeding and have a low morbidity. Thus, national bleeding-control guidelines (and certification/testing standards) now state that direct-wound pressure should be followed by a tourniquet if bleeding persists. Limb elevation (an intuitively beneficial intervention based on hydraulics and gravity) has been eliminated. Proponents state that limb elevation was eliminated because evidence-based research found it was not effective in controlling bleeding. The reality is that the effect of elevating a bleeding limb has never been studied, and this simple and time-honored intervention has simply never been shown **not** to be effective. There is a big difference between something being shown by research to be ineffective versus having no research that has proven effectiveness.

Finally, when physicians themselves embark on internal research involving their own fire department, there are two classic pitfalls to be avoided. The first is lacking the fundamental understanding of precisely what are the important questions to be studied in the fire service. The second is not being able to adapt classic medical research paradigms to the logistical and

cultural realities of the fire service. Both of these pitfalls can be readily avoided by always approaching departmental research as a collaborative effort between the physician, the department hierarchy, and the members themselves.

Essential Care and Feeding of the Fire Service Physician

The optimal integration of a physician into the fire service is not a chance occurrence. The fire department that makes a physician feel welcome, properly orients him or her to the department and the broader culture of the fire service, and strives to help him or her accomplish his or her designated duties will be rewarded with a doctor who is truly engaged and will be a true asset to the department.

About the Author

Edward T. Dickinson received his M.D. from State University New York Stony Brook in 1989 and is currently professor and director of EMS field operations for the Department of Emergency Medicine in the Perelman School of Medicine of the University of Pennsylvania. He serves as the medical director for the Malvern, Radnor, and Berwyn Fire Companies and the Haverford Township Paramedics in Pennsylvania. Dr. Dickinson is the author of *Fire Service Emergency Care* and coauthor of *Emergency Incident Rehabilitation*, both joint BRADY-IFSTA textbooks.

Dr. Granito Keynote Address Volume 7 (2013)

Fifth Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address.
Daniel Madrzykowski, Fire Protection Engineer, National Institute of Standards and Technology.
 (Mr. Madrzykowski is currently with the UL Firefighter Safety Research Institute.)

Fire Dynamics: The Science of Fire Fighting

Abstract

Fire dynamics can provide a fire officer or a firefighter with means to understand how a fire will grow and spread within a structure and how best to control that growth. Researchers have generated experimental results and computer models to explain how fire dynamics taken at the most basic level, the fire triangle, applies to the fireground. This paper will provide a brief overview of the research that demonstrates the impact that changes in fuel and construction methods have had on the fire environment. These changes have altered the model of fire behavior taught to the fire service for decades. In addition, firefighter protective equipment has also changed over the years. All these factors lead to an assessment that fire-fighting tactics may need to evolve in order to keep in balance with the changing conditions on the fireground.

These findings are the result of research conducted in conjunction with the fire service. The overarching objectives were to increase the safety and the effectiveness of firefighters. These studies were designed to focus on research results that had application on the fireground. In order for these studies to occur, it took leadership within the fire service to question the status quo. Leadership will be required in every fire department to educate the fire service as a whole and implement needed changes to the current fire-fighting practices, which have been shown to make fire conditions worse before fire control and rescue can be achieved. Leadership is needed to embrace the knowledge of fire dynamics, employ a size-up of every fire scene, and then choose the fire-fighting tactics and task assignments based on that assessment.

Introduction

In the United States (U.S.), a fire department responds to a fire every 23 seconds (National Fire Protection Association® [NFPA®], 2011). Each of these fires occurs under different conditions, hence the fire service mantra — *Every fire is different*. Yet from a science perspective, most fires share some basic similarities. The fire-heat release is due to exothermic, gas-phase, chemical reactions that produce heat and light, and they require three components to sustain the chemical reaction — fuel, oxygen, and heat. This information has been taught to fire-service personnel for many decades. Only during the past 12 years or so, fire experiments and computer models have been used to explain how the fire triangle applies to the fireground and affects the design of protective equipment and the choice of fire-fighting tactics.

This article provides a brief overview of research that demonstrates how changes in fuel and construction methods have affected the fire environment. These changes, taken separately and in combination, have altered the model of fire behavior taught to the fire service for decades. All these factors lead to an assessment that fire-fighting tactics and firefighters' protective gear must evolve to correspond with fire dynamics on the modern fireground.

Fire Dynamics

Fire dynamics is the field of study that encompasses how fires start, spread, develop, and extinguish. To characterize fire behavior meaningfully, fire dynamics must incorporate the interaction of chemistry and material science and the engineering disciplines of fluid mechanics and heat transfer. In addition, one must also consider the interactions of fire with structures, materials, and people in order to fully understand the fire dynamics of a given fire incident.

The paper "Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape province, South Africa" (Berna, 2012), which was published in April of 2012, shows that *Homo erectus* used fire productively about 1 million years ago, more than 300,000 years earlier than previously thought. Since that time, hunters, farmers, cooks, scientists, chemists, engineers, and firefighters have studied one aspect of fire or another. Each group focused on its specific area of interest in or the use of fire. For example, some studied the use of fire to form metal while others analyzed the combustion of fuel as a means to optimize the use of fuel in boilers, automobiles, aircraft, etc. For more than 100 years, National Institute of Standards and Technology (NIST), Underwriters Laboratories® (UL®), and Factory Mutual Global (FM

Global), and other organizations have studied how to protect buildings from fire by examining the fire resistance of columns and walls with furnace tests (Gross, 1991). Yet it was not until 1985 that the first textbook on fire dynamics was written (Drysdale, 1985).

In response to the 1973 report, "America Burning" (National Commission on Fire Prevention and Control, 1973), Congress passed U.S. Public Law 93-498, the "Federal Fire Prevention and Control Act of 1974." The Act called for the establishment of (1) National Fire Prevention and Control Administration (now the U.S. Fire Administration [USFA]), (2) National Academy of Fire Prevention and Control (now the National Fire Academy [NFA]), and (3) Center for Fire Research at the National Bureau of Standards (currently NIST). The Act gave NIST the mission of performing and supporting research on all aspects of fire, with the aim of "providing scientific and technical knowledge applicable to the prevention and control of fires" (Public Law 93-498, p.1546). More specifically, the Act required NIST to conduct research on "the dynamics of flame ignition, flame spread and flame extinguishment" (Public Law 93-498, p.1546). As the result of U.S.-based research programs conducted and supported by NIST in the 1970s and 1980s, as well as a significant level of fire-research activity in Canada, Japan, and the United Kingdom, a body of knowledge developed on fire chemistry, fire plumes, compartment fires, and simple models of fire phenomena. This information provided a foundation for fire-protection engineers to consider fire dynamics when designing buildings and reconstructing fires.

Changes on the Fireground

While fire researchers were making gains on understanding fire dynamics in the laboratory, the hazards on the fireground and fire dynamics that accompanied them were changing. For example, the construction techniques and materials used to build and furnish a house have changed significantly over the last 50 years.

Engineered wood products have been incorporated into the design and construction of modern structures. Engineered wood joists and trusses enable longer spans and open areas (less compartmentation) for improved use of living space in homes. Since the 1970s, the median size of a single-family home in the U.S. has increased. According to data from the U.S. Census, in 1973 the median size was 1,600 ft². By 2008, the floor area of the median house had increased by more than 50% to 2,500 ft² (U.S. Census, 2011).

In order to increase the energy efficiency of houses, insulation has improved, walls are wrapped in plastic to limit infiltration of air and water, and multi-pane windows are now the norm. When a fire occurs in an energy-efficient house, the insulation works to keep the heat and combustion products from the fire trapped in

the house and limits the amount of outside air that can be drawn inside to complete the fire triangle, provided that no doors or windows are open. As a result, fires have less oxygen. We can describe this in either of two ways: a ventilation-limited or a fuel-rich fire condition.

The objects and materials inside homes have changed as well. The design and construction of furnishings have evolved dramatically in the past 50 years. In the 1950s, a wide range of synthetic materials called *polymers* became available for use in clothing, furniture, interior finish, and insulation. Within a few years of their commercial introduction, the use of polyester, nylon, and polyurethane foam became commonplace in homes. Durability, comfort, and economics all play a role in the design and manufacturer of furnishings that people choose to buy. Today, flexible polyurethane foam is one of the most common materials in upholstered furniture. According to industry statistics, more than 1.7 billion pounds of polyurethane foam are produced and used every year in the U.S. (Polyurethane Foam Association, 2007).

These new materials, energy efficiencies, and construction methods have led to changes in the fire environment that a firefighter must face. Have fire departments added staffing, altered their training, or modified their tactics to respond to these changes?

Protective Equipment

Firefighters use protective equipment to increase their safety and effectiveness on the fireground. New materials and advances in technology offer improved protection to the firefighter from thermal hazards and toxic gases. Since the 1960s, new materials, such as aramid fibers (Nomex[®] and Kevlar[®]) and polybenzimidazole (PBI), have been introduced that do not melt and have a high resistance to ignition. These materials are now in common use as part of firefighters' protective clothing and equipment.

The evolution of the self-contained breathing apparatus (SCBA) to include lighter materials, increased air supply, electronic monitoring, and warning devices has made working in a smoke-filled building safer. Continued developments in the fields of electronics and sensing have produced improvements in situational awareness for firefighters, mainly through the use of thermal imaging. However, over the last decade, we have learned that electronic safety devices, such as Personal Alert Safety System (PASS) devices, radios, and polycarbonate SCBA facepieces are not as thermally robust as other fire-fighting personal protective equipment (PPE) components. The National Institute of Occupational Safety and Health (NIOSH) documented a series of line-of-duty deaths (LODDs) involving specific types of protective equipment. Thereafter, NIST worked with NFPA[®] and with equipment manufacturers to improve the standard test methods and requirements in order to improve the thermal resistance of the equipment and, thereby, to improve firefighter safety.

Even with these improvements, conditions in a fully developed compartment fire can still exceed the capabilities of the best protective equipment.

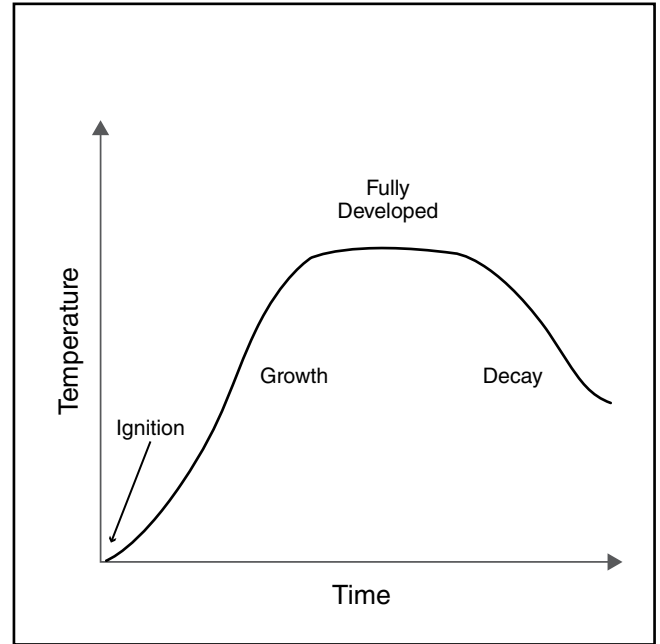
These changes on the fireground bring us to a very disturbing trend. Between the late 1970s and the late 2000s, the annual number of structure fires in the U.S. decreased by more than 50%. During the same period, the overall annual number of firefighter LODDs also declined. However, the rate of firefighter deaths due to traumatic injuries on the fireground increased during the same period from 1.8 deaths to 3.0 deaths per 100,000 fires (Fahy, 2010). This is an increase of more than 60% at a time when firefighters have access to the best equipment and technology ever available.

As I close this section about changes on the fireground, it is worth noting that during this time of change, the typical firefighter is getting less fire-fighting training, less fire-fighting experience, and less understanding of the technology that he or she relies on to keep him or her safe.

Fire Behavior

Typically, firefighters have been taught about fire behavior in structures with pen and ink drawings and a simple graph (see **Figure 1**). The idealized, qualitative graph shows that the fire begins with ignition. The fire is then in the growth phase, where the heat-release rate increases until the fire is fully developed. In a compartment fire, the transition from the growth stage to the fully developed stage may involve a flashover. *Flashover* is a transition in the development of a contained fire. In flashover, surfaces exposed to thermal radiation from fire gases in excess of 600°C (1,100°F) reach ignition temperature more or less simultaneously. Fire spreads rapidly through the compartment, with burning from floor to ceiling. Without

Figure 1: Traditional idealized fire-behavior graph showing a typical fuel-controlled fire.



an intervention, the fire transitions to the decay stage as the fuel is depleted. This ideal curve is best suited for describing a fuel-controlled fire, in other words, a fire that has all of the oxygen it needs to sustain the heat-generating chemical reaction with the fuel. In such cases, the peak heat-release rate is limited by the amount of fuel available for combustion, and the decay stage is typically related to the reduced amount of fuel available for burning. Heat-release-rate curves from free-burn sofa fires with no compartmentation effects are shown in **Figure 2**. For a typical, residential-scale room with a doorway approximately 0.9 m (3 ft) wide by 2.0 m (6.6 ft) high, the minimum heat-release rate required to flashover the room is about 2,000 kW. You

Figure 2: Heat-release rate time history from sofa “free burns.”

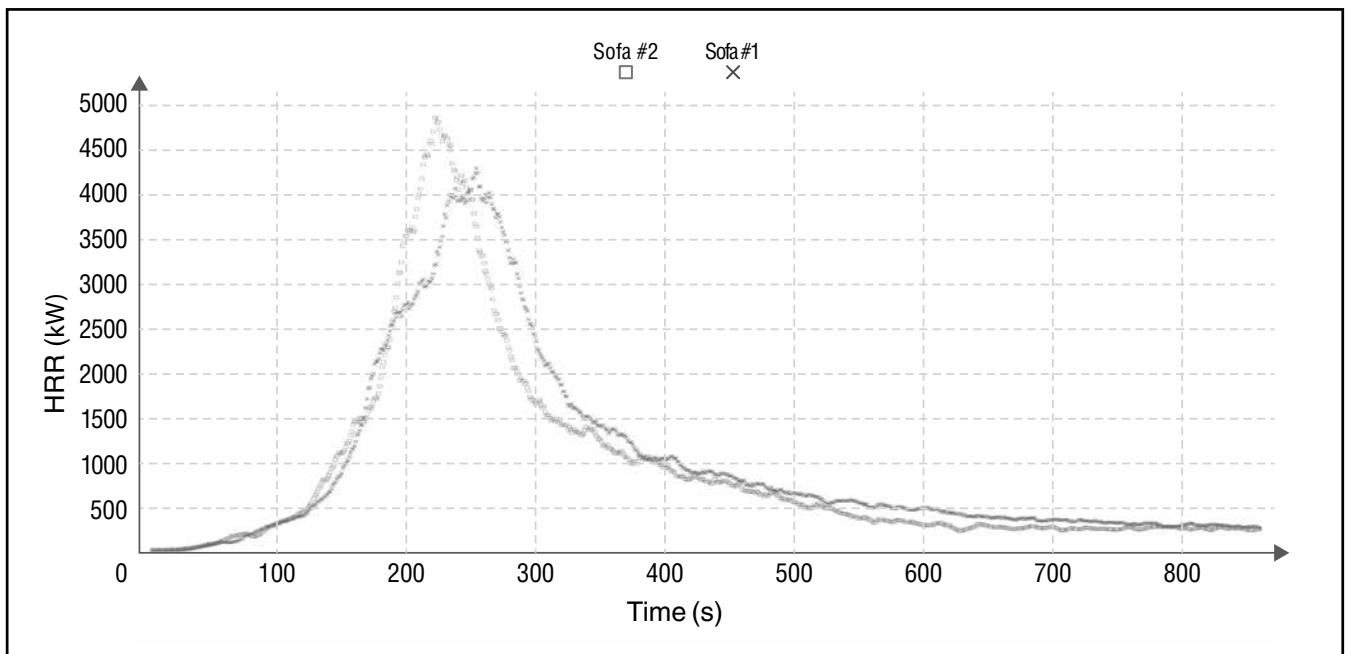
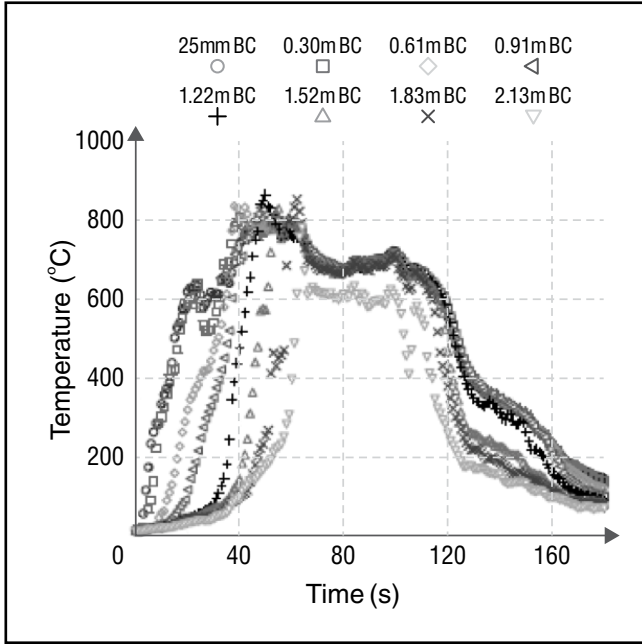


Figure 3: Temperature time-history curves from a furnished room fire with an open doorway.



can see from Figure 2 that a sofa has twice the peak heat-release rate needed to flashover the room. **Figure 3** is a graph of temperature vs. time-history curves shown from a sofa fire in a compartment with an open doorway, which allows for the continuous flow of oxygen from the outside of the compartment to the fire. Notice that in each case, the free burn and the open-room burn, the fuel-controlled pattern pertains: basic growth, fully developed, and decay.

As new homes retain heat and the gaseous fuels better than old homes and as synthetic fuels burn faster than wood and cotton, the probability of arriving to a preheated, fuel-rich fire environment has increased in recent years. As a result, fires are controlled by the amount of oxygen available to them. An idealized curve of a ventilation-controlled fire is shown in **Figure 4**. As in the fuel-controlled case, the fire begins with ignition and the growth stage. As the high-heat-of-combustion fuels burn in the nearly air-tight house, fire begins a decay stage due to limited availability of oxygen for the combustion process. As the available oxygen decreases, the heat-release rate of the fire decreases, along with the gas temperatures in the house. If a door or a window is opened while the fire is still burning, although at a reduced level, and if additional fuel is available, the introduction of outside air can result in a rapid increase in the heat-release rate of the fire and may enable enough energy generation to flashover the room. This transition has been referred to as a *ventilation-induced flashover*. Once enough oxygen has been made available to allow the fire to reach the fully developed stage, it may become fuel-controlled again until decay or until suppression by the fire department.

