NIST GCR 05-874

The Economic Consequences of Firefighter Injuries and Their Prevention. Final Report.

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National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

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Prepared for
U.S. Department of Commerce
Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-8661

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August 2004
Issued March 2005

U.S. Department of Commerce
Carlos M. Gutierrez, Secretary

Technology Administration
Phillip J. Bond, Under Secretary for Technology

National Institute of Standards and Technology
Hratch G. Semerjian, Acting Director

Notice

This report was prepared for the Building and Fire Research Laboratory of the National Institute of Standards and Technology under contract number 60NANB2D0044. The statement and conclusions contained in this report are those of the authors and do not necessarily reflect the views of the National Institute of Standards and Technology or the Building and Fire Research Laboratory.

The Economic Consequences Of Firefighter Injuries and Their Prevention

Final report

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ACKNOWLEDGMENTS

The *Economic Consequences of Firefighter Injuries and Their Prevention*, supported by a grant from the National Institute of Standards and Technology (NIST), was developed to help quantify the cost of firefighter injuries to the fire service. TriData, a Division of System Planning Corporation, performed the research.

This study is indebted to many individuals whose cooperation and assistance contributed to the research supporting the study's findings. The TriData Corporation and NIST would like to recognize the following individuals and organizations for their technical assistance with the project, and thank them for their contributions and insights.

Captain *Mike Cox*, Anne Arundel County, MD Fire Department
Captain *Ross Nickels*, Baltimore County, MD Fire Department
Acting Chief *James Merritt*, City of Newburgh, NY Fire Department
Captain *J. Hoying*, City of Dayton, OH Fire Department
Division Chief *James Hunsaker,* Denver, CO Fire Department
Chief *Donald Barkledge*, City of Fairfax, VA Department of Fire and Rescue
Penny Wright, Fort Lauderdale, FL Fire Department
Lieutenant *Michael Winsel*, Prince George's County, MD Fire/EMS Department
Katie Holloway, Burn Center at Washington Hospital Center, Washington, DC
Diane Carlson, University Hospital Burn Center SUNY at Stonybrook, NY
Deana Noffenberger and *Lana Parson*, Johns Hopkins Burn Center, Baltimore, MD
David Schaefer, Principal, Armfield, Harrison and Thomas, Insurance
Terri Katzenberger, Senior Associate, Armfield, Harrison and Thomas Insurance
Robert Reed, Traveler's Insurance Company
James Spano, CHSM, Regional Coordinator for Safety, Occupational Health, and Wellness, USGA Forest Service, Atlanta, GA
Bruce Butterworth, Butterworth Management Corporation
Susan Haga, Librarian, NIST Research Library

In addition, TriData would like to acknowledge the members of the TriData research staff who were primary contributors to the study.

Patricia Frazier, Director Center for Data Analysis and Special Studies
Nicole Hankin, Research Analyst
Philip Schaenman, President
Hollis Stambaugh, Director Center for Public Protection

EXECUTIVE SUMMARY

Every occupation brings degrees of safety risk, and one of the higher risk jobs is firefighting. At the scene or on the way to a fire, a multiple vehicle crash, an explosion, or even while training, firefighters face a relatively high chance of being injured, possibly killed. The National Institute of Science and Technology historically has been concerned with the risks to firefighters, and has devoted research to finding ways that reduce the incidence and severity of work-related firefighter injuries. In this latest research effort, NIST seeks to quantify the economic impact that injuries have to firefighters, their departments, the insurance industry, and society.

TriData Corporation of Arlington, Virginia, a public safety consulting company, conducted the cost-of-injury research and wrote this report. The research team culled information from a broad search of literature and examined various methodological approaches for insight into models that could be used to calculate the many components that comprise financial losses from injury. Though several previous studies successfully investigated certain aspects of what fires cost, each had limitations, and many dealt broadly with the cost of fire, not the costs of firefighter injuries. Studies of injury-related data, on the other hand, were helpful but did not usually address occupational injuries. When they did, costs were not necessarily a key factor of the research. The study team derived estimates, therefore, using elements of other methods and calculating costs from original research as well.

Based on methods applied from two of the more relevant economic studies, the estimated cost of addressing firefighter injuries and of efforts to prevent them is $2.8 to $7.8 billion per year. The cost elements that comprised those two studies were based on workers compensation payments and other insured medical expenses, including long-term care; lost productivity; administrative costs of insurance; and others.

Other costs heretofore have not been factored into assessments of firefighter injuries. The study team analyzed such elements as the labor costs of investigating injuries, along with the hours required for data collection, report writing, and filing. Another cost relates to what employers of firefighters pay to provide insurance coverage, and for safety training, physical fitness programs, and protective gear and equipment—all of these expenses are related to preventing injuries and reducing their severity. The study researchers were fortunate to obtain workers compensation information that was specific to the occupational codes for firefighters, a unique feature of this new research. Some of these expenses were applied to the total number of injuries, while others were factored around the total number of firefighters since they involve all firefighters, not just those who are injured. Estimates of these cost components alone accounted for $830 to $980 million in direct and indirect costs.

There is much to be done in the future if the impact of injuries to firefighters is to be reduced. To cause a drop in fireground-related injuries, preventing fires from occurring in the first place is, and always has been, the best means. In particular, controlling criminal, incendiary fires is a goal worth pursuing, since fires that are intentionally set are often more fully developed when firefighters arrive on the scene. Incendiary fires can have multiple points of origin and be fueled by accelerants so they burn faster and hotter. These are very dangerous fires. Reducing injuries that occur during training can be accomplished by better supervision, strict adherence to training guidelines and regulations, and proper preparation. Firefighters who are healthy and fit can better handle the physical requirements of the job and return to work faster if they are injured. Basic and recruit training must emphasize safety over exaggerated heroics, and drill on proper techniques. More fire departments need to take physical fitness seriously and adopt a formal program that monitors progress against goals and goals met against number and severity of injuries. There should be no compromises on using protective equipment, including SCBA.

Studies in the future need to support the information requirements of new safety and loss control initiatives Especially needed are better data and research on the severity of injuries to firefighters and the associated costs by level of severity. Few fire departments keep the types of records needed to establish an injury profile much less a program that uses that data to measure performance in meeting workplace safety goals. We need to better understand the time it costs to investigate injuries and to document reports, and though most fire chiefs know how much was budgeted for and spent on overtime, the amount which correlates to covering lost work time because of injuries, often is not identified. Finally, 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.

The study team is grateful to have contributed to the base of information on which safety and loss reduction policies and programs can be developed. There is still a lot to do to diminish the direct and indirect costs and the more intangible quality of life costs paid by firefighters who work to keep us safe.