NIST has had the opportunity to measure this type of fire behavior many times while conducting fire experiments in acquired structures. For example, NIST had the opportunity, with the Chicago Fire Department, to burn several townhouses after equipping the structures with fire-monitoring instruments. Each townhouse was furnished with a sofa, upholstered chairs, a futon, wooden bookcases, a dinette set, kitchen cabinets, and bedroom furniture. In one case, a small flame ignited the sofa, which was on the first floor in the living room. All of the exterior doors and windows were closed. Within 120 seconds after ignition, flames from the sofa impinged on the living room ceiling, and combustion products spread to every first- and second-floor room with an open door. By 210 seconds after ignition, smoke was down to the floor throughout the open areas of the townhouse, and the fire was in a decay stage due to the reduced level of oxygen inside the townhouse. At approximately 215 seconds after ignition, the front door was opened. This action resulted in a bidirectional flow at the front door. Hot, higher-pressure fire gases were flowing out of the top of the doorway and cool, lower-pressure outside air was being entrained into the fire room through the lower portion of the doorway. Smoke near the floor in the living room cleared, and the fire began to increase in heat-release rate and in physical size. At 250 seconds after ignition, the living room window was vented by a firefighter. The window glass was completely cleared from the window frame within 20 seconds. Given the hot, fuel-rich conditions in the living room, the additional ventilation resulted in flames coming out of the window and doorway by 280 seconds after ignition. A full transition through flashover in the living room occurred within a minute of venting the living room window.

Figure 4: Idealized fire-behavior graph showing a typical ventilation-controlled fire.

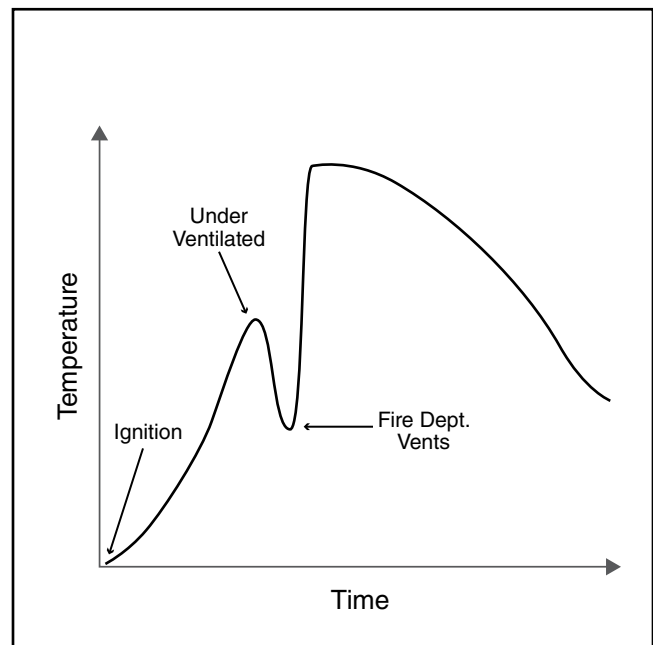


Figure 5 shows the temperature in the living room during the experiment described in the previous paragraph. Notice the shape of the temperature curves with respect to time: fire growth, followed by decay, or a decrease in heat-release rate, which is then followed by a significant and rapid increase in heat-release rate and gas temperature because of the increased availability of oxygen to the fuel-rich environment of the fire room.

Flow Path

Flow path is another concept central to fire dynamics in structures. The *flow path* is the volume between an inlet and an exhaust that allows the movement of heat and smoke from a higher-pressure area within the fire area towards lower-pressure areas accessible via doors, windows, and other openings. Depending on its configuration, a structure can have several flow paths. Operations conducted in the flow path, between where the fire is and where the fire wants to go, places firefighters at significant risk due to the increased flow of fire, heat, and smoke toward their positions. This risk is true for natural-ventilation cases with or without wind. In cases with the potential for wind to affect the heat-release rate and the movement of the fire, it is important to keep the wind at your back and to attack the fire from the upwind side.

Several LODDs have occurred where quite literally the difference between life or death depended on whether or not a glass window broke. In effect, death occurred due to a change in ventilation, while firefighters worked in a space between the fire and a lower-

pressure area where the fire wanted to go — the path of least resistance. This was the case with the three Fire Department of New York City (FDNY) firefighters who lost their lives in the Vandalia fire in Brooklyn (Madrzykowski & Kerber, 2009), the two Houston firefighters who lost their lives in a ranch house fire (Barowy & Madrzykowski, 2012), and the two San Francisco firefighters who were killed in the Diamond Heights fire (San Francisco [CA] Fire Department, 2011).

NIST conducted measurements to examine the impact of flow path and wind on fires in a mock-up apartment built in its laboratory. The fires were ignited in the bedroom of the apartment. Prior to the failure or venting of the bedroom window, which was on the upwind side of the experimental apartment, the heat-release rate from the fire was on the order of 1 megawatt (MW). Once the bedroom window was opened, the heat-release rates from post-flashover structure fires were typically between 15 MW and 20 MW. When the door from the apartment to the corridor was open, temperatures in the corridor area near the open doorway, 0.9 m (3 ft) above the floor, exceeded 600°C (1,112°F) for each of the experiments. The heat fluxes measured in the same location, during the same experiments, were in excess of 70 kW/m². Even in full protective gear, a firefighter cannot survive these extreme thermal conditions. These conditions occurred within 30 seconds of the window failure. The study also found that application of water from the exterior through the vent on the upwind side significantly cooled the fire gases and suppressed the fire (Madrzykowski & Kerber, 2009).

Figure 5: Temperature time-history curves from a furnished room fire that was initially closed and then vented to the outside by opening the front door and venting the living room window.

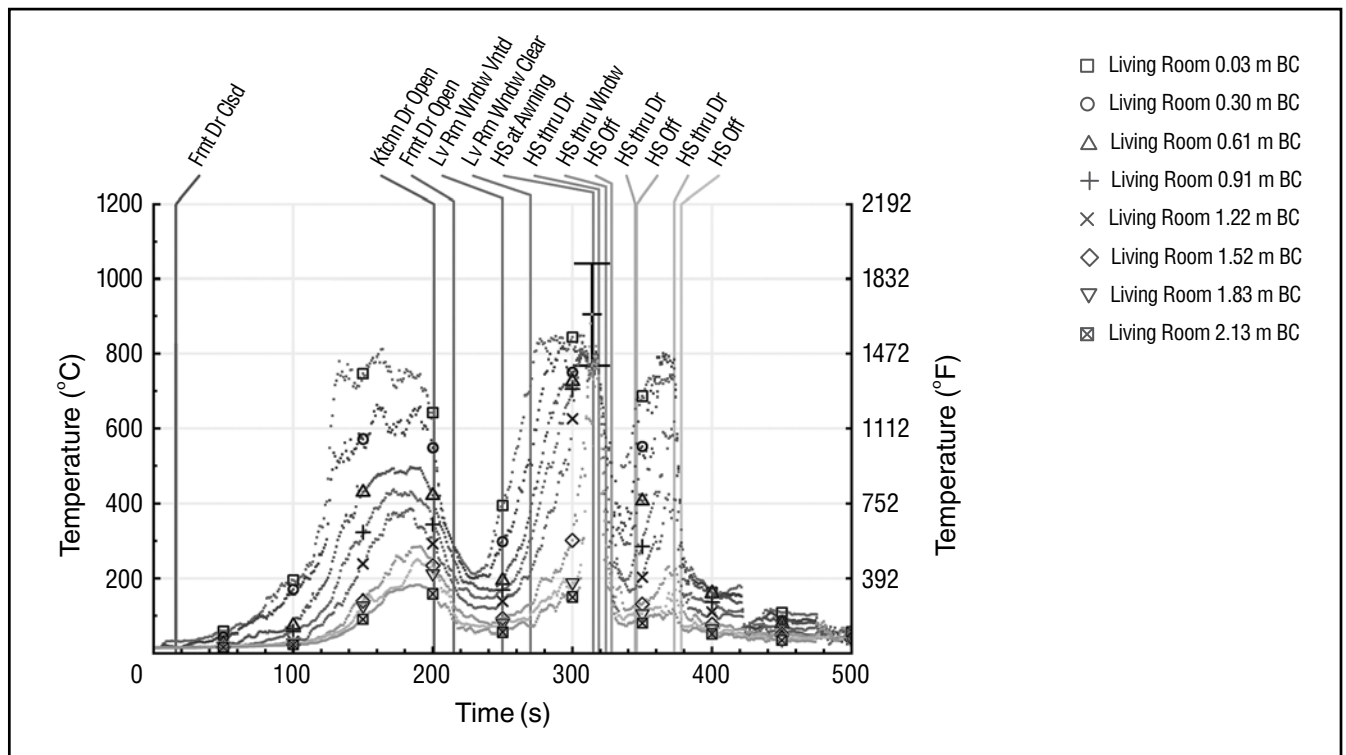
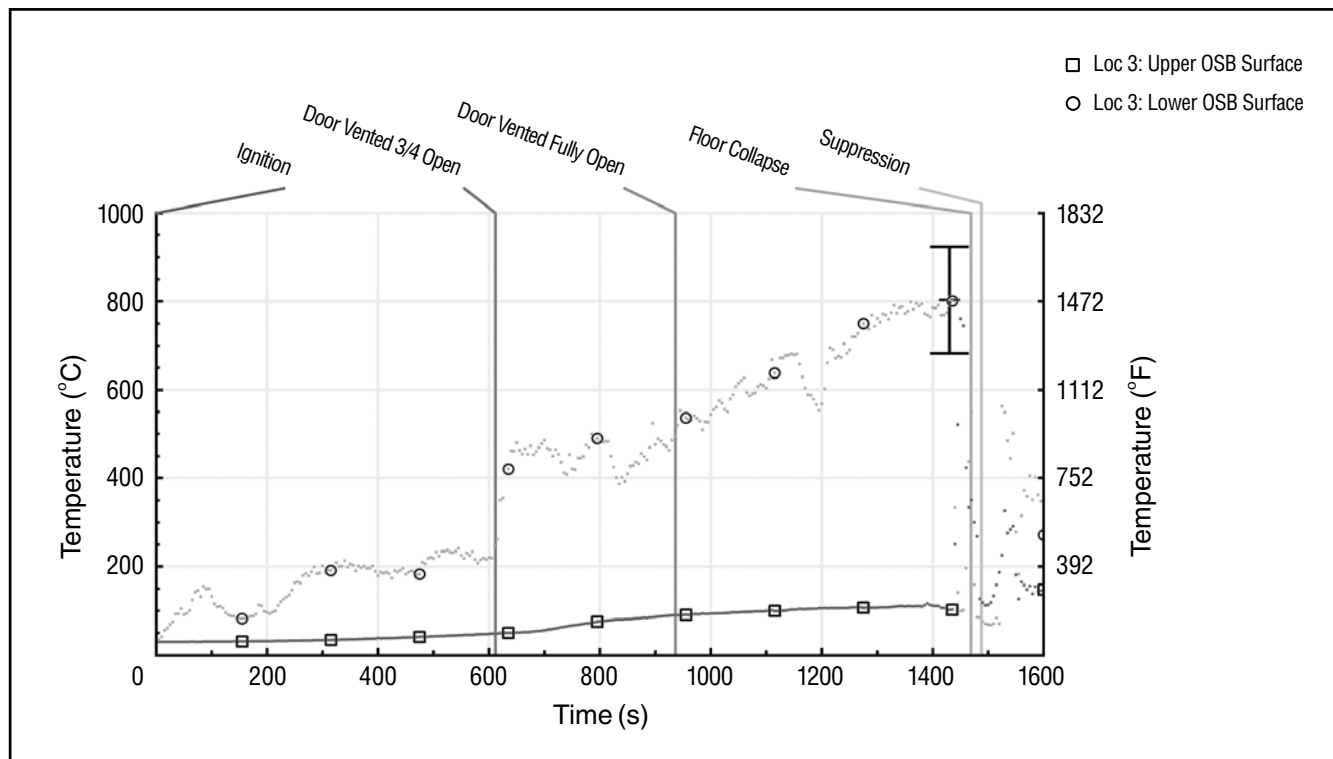


Figure 6: Temperature time-history curves comparing the temperature of the fire-compartment (lower) side of oriented strand board (OSB) subflooring and the temperature of the upper-level room side of the OSB. The measurement locations are separated only by the OSB, which is approximately 18 mm (0.75 in) thick.



Operating Above the Fire

Fire operations above a fire in a wood-framed structure with an unprotected engineered wood-floor assembly bring together several of the risk factors that we have been discussing. In a basement fire, the exposed wood-floor assembly is a sufficient and well-placed fuel load that can support rapid-fire growth and the transition through flashover if there is enough ventilation available. Due to the excellent insulation capabilities of wood-based subflooring and floor coverings, even firefighters with thermal imagers might be unaware that a post-flashover fire burns below them and that the structural integrity of the floor on which they are standing is compromised until they fall through it. The thermal imager can only sense increased temperature due to heat flow through the floor and floor coverings. During basement fire experiments, NIST has measured temperatures in excess of 800°C (1,400°F) on the lower (fire side) of the floor assembly while the temperature on the upper side of the flooring was 100°C (200°F) or less just prior to the collapse of the floor as shown in **Figure 6** (Madrzykowski & Kent, 2011).

In basement fires, current practice calls for firefighters to fight their way down the stairs to suppress the fire. If the firefighters survive crawling on a floor assembly that may be burning underneath them, they will find the stairway and place themselves in the flow path between the fire in the basement (high temperature/high pressure area) and the open front door (exhaust vent to lower temperature/lower pressure area) through which they entered the house. In other words, the fire-

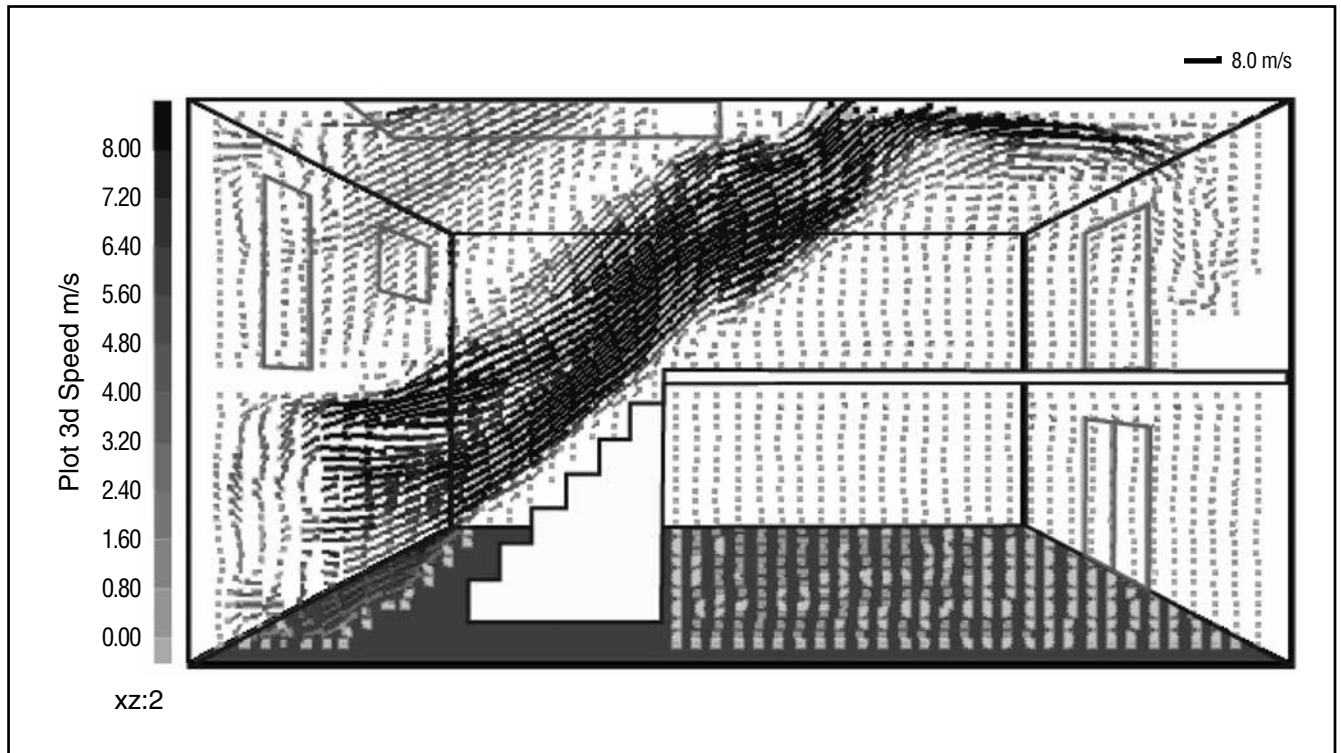
fighters are trying to work their way down the chimney of a burning fireplace. This is a high-hazard location with the potential for high convective heat transfer. This scenario is similar to the one that claimed two firefighters' lives in the Cherry Road fire in Washington, DC (Madrzykowski & Vettori, 1999). The flow path from the post-flashover fire in the basement up the stairs is shown in **Figure 7**.

What approach works with this difficult fire scenario? Is it water applied from the exterior through a basement window or door? This exterior offensive tactic is known by many names: *early water*, *blitz attack*, *resetting the fire*, *softening the target*, and *hitting it hard from the yard*, to name a few. In basement-fire experiments NIST conducted with FDNY and UL®, flowing a hose stream into a basement window for 60 seconds reduced the temperatures from 900°C (1,700°F) to 150°C (300°F) in the basement. The temperatures at the top of the stairs leading to the basement decreased from 300°C (600°F) to 100°C (200°F). In addition, the temperatures throughout the rest of the townhouse also decreased due to the exterior hose-stream application. Applying water through the window did not push or spread the fire, and no excess steam was forced throughout the structure. Applying water through the window into the fire area quickly mitigated the hazard. **Figure 8** shows this example in graphic form.

Research Summary

Many of the fire-dynamic applications on the fireground presented earlier were intuitive. Some were not.