I. INTRODUCTION

Each year, tens of thousands of firefighters are injured while fighting fires, rescuing people, responding to hazardous materials incidents, and training for their job. While the majority of injuries are minor, a significant number are debilitating and career-ending. Such injuries exact both a great human toll and financial toll. In addition to the costs the firefighters bear—economically and in terms of pain and suffering—the jurisdictions where they work must absorb the direct costs of lost work time, possibly higher insurance premiums, disability and early retirement payments, overtime for substitutes, and costs to train replacement personnel.

The National Institute of Standards and Technology wanted an estimate of the economic consequences of injuries to firefighters for the purpose of evaluating what new research would both positively impact costs and reduce injuries. TriData Corporation of Arlington, Virginia, a public safety consulting company that specializes in fire protection research, including data analysis, after-action investigations, and research on firefighter injuries, conducted this study.

What does it cost when a firefighter is injured and how can that cost be compared to the expenses associated with preventing and mitigating injuries from occurring? This study seeks answers to the cost implications of firefighter injuries by researching how the costs could be measured and quantified. The goal of this study is to contribute to the reduction of firefighter injuries by bringing to light their economic impact and focusing attention on the problem. By suggesting ways to assess what injuries cost, the study provides local governments with ideas they can use to pursue their own injury impact and prevention analysis. At the state and federal level, larger-scale research and analyses can be pursued to identify what actions would be most likely to reduce the incidence and severity of firefighter injuries.

Much of the data needed for this study was not neatly available or, if available, was not comprehensive. This data availability issue surfaced in all aspects of the project. Even quantifying the numbers of firefighters and fire departments nationwide proved to be instructive: there is no unqualified source. There are, however, informed estimates based on credible surveys for these basic numbers. Numbers and costs associated with overtime, investigations, physical fitness programs, lost time from work, prevention-related costs (e.g., training), and type of injury (or by other component), were more challenging, as specific information in these and other areas is not commonly collected. Encouraging the fire service to begin to track costs related to injuries is as important as producing the broad estimates derived on the economic consequences of firefighter injuries.

The research reflected in this project produces an indication of the magnitude of the costs that together reflect the economic consequences from injured firefighters. It marks a first attempt to quantify the cost of firefighter injuries. What differentiates this study from other cost-of-fire

studies is the consideration of the impact of firefighter injuries on workplace costs as firefighter injuries are, by definition, injuries that occur on the job. Firefighters and fire departments strive to contain these injuries and their effects on the individual firefighter as well as the effect on the department as a whole. Few, if any, previous studies considered this component in sufficient detail to estimate the costs. This aspect of cost analysis is complex and is worthy of further, in-depth study.

Data collected and cost estimates derived from this data are based on the most recent data available. Wherever possible, costs are standardized to 2002 data and rounded to the nearest thousand.

Project Scope

The justification for investing in firefighter safety can be made solely in terms of reducing injuries and suffering, an argument made on moral grounds. No one would argue the value of doing everything possible to make firefighting a less hazardous occupation, but many factors influence risk reduction, each with its own price tag and cost-benefit value. There are alternative ways to spend federal and local government monies to reduce injuries to various population groupings. It is useful to consider the economic tradeoff as well as the potential reduction in injuries.

Proper firefighter equipment and tools are two of the most basic investments to protect firefighter safety. Training is another critical component in the injury prevention arsenal, though training itself can and does cause injuries.[1] However, the most effective way to reduce injuries is to prevent fires from occurring in the first place. Since over half of firefighter injuries occur on the way to, at, and returning from the fireground, eliminating more fires automatically reduces the risk of injury. All efforts toward preventing fires and other emergency incidents have a direct impact on firefighter safety.

The challenge for fire departments and local governing bodies is judging how to assign the available solutions for reducing direct and indirect expenses from injuries so as to incur the best payoff. For example, should training receive the lion's share of monies so that safe and proper fireground tactics and procedures are emphasized over, for example, upgrades in equipment? Do formal physical fitness programs and requirements make a measurable difference in reducing the rate of injuries and acute, work-related illness? If the answer is "yes," then should more shift time be devoted to maintaining physical fitness, even if it means that time for refresher training on basic skills may suffer?

[1] U.S. Fire Administration, *Trends and Hazards in Firefighter Training: Special Report,* FA-TR-100.

As part of an injury cost-benefit assessment, fire departments need to address those injuries where the greatest concern and cost impact lie. Is it infrequent, but more severe injuries, or is it commonly occurring injuries (strains, falls, slips, cuts, etc.), which affect more personnel every year? What types of injuries cost the most on an annual basis? Severe burn injuries are arguably the worst kind of injury to suffer and the associated direct and indirect costs can be substantial. Back injuries, though, can result in many lost days of work and, with recurring flare-ups over the years, can incur substantial medical expenses and overtime costs. Information on the economic burden of injuries will help decision makers set or adjust priorities and justify new expenditures when necessary. These issues, and others like it, are critical components of the assessment.

Fire departments can use the information in this report to estimate the cost implications of injuries that occur, and of the measures designed to prevent them. The first step is to assemble and evaluate departmental injury data over several years and then develop a specific injury profile reflecting the department's actual experience, rather than relying on industry or national averages. Fire officials can then apply cost factors to the injury data and estimate the overall loss picture for their department.

For NIST, the research results from this study on the economic burden of firefighter injuries can be used to determine what new research might lead to a reduction in injury costs and to enhancing firefighter safety. Such research often more than pays for itself, as was documented in a previous TriData study for the Center for Fire Research.[2] TriData showed that NIST fire research reaped significant economic dividends across society and sectors of the economy. There is a valuable leverage of dollars when they are invested in research directed toward reducing casualties and losses from fires, engineering better safety measures, and reducing liability.

Definition of Firefighters

For this study, the term *firefighters* encompasses all individuals who are members of career, volunteer, or combination departments, and who carry out any fire department-related service. Paramedics, training officers, members of special search and rescue teams, and others all are reflected in the term *firefighter*. Federal civilian and military firefighters are considered in the study and estimates on their injuries are captured, but most of the data found pertained to local fire department personnel.

[2] TriData Corporation, *Estimated Impact of the Center for Fire Research Program on the Cost of Fire,* for National Institute of Standards and Technology, 1991.

Definition of Injury

The term *injury* in this study is inclusive of all on-duty injuries (fireground and elsewhere) and occupational illnesses, though the latter are difficult to define and count as discussed below. As noted previously, firefighters not only perform basic firefighting, but also provide emergency medical service (EMS), hazardous incident mitigation, technical rescues, and other services that all can lead to injury or exposure to harmful substances. Transportation-related injuries (in fire vehicles or personal cars) that occur during operations, injuries that occur in the station house from training and physical fitness, or other miscellaneous duties are considered on-duty injuries as well (Table 1.)