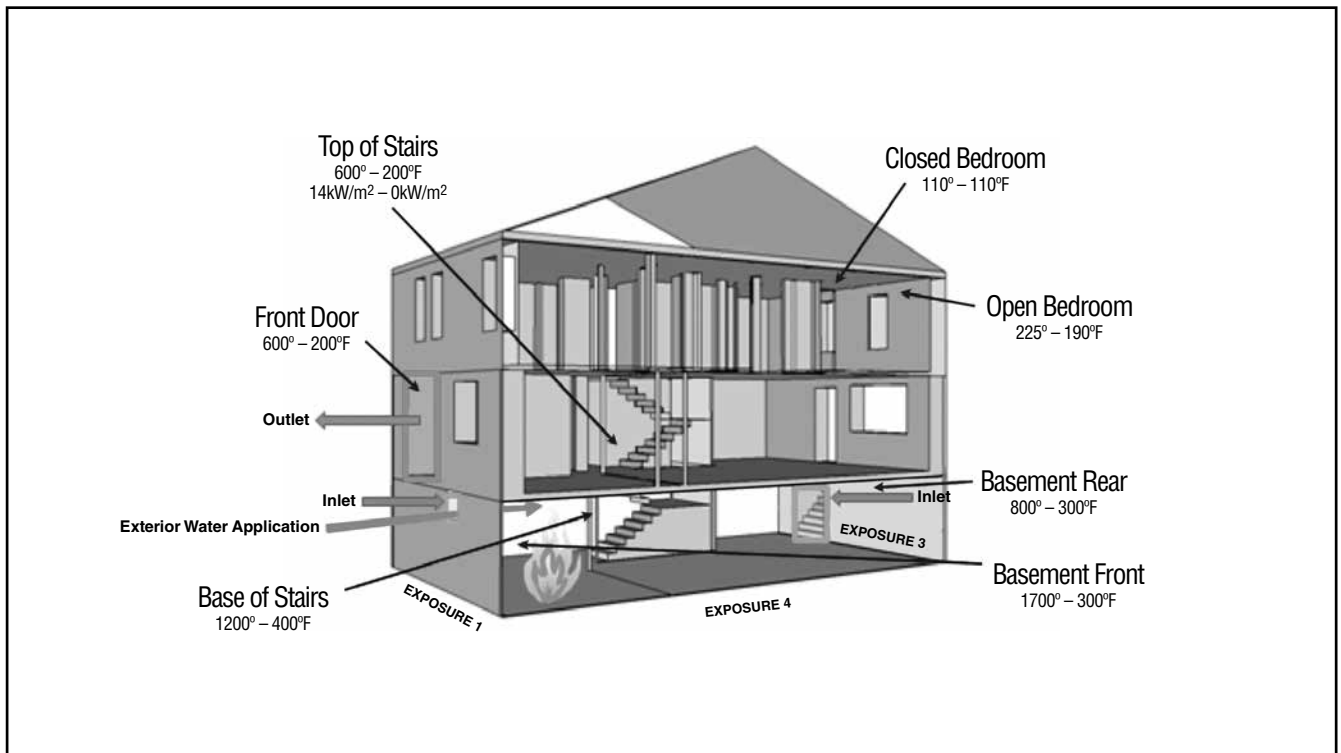
Figure 7: The flow path of high-momentum fire gases going up the stairs can be seen in this NIST Fire Dynamics Simulator model of the Cherry Road fire. The firefighter victims were all working in the room at the top of the stairs.



While many in the fire service recognized some of the increased hazards in residential fires individually, few understood the synergy between the synthetic-fuel loads, reduced compartmentation, and the lightweight and energy-efficient construction. Fire-test results have shown that the synthetic-fuel fire is more reactive to the introduction of oxygen than are fires fueled by wood

and cotton. For the fire service, this fact means that synthetic-fuel fires are less forgiving in terms of how quickly conditions on the fireground can change. The thermal conditions generated by a fire can exceed the material limitations of firefighters' personal protective equipment (PPE) by more than 500°C (1,000°F). Of course, human thermal limitations are significantly

Figure 8: The impact of flowing a hose stream into a basement fire through the basement window at 180 gpm for 60 seconds.



lower than that. To escape harm, firefighters must understand the capabilities and the limitations of their PPE.

Given the firefighter fatality and injury rates and the challenges faced, fire-department leaders need to consider revising their tactics to improve firefighter safety and effectiveness. Controlling the oxygen leg of the fire triangle through door and flow-path control and controlling the heat side of the fire triangle through early suppression from the exterior must be considered, even if these tactics go against current practice.

Firefighters at all levels need to be armed with improved knowledge about fire dynamics, their workplaces, and the equipment that they use to protect themselves. For example, smoke is fuel, venting does not always equal cooling, and most structure fires are ventilation-limited (fuel-rich) and therefore very reactive to additional oxygen.

Fire officers need to locate and assess the fire and then consider all available tactics before directing their crews, using the safest and most effective tactics possible. This option is good not only for the firefighters but also for victims trapped in the building. What are some of these tactical options? Keep the wind at your back, and stay upwind of the fire. Identify and control potential flow paths by managing ventilation (i.e., open doors and windows). An exterior direct attack on the fire from the burned side may be the best option. Use all available options to prevent firefighters from working above a fire with an unrated floor assembly.

Leadership and Implementing Change

Now that research has elevated our understanding of fire dynamics within structures, fire-service leaders must use the data to develop educational and training tools and to share information across the ranks and generations of firefighters. Standard operating procedures (SOPs) must be revised to incorporate our new understanding. All of the elements of training, certification, and practice must be coordinated to make the most effective use of the knowledge.

As a result of the assistance of the U.S. Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA) to firefighter research and development grants, more high-quality research is being conducted with the fire service than at any other time in history. The research yields not only reports and numerical data but also experiment videos useful for educating the fire service. Producers of training materials such as the International Fire Service Training Association (IFSTA) are incorporating the research results in its manuals and online training apps.

Fire-service leaders must embrace research-based tactics in order to motivate their instructors and get buy-in from their staffs. Annual training needs to be conducted and SOPs need to be revised so that all members of the fire department, not just the new candidates, are aware of flow-path hazards and the new

technology capabilities. It will also be important to work with mutual-aid fire departments to ensure that they understand that you have added new tools and options to your department's playbook.

Implementation

Being a leader in changing the status quo requires knowledge, fortitude, and diplomacy. It will require hard choices in times of lean resources to dedicate effort to revising SOPs and to developing and providing additional training for your seasoned firefighters. Change is best accepted in a supportive environment when leadership is leading by example.

A great example of implementing change is available from the largest fire department in the U.S.: FDNY. FDNY had a history of injuries and deaths in wind-impacted fires in high-rise buildings. They embraced researchers and representatives from fire departments across the country and around the world to understand the problem and possible solutions. They supported real-scale fire experiments in a high-rise building as a means to find a better way of fighting a high-rise fire (Madrzykowski & Kerber, 2009; Kerber & Madrzykowski, 2009).

Once the findings from the NIST laboratory and high-rise studies were presented to them, the leadership in FDNY moved swiftly to implement changes to improve the safety of their firefighters. They started a pilot program in two areas of the city. The firehouses in these areas received additional training and new equipment such as positive-pressure ventilation fans, wind-control devices, and high-rise nozzles. A DVD-based training program was developed on the hazards of wind-impacted fires and the use of flow-path control, positive-pressure fans, and exterior hose streams. That program was distributed across the department. For annual training day, a program was developed in which firefighters conducted hands-on training evolutions with the new equipment and learned about the fire dynamics behind the new tactics. Then FDNY installed the *Diamondplate* system, computer kiosks in all firehouses that allow the department to push training materials on a weekly basis to the firefighters. FDNY partnered with Polytechnic Institute of New York University (NYU-Poly) to develop an interactive computer-based training program, ALIVE, on wind-driven fires based on the FDNY materials and the NIST reports (NYU-Poly Fire Research Group, 2008). Within 18 months after the completion of the experiments on Governors Island, NY, FDNY firefighters were using the new tools and tactics and saving their own.

FDNY then reexamined their ventilation practices on non-wind-impacted fires, based on what was learned about the modern fire environment and flow paths from the wind-driven study and additional research conducted with NIST and UL®. As a result, a new ventilation bulletin has been issued by the department that is based on and incorporates the science of fire fighting (FDNY, 2013).

Summary

These findings are the result of research that has been conducted in conjunction with the fire service. The overarching objective of all of the studies was to increase the safety and the effectiveness of firefighters. These studies were designed to focus on research results that had application on the fireground. In order for these studies to occur, it took leadership within the fire service to question the status quo. It took leadership to engage the researchers and ask the hard questions. Now that researchers and members of the fire service have a better understanding of the fire dynamics of a structure fire, that information must be shared. Now that the reports, data, videos, and training materials are available, that information must be taught. Leadership will be required in every fire department to educate the fire service as a whole and to implement needed changes to current fire-fighting practices that make fire conditions worse before fire control and rescue can be achieved. Now is the time to embrace the knowledge of fire dynamics based on chemistry and physics, employ a size-up of every fire scene, and then choose the fire-fighting tactics and task assignments based on that assessment.

References

- Barowy, A., & Madrzykowski, D. (2012). *Simulation of the dynamics of a wind-driven fire in a ranch-style house — Texas* (Technical Note No. 1729). Gaithersburg, MD: National Institute of Standards and Technology (NIST).
- Berna, F. (2012). Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape province, South Africa. *Proceedings of the National Academy of Sciences of the United States of America*.
- Drysdale, D. (1985). *An introduction to fire dynamics*. West Sussex, England: John Wiley & Sons Ltd.
- Fahy, R. F. (2010). *U.S. fire service fatalities on structure fires 1977–2009*. Quincy, MA: National Fire Protection Association® (NFPA®).
- Federal Fire Prevention and Control Act of 1974, Public Law 93-498. U.S. Statutes at Large 88 Stat. (1974).
- Fire Department of New York City (FDNY). (2013). Chapter 16a. *Probationary firefighters manual*. Retrieved from http://www.nyc.gov/html/fdny/html/units/training/pdf/proby_manual/16a_ventilation.pdf
- Gross, D. (1991, July). *Fire research at NBS: The first 75 years*. Third International Symposium, conducted at the meeting of the International Association for Fire Safety Science, Fire Safety Science Proceedings. Edinburgh, Scotland.
- Kerber, S., & Madrzykowski, D. (2009). *Fire fighting tactics under wind driven conditions: 7-story building experiments* (Technical Note No. 1629). Gaithersburg, MD: National Institute of Standards and Technology (NIST).
- Madrzykowski, D., & Kent, J. L. (2011). *Examination of the thermal conditions of a wood floor assembly above a compartment fire* (Technical Report No. NIST TN-1709). Gaithersburg, MD: National Institute of Standards and Technology (NIST).
- Madrzykowski, D., & Kerber, S. (2009). *Fire fighting tactics under wind driven conditions: Laboratory experiments* (Technical Note No. 1618). Gaithersburg, MD: National Institute of Standards and Technology (NIST).
- Madrzykowski, D., & Vettori, R. (1999). *Simulation of the dynamics of the fire at 3146 Cherry Road NE, Washington D.C.* (Interagency/Internal Report No. 6510). Gaithersburg, MD: National Institute of Standards and Technology (NIST).
- National Commission on Fire Prevention and Control. (1973). *America Burning* (Report).
- National Fire Protection Association® (NFPA®). (2011). *The U.S. fire problem*. Retrieved from <http://www.nfpa.org/research/fire-statistics/the-us-fire-problem>
- NYU-Poly Fire Research Group. (2008). *Wind-driven high-rise fires*. Retrieved from <http://www.poly.edu/admissions/fire/alive/alive8a.html>
- Polyurethane Foam Association. (2007). *Flexible polyurethane foam: Industry at a glance*. Retrieved from www.pfa.org
- San Francisco (CA) Fire Department. (2011). *Safety investigation report line of duty deaths, 133 Berkeley Way*. Retrieved from <http://sf-fire.org/modules/showdocument.aspx?documentid=2648>
- U.S. Census. (2011). *Median and average square feet of floor area in new single-family houses completed by location*. Retrieved from <http://www.census.gov/const/C25Ann/sfttotalmedavgsgft.pdf>

About the Author

Daniel Madrzykowski, PE, FSFPE is a fire protection engineer and the leader of the Fire Fighting Technology Group of the Fire Research Division in the Engineering Laboratory at the National Institute of Standards and Technology (NIST). Dan's research studies focus on improving firefighter safety. Dan has also conducted fire investigation related studies in a wide range of areas including firefighter line-of-duty deaths (LODDs). Because of Dan's research with the Fire Department of New York City (FDNY), FDNY awarded him with the rank of Honorary Battalion Chief.

Sixth Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address.
Dr. Anne Eyre, Trauma Training Consultant, Coventry, United Kingdom (UK).

The Making of a Hero: An Exploration of Heroism in Disasters and Implications for the Emergency Services

Abstract

This paper explores the phenomenon of heroism in the context of behavioural responses to disaster. Drawing on social scientific, media, and health and safety sources, it reflects on the impact and consequences of being labelled a hero. Consideration is given to the implications of heroism for the emergency services arising from recent cultural and legal developments within the United Kingdom (UK). The paper calls for a more informed understanding and debate about the meaning and implications of heroism in disasters.

Introduction

“Show me a hero and I’ll write you a tragedy.”

(F. Scott Fitzgerald Quote)

References to heroes and heroic acts in disasters are common, particularly when it comes to mass fatality incidents. Accounts and analyses of heroic acts appear in sources as wide ranging as the news media and popular culture through to academic papers and health and safety guidance literature (see References section and Appendix). However, although these various sources may be using the same term, are they all talking about the same kinds of behaviour and attributes/qualities?

This article begins by examining the psychological and social context of major emergencies as potentially traumatic events and the significance of these for understanding disaster-related actions and behaviour. In some cases reactions to disasters may be as much about spontaneous, instinctive human responses as they are about the measured implementation of preprepared emergency procedures. It is important to acknowledge this reaction if we are to understand, anticipate, and interpret extraordinary and heroic acts where people risk their own lives in responding to the needs of others.

The newsworthiness and other social and political agendas served by the discourse of disaster heroes will be briefly referred to along with the wider consequences of being labelled a *hero*. For a member of the public who becomes the victim-cum-hero, finding oneself unwittingly caught up in a life-threatening event can be life-changing enough, but in the aftermath there may be additional costs associated with identifications of heroism such as additional survivor guilt.

Members of the emergency services may be described as everyday (albeit often reluctant) heroes to the extent that they deliberately enter environments of risk as part of their ordinary duties, but their actions in the context of major emergencies may attract additional attention and analysis in the following days and weeks. The article considers the renewed focus on risk, health, and safety within emergency response prompted by a series of major incidents and investigations within the United Kingdom (UK) and the consequences these have had for revisiting the interpretation and guidance around acts considered heroic within the law, custom, and practice.

Understanding Disaster Experiences and Heroism

Exceptional events often generate exceptional individual and social reactions. To understand disaster-related behaviour, it is important to appreciate how such circumstances can impact on the perceptions, experiences, and social responses of those involved in them and what this means for questions of heroism. Focussing on disasters as psychological and social experiences gives some insight into understanding when behaviour is truly heroic and its implications.

Major emergencies or disasters are, thankfully, relatively abnormal events rather than everyday occurrences within communities.¹ Psychologists and sociologists highlight how behavioural responses reflect the ways in which they differ from normal, everyday experiences and routine emergency response. Major emergencies are, to a lesser or greater extent,

- of a different order in terms of emergency procedures and scale of response. The declaration of an event as a major incident or disaster usually triggers a specific set of procedural responses, namely the implementation of *special arrangements* such

as major incident plans. Actions described as heroic tend to fall outside of or beyond prescribed emergency procedures; they are usually spontaneous and unplanned, may be often committed by ordinary bystanders who are not following formal emergency procedures, or they may be committed by emergency responders breaking with or exceeding formal protocols.

- often described as *surreal* and quite different in feel from scenes displayed in disaster films or other imaginary scenarios. Many emergency responders reflecting on their first-hand experience of real disaster have emphasised the contrast with drills or exercises and the impact of such experiences on them both during the event and afterwards. Typical of this is the comment made by a firefighter who responded to the Ladbroke Grove train crash in London, 1999, in which 31 people were killed. Commenting on the initial reactions of shock while gathering up the personal belongings of those who had so suddenly died, the firefighter commented on the feeling of being unprepared for such an encounter: “In training, you are shown photos of other major incidents so you are prepared in that way, but nothing in my training prepared me for it when I saw it in real life” (BBC News, 1999).
- experienced as chaotic by those caught up in them and first on scene, at least in the initial phases at the point where sense is being made of what is occurring and before a coordinated emergency response kicks in. Initial emergency calls during the London Bombings, July 7, 2005, typified this reality with first responders facing “considerable difficulties in assimilating information that is coming in as clearly a very confused incident presented itself” (Hugo Keith, Queen’s Counsel [QC], speaking at the Inquest, October 11, 2010; Her Majesty’s [HM] Coroner, 2010). In such circumstances, heroic acts may be associated with their bringing leadership or order to bear or restoring control in the midst of chaos and destruction. The individuals who formed a *human bridge* to lead fellow passengers to safety in the midst of ferry disasters have been described as heroes in this sense (TNT Magazine, 2012; Kent Online, 2012).
- prolonged events, where notions of heroism are associated with notions of endurance as well as spectacular single acts (Smith, 2011). The *Fukushima 50* in Japan have been described in heroic terms. Heroism here has been linked to their continuing work to restore control over the ongoing threats and hazards caused by the nuclear disaster in Japan in March, 2011, as well as their initial, self-sacrificing responses at the nuclear plant as the disaster unfolded (Yokota & Yamada, 2012).
- potentially traumatic, insofar as those directly exposed to them have experienced, witnessed, or been confronted with an event or events that involve actual or threatened death or serious injury, or a threat to the physical integrity of oneself or others (American Psychiatric Association, 2013). Heroes may be those who take the *fight* rather than the *flight* option in disasters, rushing in to save others at the expense of themselves. As well as generating physical and psychological reactions during immediate impact, the traumatic nature of such events continues to generate psycho-social effects in the following days and weeks. For those whose natural instinct in disaster was to save themselves rather than others, survivor guilt may be compounded by the lavish praise being bestowed on the selflessness of heroes.
- large-scale community events with likely ripple effects and impacts. The community effects of disaster are described by the sociologist Kai Erikson (1976) in the aftermath of the Buffalo Creek flooding disaster in 1972. His classic ethnographic account gives a powerful description of the effects of collective trauma, which he describes as a blow to the basic tissues of social life that damages the bonds attaching people together and impairs the prevailing sense of communality.
 - Rob Gordon (2009) has analysed further the social processes and dynamics that transpire within a community when a disaster strikes. He describes how emerging distinctions and differences between individuals can cause cleavage planes, severing the fabric of social support systems, and causing tension and conflict during recovery stages.
 - Singling out and rewarding some individuals as heroic may create or reinforce unhelpful or unintended hierarchies of worthiness exacerbating group or community tensions, for example, where some individual acts or actors are formally commended with awards while others are not.
- public and political events in which every detail, decision, and action by those involved as victims, survivors, witnesses, and responders as well as the reactions of those mourning and bereaved may be observed, scrutinised, and evaluated. Legal accountability for actions in disasters, both individual and corporate, may be examined through lengthy processes and procedures such as inquests, public inquiries, and health and safety investigations. Far from praising the risk-taking behaviour and morality of heroes, legal judgements and disciplinary procedures may take a rather more negative view of such actions.

Disaster Behaviour: Bringing Out the Best in People

Social scientists have spent decades reviewing human reactions and responses to disasters as part of their studies of individual and collective behaviour. Their contribution is a reminder of the importance of ensuring the needs of people are at the heart of emergency planning, response, and recovery strategies. Working with emergency managers, they seek to make sure emergency plans and procedures are appropriate and successful by being based on experience and evidence about how people typically behave and respond in the impact and aftermath phases of disaster. Furthermore, their work plays an important role in demystifying and debunking the erroneous myths and beliefs often perpetuated by media and other, often partial, reports of disaster behaviour.

Examples of disaster myths include the notions that disasters produce wide-scale, counterproductive, and antisocial behaviour such as panic, social disorganisation, and looting. This is not to say that such phenomena do not exist, but rather that reports about their prevalence often tend to be exaggerated by the media. In fact, evidence from across different kinds of disaster and societies suggests that on the whole endangered publics and disaster victims respond and adapt well during and after disasters (Tierney, Bevc, & Kuligowski, 2006).

Contrary to the classic notion of the *disaster syndrome* — a zombie-like condition that renders disaster victims hapless and helpless (Quarantelli & Dynes, 1970) — social scientific research has also highlighted that, at least in the immediate aftermath of disasters, community resilience and unity, strengthening of social ties, self-help, heightened initiative, altruism, and pro-social behaviour more often prevail (Auf der Heide, 2004). An example of pro-social, positive responses to disaster was the way in which the people of Oklahoma reacted in the aftermath of the bombing of the Murrah Building on April 19, 1995. Behaviour later described as “selfless acts of heroism” (Coats, 2011) included local citizens and members of the emergency services running towards the disaster scene to rescue survivors immediately after the bombing rather than away from the building. This behaviour and other examples led to the term *The Oklahoma Standard* being coined to define a new level of caring during and after disasters:

When a need for blood was broadcast, it had to be followed by an advisory to stay home, because more people lined up than were needed. When an announcement was made that work boots were needed at the site, workers pulled up and took off their boots and left them. First responders from out of town found that they could not go to a restaurant and pay for their own meals. Either the restaurant owner would

refuse their money or another diner had already covered the ticket. The legend of the “Oklahoma Dollar” is based upon a first responder commenting that he was leaving Oklahoma with the same dollar he had when he arrived because, during his entire stay in Oklahoma, he had been unable to spend that dollar (Oklahoma City National Memorial and Museum, 2014).

The behaviour exhibited during and after this incident was not unusual for large-scale, mass-fatality incidents. Reinforcing the themes of Erikson and Gordon given earlier, Zunin and Myers (2000) refer to a *honeymoon* phase reflecting a common aspect of community responses in disaster. They describe this as following on from a rescue or heroic phase where people may risk their own safety to save others, including strangers.

Heroism, Self-Sacrifice, and Disasters

The association between life-saving actions and heroism dates back as far as Greek mythology where heroes (and heroines) were depicted as courageous characters displaying the will for self-sacrifice for some greater good of all humanity. They were often venerated as demigods and although today’s heroes may not quite be worshipped in the traditional sense, the cult of the hero personality may seem close to adulation at times. Today heroism remains associated with moral excellence and positive qualities such as nobility, bravery, and fortitude (McLeish, 1993).

Although the popular meaning and application of notions of heroism to disaster-related behaviour has been somewhat stretched in contemporary popular culture,² it still tends to be associated with positive moral qualities, meritorious life-saving endeavours, and exceptional acts of self-sacrifice. Examples where heroes have been identified by the media and praised for their actions include the extreme risk-taking as part of initial rescue efforts in responses to terrorist incidents in Oklahoma City, 1995; New York City, 2001; London, 2005; Glasgow, 2007; and Boston, 2013.

The hero label is commonly applied by journalists and members of the public as part of telling the story and a simplistic media discourse about good (heroes) and bad (blameworthy) people in the aftermath of disasters. It is interesting to see how the media return to familiar themes and phrases in telling stories from one disaster to another. The notion of a *human bridge*, for example, used to describe a British man helping fellow passengers to safety during the sinking of the Costa Concordia in 2012 was the same description applied to another British hero during the sinking of a ferry off Zeebrugge in 1987 (United Press International, 1987; M. Fricker, 2102; BBC News, 1987; and Kent Online, 2012).

Beyond the media, academic reviews also include references and analyses of the heroic actions of individuals associated with disasters, rescue, and

response (e.g., Lois, 1999). Levinson (2002) questions the appropriateness of these reviews. Analysing Israeli news media coverage of bombing incidents over two consecutive days in Jerusalem and Haifa in 2001, he critiques the accuracy of initial accounts, including dramatic reports of heroism that formed a key element of the coverage. Drawing on the work of others, Bennett and Daniel (2002) reflect on how accounts of heroism are part of what makes disaster stories *newsworthy*:

The selection of obtrusive incidents for reporting by newspapers depends critically on editorial perceptions of what kinds of event appeal to the public imagination. Stories about disasters have much to offer in this respect, as they can be dramatic, emotive and awe inspiring. Also they furnish numerous opportunities for reporting personal dramas and heroic rescues . . . for indulging the public's apparent fascination with horrific events . . . and for satiating the apparent wish of many people to experience vicariously the suffering and tragedy of others (p. 34)

The Disaster Hero: A Good News Angle on a Bad News Story

As well as raising the important question of whether accounts of heroism in disasters are accurate, such commentary helps explain why references to heroism may be so prolific in disaster reporting. Accounts of heroism are eminently *newsworthy*, satisfying the thirst for a good news angle on a bad news story. Not only this, disaster heroism is *newsworthy* in the classic sense because it involves unexpected and dramatic events and includes a human-interest perspective with which the audience may be able to personally connect and find meaning (Galtung & Ruge, 1965).

The *newsworthiness* of the disaster hero may even contribute to circumstances where the hero becomes the story in itself, well beyond reports of emergency rescue or response that initially impelled an individual or individuals into the limelight. A cult of personality may arise, established and propagated by the mass media and social media, whereby a hero's identity and actions take on a dynamic life and significance of their own, potentially in place of truth, accuracy, or proportionality.

An example of this is John Smeaton, a baggage handler at Glasgow International Airport, who was involved in helping to thwart a terrorist attack there in 2007. When terrorists drove a burning jeep filled with explosives into the airport entrance, Smeaton helped to wrestle one of the attackers to the ground. He was subsequently hailed a hero for having stood up to the terrorists and received a string of awards and positive affirmations. A John Smeaton Appreciation Society was set up on Facebook hailing him a *hero for our time*, and a tribute website received 500,000 hits in its first 48 hours. Smeaton gave television interviews

that were broadcast worldwide, and over the following months he was invited to meet a number of senior political figures including the Prime Minister and the New York City Mayor Michael R. Bloomberg. His awards included the CNN Everyday Superhero Award, a Daily Mirror Pride of Britain Award, and a Queen's Gallantry Medal.

A year later reports began to circulate in the national press that Smeaton's involvement in the incident had been exaggerated and that others who had done more to restrain the attackers had not been recognised with awards such as the Queen's Gallantry Medal. Smeaton was branded a fake and found himself on the receiving end of negative media attention. Interviewed five years after the incident, he described the impact of being assigned a hero label:

It was absolutely crazy. I just did what I thought I had to do . . . I went to help the police officer. Before I knew it, I am thrust into the limelight. I had everybody chasing after me. To be honest, I didn't know what way to turn, what to do It was very difficult. I am a normal guy, and all of a sudden I am on the front page of newspapers, on international news programmes. You don't know which way to turn. It was unbelievable. (BBC News, 2008)

Heroism as Resistance to Terrorism

A symbolic aspect of Smeaton's *heroism* was the sense that his actions not only thwarted a violent act but spoke for the wider public, nationally and internationally, in resisting the fear and threat generated by terrorism. In a television news interview days after the incident, watched by millions around the world, a journalist asked him what message he would give to any future terrorist who tried to launch an attack. Smeaton replied:

They can try and come to Britain, and they'll try and disrupt us any way they want, but the British people have been under a lot worse things than this and we always stand proud and (if) you come to Glasgow, Glasgow doesn't accept this, do you know what I mean, this is Glasgow, you know, so we'll set about you. (STV Glasgow, 2007)

In this setting, heroism represented resilience and defiance against the threat and vulnerability caused by international terrorism. Perhaps faith in the power of heroes in the face of violent and traumatic scenes affirms the social belief that goodness and goodwill will prevail over threats to safety and social harmony. The need to identify people as heroes may be an unconscious response to the sense of collective threat posed by the terrorists and a need to affirm the belief that most people are good, rather than bad, in a world that really is a safe place most of the time.

While at its roots there have been political connotations attached to legends of heroism and personality cults, equating heroic spontaneous reactions with political resistance to terrorism may be confusing. Similarly in defining heroism, there is an important distinction to be made between suffering injury during disaster and taking explicit actions to save the lives of others as an incident unfolds. It becomes problematic if survival *per se* becomes a reason to call someone a hero.

In the days after the Boston bombings, 2013, some media reports applied the *hero* label more generally to people present at the scene as victims, bystanders, and responders. The term seemed to be liberally used to distinguish between non-perpetrators and those who perpetrated the deliberate act of violence. The inference here was that *heroism* is associated with innocence and with resistance to evil and the terrorists' intention.

One seriously injured survivor, Jeff Bauman, attracted extensive media attention for his heroism that has been associated both with surviving and with trying to help the authorities identify the perpetrators by giving them a description:

We're just so proud of him, said his boss Kevin Horst. We do consider him a hero, both for what he did for law enforcement, whatever role he played in that, but more importantly, he's a hero for how he's handling this time. He's got such a great attitude. (WCVB, 2013)

The local news media reported how the Boston bombing hero was receiving dozens of letters each day from people moved by his story. His colleagues created *Team Bauman* T-shirts, and one news report stated that he had received more than \$600,000 in donations for his medical bills over the previous week (Peterson, 2013).

Everyone's a Hero, But Some are More Heroic Than Others

In the immediate aftermath of the Boston bombings, much media focus was on identifying and detaining the perpetrators, and so it is understandable that efforts to assist the authorities were greatly appreciated within the wider community. Loosely aligning notions of heroism to crime reporting in these circumstances, however, is unhelpful because, again, it blurs distinctions in this case between acts of genuine self-sacrifice and civic duty. Furthermore, it makes the decision to formally recognise truly heroic behaviour more difficult since everyone involved may potentially be identified as a hero.

Alternatively, calling everyone caught up in or responding to disaster a hero may be an attractive prospect for some people since it prevents differentiation and the idea of some heroes being singled out by the media as being more heroic than others. John Smeaton, for example, later acknowledged that others

too had acted bravely during the Glasgow attack, not just him, adding: "They all should be recognised for their efforts and behaviour instead of debating who did the most. It should not be turned into a competition." (Fraser, 2012)

Another example of this sentiment was displayed by Thomas Barrett, a patrolman in the Boston Police described by *Time Magazine* as *A Hero Among Heroes* for acting on his instinct and training in assisting injured people in the bombings. Barrett's response to the attribution reflected the instinct to label everyone involved as heroes, not just himself, as *Time Magazine* reported:

It's a moment of valour he won't soon forget. Barrett borrows a quote about a character from Stephen Ambrose's *Band of Brothers* to describe the experience: "His grandson asked him if he was a hero in the war," and he said, "No, I wasn't. But I served in the company of heroes." Last Monday, Barrett thought similarly. "That day, everybody from my station was a hero. Everybody from the police department was a hero. And at that point, everybody in the city was a hero." (Katz, 2013)

The Costs of Heroism: Intrusion and Survivor Guilt

Today disaster scenes are beamed into our living rooms, including breaking news stories covering every aspect of the unfolding drama. More than ever before, disasters have become public events in the sense of actions, reactions, and behavioural responses being captured, recorded, reviewed, and replayed through social and other media. The cost of this may be uninvited intrusions into privacy. For some people caught up in this media analysis, enduring coverage renders them unable to escape public attention, exposure, and scrutiny. This attention may be all the more unwelcome during particularly sensitive times such as the fraught emotional aftermath of a traumatic experience.

It is not unusual for those to whom the hero label is attributed to express reluctance and to resist or deflect media attention. Associating their actions with implications of extraordinary qualities and goodness may feel inappropriate or unfair. Examples of this reaction following the Boston bombing include the following:

- A man photographed carrying a woman to safety after the explosions who, when interviewed, said: "While I appreciate the interest in hearing our perspective on today's horrific events, the spotlight should remain firmly on the countless individuals — first responders, medics, EMTs, runners who crossed the finish line and kept on running straight to give blood, and the countless civilians — who did whatever they could to save lives. They were the true heroes." (NBC News, 2013)

- An active-duty service member was photographed wrapping the red shirt he wore during the Marathon around the bloody leg of a man at the blast site. His reluctance to be identified led to his being referred to as “the man who gave the shirt off his back.” (NBC News, 2013)

Focusing on heroism can distract from the true horrors of confronting mass death and injury. Meanwhile for those whose natural instinct and reaction during disaster was to save themselves and flee from danger, notions of heroism may later feed powerful reactions of survivor guilt. Writing a few weeks after the Boston bombing, journalist Beth Teitell (2013) recorded how, since the attack, many of the wounded have shared their stories with the public. But, she adds, “In private, some uncounted number of runners and spectators are suffering from feelings of intense guilt because when violence struck, they didn’t dash in to help. Instead, they made sure their own loved ones were safe amid the harrowing chaos — or fled the danger to make sure they would survive to care for their families.”

Teitell interviewed Jane Blansfield Finch, a clinical social worker and Red Cross volunteer, about people’s reactions. Finch suggested that even though many anointed as heroes said they did not deserve the honour, the public veneration of those who jump to help in a disaster serves a greater purpose because it encourages altruism. At the same time she acknowledged that there is a downside: “It puts pressure on people to think, ‘If I’m not out there helping strangers, am I worthwhile?’” (Teitell, 2013)

Emergency Service Responders as Heroes

For members of the emergency services, there can be a strong sense that risk-taking comes with the job; but the exceptional conditions associated with disaster response and recovery has particular implications, both for their role and subsequent recognition of their actions in relation to heroism. When emergency responders become identified as disaster heroes, stories highlighting their personal circumstances and subsequent lives are invariably newsworthy, especially if they can be linked to a salacious or sensationalist storyline (e.g., Camber, 2011; Stritof, S. & Stritof, B. 2013). Unsurprisingly, for example, much media coverage was given internationally to Bryce Reed, the paramedic first hailed a hero for helping save victims of the fertiliser plant explosion in West, Texas, and later charged with the federal charge of possessing an explosive device.

After the London bombings on July 7, 2005, 23 members of emergency teams and transport workers who helped victims of the attacks were formally recognised in the Queen’s New Year Honours list in 2006 (BBC News, 2005). Many others who behaved heroically on that day were not so recognised. And in contrast to this period where certain heroic acts were formally recognised and publically praised, aspects of the emergency response as a whole were later criti-

cised, both in the report of the London Assembly in 2006 and in the inquests conducted during 2011 into why 52 innocent people died.

Although the emergency response on July 7 was commended on the whole, such intense public scrutiny and elements of criticism during the lengthy subsequent legal procedures must have had an impact on all involved in the emergency response, including those who may have felt a sense of falling *from hero to zero*. It is important that psychological, social, and organisational support is made available for responders during these later, longer-term phases following disaster as inevitable legal procedures take their course. The impact of events and their appraisal may be no less significant at these points.

Tributes to Fallen Heroes

When first responders lose their lives during disaster response, the impact on families, public-service organisations, and the wider community is painfully felt and especially poignant, even more so when there is multiple loss. Tributes by key political and national figures in the aftermath of such events often make specific references to their bravery and heroism.

An example of this situation is the following comment made by Sanford Coats, the US Attorney for the Western District of Oklahoma, in remembering the tenth anniversary of the tragic events on September 11, 2001, and April 19, 1995:

Just like the morning of September 11, brave Oklahoma firefighters, medical personnel, and police officers risked their lives by going into a burning, unstable building in *selfless acts of heroism* [emphasis added] to rescue survivors. Indeed, one first responder gave the ultimate sacrifice in an effort to rescue survivors, becoming one of the 168 casualties of the bomb. (Coats, 2011)

After the explosion at the fertiliser plant in West, Texas, in April, 2013, where 11 of the 14 fatalities were firefighters, the news media made specific reference to the fact that most of the deaths were first responders and, as with other disasters where multiple members of the emergency services are killed, the mourning rituals and memorials received special media coverage (Fernandez, 2013). In an article entitled “Heroes in West, Texas, explosion honoured,” *USA Today* reported on President Obama travelling to the town to speak at the memorial service for those killed in the explosion and ordering flags at government building to be lowered to half-mast in honour of the victims (*USA Today*, 2013).

Heroism, Common Sense, and Common Safety

If heroism is about exceptional or extraordinary behaviour, should it be applied to the ordinary work of members of the emergency services? Clearly, distinctions are made between the usual and exceptional work

of emergency responders when bravery awards are given to recognise particular acts of merit as opposed to actions that are more run of the mill. Notions of heroism as reflecting moral virtue also raise important questions about what kinds of attitudes and behaviours are right, appropriate, and desirable in those exceptional environments where many lives are at risk or in situations where the lives of some may be put at greater risk through potential life-saving actions for others. Such questions fall within the remit of health and safety law and practice, but there are broader philosophical and practical issues to consider: “There is (also) a need to stimulate a debate about risk in society to ensure that everyone has a much better understanding of risk and its management” (Lofstedt, 2011, p. 6).