Table 1. Types of Injury – 2002

Type of Injury	Number	Percent
Responding to or returning from an incident	5,805	7
Fireground	37,860	47
Non-fire emergency	15,095	19
Training	7,600	9
Other on-duty	14,440	18
Total	**80,800**	**100**

Source: National Fire Protection Association

Injuries also include psychological disorders, especially if they require treatment or cause lost time from work. Most fire service personnel today are aware of critical incident stress syndrome, and recognize when firefighters are symptomatic, especially following difficult incidents (e.g., those involving the death of a child or another firefighter, mass casualty incidents, and so forth.) Although counts for psychological injuries are not available, the cost of counseling or treatment is often included in the information gathered by the study.

The general guidelines for defining injury were as follows:

- Specific to and caused by a job-related situation, regardless of what job the injured individual was performing at the time (fireground operations; rescue – all types; extrication and accident scenes; EMS; investigations; overhaul operations; training; and so forth.)
- Acute injuries, trauma, and illnesses.
- Diseases and illnesses that develop over time (e.g., emphysema, cancer, heart attack and stroke). Originally, this category of illness was excluded; however, since these conditions are covered by workers compensation insurance in many states, it is appropriate to count them as part of the study.

Issues and Considerations

Special attention was paid to injuries that occurred at the scene of the fire, because, though the number of fire calls continues to drop, the *rate* of injuries at the fire scene, while fluctuating from year to year, has remained about the same over the last 15 years. According to the National Fire Protection Association (NFPA), the rate of fireground injuries per 1,000 fires over a 15-year period (1988-2002) ranged from a high of 28.3 registered in 1990, to a low of 22.4 in 2004. (See Table 2.) The average rate of these injuries was 25.5. In comparison, the injury rate at non-fire emergencies has dropped from a high of 1.43 in 1992 and consistently remained under 0.94 since 1995.

Table 2. Firefighter Injuries at the Fireground, and at Non-Fire Emergencies 1998-2002

At the Fireground			*At Non-Fire Emergencies*	
Year	*Injuries*	*Injuries per 1,000 Fires*	*Injuries*	*Injuries per 1,000 Incidents*
1988	61,790	25.4	12,325	1.13
1989	58,250	27.5	12,580	1.11
1990	57,100	28.3	14,200	1.28
1991	55,830	27.3	15,065	1.20
1992	52,290	26.6	18,140	1.43
1993	52,885	27.1	13,675	1.25
1994	52,878	25.7	11,810	0.84
1995	50,640	25.8	13,500	0.94
1996	45,725	23.1	12,630	0.81
1997	40,920	22.8	14,880	0.92
1998	43,080	24.5	13,960	0.82
1999	45,500	25.0	13,565	0.76
2000	43,065	25.2	13,660	0.73
2001	41,395	23.9	14,140	0.73
2002	37,860	22.4	15,095	0.77

Source: National Fire Protection Association

One data problem that arises is how to count exposures to hazardous materials. If personnel use properly fitted self-contained breathing apparatus (SCBA), and use it in accordance with accepted standards, their exposure will be limited. Likewise, emergency medical technicians (EMT) know to wear gloves before working with a patient, and all fireground personnel should wear proper bunker gear, including work gloves, that prevent contact with harmful substances. In reality, however, some firefighters do not have proper SCBA, nor wear it as often or for as long as they should. Personnel sometimes are careless, take risks, or lack the right equipment.

When firefighters are exposed to smoke or other toxic substances and the situation warrants (the safety officer or incident commander believes there might have been an exposure incident[3] even though the firefighter does not complain of symptoms), some fire departments send firefighters to the hospital to evaluate their condition and any deleterious effects caused by the exposure. This practice also is done to establish a record on the exposure and what the tests revealed. Even if no injury or illness occurs, the cost of time at the hospital for medical evaluation, and of record keeping, count toward the cost of the real or potential injury.

Some fire departments record illnesses that result from exposure to hazardous materials or pathogens as injuries, which is unfortunate because it muddies the definition. Hepatitis or HIV infection resulting from exposure to the blood of an EMS patient often is recorded by the department, but long term illnesses—such as cancer or heart disease that may be related to or exacerbated by the firefighter's job—are not always captured in the fire department's count.

Methodology

TriData approached this study in two stages. To begin, the universe of direct and indirect costs stemming from injuries was identified. From those cost areas, sources of data that measured these costs, or at least a method that could be used to develop estimates of these costs, were researched. Studies have been conducted for the Centers for Disease Control, the Consumer Product Safety Commission (CPSC), the National Highway Traffic Safety Administration (NHTSA) and others that estimated the cost of injuries in different settings, for example, motor vehicle accidents. This body of research was reviewed, along with previous studies for NIST. Economic reports from researchers in Australia, at the National Fire Protection Association, and at universities also were examined.

Data from the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor was acquired. The Bureau collects injury data from the states, and produces summaries across several types of reports. That data is discussed later in this report, as is cost data from the National Council on Compensation Insurance (NCCI). Both the BLS and the NCCI information is based on data reported by policy providers on workers compensation insurance claims to state entities and then captured by the federal government and the insurance industry in general. At the municipal level, the International City Management Association's (ICMA) Municipal Yearbook (2002 edition) provided a sampling of what cities in different population ranges spend on insurance for firefighters—one aspect of costs relating to injuries. National Fire Incident

[3] Exposure incident means a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

Reporting System (NFIRS) data was used to provide insight into the profile of firefighter injuries by severity and type.

The phase one research helped to define what aspects of the whole cost-of-injury picture could be estimated. Some of the original ideas had to be set aside because the data that was needed to prepare an estimate could not be located nor extrapolated with a sufficient degree of reliability. The research also aided in determining the most important components of cost (e.g., medical payments) and which ones could be assigned a lower priority (e.g., workplace retrofitting costs). The NIST project manager and the project team discussed the direction of the project and made refinements to the scope. Discovering what was possible to calculate, and what fell short of that goal, was an important finding in stage one.

The second phase of the study addressed applying various methods of estimating the number of firefighter injuries and their associated costs. No single, all-encompassing strategy was found that could be employed to generate a single, bottom line dollar figure for the cost of firefighter injuries. Rather, procedures for estimating different aspects of firefighter injuries and what it costs to prevent and address these injuries were uncovered and developed. More details on these methods are provided in Section III.

II. FIREFIGHTER DATA

The vast majority of firefighters in the United States work at the local level. The U.S. has a long-standing tradition of volunteerism and over three-quarters of firefighters are volunteers. The military and private sector also employ a small number of firefighters.