In the UK, discussions about heroism in the emergency services have been prompted by just such a debate and developments in health and safety. In 2010 the UK Government commissioned a review by Lord Young of the operation of health and safety laws (HM Government, 2010). While the driver was to reduce bureaucracy, confusion, and fears of an increasingly litigious *compensation culture*, the review also focussed on activities of members of the emergency services and the implications for acts of heroism. It outlined the responsibility of employees under health and safety legislation to take reasonable care of themselves and others, but added that the nature of jobs within the emergency services means individuals may occasionally put themselves at risk to save the life of someone else. Where this happens, stated the report, the last thing that should be contemplated is a prosecution for noncompliance with health and safety legislation. Lord Young stated: “Where an unfortunate incident occurs and an officer puts him or herself at risk in the line of their duty to protect the public, I take the view that it would not be in the public interest to take action and investigate under health and safety laws” (p. 35). However, Lord Young also recognised that there was some ambiguity in such cases and a need for greater certainty in this important area. Indeed, this is illustrated in his comments further on in the report:

It is important to recognise that individuals have personal choices to make and they may choose not to put themselves at unreasonable risk. However, those officers who go the extra mile and put themselves in harm’s way to protect the public should continue to be recognised and rewarded for their bravery. (p. 36)

The report thus recommended that “police officers and fire-fighters should not be at risk of investigation or prosecution under health and safety legislation when engaged in the course of their duties if they have put themselves at risk as a result of committing a heroic act” (HM Government, p. 36) and invited the Health and Safety Executive (HSE), the Association of Chief

Police Officers, and Crown Prosecution Service to consider further guidance to put this into effect.

Balancing Operational and Health and Safety Duties

This focus on risk, health, and safety within emergency response came at a significant moment in the UK. In the preceding years, the challenging nature and extremely dangerous environments in which firefighters and other emergency responders have to work had been highlighted by a series of serious and fatal incidents that had exposed emergency responders to personal risk in the course of their attempts to rescue victims. At the same time, the actions and risk assessments of responders were coming under some criticism by investigators, the media, and the public, including bereaved families. The incidents and investigations included the following:

- The London bombings, 2005, which killed 52 people and 4 terrorists, and where the response of the emergency services was reviewed and critiqued both through the inquest and a review by the London Assembly (Greater London Authority, 2006).
- The death of a woman trapped in a mine shaft in 2008 whose rescue was inhibited for over six hours. The fatal accident inquiry concluded Mrs. Hume may have lived if emergency services — and the fire service in particular — had removed her sooner. The sheriff’s ruling criticised procedural failings that led to the delay and said senior officers on the scene “rigidly stood by their operational guidelines.” (Carrell, 2011; BBC News, March 29, 2012)
- The Cumbria shootings, 2010, in which 12 members of the public lost their lives and a further 11 people were seriously injured. A peer review of the emergency response by the Assistant Chief Constable of West Mercia Police concluded that there were differing “risk thresholds” between the services and that the interoperability between the police and ambulance service needed to be improved (Chesterman, 2011).
- A fatal fire at a warehouse in Warwickshire, 2007, where four firefighters lost their lives. Warwickshire County Council was fined £30,000 after pleading guilty to a health and safety charge. Three fire service managers were prosecuted for manslaughter by gross negligence. After all were found not guilty, the Chief Fire Officer condemned the decision to press criminal charges against them (BBC News, December 7, 2012).

As a result of these and other incidents, the HSE began working with senior leaders of the police and fire services to clarify a number of complex and

interrelated issues. Their aim was to avoid a risk-averse culture, provide mechanisms for ensuring early and wide learning from incidents, and set out the expectations of the services in relation to the management of dynamic and often dangerous situations.

Redefining Heroic Acts of Emergency Responders

Endorsing the recommendations of the Young Report (HM Government, 2010), the HSE, Association of Chief Police Officers, police authorities, and fire and rescue authorities worked together to identify how a balance could be struck between high-risk operational duties and the health and safety of themselves and others. The result has been the issuing of statements and further guidance for both the police services and the fire and rescue authorities clarifying the balance between operational and health and safety duties in the emergency services and clarifying the meaning and consequences of acts deemed heroic (HSE 2009; HSE 2010).

In relation to the Fire Service, for example, the HSE has clarified its interpretation and actions relating to "heroism." The HSE will view the actions of individual fire-fighters as heroic when:

- it is clear that they have decided to act entirely of their own volition,
- they have put themselves at risk to protect the public or colleagues, and
- the individuals' actions were not likely to have put other officers or members of the public at serious risk.

In the event of the HSE being notified of a serious incident, inspectors may need to make initial enquiries about the nature of the incident and may need to conduct an investigation of the Fire Service's operational arrangements and management of health and safety. If during this investigation it becomes clear, however, that the incident involved an act of heroism by individual firefighters, then the HSE will not investigate the actions of the individuals in order to take any action against them (HSE, 2010).

Concluding Comments

There is likely to be much interest in the UK in the application of this guidance in the event of it having to be applied following future emergencies and disasters. More broadly, and with reference to the themes explored in this paper, members of the UK emergency services and the wider public might benefit from a more informed understanding and debate about the meaning and implications of notions *heroism*, particularly in the context of extreme events.

In the United States (US) too, where a different cultural and legal environment exists for considering issues around notions of heroism, litigation, and

health and safety, guidance exists (International Association of Fire Fighters [IAFF]/National Institute of Occupational Safety and Health [NIOSH], 2013) and further debate has begun about the context and consequences of *heroism*, the actions of emergency responders, and the implications of their actions both on families and responders themselves (Nicol, 2013). Ultimately, such reflections may also contribute to our thinking and expectations around good, worthy, and commendable behaviour in more ordinary circumstances.

The characteristic of genuine heroism is its persistency. All men have wandering impulses, fits and starts of generosity. But when you have resolved to be great, abide by yourself, and do not weakly try to reconcile yourself with the world. The heroic cannot be the common, nor the common the heroic. (Emerson, 1841)

References

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.
- Auf der Heide, E. (2004). Common misconceptions about disasters: panic, the "Disaster Syndrome," and looting. In M. O'Leary, *The first 72 hours: A community approach to disaster preparedness*. Lincoln, NE: iUniverse Publishing.
- BBC News. (1987, December 31). 1987: Zeebrugge heroes honoured. Retrieved from http://news.bbc.co.uk/onthisday/hi/dates/stories/december/31/newsid_2560000/2560075.stm
- BBC News. (1999, October 11). Nothing prepared me for the horror. Retrieved from <http://news.bbc.co.uk/1/hi/uk/468271.stm>
- BBC News. (2005, December 31). Honours tribute to 7 July workers. Retrieved from http://news.bbc.co.uk/2/hi/uk_news/4569560.stm
- BBC News. (2008, March 16). Airport hero rejects "fake" claim. Retrieved from http://news.bbc.co.uk/1/hi/scotland/glasgow_and_west/7299436.stm
- BBC News. (2012, March 29). Alison Hume inquiry: Mineshaft rescue "lacked focus." Retrieved from <http://www.bbc.co.uk/news/uk-scotland-glasgow-west-17552330>
- BBC News. (2012, December 7). Timeline: Warwickshire firefighter deaths. Retrieved from <http://www.bbc.co.uk/news/uk-england-coventry-warwickshire-16651345>
- Bennett, R., & Daniel, M. (2002). Media reporting of Third World disasters: The journalist's perspective. *Disaster Prevention and Management*, 11(1), 33–42.
- Camber, R. (2011, January 6). 7/7 hero is £100m cocaine kingpin: Fireman among 33 sent to jail as Britain's biggest drugs gang is smashed. *Daily Mail*. Retrieved from <http://www.dailymail.co.uk/news/article-1344289/7-7-hero-Simon-Ford-100m-cocaine-kingpin-jailed-police-smash-drug-gang.html#ixzz2Pt73XpMo>
- Carrell, S. (2011, November 16). Rescue services criticised over death of woman left in mine shaft for six hours. *The Guardian*. Retrieved from <http://www.guardian.co.uk/uk/2011/nov/16/woman-left-in-mine-shaft>
- Chesterman, S. (2011, March 28). Operation Bridge: Peer review into the response of Cumbria Constabulary following the actions of Derrick Bird on 2 June 2010. [Independent Peer Review, Final Report]. Retrieved from www.cumbria.police.uk/Admin/.../ACC_Chestermans_report.pdf

- Coats, S. (2011). The Oklahoma City bombing: From national tragedy, we continue through our resilience to work for comfort, strength, peace, hope and serenity, Offices of the US Attorneys, US Department of Justice. Retrieved from (http://www.justice.gov/usao/briefing_room/ns/oklahoma_city.html)
- Emerson, R. W. (1841). *Essays and English Traits*. (Vol. V: The Harvard Classics). New York: P. F. Collier & Son, 1909–1914. Retrieved from Bartleby.com, 2001: <http://www.bartleby.com/5/107.html>
- Erikson, K. (1976). *Everything in its path: Destruction of community in the Buffalo Creek flood*. New York: Simon and Schuster.
- Fernandez, M. (2013, April 20). A Texas town mourns the first responders who paid with their lives. *The New York Times*. Retrieved from http://www.nytimes.com/2013/04/21/us/in-texas-mourning-first-responders-who-paid-with-their-lives.html?pagewanted=all&_r=0
- Fraser, G. (2012, June 30). *John Smeaton: From Glasgow Airport terror attack hero to fish farmer*. STV Glasgow. Retrieved from <http://local.stv.tv/glasgow/magazine/108635-john-smeaton-from-glasgow-airport-terror-attack-hero-to-fish-farmer/>
- Fricker, M. (2012, January 17). Costa Concordia: Hero British teenager made himself into human ladder to save passengers. *Daily Mirror*. Retrieved from <http://www.mirror.co.uk/news/uk-news/costa-concordia-hero-british-teenager-158783>
- Galtung, J., & Ruge, M. (1965, March). The structure of foreign news: The presentation of the Congo, Cuba and Cyprus crises in four Norwegian Newspapers. *Journal of Peace Research*, 2(1), 64–90.
- Gordon, R. (2009, April). Community impact of disaster and community recovery. *InPsych*, Australian Psychological Society. Retrieved from http://www.psychology.org.au/inpsych/community_impact/#s3
- Greater London Authority. (2006, June). Report of the 7 July Review Committee. London. Retrieved from <http://www.london.gov.uk/mayor-assembly/london-assembly/publications/report-7-july-review-committee>
- Health and Safety Executive (HSE). (2009). *Striking the Balance between Operational and Health and Safety Duties in the Police Service*. Crown Copyright. Retrieved from <http://www.hse.gov.uk/services/police/duties.pdf>
- Health and Safety Executive (HSE). (2010). *Striking the Balance between Operational and Health and Safety Duties in the Fire and Rescue Service*. Crown Copyright. Retrieved from <http://www.hse.gov.uk/services/fire/heroism.htm>
- Her Majesty's (HM) Coroner. (2012). *Coroner's Inquest into the London bombings of 7 July 2005*. Judicial Communications Office. Retrieved from <http://webarchive.nationalarchives.gov.uk/20120216072438/http://7julyinquests.independent.gov.uk/>
- Her Majesty's (HM) Government. (Lord Young of Graffham). (2010, October 15). *Common sense, common safety*. Cabinet Office, London.
- International Association of Fire Fighters/National Institute of Occupational Safety and Health (IAFF/NIOSH). (2013). *Suggested Guidance for Supervisors at Disaster Rescue Sites*. Washington DC: IAFF/NIOSH. Retrieved from <http://www.iaff.org/hs/Alerts/NIOSHdisaster.asp>
- Katz, Andrew. (2013, April 22). A hero among heroes: A Boston cop's story at the marathon. *Time Magazine*. Retrieved from <http://nation.time.com/2013/04/22/a-hero-among-heroes-a-boston-cops-story-at-the-marathon/#ixzz2StoEUom9>
- Kent Online. (2012). *Andrew Parker — The human stepping stone*. The Human Factor Engineering (HFE) Tragedy 25 Years On (Video Results). Retrieved from http://www.kentonline.co.uk/kentonline/home/special_reports/herald_of_free_enterprise/andrew_parker_-_the_human_step.aspx
- Levinson, Jay. (2002). Israeli news media coverage: Bombing near Zion Square, Jerusalem. *Disaster Prevention and Management*, 11(1), 44–45.
- Lofstedt, R. (2011, November). *Reclaiming health and safety for all: An independent review of health and safety legislation*. Presented to Parliament by the Secretary of State for Work and Pensions by Command of Her Majesty, CM 8219, Crown Copyright.
- Lois, J. (1999). Socialization to heroism: Individualism and collectivism in a voluntary search and rescue group. *Social Psychology Quarterly*, 62(2), 17–135.
- McLeish, K. (Ed.). (1993). *Bloomsbury guide to human thought*. London: Bloomsbury Publishing Limited. Retrieved from corp.credoreference.com/component/booktracker/edition/ or also Credo Reference: prod.credoreference.com/topic/heroes/pdf
- NBC News. (2013). *Amid the chaos and carnage in Boston, heroes emerge*. Retrieved from <http://usnews.nbcnews.com/news/2013/04/16/17780108-amid-the-chaos-and-carnage-in-boston-heroes-emerge?lite>
- Nicol, S. (2013, August 2). Pa. Firefighters Hear Tearful Message About Victim. *Firehouse.com News*. Retrieved from <http://www.firehouse.com/news/11077235/woman-whose-husband-seriously-hurt-by-responder-asks-dept-not-give-him-heros-funeral>
- Oklahoma City National Memorial and Museum. (2014). *The Oklahoma Standard*. Retrieved August 31, 2013, from <http://www.oklahomacitynationalmemorial.org/secondary.php?section=6&catid=165>
- Peterson, H. (2013, April 25). Heartwarming moment bomb hero who lost both his legs gave an 18th birthday gift to teen who was wounded alongside him. *Mail Online*. Retrieved from <http://www.dailymail.co.uk/news/article-2314195/Jeff-Bauman-Boston-bombings-hero-lost-son-iraq-describes-emotional-hospital-visit-man-life-famously-saved.html#ixzz2SuGRQjdJ>
- Quarantelli, E. L., & Dynes, R. R. (1970, January/February). Editors' Introduction [special issue on organizational and group behaviour in disaster]. *American Behavioural Scientist*, 13(3), 325–330. Retrieved from <http://udspace.udel.edu/handle/19716/2348>
- Smith, J. (2011, March 20). Out of the gloom of disasters shine the heroes who give us all hope. *The Independent*. Retrieved from <http://www.independent.co.uk/voices/commentators/joan-smith/joan-smith-out-of-the-gloom-of-disasters-shine-the-heroes-who-give-us-all-hope-2246975.html>
- Stritof, S., & Stritof, B. (2013). *Cheating heroes: More victims of September 11th*. Retrieved from <http://marriage.about.com/cs/infidelity/a/cheatingheroes.htm>
- STV Glasgow. (2007). *Glasgow airport attack: John Smeaton becomes a worldwide celebrity*. Retrieved from <http://local.stv.tv/glasgow/magazine/108635-john-smeaton-from-glasgow-airport-terror-attack-hero-to-fish-farmer/>
- Teitell, B. (2013, May 9). Some agonize over fleeing Marathon bombing scene. *The Boston Globe*. Retrieved from <http://www.bostonglobe.com/lifestyle/style/2013/05/08/boston-marathon-heroes-are-lauded-some-who-didn-rush-help-grapple-with-guilt/SNUKISFLDMKTmz3Sen69dP/story.html>
- Tierney, K., Bevc, C., & Kuligowski, E. (2006, March). Metaphors matter: Disaster myths, media frames, and their consequences in Hurricane Katrina. *Annals, American Academy of Political and Social Science (AAPSS)*, 604.
- TNT Magazine. (2012, January 17). *British cruise ship hero survivor acted as human bridge*. Retrieved from <http://www.tntmagazine.com/travel/news/british-cruise-ship-hero-survivor-acted-as-uhuman-bridgeu>

United Press International. (1987, March 10). Lanky Banker's Human Bridge Saved 20 on Ferry. *Los Angeles Times*. Retrieved from http://articles.latimes.com/1987-03-10/news/mn-5952_1_small-island

USA Today. (2013). *Heroes in West, Texas explosion honoured*. USA Now video. Retrieved from <http://www.usatoday.com/videos/news/usanow/2013/04/25/2112287/>

WCVB. (2013, April 27). *Communities rally support for Boston bombing hero*. Retrieved from <http://www.wcvb.com/news/local/metro/communities-rally-support-for-boston-bombing-hero/-/11971628/19923962/-/jqoolz/-/index.html>

Yokota, T., & Yamada, T. (2012, March 4). Heroes of Japan's Nuclear Disaster All but Forgotten. *The Daily Beast, Newsweek*. Retrieved from <http://www.thedailybeast.com/newsweek/2012/03/04/heroes-of-japan-s-nuclear-disaster-all-but-forgotten.html>

Zunin L. M., & Myers, D. (2000). *Training manual for human service workers in major disasters* (2nd ed., DHHS Publication No. ADM 90-538). Washington, DC: Department of Health and Human Services (DHHS), Substance Abuse and Mental Health Services Administration, Centre for Mental Health Services.

Endnotes

¹ In this paper the terms *major emergency* and *disaster* are used interchangeably to refer to large-scale incidents placing life and/or property in danger, often involving multiple casualties and/or fatalities and likely requiring multiagency response and assistance.

² For example an online game produced by the US Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA) claims to equip players with all the information, tips, and resources needed to prepare them to be a *real-life Disaster Hero* in the aftermath of natural disaster or a man-made disaster (See <http://www.disasterhero.com/>).

Appendix For Further Reading

Although the references that follow were not cited in the text of this keynote address, they proved useful resources in the writing of the article.

Addley, E. (2011). 7/7: How victims and heroes were made with a terrible randomness. *The Guardian*. Retrieved from <http://www.guardian.co.uk/uk/2011/jan/27/7-7-bombings-victims>

Drabek, T. (1986). *Human system responses to disaster: An inventory of sociological findings*. New York: Springer-Verlag.

Edwards, R. (2007, July 3). The making of a legend on the Internet. Retrieved from <http://www.telegraph.co.uk/news/uknews/1556377/The-making-of-a-legend-on-the-internet.html>

Erikson, K. (1994). *A new species of trouble*. New York: W. W. Norton & Company.

Eyre, A. (2006). *Community support after disasters — Report of Winston Churchill travelling fellowship*. Winston Churchill Memorial Trust.

Eyre, A. (2006). Remembering: Community commemorations after disaster. In *Springer Handbook of Disaster Research*. New York: Springer.

Mattson, J. (2012, April 20). *Most of the deaths in West, Texas explosion were first responders*. Global Post online. Retrieved from <http://www.globalpost.com/dispatch/news/regions/americas/united-states/130420/first-responders-majority-deaths-texas-explosion>

Raymond, K. (2008, April 18). Another OKC Bombing Hero Commits Suicide. *The Oklahoman*. Retrieved from http://www.prisonplanet.com/articles/april2008/180408_b_okc.htm

About the Author

Dr. Anne Eyre is a UK sociologist specialising in psychosocial aspects of major incidents, emergency planning, and disaster management. Her work focuses on the management and support of people with the aim of ensuring the needs of people are at the heart of contingency planning, emergency response, and post-incident recovery.