Number of Firefighters

A basic data point in this study was the overall number of firefighters in the United States. The U.S. Fire Administration (USFA) and NFPA are two main sources of civilian fire-related data. Table 3 presents how their counts of firefighters compare. The estimates are remarkably close and any of the three could be used as the baseline number of civilian firefighters. As the NFPA data is widely accepted and contains useful categories, it was the source selected as the basis for the study estimates that required the number of career, volunteer, or total number of firefighters. Neither of these primary sources covered military, private sector, or contract firefighters. Estimates for military firefighters were developed and are shown separately in Table 4. The study team was unable to ascertain numbers for contract and private sector firefighters other than those included under the military firefighter counts, but the number is believed to be small.

Table 3. Estimates on Total Number of Firefighters

Source	Total # of Firefighters	Career	Volunteer
NFPA[4]	1,108,250	291,650	816,600
USFA[5]	1,088,950	266,100	822,850
USFA[6]	1,238,400	385,000	853,400

Estimates for military firefighters were not readily available through the separate services. The only source discovered for this information was from the retired Department of Defense (DoD) firefighters' website. According to that source, approximately 25,000 firefighters serve in the Army, Navy, Marine Corps, and Air Force.[7] This number includes military personnel

[4] National Fire Protection Association, *U.S. Fire Department Profile Through 2002,* October 2003.
[5] U.S. Fire Administration, *A Needs Assessment of the U.S. Fire Service,* FA-240, December 2002.
[6] Projected from Fire Department Census Database (TriData Projection). Based on data collected from 22,044 departments registered with National Fire Department Census as of 4/1/04. Projection assumes the total number of fire departments to be 30,310 as estimated by NFPA (2002 data).
[7] www.dodfire.com, accessed May 12, 2004. http://www.dodfire.com/Retirees/dl/QNN_vol1_04.pdf

as well as civil service and contract firefighters serving the armed forces as DoD employees. Adding these 25,000 firefighters brings the total number of firefighters to 1,133,250.

Assuming that the ratio of firefighters to all other job positions in the military is about the same throughout the services, these 25,000 firefighters would be distributed across DoD in accordance with the percentages shown in Table 4. Note: the number of Coast Guard firefighters (part of the Department of Homeland Security, not DoD) is not included as insufficient information was available to make an informed determination.

Table 4. Estimated Number of Military Firefighters

Department	Number of Personnel[8]	Distribution Across DoD (percent)	Estimated Number of Firefighters
Army	493,816	35	8,658
Navy	377,369	26	6,616
Marine Corps	175,616	12	3,079
Air Force	379,086	27	6,646
Total DoD*	**1,425,887**	**100**	**25,000**

*Totals may not add due to rounding.

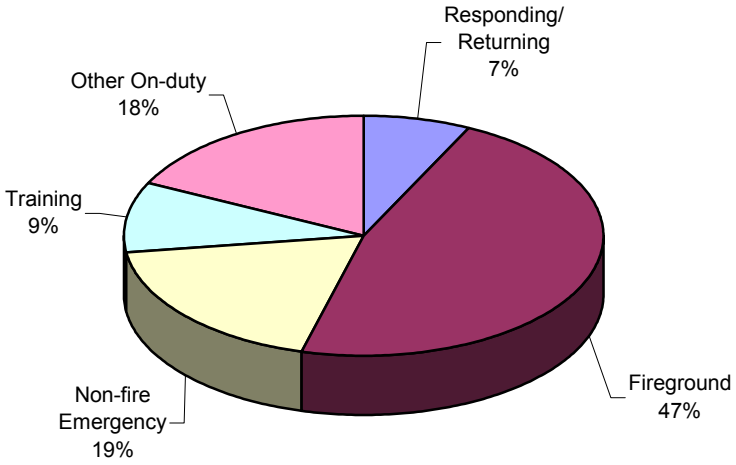
Source: Office of the Secretary of Defense, Directorate for Information Operations and Reports

Firefighter Injury Data

In 2002, an estimated 80,800 civilian firefighter injuries occurred in the line of duty—an almost two percent decrease from 2001.[9] As shown previously in Table 1 and here in Figure 1, the majority (51 percent), occurred on the fireground, followed by other on-duty activities, and non-fire emergencies. Fireground operations include all tasks associated with fire suppression and incident mitigation including fire attack, water supply, command, salvage, and overhaul. On-duty activities also consist of inspections, public education, and fire investigations. Non-fire emergencies include EMS calls, motor vehicle collisions, hazardous materials incidents, natural disasters, terrorist events, and others.

[8] Office of the Secretary of Defense, Directorate for Information Operations and Reports, http://web1.whs.osd.mil/mmid/military/ms0.pdf, data as of March 31, 2004.
[9] *U.S. Firefighter Injuries 2002*, National Fire Protection Association, January 2003.

Figure 1: Firefighter Injuries by Type of Duty (2002)



Source: National Fire Protection Association

Military firefighter injuries are estimated to account for an additional 110 injuries, bringing the overall total of firefighter injuries to 80,910. These 110 injuries were derived based on data from the Naval Safety Center, the keeper of the Department of Defense fire data. This data revealed that over the 10-year period of 1991 through 2000 there were 286 Navy firefighter injuries, averaging about 29 injuries per year for the Navy's estimated 6,620 firefighters, a very low number and an enviable record. Assuming the percentage of firefighters who are injured is the same throughout DoD's firefighter units, the total estimated number of military firefighter injuries per year is 110. Table 5 itemizes these DoD firefighter injury estimates.

Table 5. Estimated Number of Military Firefighter Injuries per Year

Branch of DoD	*Estimated Number of Firefighters*	*Estimated Number of Injuries per Year*
Army	8,658	38
Navy	6,616	29
Air Force	3,079	13
Marines	6,646	29
Total DoD*	**25,000**	**110**

*Totals may not add due to rounding.

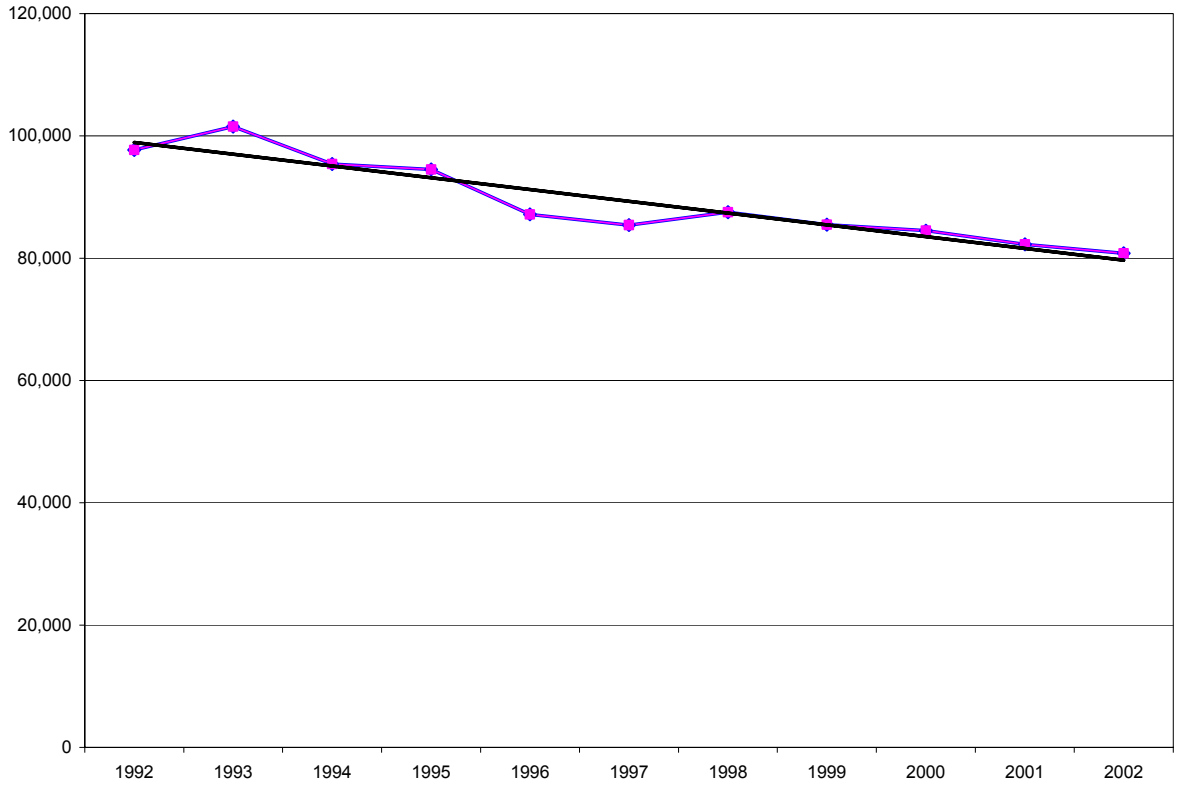
Throughout this report, the assumption is made that the military firefighter injury statistics mirror those of their non-military counterparts. Cost calculations in this report include military injury statistics where appropriate; however, trend and distribution statistics will not and

reflect only non-military firefighter injuries. The military portion is a very small part of the total cost.

Trends in Firefighter Injuries

As illustrated by Figure 2, the number of civilian firefighter injuries has trended downward by nearly 20 percent over the past decade. The incidence of injuries per 1,000 calls has also decreased, from a high of 6.6 in 1992 to a low of 4.1 in 2000.[10] At the same time, overall fire department call volume has increased nearly 40 percent since 1992; however, much of that increase reflects calls for emergency medical and other non-fire services where the rate of injury is lower than the injury rate for working fires.

Figure 2: Firefighter Injuries 1992-2002



Source: National Fire Protection Association

In theory, some portion of the downward trend in firefighter injuries can be attributed to a decrease in the number of fires fought, as fewer fires lead to fewer opportunities for injury. Other critical components in the downward trend in injuries are the development of improved safety

[10] Call volume data taken from the NFPA's *Fire Department Calls*, October 2001.

practices and better protective equipment (including apparatus). The use of self-contained breathing apparatus (SCBA) is the norm in fire suppression operations, and most firefighters are equipped with Nomex hoods, which cover their ears and neck. A new problem is threatening to develop, however. As protective gear has improved, firefighters can get deeper into a fire and remain there for longer periods of time before they feel the heat and realize they should retreat. This situation puts the firefighter at risk. Protective ensembles may have become almost too effective.

Other factors that have contributed to fewer injuries are closed passenger cabs and restraint systems that were not available in the past. Such safety features better protect vehicle occupants in the event of a collision. As common as are closed cabs, SCBA, hoods, and other safety features, some fire departments, especially volunteer departments in rural areas, still do not have the latest, improved gear and equipment. Generous federal grant programs in recent years, however, have allowed many of these departments to purchase new equipment and reduce that particular safety gap.

Nature of Injury

Muscle injuries (primarily strains and sprains) accounted for nearly half of firefighter injuries in 2002 (see Table 6.) Overexertion was a primary causative factor for muscle injuries, many of which involved the back. Open wounds, cuts, bleeding, and bruising accounted for the second largest portion of fire service injuries. Over two-thirds of injuries are the result of these two injury groups. Burns, an injury commonly associated with fire, are not a major cause of firefighter injuries but the cost of severe burn injuries can be large, as discussed in Chapter III.

Table 6. All Duties Combined—Nature of Civilian Firefighter Injuries 2002

Nature of Injury	*Number of Injuries*	*Percent of Injuries*
Sprain, Strain, Muscular Pain	39,390	48.8
Wound, Cut, Bleeding, Bruise	16,220	20.1
Other	9,650	11.9
Burns (Fire or Chemical)	3,855	4.8
Thermal Stress	3,225	4.0
Smoke or Gas Inhalation	2,575	3.2
Dislocation, Fracture	2,340	2.9
Other Respiratory Distress	1,360	1.7
Burns and Smoke Inhalation	1,165	1.4
Heart Attack or Stroke	1,020	1.3
Total*	**80,800**	**100.0**

*Totals may not add due to rounding.

Source: National Fire Protection Association

Severity of Injury

The USFA's NFIRS database provides the best source of data for the level or severity of injury. Data from nearly half of the nation's estimated 30,000 fire departments is reflected in the system. While this voluntary system is not a census of firefighter injuries, fire data analysts, nonetheless, consider the data profiles as the best picture of the nature of the U.S. fire problem. The accepted practice is to use the profiles to distribute the overall estimates created by the NFPA survey into various sub-components. Based on this distribution technique, injuries to an estimated 28,000 firefighters (one-third of firefighter injuries) result in lost work time (Table 7.)

Table 7. Severity of Civilian Firefighter Injuries

NFIRS Injury Severity	NFIRS Sample	Percent	Firefighter Injury Estimate
First aid only	548	25.9	20,965
Treated by physician, no lost-time	833	39.4	31,869
Moderate, lost time	689	32.6	26,359
Severe, lost time	37	1.8	1,416
Life threatening, lost time	5	0.2	191
Total*	**2,112**	**100.0**	**80,800**

*Totals may not add due to rounding.

Source: NFIRS, 2001 Version 5.0 data

Burns are not a major type of injury insofar as their numbers are concerned—approximately 6.2 percent, or 5,020 firefighter injuries, are burn-related (thermal and chemical burns and burns from smoke inhalation). Burns are a subset of injuries that receive special attention, both in estimating economic consequences and in pursuing ways to mitigate them.