Anne works independently and provides research, training, and consultancy services for a range of organisations within the public, private, and voluntary sectors. She also programme manages an annual UK conference on Fire-Related Research and Developments. This event, supported by the UK Fire Service College and the Institution of Fire Engineers, focuses on bringing researchers and practitioners together to promote evidence-based best practice, and often draws international representatives reflecting on US experiences and approaches.

After the 2004 Asian Tsunami, whose victims included many UK citizens, Anne coordinated the Tsunami Support Network established by the British Red Cross Society to support those in the UK affected by the disaster. Anne is also Vice-Chair of Disaster Action (www.disasteraction.org.uk), a charity representing the interests of those directly affected by disaster. In this capacity, she has assisted in providing strategic advice around family and community support to those responding to various mass-fatality incidents, including the September 11, 2001, attacks; the London Bombings, 2005; and the Aberdeen Helicopter crash, April, 2010.

Anne's publications have included two research reports commissioned by the UK Government focussing on the development of best practice in humanitarian assistance after a disaster. She is a Fellow of the Winston Churchill Memorial Trust and in 2006 spent time in New York and New Jersey examining community support strategies after the terrorist attacks in September, 2001. This report is available online through the Trust's website.

Seventh Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address. **Chief Dennis Compton**, Chairman of the National Fallen Firefighters Foundation Board of Directors.

Do Current Fire-Service Issues Offer Political and Operational Leadership Challenges?

Abstract

The purpose of this paper is to share the results of a survey taken of metropolitan fire chiefs in 2013 and to demonstrate how the solutions to the challenges/issues they raise can be both operational and political in nature. The paper also provides guidance to fire-service leaders concerning the potential of elevating their individual and collective effectiveness in the political arena.

Keywords: *metropolitan fire chiefs, fire service challenges, leadership, management, politics*

Introduction

In 2013, I conducted a survey involving a group of fire chiefs who currently manage metropolitan fire departments in the United States. The departments selected for the survey were literally located from east coast to west coast and from north to south. The fire chiefs were each asked to respond to just the following two questions:

1. What do you think is the most significant challenge facing your fire department through 2015?
2. What do you think is the most significant challenge facing the fire service on a national basis through 2015?

It was a rather simple and straightforward survey, but even still, I was somewhat surprised, and very happy, when I achieved a 100% rate of return.

As I should have expected, a theme emerged in the survey responses. It is interesting that each of the challenges identified by the fire chiefs has both political and operational solutions. However, if the fire chiefs take an either/or approach (political or operational) to the issues, utilizing one approach without the other, they will most probably be limited in their capabilities to address their issues effectively. Some of the challenges identified by the respondents (fire chiefs) as local in nature were identified as national challenges by other fire chiefs who responded. The following section lists the primary challenges identified *collectively* by the survey respondents, listed without regard to local or national categories. In reality, most of the issues are both locally and nationally significant to the fire service anyway. For purposes of this article, the challenges raised by these fire chiefs are not listed in any order or priority. These challenges/issues are followed by basic leadership strategies that might increase the influence of fire-service leaders in the political arena.

2013–2015 Fire-Department and Fire-Service Challenges

- **Understanding the Patient Protection Affordable Health Care Act (PPACA) and its impact on fire-service-based emergency medical services (EMS) systems** — This challenge includes the importance of positioning the fire service as a resource and an important player in health-care reform as the PPACA is fully phased in and implemented.
- **Enhancing the effectiveness of fire-service-based EMS service-delivery systems overall** — Especially important is how they relate to various social-services aspects of EMS call volumes.
- **Better educating the public and policymakers about the current and future roles of the fire service in overall public safety** — The fire service has morphed into an all-hazards emergency-services organization; and many elected officials and members of the general public are not aware of the full menu of services provided.
- **Addressing collectively issues related to the image of the fire service and firefighters** — This challenge includes understanding the political climate and how it has motivated policy and legislative actions relating to pay, pensions, and other benefits. Responding to these (often politically motivated) accusations is not simply a responsibility of *labor*. The credibility of firefighters, fire departments, and even the fire service as a whole could be at stake moving forward.
- **Meeting the overall day-to-day firefighter safety, staffing, training, and customer-service requirements of managing a fire department in**

a rapidly changing governmental climate — With the pressures of increased expectations placed on fire departments, coupled with what has been a declining economy since 2008, meeting day-to-day organizational requirements have become very difficult. Managing heightened (and sometimes unrealistic) expectations placed upon fire chiefs and fire departments, both internally and externally, have become more challenging.

- **Recognizing that the longevity of metropolitan fire chiefs has been shortened** — With this reality, fire departments now face the challenge of transitioning to a new fire chief more frequently than in the past, while at the same time maintaining department morale and organizational focus. This situation creates political and functional challenges that can make it difficult for the organization to consistently function at a high level as well as for a fire chief trying to implement necessary changes.
- **Recognizing the challenges of dealing with local budgets, while simultaneously being threatened by reductions in funding for federal grant programs** — Reducing federal public-safety grant funding, while assuming that local governments will simply absorb the ongoing financial support of those lost resources or programs, may not be financially practical or possible.
- **Embracing the realization that the labor/management relationships within a fire department can, perhaps more than ever before, dictate the organization's ability to deliver quality service, while also adequately supporting the members who are trying to provide that service**
- **Recognizing the challenge for fire departments to create a different and better path forward as the economy continues its recovery** — This challenge will include realizing that political support to simply reinstate the fire department to where it was precession may be lacking.
- **Replacing the infrastructure needs of fire departments** — Since the economic downturn began, many fire departments have not been able to replace worn apparatus, equipment, facilities, communications systems, etc. In order to save money, decisions were made to retain these resources long after they should have been replaced. This payment is coming due; and creating an acceptable plan to recover from the past, and then go forward, could be challenging to fund and implement.
- **Communicating and selling the need for an adequate fire-suppression force when data indicate that the frequency of its use is declining** — Fire deaths in many large cities have declined considerably over the years and might

continue to do so. A significant challenge for fire departments is that no matter what the frequency of fire-related emergencies, an adequate fire-suppression response is critical to the safety of the public and firefighters. Addressing this issue might be especially difficult for fire departments that have not embraced and integrated EMS, hazardous materials responses, technical rescue, fire prevention, and all-risk public education as regular duties of their firefighters.

Effective Leadership Can Equate to Political Influence

The fire service must place a high priority on institutionalizing its political influence at all levels of government — local, state/regional, and national. Most, if not all, of the resources a fire department receives to function will come as a result of the votes of elected officials serving at some level of government. Without political support, a fire department may lack the basic resources necessary to function effectively and safely. Fire-service leaders must possess the political acumen to engage in processes necessary to achieve the goals of the organization and maintain the public's safety.

The public image of the fire service is critical to the overall success of fire departments. The conduct and performance of fire-service members can be helpful or hurtful to that image. Time and again, the traditional media and social media contain information about fire departments and firefighters that is shared with the general public. That information can be a very positive thing, and most often is, but sometimes the reports cover behavior and/or performance that put the fire department in a bad light.

It is important that the fire service is viewed by the public as an active community participant in ways that are mission related, being involved in community decisions, and being supported by community leaders. There are many ways these goals can be accomplished, and most involve some level of activism by members of the fire department. The most obvious way for fire-department leaders to be viewed as community leaders is to engage in activities and organizations that attract other community leaders to their endeavors. Communications with elected officials, agency heads, and staff should be a priority for fire-department leaders. Interaction with schools, service on boards, commissions, and associations, as well as participation in cross-functional planning sessions, should be priorities for fire departments. The fire service simply should not isolate itself in a public-policy arena that encourages partnerships, coalitions, and positive relationships with others. Integrating fire-service leaders into the public-leadership arena helps over time to validate the fire service as a leader in the eyes of its partners.

Fire-service leaders should strive to serve as *trusted advisors* to elected officials and their staff members. When interacting within this environment, the trusted

advisor must always tell the truth and never be threatening. Emphasis should be placed on trying to build trusting and respectful relationships within the political arena. The professional staff of elected officials is important and influential. Staff members often conduct briefings with the elected officials and control access to them as well. It will pay great dividends to treat them accordingly.

It is important that the fire service as a whole support the Congressional Fire Services Institute (CFSI) in Washington, DC. This organization works in support of a number of fire-service issues and federal legislation each year. To be effective, they need the resources necessary to fill that role. Several national fire-service organizations have Government Affairs Directors who serve on the National Advisory Committee (NAC) of the CFSI. There are several ways that members of the fire service can provide the support necessary to ensure that the CFSI continues to function at a high level. Visiting www.cfsi.org will provide information on how to take advantage of those opportunities and a lot more.

Fire-service issues should never be framed as partisan issues — they are American issues. The fire service must be successful politically no matter what particular party is in power in the executive or legislative branches of government. Lacking respect for this reality can cause support for the fire service to swing up and down, depending on the outcome of elections each time they are conducted. The leadership of local fire departments, state-level organizations, and national fire-service associations make a significant difference in how the political process impacts the fire service at all levels of government. These leaders must always conduct themselves in a way that is in the best interest of the fire service.

Conclusion

The survey responses from the selected fire chiefs could serve as guidance to major fire-service membership organizations and associations when deciding what types of support and information to provide to their members. These organizations and associations should consider and utilize what these fire chiefs identified as their most important challenges when forming the basis for the guidance they receive from the organizations to which they belong and often pay dues. Major fire-service conference and webinar managers

could use survey results to help formulate some of their education and training offerings in an effort to more effectively focus on the current challenges of fire chiefs and chief officers in general. Political effectiveness of fire-department leaders should also be among the critical subjects they address.

The political process drives many of the decisions that affect the fire service in significant ways. Putting emphasis on preparing fire-department leaders to effectively engage politically is important and must be considered a leadership requirement. These challenges and political strategies could actually form the foundation for a series of articles in years to come. The operational and political aspects of addressing the issues identified in this article will play major roles in the overall success of the fire service in both the short term and long term. Even though other major fire-service issues or challenges may emerge over the next few years, the input of these metro fire chiefs in identifying the current challenges is helpful, and it should provide the fire service with a degree of leadership guidance.

About the Author

Chief Dennis Compton is a well-known speaker and the author of several books including his most recent offering titled *Progressive Leadership Principles, Concepts, and Tools* (published by Fire Protection Publications in 2010). He has also authored the three-part series of books titled *When in Doubt, Lead*, the book *Mental Aspects of Performance for Firefighters and Fire Officers*, as well as many articles, chapters, and other publications.

Dennis served as the Fire Chief in Mesa, Arizona, for five years and as Assistant Fire Chief in Phoenix, Arizona, where he served for twenty-seven years. Chief Compton is the Past Chairman of the Executive Board of the International Fire Service Training Association (IFSTA) and Past Chairman of the Congressional Fire Services Institute's National Advisory Committee. He is currently the Chairman of the National Fallen Firefighters Foundation Board of Directors, and Co-Chairman of the Fire Service-Based EMS Advocates Coalition Steering Committee.

Eighth Annual Dr. John Granito Award for Excellence in Fire Leadership and Management Keynote Address.
Dr. Denise L. Smith, Health and Exercise Sciences, Skidmore College, Saratoga Springs, New York, and
 University of Illinois Fire Service Institute, Champaign, Illinois.

Understanding and Preventing Sudden Cardiac Events in the Fire Service

Abstract

Approximately 90 United States (US) firefighters die in the line of duty each year. Sudden cardiac deaths (SCDs) are responsible for approximately 45% of all duty-related fatalities. Cardiovascular strain during fire fighting is evidenced by changes in cardiac, vascular, and coagulatory function. Increased cardiovascular strain can trigger sudden cardiac events in individuals with underlying cardiovascular disease (CVD). This paper presents data on cardiovascular strain, the interaction between underlying CVD and cardiovascular strain of fire fighting, and how this interaction is linked to SCD. Finally, the paper presents recommendations to prevent CVD deaths in the fire service.

Introduction

Firefighters perform strenuous physical work while wearing insulating personal protective equipment (PPE) under hot, hostile conditions. Asphyxiation and burn injuries are major concerns in the fire service, and policies and procedures and equipment advances have been adopted to ensure that the number of these fatalities is as low as possible. However, 45% of firefighter line-of-duty deaths are caused by sudden cardiac death (SCD) (Fahy, LeBlanc, & Molis, 2016), and there is far more that can be done to decrease these fatalities and the hundreds of nonfatal cardiac events. Additional information and more understanding are required to develop effective policies that help prevent SCD. A better understanding of the cardiovascular and physiological demands of fire fighting, as well as the underlying risk factors that contribute to cardiac death, will aid in the pursuit of reducing cardiovascular fatalities among firefighters.

The purpose of this paper is to (a) present data on the cardiovascular strain of fire fighting as evidenced by cardiac, vascular, and blood/coagulatory responses, (b) describe the medical causes of cardiovascular fatalities, (c) present a theoretical model of how fire fighting can trigger a cardiac event in an individual with underlying cardiovascular disease (CVD), and (d) discuss steps to prevent SCD among firefighters.

Acute Cardiovascular Strain of Fire Fighting

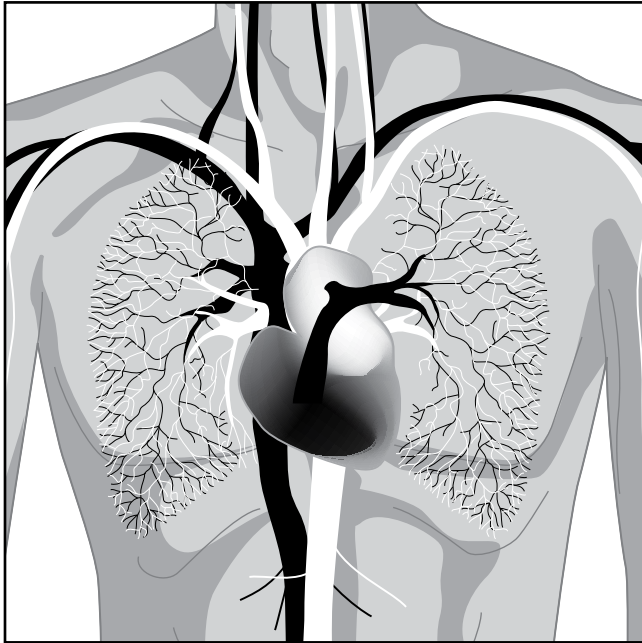
It is well established scientifically and well known experientially that fire fighting causes cardiovascular strain. Intuitively, most people accept that the cardiovascular strain caused by fire fighting can lead to fatal cardiac events. Importantly, all firefighters experience cardiovascular strain when fighting a fire. However, most individuals recover from the stress of fire fighting

without incident. In individuals with underlying CVD, however, the strain of fire fighting may trigger an acute cardiovascular event.

Firefighters wear heavy PPE and perform strenuous activities such as forcible entry, hose advancement, search and rescue, and ventilation in elevated temperatures. Thus, it is no surprise that fire fighting causes cardiovascular strain. While most firefighters know that fire fighting leads to elevated temperatures and high heart rates, few know of other cardiovascular changes that may have important implications for their health and safety. This paper reviews research that characterizes the effect of fire fighting in all components of the cardiovascular system: the heart, vessels, and blood (see **Figure 1**, p. 52).

Fire fighting results in elevated heart rate and blood pressure. As core temperature rises, heart rate continues to increase and may remain elevated even during rest periods. In order to better characterize cardiac responses to fire fighting, a full echocardiographic examination was performed before and after a 3-hour training period, consisting of multiple 12- to 15-minute evolutions. Findings show that the training activity resulted in a 13% reduction in stroke volume (Fernhall, Fahs, Horn, Rowland, & Smith, 2012), which was accompanied by significant reductions in left ventricular diastolic size and volume, left ventricular shortening fraction, and ejection time. All of these findings suggest impaired contractile function of the heart. Furthermore, we found a decrease in blood-flow velocities through the mitral valve that suggests impaired diastolic function, indicating that the ventricle was not relaxing completely during diastole to permit optimal filling. This study suggests that heart function is greatly affected by fire-fighting activity.

Figure 1: Components of the Cardiovascular System: The Heart, Vasculature, and Blood Are All Affected by Fire-Fighting Activity.



Fire fighting also affects the vasculature system. During the same study referenced earlier (Fernhall et al., 2012), findings show that after 3 hours of fire training, aortic stiffness and forearm blood flow increased. The fact that blood flow increases is certainly consistent with the need to deliver more blood flow to the working muscle and the skin in an attempt to dissipate heat. However, the increase in aortic stiffness was an unexpected finding that may suggest that some vessels will experience increased pressure or decreased blood flow. Additional research is needed to fully understand the implications of this finding.

Horn et al. (2011) evaluated the effect of fire-fighting activity on vascular and central hemodynamic functions. After 18 minutes of fire fighting, rate-pressure product (RPP), a measure of myocardial work, significantly increased and rapidly decreased to prefire-fighting levels within the first 30 minutes of recovery. In contrast, the subendocardial viability ratio, an indicator of myocardial oxygen perfusion, significantly decreased and slowly returned to baseline levels between 30–90 minutes after fire fighting. These findings suggest a myocardial oxygen supply-demand mismatch during the recovery period, which could lead to ischemic events in firefighters with underlying disease.

Fire fighting also leads to important changes in the blood; specifically in coagulatory function. For example, the effects of fire-fighting activities on platelets, coagulation (blood clotting), and coagulation breakdown were evaluated before and up to 2 hours after completing fire-fighting activities. Platelet number and activity increased following fire-fighting activity. Furthermore, aPTT, a global measure of coagulation, increased immediately postfire fighting and remained elevated during 2 hours of recovery (Smith et al., 2014).

These findings are clinically significant because they indicate that fire fighting promotes a hypercoagulatory state that may persist for several hours after fire fighting. Elevated coagulation results in a prothrombotic state, increasing the likelihood of thrombus formation, which may lead to arterial occlusion and ischemia and/or a fatal arrhythmia.

As summarized in **Figure 2**, our research convincingly demonstrates that fire fighting causes significant cardiovascular strain. The strenuous physical work, heat stress, and PPE worn by firefighters greatly affect all components of the cardiovascular system, including the heart, the vessels, and the blood (Smith, DeBlois, Kales, & Horn, 2016). In individuals with underlying cardiovascular disease, these changes increase the likelihood of a sudden cardiac event.