Most burns are not severe and are treated without the need for hospitalization (Table 8.) Typically burns involve the hands, ears, and neck. A serious burn injury, however, is arguably the most devastating of all injuries by every measure of pain, suffering, and cost.

Table 8. Civilian Firefighter Burn Injury Severity

NFIRS Injury Severity	NFIRS Sample	Percent	Firefighter Burn Injury Estimate
First aid only	120	47.1	2,362
Treated by physician, no lost time	75	29.4	1,476
Moderate, lost time,	56	22.0	1,102
Severe, lost time	3	1.2	59
Life threatening, lost time	1	0.4	20
Total*	**255**	**100.0**	**5,020**

*Totals may not add due to rounding.

Source: NFIRS, 2001 Version 5.0 data

The study team talked to personnel[11] from several burns centers along the East Coast, and inquired into the numbers of firefighters they typically see in the course of a year and the nature and severity of their injuries. It was found that hospitals do not generally collect statistics according to occupation. All of the burn units did agree that, generally speaking, the percentage of patients they treated who are firefighters is small—about one percent or less each year.

[11] Burn Center at Washington Hospital Center (Katie Holloway), University Hospital Burn Center SUNY at Stonybrook, NY (Diane Carlson), and the Johns Hopkins Burn Center, Baltimore, MD (Deana Noffenberger and Lana Parson).

III. COST OF FIREFIGHTER INJURIES

Firefighter injuries result in both direct out-of-pocket costs related to the injury and indirect costs for preventing or mitigating injuries. One problem that emerges is that direct and indirect costs are not uniformly defined. What is a direct cost in one study is captured as indirect in another. Also, the list of indirect expenses can be built out to the extreme and at some point cannot be calculated. Direct costs usually include all the costs related to treating and compensating for the immediate injury or illness. All other costs, for example, the cost of personal protective equipment and overall costs to society, are considered as indirect. For this study, direct and indirect costs (costs to both the firefighter and the employer) were defined according to the discussion below.

Another issue to consider is who or what is affected by the cost: society, the firefighter, the taxpayer, the insurance company, or another entity. In the case of insurance costs, both the insurance company paying the claim and the jurisdiction paying the premium are affected as well as the firefighter who may encounter ancillary costs not covered by the policy. Legal costs are another example where costs may be related to both the plaintiff and the defendant.

Components of Direct and Indirect Costs

The ***direct*** costs of firefighter injuries—those costs that are a direct result of the injury—include:

- Lost wages of the injured firefighter that exceed disability payments
- Overtime wages, above the cost of the injured firefighter's wages, to fill in for the firefighter
- Medical costs
- Costs of psychological counseling for pain and anguish suffered by the firefighter, the firefighter's family, and (occasionally) the firefighter's co-workers
- Time spent by the firefighter, supervisors, and others in investigating the incident and writing the injury report
- Cost of outside investigations[12]
- Disability/retirement income (when firefighters cannot return to work for years, or retire on disability short of a normal career length)
- Litigation costs

[12] For example, the Occupational Safety and Health Administration; National Institute of Occupational Health and Safety; Environmental Protection Agency; and insurance carriers.

The ***indirect*** costs include:

- Additional staff sent to firegrounds for preventing and dealing with firefighter injuries (staff to meet the two-in/two-out rule; rapid intervention teams; safety officers)
- Cost of firefighter protective equipment
- Maintenance of protective equipment (e.g., cleaning and inspecting protective suits after each use—required now by NFPA standard)
- Cost of training for firefighter safety (e.g., how to escape in extreme situations, buddy breathing)
- Administrative costs of insurance
- New safety technology such as sensors that are being developed to locate firefighters
- Cost of safety officers
- Union time and fire management time spent on negotiations related to safety
- Safety aspects of firefighter personnel record keeping

Looking at costs through yet another filter, it is possible to organize the types according to location or function, which in turn facilitates measuring and evaluating the impacts. Table 9 depicts this means of organizing cost types. Sources of data for each type of cost were then collected, searched, and evaluated. Several of the costs listed are intangible and cannot be measured in terms of dollar value.

Table 9. Matrix of Categories of Costs

Type of Cost	*Discussion*
DIRECT	
Workplace	
Backfilling	Cost of personnel to replace injured worker while recuperating.
Lost Productivity	Costs associated with inability to perform required functions because replacement workers are not as skilled as injured worker or because replacement workers cannot be found.
Administration	
Legal Fees	Lawyer fees to defend personal injury lawsuits brought by firefighters and to prosecute against claims decisions. Includes legal fees, court costs, and settlements/ judgments excluding punitive damages, and pain and suffering.
Paperwork and Data Collection	Cost of personnel time and systems used in filing reports of injury, claims for compensation, insurance forms, collecting information, etc.

Type of Cost	Discussion
Investigations	Time, expenses, and materials associated with investigating and documenting incidents and injury claims.
Insurance	
Non-Medical Payouts	Wage differential payments made by insurance companies on disability coverage.
Premium Increases	Increase in insurance premiums.
Medical Expenses	
In-patient	Costs directly related to hospitalization for required medical services, medications, orthopedic devices, rehabilitation, care providers, etc.
Out-patient	Costs directly related to required medical services, medications, rehabilitation, orthopedic devices, home care, care providers, psychiatrists, social workers, etc.
Long-Term Care	Costs of long-term care (e.g., nursing, medications, physical therapy, etc.).
Physical Changes to Home and Workplace	Costs of retrofitting workplace and home (e.g., ramps, etc.).
Federal Payments	
Public Safety Officers Benefit Program	Cost of federal payments under the Public Safety Officers Benefit law. These are made for fatalities and for completely disabling injuries that prevent the injured person from resuming gainful employment.
Lost Income	
Volunteer	Difference between regular wages and those paid under disability status, to include the loss of all wages from primary employment.
Career	Difference between regular wages and those paid under disability status.
Second Jobs	Loss of wages from any additional sources of income
Caregiver	Loss of wages for any caregiver forced to reduce/terminate employment in order to give care to injured person.
INDIRECT	
Insurance	
Administrative Costs	Costs related to the administration of insurance; does not include indemnity or medical payouts.
Prevention	
Turn-out gear and other personal protective equipment (PPE)	Costs of equipment, including maintenance and upgrades to firefighter protective ensemble.
Vehicle Safety Measures	Costs of retrofitting vehicles for improved occupant protection.

Type of Cost	Discussion
Personnel Accountability	Cost of implementing and maintaining personnel accountability systems, including the costs of the devices, disposable supplies, and record keeping.
Safety and Survival Training	Costs of training firefighters in safety and survival. Includes back-filling on-duty firefighters, training development costs, delivery costs (e.g., fees for instructors, facility, training materials).
Physical Fitness and Wellness Program	Costs of training, equipment, and record keeping.
Other Direct Costs	
Pain and Suffering	Intangible costs and consequences of changes in the lives of the injured person and/or family members.
Deprivation of Volunteerism	Intangible costs of removing viable volunteers from the community if new volunteers do not replace them.
Reduced Tax Revenues	Effect of reduced taxable wages on the federal, state, and local governmental revenue stream.
Reduced Spending	Multiplier effect of removing disposable income from the economy.

Cost Assessment Examples

There are several ways to approach estimating the economic impact of injuries to firefighters. Crude estimates can be made by calculating measures for one aspect of the picture and, using this as a rough approximation, extrapolating over the remaining aspects. Thus, if the cost of one type of injury is known, one could factor the costs of the other injuries in like fashion, working under the assumption that all the injuries have similar characteristics. Of course this is less precise than knowing the respective cost of each type of injury and then adding them together, but often it is not possible to obtain exact figures and basic assumptions must be made to at least approximate a range of answers. Results of other economic analyses where there is a degree of comparability were consulted, and a range of costs based on those models was developed. At the same time, the study team worked to obtain reliable workers compensation information and other data sources for more exact estimates.

The Cost of Injury to Victoria 1993–94 (Australia)

A decade ago, researchers in Australia sought to identify and describe the epidemiology of all injuries in the State of Victoria over a one-year period, and then estimate the lifetime costs of these injuries to the community.[13] Watson and Ozanne-Smith used injury data from the public health sector and mortality databases[14] that grouped injuries according to severity: medical treatment only, hospitalizations, and deaths. These were compared against cause, age, gender, location, and activity at the time of injury. Their methodology is one that could be applied to studies of injuries—including firefighter injuries—in the United States. The Victoria analysis of injury costs does not capture pain and suffering costs nor workers compensation awards. As a result, their research returns an estimated cost which is low in comparison to the other assessment models.

The Australian researchers documented that work-related injuries counted for 11 percent of all injuries in terms of the activity in which individuals were engaged at the time of injury. The average costs per injury for firefighters in U.S. 2002 dollars, adjusting for the 1993 exchange rate of 1.47 Australian dollars and adjusting for inflation, would be as shown in Table 10. The total direct costs for the injured firefighters would be about $260 million. Table 11 uses the study's per-injury cost to include a value for losses due to reduced productivity and any resultant disability. With these indirect costs included, the estimate increases to $310 million.

Table 10. Direct Cost Per Injury Based on Victoria, Australia Injury Study

Category	*Cost per Injured Person ($1993 Australian)*	*Cost per Injured Person ($2002 U.S.)*	*Estimated Cost of Firefighter Injuries*
Medical	$1,628	$1,378	$111,497,000
Disability	2,175	1,841	148,960,000
Total Cost*			**$260,458,000**

*Costs are rounded; totals may not add.

[13] Watson W. and Ozanne-Smith J. *The Cost of Injury to Victoria 1993–94*. Melbourne: Monash University Accident Research Centre, Report No. 124, 1997. http://www.general.monash.edu.au/muarc/rptsum/es124.htm, 11/16/02.

[14] Watson and Ozanne-Smith's mortality data come from Victoria's Coronial databases.

Table 11. Lifetime Cost of Injury Based on Victoria, Australia Injury Study

Cost	Cost per Injured Person ($1993 Australian)	Cost per Injured Person ($2002 U.S.)	Firefighter Injuries*	Estimated Cost of Firefighter Injuries
Hospitalized Costs	$20,609	$17,445	66,103	$ 51,957,000
Non-hospitalized Costs	929	786	14,807	258,303,000
Total**			**80,910**	**$310,260,000**

* Injuries are based on Table 7, with adjustments made for military firefighters; half of the moderate injuries are assumed to have hospitalization costs.
**Costs are rounded, totals may not add.

The next study also calculated injury costs by using lifetime cost and loss of productivity as factors that, with others, comprised an analysis of comprehensive cost of injury.

Economic Impact of Motor Vehicle Crashes – United States, 2000

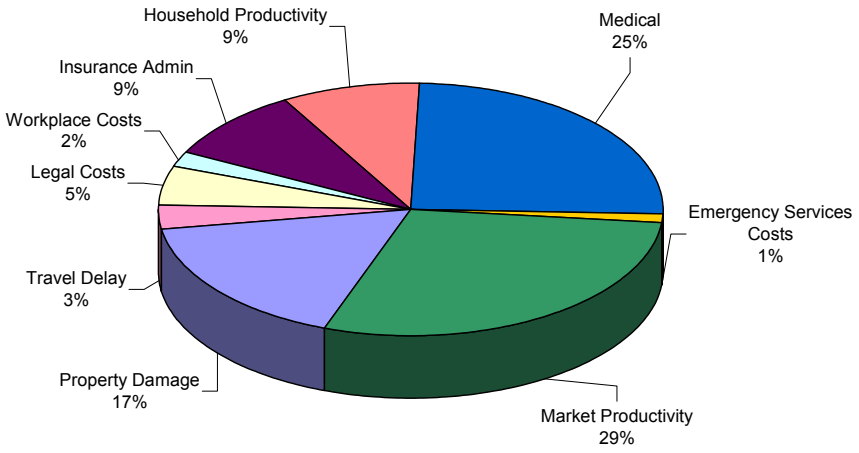
One cause of injuries that has been well researched in the United States is motor vehicle crashes. NHTSA conducted an excellent study resulting in the report, *The Economic Impact of Motor Vehicle Crashes 2000*. In their study, NHTSA captured the human capital and societal costs of crash injuries. The concept involves direct and indirect costs from the injury, both to society and to individuals, and addresses the costs of decreased production and decreased consumption as well as emergency medical costs, rehabilitation costs, long-term care and treatment costs, insurance administration expenses, legal costs, and employer/workplace costs. NHTSA's method did not apply values to loss of emotional well being (other than direct medical costs related to that) or pain and suffering.

NHTSA researchers evaluated the following costs:

- Medical
- Emergency Services
- Market Productivity
- Household Productivity
- Insurance Administration (overhead costs)
- Workplace
- Legal Costs
- Property Damage

The distributions of the preceding costs are depicted in Figure 3.

Figure 3. Components of Total Costs, Non-Fatal Injuries



Source: National Highway Traffic Safety Administration

NHTSA used the abbreviated injury scale (AIS), which ranks severity of injury from minor (1) to untreatable or fatal (6), as the basis for estimating cost. As vehicle crash victims often have multiple injuries, NHTSA took the injury with the highest cost within each severity level to create a maximum abbreviated injury scale (MAIS). The values in their estimates, therefore, should be considered as the high end of costs. Costs per severity of injury were calculated for each of the major components listed above. Property damage only (PDO) costs were summarized separately. The researchers also calculated the costs of injuries that were "less than minor" on the AIS scale, creating a MAIS 0 rating. The MAIS injury scale is noted in Table 12. These per-injury costs are shown in Table 13.