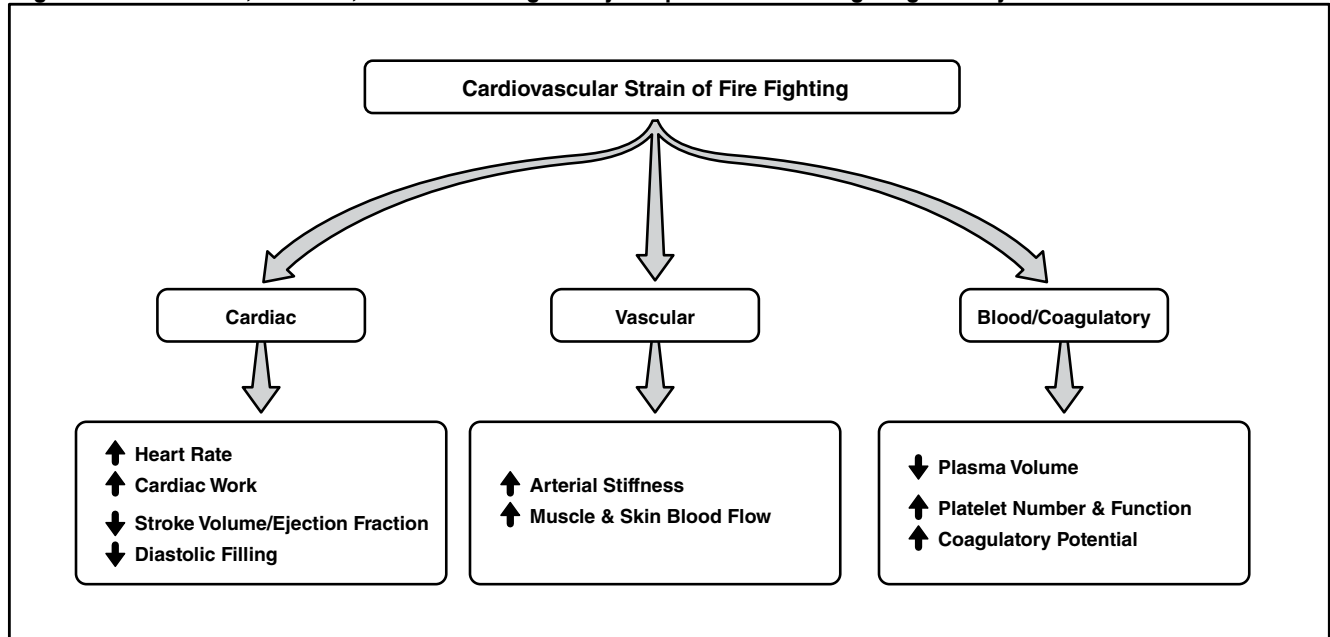
Medical Cause of Sudden Cardiac Events

There are numerous cardiovascular diseases that can result in death. However, when considering sudden cardiac events, the majority of events are caused by myocardial infarction (heart attack) or ventricular arrhythmia. While there is a strong tendency to believe that heart attacks are responsible for most deaths, the data suggest that both heart attacks and arrhythmias are important causes of death in the general population and in the fire service. Importantly, underlying changes in coronary vessels (coronary heart disease) and structural changes to the heart (cardiomegaly and left ventricular hypertrophy) are associated with increased risk of suffering a sudden cardiac event.

Atherosclerosis, characterized by atherosclerotic plaque accumulation within arteries, leads to coronary heart disease (CHD). Increased atherosclerotic plaque progressively narrows arteries (causing stenosis), which leads to ischemia and causes angina as the ability to deliver oxygen to the heart is impaired. During increased cardiovascular stress, such as fire fighting, plaque rupture can occur, leading to clot formation and a myocardial infarction. The ischemia produced by narrowing of the arteries can also increase the likelihood of arrhythmias, especially in the presence of structural heart changes such as cardiomegaly and left ventricular hypertrophy.

Cardiomegaly (enlarged heart) and left ventricular hypertrophy (LVH) or increased left ventricular mass, are structural abnormalities that increase the risk of SCD, particularly the risk of experiencing an arrhythmia. Furthermore, the increased risk is independent of nonmodifiable risk factors of coronary heart disease such as age and gender (Verdecchia et al., 2001; Schillaci, Verdecchia, Reboldi, Pede, & Porcellati, 2000; Casale et al., 1986). LVH is strongly associated with hypertension, obesity, coronary artery disease, and obstructive sleep apnea (Levy, Garrison, Savage, Kannel, & Castelli, 1990; Haider, Larson, Benjamin, & Levy, 1998; Hedner, Ejnell, & Caidahl, 1990). LVH has been shown to predict cardiovascular morbidity

Figure 2. The Cardiac, Vascular, and Blood/Coagulatory Responses to Fire-Fighting Activity.



and mortality in many general population studies. In a study examining firefighter duty-related CHD deaths, 76% of fatalities had evidence of LVH (Kales, Soteriades, Christoudias, & Christiani, 2003). Additionally, in young firefighters under the age of 45, 66% of cardiac fatality cases had evidence of cardiomegaly (Yang et al., 2013). These studies provide evidence that cardiomegaly/left ventricular hypertrophy (LVH) play a critical role in CVD events in the fire service.

Cardiovascular Disease Risk Factors in Firefighters

The cardiovascular strain associated with fire fighting is strongly influenced by the characteristics of each firefighter, most notably his or her health status and fitness profile. Underlying CVD increases cardiovascular strain and greatly increases the risk of a cardiovascular event. In contrast, a high fitness level results in less cardiovascular strain and a shorter recovery for a given amount of work and a decreased risk of a fatal CHD event compared with a low fitness level (Kodama et al., 2009; Lee et al., 2011).

Unfortunately, research indicates that there is a high prevalence of CVD risk factors among firefighters and that many firefighters do not meet the recommended fitness level to safely perform essential fire-fighting tasks. Specifically, research shows the following risk factors:

- a. **Hypertension** — Fifteen to 40% of firefighters have high resting blood pressure (Posten, Haddock, Jahnke, Jitnarin, & Day, 2013; Baur, Christophi, & Kales, 2012; Soteriades, Kales, Liarakapis, & Christiani, 2003) and greater than 50% of firefighters have prehypertension (Soteriades et al., 2003; Fahs et al., 2009).
- b. **Cholesterol** — Greater than 20% of firefighters have high serum cholesterol (Donovan et al., 2009; Soteriades et al., 2002).

- c. **Overweight and Obesity** — More than 50% of firefighters are overweight and an additional 20 to 30% are obese (Poston, Jitnarin, Haddock, Jahnke, & Day, 2014; Baur, Christophi, & Kales, 2012; Choi et al., 2016; Fahs et al., 2009).

- d. **Smoking** — Approximately 15% of firefighters are current smokers (Haddock, Jitnarin, Poston, Tuley, & Jahnke, 2011).

- e. **Physical Fitness** — Many firefighters do not meet the minimum recommended aerobic fitness level (12 metabolic equivalents) to safely perform essential tasks on the fireground (Baur, Lieba, Christophi, & Kales, 2012; Durand et al., 2011).

Several studies have clearly shown that SCD occurs primarily in firefighters who have an excess of CVD risk factors and some form of underlying CVD (Kales et al., 2003; Geibe et al., 2008; Holder, Stallings, Peeples, Burress, & Kales, 2006). **Table 1**, p. 54 summarizes research documenting the relative risk of on-duty firefighter CHD fatalities by CVD risk factor (Kales et al., 2003).

The odds of CHD duty-related death for obese firefighters are approximately 3 times greater than those of non-obese firefighters. Obesity is also associated with elevated risks of job-related disability and non-CHD retirement. Between 40 and 50% of firefighters who suffered a duty-related CHD fatality were smokers, and current smoking is associated with almost a ninefold increase in risk of duty-related death compared with nonsmoking (Kales et al., 2003). Among the modifiable CVD risk factors, hypertension is associated with the greatest increased risk of duty-related death, with hypertensive firefighters having a 12-fold increased risk of duty-related cardiac death. Importantly, hypertension plays a key role in structural damage to the vessels with CHD and in causing structural changes to the heart (cardiomegaly and

LVH). The risk of duty-related CHD death increases by threefold to 12-fold for major CVD risk factors; however, the strongest predictor of CHD-related death is a prior diagnosis of CHD (based on peripheral artery disease, carotid stenosis, and history of thrombotic stroke or transient ischemic attack), which increases risk by 35-fold. While only 1% of career firefighters and 9% of volunteers have established CHD, 31% of firefighters who experienced fatal CHD events had previously established disease (Soteriades, Smith, Tsismenakis, Baur, & Kales, 2011).

Table 1. Risk of Duty-Related Coronary Heart Disease (CHD) Death by Cardiovascular Disease (CVD) Risk Factor.

Risk Factors	Odds Ratio
Obesity (BMI ≥ 30 kg/m ²)	3.1
Cholesterol	4.4
Diabetes	10.2
Hypertension	12.0
Current smoking	8.6
Prior diagnosis of CHD	35.0

BMI: Body mass index

CHD: Coronary heart disease

Odds ratio represents the likelihood that an outcome will occur (here, cardiac fatality) given a particular exposure (here, a cardiovascular disease risk factor). Modified from Kales et al., 2003.

Triggering Sudden Cardiac Events During Fire Fighting

Occupational stressors associated with fire fighting can be divided into three broad categories: (1) physical, (2) emotional, and (3) environmental. The physical stress associated with fire fighting includes the performance of strenuous static and dynamic muscular work and aerobic exertion while wearing heavy, encapsulating PPE. Fire-fighting activities result in elevated oxygen consumption (over 40 ml.kg⁻¹.min⁻¹) (National Fire Protection Association® [NFPA®], 2013) and elevated blood pressure (Feairheller, 2015) and cardiac work (Fernhall et al., 2012). The release of catecholamines, resulting in increased sympathetic nervous system activity, helps coordinate the body's response to fire fighting. Activation of the sympathetic nervous system can be attributed to emotional stress signaled by the sounding of an alarm and can last throughout fire-fighting duties (Kales, Soteriades, Christophi, & Christiani, 2007).

Emotional stress can be further augmented by the constantly shifting dangerous-to-life-and-health environment. Environmental stress, such as the presence of fire heat, smoke/reduced visibility, and toxic particulate matter, can further add to a firefighter's emotional stress. The fire environment can result in rapid rises in core temperature (Horn, Blevins, Fernhall, & Smith, 2013), severe dehydration (Horn, DeBlois, Shalmyeva,

& Smith, 2012), and exposure to smoke particulates that can negatively affect a firefighter's physiology (Mittleman, 2007).

These occupational stressors do not function independently. Rather, physical, emotional, and environmental stressors interact to provoke or trigger sudden cardiac events in susceptible firefighters. In fact, more than 30% of cardiovascular line-of-duty deaths within the fire service occur during fire-suppression activities, despite the fact that this duty comprises only 1 to 5% of annual working time (Kales et al., 2007). This factor suggests that the risk of suffering from sudden cardiac death during fire-suppression duties is nearly 50 times that of station duties.

Theoretical Model for Sudden Cardiac Events in the Fire Service

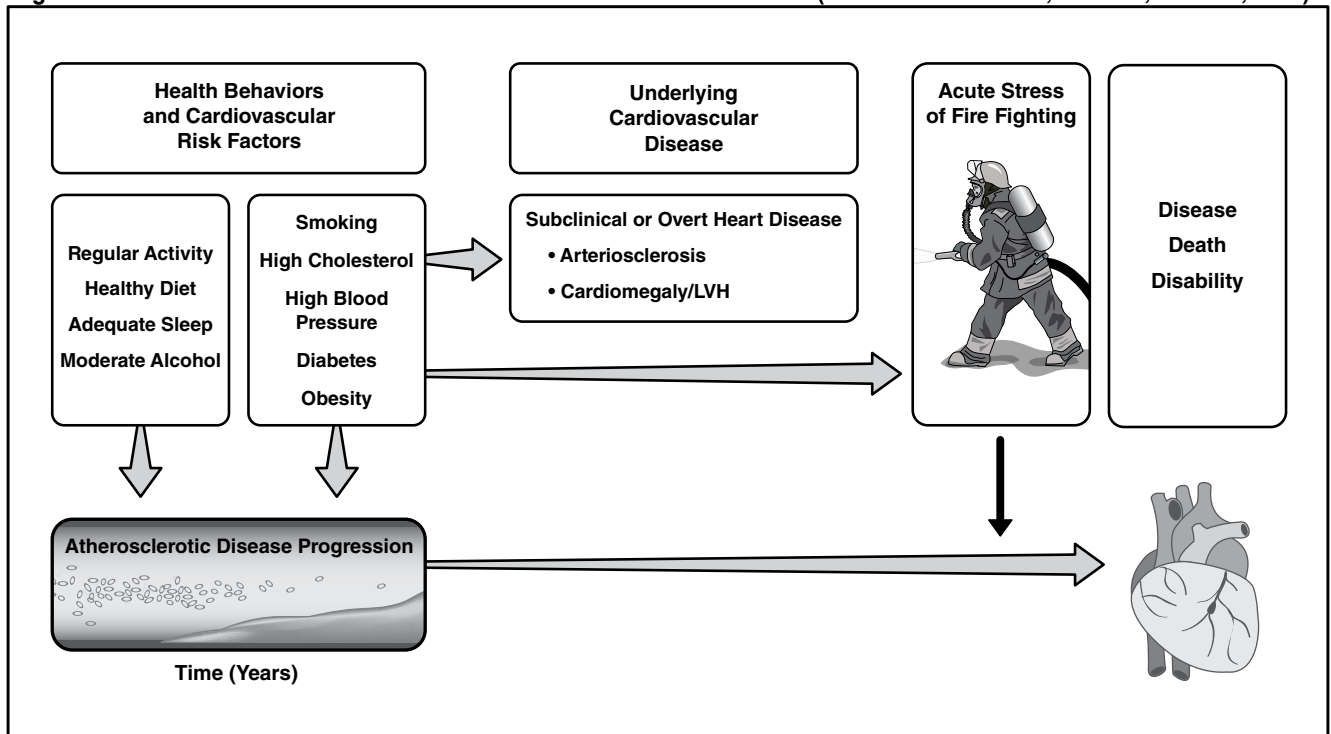
The cardiovascular strain of fire fighting discussed in the previous section interacts with an underlying cardiovascular disease state to precipitate sudden cardiac death in susceptible individuals (Smith, DeBlois, & Kales, 2014). Health behaviors, such as a healthy diet, adequate sleep, and moderate alcohol consumption, interact with cardiovascular disease risk factors (sedentary lifestyle, obesity, elevated cholesterol, etc.) to affect CVD progression, which can develop over several years or decades. Over time, unhealthy behaviors and excessive CVD risk factors can result in CVD. CVD may produce symptoms, such as angina or shortness of breath, or may be completely asymptomatic. The cardiovascular strain of fire fighting can lead to plaque rupture and thrombus formation, precipitating a myocardial infarction, or it may lead to ischemia that triggers a fatal or nonfatal arrhythmia.

As illustrated in **Figure 3**, SCD in firefighters occurs because of a complex interaction between health behaviors and CVD risk factors, underlying CVD state, and the acute stress of fire fighting. CVD develops over many years, even decades, and this disease progression is influenced both positively and negatively by health behaviors. As disease progresses, it results in (1) subclinical CVD (detected or undetected), which manifests as coronary heart disease (CHD) with plaque buildup in the arteries; (2) hypertensive heart disease, which is characterized by enlargement of the heart; or (3) a combination of both coronary atherosclerosis and structural heart changes. In the presence of *chronic* underlying disease, the cardiovascular strain associated with fire fighting may lead to an acute sudden cardiac event, either due to thrombus formation or arrhythmia.

Mitigating Sudden Cardiac Death in the Fire Service

Several discrete steps that fire service leaders can take to decrease the risk of SCD among firefighters are as follows:

Figure 3. Theoretical Model for Sudden Cardiac Events in the Fire Service (Modified from Smith, DeBlois, & Kales, 2014).



- 1. Ban Smoking** — Smoking greatly increases the risk of SCD as well as being a cause of cancer and respiratory disease. The fire service should completely ban smoking and tobacco products.
- 2. Adopt and Implement Wellness/Fitness Programs** — A comprehensive wellness program includes fitness programming, nutrition, injury prevention, and behavioral health services. Implementing a wellness/fitness initiative will improve firefighters' overall health and physical fitness profiles, reduce CVD risk factors, and decrease cardiovascular (CV) events. Regular physical activity, a healthy diet, and adequate sleep are necessary to ensure firefighters are prepared for the physical, emotional, and environmental stressors they encounter on the job. A wellness/fitness initiative is an important step to address modifiable risk factors associated with SCD, including obesity, hypertension, high serum cholesterol, and Type 2 diabetes.
- 3. Require Annual Medical Evaluations and Return to Work Evaluations by Physicians Familiar with Physiological Strain of Fire Fighting** — Annual medical evaluations provide an opportunity to identify firefighters in need of risk reduction before an adverse event can occur. Counseling and aggressive treatment of CVD risk factors could delay or prevent the development of CVD. Paying particular attention to modifiable risk factors (cholesterol, blood pressure, smoking, etc.), firefighters who are most susceptible to cardiac events should undergo screenings to diagnose subclinical or overt CVD.

- 4. Seek Medical Attention for Symptoms of a Heart Attack** — Most firefighters know the symptoms of a heart attack, and yet, far too often these signs are ignored. If a firefighter experiences chest pain, shortness of breath, or unexplained fatigue, she or he should seek medical attention.

Conclusions

Fire fighting involves strenuous work, results in activation of the sympathetic activation response (adrenaline release), and occurs in severe environmental conditions. The combination of physical, emotional, and environmental stressors results in considerable cardiovascular strain. Research has shown that all components of the cardiovascular system are greatly affected by fire fighting. The theoretical model proposed in this paper is based on extensive research and proposes that in susceptible individuals with underlying heart disease (most often CHD and LVH), the cardiovascular strain associated with fire fighting may trigger a sudden cardiac event. The precise mechanisms causing a cardiovascular event may vary, depending upon the underlying disease state. Increases in cardiac demand may cause rupture of vulnerable plaque, resulting in occlusion of coronary arteries, and this event may be exacerbated by hypercoagulability that increases the risk of thrombotic (blood clotting) events. Ischemia (a lack of oxygen delivery) can also result in direct electrical and mechanical changes in the cardiac muscle, leading to fatal arrhythmias. Importantly, arrhythmias are much more likely to occur in an individual with structural

changes in the heart, especially cardiomegaly and left ventricular hypertrophy. Hypertension and obesity are the strongest risk factors for structural heart changes. Structural changes in the heart seldom produce symptoms, thus many people with enlarged hearts are not aware of this condition. Exposure to environmental conditions (such as gaseous and particulate toxicants in smoke) may also increase susceptibility to arrhythmias (Dockery, 2001; Goldberg et al., 2001; Mittleman, 2007), particularly in those with LVH and other forms of cardiomegaly.

To help mitigate the cardiovascular strain in firefighters, the fire service should take the following steps:

1. Ban smoking.
2. Adopt and implement wellness/fitness programs.
3. Provide annual medical evaluations and return-to-work evaluations by a physician familiar with the stress of fire fighting.
4. Seek medical attention when a firefighter is experiencing symptoms of a heart attack.

References

- Baur, D. M., Leiba, A., Christophi, C. A., & Kales, S. N. (2012). Low fitness is associated with exercise abnormalities among asymptomatic firefighters. *Journal of Occupational Medicine, 62*(7), 566–569.
- Baur, D. M., Christophi, C. A., & Kales, S. N. (2012). Metabolic syndrome is inversely related to cardiorespiratory fitness in male career firefighters. *Journal of Strength and Conditioning Research, 26*(9), 2331–2337.
- Casale, P. N., Devereux, R. B., Milner, M., Zullo, G., Harshfield, G. A., Pickering, T. G., & Laragh, J. H. (1986). Value of echocardiographic measurement of left ventricular mass in predicting cardiovascular morbid events in hypertensive men. *Annals of Internal Medicine, 105*, 173–178.
- Choi, B., Steiss, D., Garcia-Rivas, J., Kojaku, S., Schnall, P., Dobson, M., & Baker, D. (2016). Comparison of body mass index with waist circumference and skinfold-based percent body fat in firefighters: Adiposity classification and associations with cardiovascular disease risk factors. *International Archives of Occupational & Environmental Health, 89*(3), 435–448.
- Dockery, D. W. (2001). Epidemiologic evidence of cardiovascular effects of particulate air pollution. *Environmental Health Perspectives, 109*(Suppl. 4), 483–486.
- Donovan, R., Nelson, T., Peel, J., Lipsey, T., Voyles, W., & Israel, R. G. (2009). Cardiorespiratory fitness and the metabolic syndrome in firefighters. *Journal of Occupational Medicine, 59*, 487–492.
- Durand, G., Tsismenakis, A. J., Jahnke, S. A., Baur, D. M., Christophi, C. A., & Kales, S. N. (2011). Firefighters' physical activity: Relation to fitness and cardiovascular disease risk. *Medicine & Science in Sports & Exercise, 43*(9), 1752–1759.
- Fahs, C. A., Smith, D. L., Horn, G. P., Agiovlasis, S., Rossow, L. M., Echols, G., . . . Fernhall, B. (2009). Impact of excess body weight on arterial structure, function, and blood pressure in firefighters. *American Journal of Cardiology, 104*, 1441–1445.
- Fahy, R. F., LeBlanc, P., & Molis, J. L. (2016). *Firefighter fatalities in the United States: 2015*. Quincy, MA: National Fire Protection Association® (NFPA®).
- Fairheller, D. L. (2015). Blood pressure and heart rate responses in volunteer firefighters while wearing personal protective equipment. *Blood Pressure Monitoring, 20*(4), 194–198.
- Fernhall, B., Fahs, C. A., Horn, G., Rowland, T., & Smith, D. (2012). Acute effects of firefighting on cardiac performance. *European Journal of Applied Physiology, 112*, 735–741.
- Geibe, J. R., Holder, J., Peeples, L., Kinney, A. M., Burress, J. W., & Kales, S. N. (2008). Predictors of on-duty coronary events in male firefighters in the United States. *American Journal of Cardiology, 101*(5), 585–589.
- Goldberg, M. S., Burnett, R. T., Bailar, J. C. III, Tamblyn, R., Ernst, P., Flegel, K., . . . Vincent, R. (2001). Identification of persons with cardiorespiratory conditions who are at risk of dying from the acute effects of ambient air particles. *Environmental Health Perspectives, 109*(Suppl. 4), 487–494.
- Haddock, C. K., Jitharin, N., Poston, W. S. C., Tuley, B., & Jahnke, S. A. (2011). Tobacco use among firefighters in the central United States. *American Journal of Industrial Medicine, 54*(9), 697–706.
- Haider, A. W., Larson, M. G., Benjamin, E. J., & Levy, D. (1998). Increased left ventricular mass and hypertrophy are associated with increased risk for sudden death. *Journal of the American College of Cardiology, 32*(5), 1454–1459.
- Hedner, J., Ejnell, H., & Caidahl, K. (1990). Left ventricular hypertrophy independent of hypertension in patients with obstructive sleep apnea. *Journal of Hypertension, 8*(10), 941–946.
- Holder, J. D., Stallings, L. A., Peeples, L., Burress, J. W., & Kales, S. N. (2006). Firefighter heart presumption retirements in Massachusetts 1997–2004. *Journal of Occupational and Environmental Medicine, 10*, 1047–1053.
- Horn, G. P., Blevins, S., Fernhall, B., & Smith, D. L. (2013). Core temperature and heart rate response to repeated bouts of firefighting activities. *Ergonomics, 56*(9), 1465–1473.
- Horn, G. P., DeBlois, J., Shalmyeva, I., & Smith, D. L. (2012). Quantifying dehydration in the fire service using field methods and novel devices. *Prehospital Emergency Care, 16*(3), 347–355.
- Horn, G. P., Gutzmer, S., Fahs, C. A., Petruzzello, S. J., Goldstein, E., Fahey, G. C., . . . Smith, D. L. (2011). Physiological recovery from firefighting activities in rehabilitation and beyond. *Prehospital Emergency Care, 15*(2), 214–225.
- Kales, S. N., Soteriades, E. S., Christophi, C. A., & Christiani, D. C. (2007). Emergency duties and deaths from heart disease among firefighters in the United States. *New England Journal of Medicine, 356*, 1207–1215.
- Kales, S. N., Soteriades, E. S., Christoudias, S. G., & Christiani, D. C. (2003). Firefighters and on-duty deaths from coronary heart disease: A case control study. *Environmental Health, 2*, 14.
- Kodama, S., Saito, K., Tanaka, S., Maki, M., Yachi, Y., Asumi, M., . . . Sone, H. (2009). Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: A meta-analysis. *JAMA: The Journal of the American Medical Association, 301*(19), 2024–2035.
- Lee, D.-c., Sui, X., Artero, E. G., Lee, I. M., Church, T. S., McAuley, P. A., . . . Blair, S. N. (2011). Long-term effects of changes in cardiorespiratory fitness and body mass index on all-cause and cardiovascular disease mortality in men: The Aerobics Center Longitudinal Study. *Circulation, 124*(23), 2483–2490.
- Levy, D., Garrison, R. J., Savage, D. D., Kannel, W. B., & Castelli, W. P. (1990). Prognostic implications of echocardiographically determined left ventricular mass in the Framingham Heart Study. *New England Journal of Medicine, 322*(22), 1561–1566.
- Mittleman, M. A. (2007). Air pollution, exercise, and cardiovascular risk. *New England Journal of Medicine, 357*, 1147–1149.

- National Fire Protection Association® (NFPA®). (2013). NFPA® 1582: *Standard on comprehensive occupational medical program for fire departments*. Quincy, MA: NFPA® Publications.
- Poston, W. S., Jitnarin, N., Haddock, C. K., Jahnke, S. A., & Day, R. S. (2014). Accuracy of self-reported weight, height and BMI in US firefighters. *Occupational Medicine (London)*, 64(4), 246–254.
- Poston, W. S. C., Haddock, C. K., Jahnke, S. A., Jitnarin, N., & Day, R. S. (2013). An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health*, 13(1), 1–14.
- Schillaci, G., Verdecchia, P., Reboldi, G., Pede, S., & Porcellati, C. (2000). Subclinical left ventricular dysfunction in systemic hypertension and the role of 24-hour blood pressure. *American Journal of Cardiology*, 86, 509–513.
- Smith, D. L., DeBlois J. P., Kales S. N., & Horn G. P. (2016). Cardiovascular strain of firefighting and the risk of sudden cardiac events. *Exercise and Sport Sciences Reviews*, 44(3), 90–97.
- Smith, D. L., Horn, G. P., Petruzzello, S. J., Fahey, G., Woods, J., & Fernhall, B. (2014). Clotting and fibrinolytic changes following firefighting activities. *Medicine & Science in Sports & Exercise*, 46(3), 448–454.
- Smith, D. L., DeBlois, J. P., & Kales, S. N. (2014). Combatting Sudden Cardiac Death (SCD) in the United States (US) Fire Service. *International Fire Service Journal of Leadership & Management*, 8, 23-30.
- Soteriades, E. S., Smith, D. L., Tsismenakis, A. J., Baur, D. M., Kales, S. N. (2011). Cardiovascular disease in US firefighters: A systematic review. *Cardiology in Review*, 19(4), 202–215.
- Soteriades, E. S., Kales, S. N., Liarokapis, D., & Christiani, D. C. (2003). Prospective surveillance of hypertension in firefighters. *Journal of Clinical Hypertension*, 5(5), 315–320.
- Soteriades, E. S., Kales, S. N., Liarokapis, D., Christoudias, S. G., Tucker, S. A., & Christiani, D. C. (2002). Lipid profile of firefighters over time: Opportunities for prevention. *Journal of Occupational and Environmental Medicine*, 44(9), 840–846.
- Verdecchia, P., Carini, G., Circo, A., Dovellini, E., Giovannini, E., Lombardo, M., . . . The MAVI Study Group. (2001). Left ventricular mass and cardiovascular morbidity in essential hypertension: The MAVI study. *Journal of the American College of Cardiology*, 38(7), 1829–1835.
- Yang, J., Teehan, D., Farioli, A., Baur, D. M., Smith, D., & Kales, S. N. (2013). Sudden cardiac death among firefighters ≤45 years of age in the United States. *The American Journal of Cardiology*, 112(12), 1962–1967.

Competing Interests

The author has served as an expert witness in legal cases involving firefighters.

Acknowledgments

Funding for this work was provided to the author by the US Federal Emergency Management Agency (FEMA), Assistance to Firefighters Grant (AFG), Program Award EMW-2013-FP-00749 (PI: Dr. Denise L. Smith).

About the Author

Denise L. Smith, Ph.D., is a Professor of Health and Exercise Sciences at Skidmore College, where she directs the First Responder Health and Safety Laboratory, and is a Research Scientist at the University of Illinois Fire Service Institute. Dr. Smith has coauthored several textbooks and has published over 60 scientific papers, primarily on firefighter cardiovascular health. She lectures extensively on health and safety issues in the Fire Service. Her research has been funded by FEMA-AFG, DHS S&T, NIOSH, and DOD. She is a fellow of the American College of Sports Medicine and a member of the NFPA® Fire Service Occupational Safety and Health committee.

The *International Fire Service Journal of Leadership and Management* is a refereed or peer-reviewed journal published annually. It is published by Oklahoma State University (OSU), International Fire Service Training Association (IFSTA), and Fire Protection Publications (FPP). Detailed information about the journal is provided below.

Preparing an Article for Publication in IFSJLM

Articles submitted for review should be in general conformance with the guidelines outlined below. If the manuscript is accepted for publication, it is the responsibility of the author(s) to prepare a final manuscript that conforms to *IFSJLM* style requirements and to submit to the editor an electronic copy of the paper as a Microsoft Word® file.

Articles should be no longer than 30 pages in length (including tables, figures, references, and notes). Manuscripts must be typed, double-spaced, on paper sized 8.5 by 11 inches, and use standard margins.

Given the readership of the journal, articles should avoid technical jargon, mathematical modeling, etc. and be of interest to both academics and practitioners. Articles using survey and statistical data are encouraged, but information and findings should be communicated clearly and concisely.

Tables and figures should not be placed in the text. Each table or figure should appear on a separate piece of paper and placed at the end of the manuscript. In the text of the manuscript, indicate approximate placement of tables and figures by using inserts: [e.g., Table 1 About Here].

On a detachable first page of the manuscript, include the title of the manuscript and all identifying material for each author: i.e., names, affiliations, mailing addresses, telephone numbers, and email addresses. If the article is co-authored, place an asterisk by the name of the person who will serve as a point of contact. Also on this page, provide a short 75- to 100-word biographical sketch that includes information about each author, their positions, their organizations, and previous publications and/or professional interests.

A 50- to 75-word article abstract should accompany an article. The abstract should concisely identify the research question studied, theoretical framework employed, methods used, and major findings of the research.

IFSJLM uses the American Psychological Association (APA) reference style to cite literature used in the article. This author-date method of citation requires that you cite the author's surname and date of publication (e.g., Neal, 2000). To cite a specific part of a source, such as a quote from an article, provide the author's surname, date of publication, p. for page and page number (e.g., Neal, 2000, p. 42). For complete information on using the APA style see the most recent edition of the *Publication Manual of the American Psychological Association*. This manual can be found at your local bookstore, research library, or can be purchased online at: <http://www.apastyle.org/> Sources cited in the text should be listed in a references list following the style also outlined in the APA Manual.

Submission Requirements and Information

All manuscripts submitted to *IFSJLM*: (1) must be original (not previously published in whole or part in either print or electronic format) and (2) must not be under review for publication elsewhere. Upon acceptance and publication, the Board of Regents for the State of Oklahoma retain the exclusive rights to publication. Journal articles and book reviews are copyrighted by the Oklahoma State University Board of Regents, with all rights reserved. Copyright assignment is a condition of publication. Authors will be provided and will be asked to sign a copyright assignment. Crown manuscripts are exempt from the copyright requirement.

Please submit an electronic copy of an article or book review in Microsoft Word® format to: **bob.England@okstate.edu**

Article Review Process

All articles, unless otherwise noted upon publication, submitted to *IFSJLM* are peer reviewed. *IFSJLM* uses a double-blind review process: The author does not know who reviewed the article and the reviewers do not know who wrote the article. Thus, it is important that the author only be identified on the cover page. The editor will remove the cover page before the article is sent out for review. Avoid making references to previous research by referring to oneself in the third person and referencing such work. The review version of the article should not thank colleagues for reviewing a draft of the manuscript or state that an earlier version of the paper was presented at a conference. If accepted for publication, the final version of the article can contain such information. As they read an article, peer reviewers are trying to answer the following questions: Is the material in the article accurate and relevant? Is the article grounded in theory? Are the methods used in the study appropriate and appropriately used? Does the article significantly add to our understanding of fire leadership and management? If not, the article may merit publication, but not in *IFSJLM*.

Reviewers are asked to evaluate articles within a 60- to 90-day time frame. If they cannot meet this parameter, they are instructed to inform the editor as soon as possible so that a new reviewer can be selected. After the editor receives all peer reviews, a decision is made to (1) accept the article for publication (subject to preparation guidelines and editing by journal staff), (2) accept the article pending specific revisions required by the peer reviewers, (3) allow the author to "revise and resubmit" the article for review based on general guidelines suggested by the reviewers, or (4) reject the article. Articles accepted under the "revise and resubmit" category are sent out for a second round of reviewers with no implied guarantee of acceptance. The editor of *IFSJLM* decides which articles will appear in the journal based on the peer review process. Decisions made by the editor are final. Reviewers' comments are made available to manuscript authors. Book reviews are NOT peer reviewed. The journal editor is responsible for deciding which book reviews to include in *IFSJLM*.

Journal Information

Book Reviews

Book reviews can be of a single book or several books that are tied together by a common theme (e.g., four different books on the topic of terrorism). Book reviews should not exceed five (5) double-spaced 8.5" by 11" pages using standard margins. Book reviews are not peer reviewed and are published at the discretion of the editor.

Book reviews should provide thoughtful analyses of the importance, utility, and/or meaning of a single book or several books to the development of the international fire service. In other words, the review should not focus on the merits and demerits of the book itself, but rather should focus on the nexus between the message of the book(s) and the development of fire leadership and management. Book reviews must focus on leadership and management issues, topics, and themes.

Electronic Access

Electronic access to all issues of the Journal except for the most current two years is available at: www.ifsjlm.org.

Permissions:

Contact: Mike Wieder, Fire Protection Publications, Oklahoma State University, 930 N. Willis St., Stillwater, Oklahoma 74078-8045; E-mail: mwieder@osufpp.org, Phone: 405-744-4255

Subscription

IFSJLM is published annually (in September/October). Subscription prices are: \$20 per year for students and \$50 for all other individuals and institutions. A flat fee of \$10 per year is added to all international subscriptions. Proof of student status is not required; we rely on professional ethics.

Please complete this page and submit to:

**IFSJLM-Subscriptions
C/O Mike Wieder
Fire Protection Publications
Oklahoma State University
930 North Willis St.
Stillwater, Oklahoma 74078**

Name: _____

Address: _____

Zip/Postcode: _____

Phone Number: _____

Email: _____

Payment: If paying by credit card, please call 1-800-654-4055. We accept Visa and Mastercard. Please have your card number and card expiration date handy. If paying by check: Make payable to Fire Protection Publications. Remember to add \$10 per year if the journal is being delivered outside of the United States.

DISCLAIMER

The International Fire Service Journal of Leadership and Management is an academic journal. As such, articles that appear in the journal are “approved” for publication by two to four anonymous members of the Journal’s Editorial Board and/or ad hoc peer reviewers. As editor I do not choose the articles that appear in the journal nor do I edit the content or message of an article once accepted. The copy editor and I only edit for style and readability.

The ideas and comments expressed in an article are those of the author(s) and should not be attributed to members of the Journal’s production team, Editorial Board, or to the sponsors of the journal, which are Oklahoma State University (OSU), the International Fire Service Training Association (IFSTA), and Fire Protection Publications (FPP). We simply publish that which has been peer approved. If for some reason an article causes consternation, you, the reader, are urged to contact the author directly to engage in a dialogue; that is how academic journals work. An author’s e-mail is provided with each article. Or, if you wish, you can submit a three- to five-page “response” to an article in which you outline significant theoretical and/or methodological objections to an article. The response may be accepted for publication. If so, the author will be allowed to offer a three- to five-page “rejoinder” to the response. This is how academic journals work. For the most part, however, you should direct your comments directly to the author. Responses and corresponding rejoinders will be rare and will be published at the discretion of the Journal editor. Journals are intended to stimulate debate and conversation. If you do not like what you read, contact the author or write an article for peer review that offers an alternative perspective.

Dr. Robert E. England
Editor

Oklahoma State University in compliance with Title VI of the Civil Rights Act of 1964 and Title IX of the Educational Amendments of 1972 (Higher Education Act) does not discriminate on the basis of race, color, national origin or sex in any of its policies, practices or procedures. This provision includes but is not limited to admissions, employment, financial aid and education services.

Published in cooperation with Oklahoma State University, Fire Protection Publications, and the International Fire Service Training Association. *International Fire Service Journal of Leadership and Management*, Copyright © 2007 Board of Regents, Oklahoma State University. All Rights reserved. No part of this publication may be reproduced without prior written permission from the publisher.