Table 12. Maximum Abbreviated Injury Scale

Severity Level	*Description*
MAIS 0	Less than Minor
MAIS 1	Minor
MAIS 2	Moderate
MAIS 3	Serious
MAIS 4	Severe
MAIS 5	Critical
MAIS 6	Fatal

Table 13. Average Per Injury Costs by Severity of Injury and Components Motor Vehicle Crashes ($2000)

Cost Component	PDO	MAIS 0	MAIS 1	MAIS 2	MAIS 3	MAIS 4	MAIS 5	Fatal
Medical	$ 0	$ 1	$ 2,380	$ 15,625	$ 46,495	$ 131,306	$ 332,457	$ 22,095
Emergency Services	31	22	97	212	368	830	852	833
Market Productivity	0	0	1,749	25,017	71,454	106,439	438,705	595,358
Household Productivity	47	33	572	7,322	21,075	28,009	149,308	191,541
Insurance Administration	116	80	741	6,909	18,893	32,335	68,197	37,120
Workplace Cost	51	34	252	1,953	4,266	4,698	8,191	8,702
Legal Costs	0	0	150	4,981	15,808	33,685	79,856	102,138
Total	**$ 245**	**$ 170**	**$ 5,941**	**$ 62,020**	**$178,358**	**$337,301**	**$1,077,567**	**$957,787**

Source: National Highway Transportation Safety Administration

To apply this method to firefighter injuries, the NFIRS injury severity codes were mapped to the non-fatal MAIS injury categories (MAIS 0-5). Two approaches to the mapping were used, each based on slightly different assumptions on reasonable relationships between MAIS 0, "less than minor injury," and NFIRS severity code 1, "reported injury only." As with the NHTSA methodology, the summary costs for each MAIS category were calculated by multiplying the average per-person injury costs in each MAIS level by the estimated number of injuries for civilian firefighters. Military firefighter injury costs were estimated computing an average cost and applying it to the number of military firefighter injuries. The outcome of these computations is shown in Table 14. As a per-injury cost, MAIS 0 costs are barely noticeable against the per-injury costs of the other MAIS categories. However, when multiplied against the number of injuries in the category, the costs are not small.

From these computations, if firefighter occupational injuries were like those of people involved in motor vehicle accidents, the estimated comprehensive cost of firefighter injuries for 2002 would range between $6.0 billion and $7.8 billion. Note that NHTSA's injuries included injuries to children and that vehicle crash injuries were not generally occupational injuries. Both of these elements affect the value of these results as being directly comparable to firefighter on-duty injuries. Further research is needed to ascertain the applicability of this promising cost model.

Table 14. Comprehensive Injury Costs by MAIS for Non-Fatal Injuries

NHTSA		Estimate Including MAIS 0		Estimate Excluding MAIS 0	
Severity Level	Average Per Injury Cost ($2002)*	Estimated Firefighter Injuries	Estimated Cost	Estimated Firefighter Injuries	Estimated Cost
MAIS 0	$178	19,437	$3,452,000		
MAIS 1	$6,207	15,922	$98,821,000	20,965	$130,123,000
MAIS 2	$64,793	24,202	$1,568,141,000	31,869	$2,064,868,000
MAIS 3	$186,333	20,018	$3,730,098,000	26,359	$4,911,648,000
MAIS 4	$352,384	1,075	$378,816,000	1,416	$498,810,000
MAIS 5	$1,125,751	145	$163,540,000	191	$215,343,000
Costs for Civilian Firefighters**		80,800	$5,942,867,000	80,800	$7,820,792,000
Average Cost/Injury			$74,000		$97,000
Costs for Military Firefighters**		110	$8,091,000	110	$10,647,000
Total Cost**			**$5,950,957,000**		**$7,831,439,000**

* Comprehensive, but without property damage.
** Costs are rounded, totals may not add.

Meade Analysis – Cost of Fire Safety in a Modern Society

Research scientist William Meade documented his analysis of fire safety costs in a 1991 study, which has been widely acknowledged and used as reference for estimating the cost of various components of the U.S. fire problem. The report, *A First Pass at Computing the Cost of Fire Safety in a Modern Society,*[15] cites an NFPA analysis, based on an economic theory used to estimate injury costs by determining what a person would be willing to pay to avoid certain levels and types of injury, for the per-injury cost of fire. Using 2002 dollars, this original per-injury cost of $35,000 adjusts to $57,450 per injury. Multiplied by the firefighter injuries in 2002, this analysis produces a total cost of $4.6 billion.

Societal Costs of Cigarette Fires

In 1993, the National Public Services Research Institute (NPSRI), under contract to the U.S. Consumer Product Safety Commission, published their study, *Societal Costs of Cigarette Fires,*[16] the last of a series of six research reports emanating from the Fire Safe Cigarette Act of 1990 regarding the practicality of a performance standard for "safe" cigarettes. The injury costs focused on burn and anoxia injuries. Six research tasks comprised the basis of the report:

[15] Meade, William P., *A First Pass at Computing the Cost of Fire Safety in a Modern Society*, The Herndon Group, Inc. for National Institute of Standards and Technology, March 1991.
[16] National Public Services Research Institute, *Societal Costs of Cigarette Fires,* for Consumer Products Safety Commission, 1992.

MEDICAL COST ESTIMATES – Researchers estimated the costs of burns according to broad categories, which then were further broken down by age, gender, and diagnostic details specifically for cigarette fire burns. Hospital costs were calculated per emergency room treat-and-release cases and cases involving overnight or longer stays. Costs were built from a variety of injury data sources, including workers compensation data (as maintained by the National Council on Compensation Insurance) and hospital discharge survey data. Medical costs for non-hospitalized cases were based on data from the National Medical Expenditure Survey and third-party payer data.

TRENDS IN BURN INJURY TREATMENT AND HOSPITALIZATION – Interviews with burn experts and a review of medical literature helped determine these trends as well as their effect on costs and outcomes. Though the information is dated, the study suggests that each year an average of 330,000 visits to emergency rooms are due to burns, half of which are thermal burns (flame or hot objects). At the time the base data was drawn (1991-1992), hospital discharge data from California and the National Fire Incident Reporting System confirmed that percentage. The research showed that the length of stay in a hospital for burn injuries was about 10 days; however, when the injury was complicated by anoxia, the length of stay doubled to 20 days.

INVESTIGATIONAL CASE STUDIES ON BURN INJURIES – In-depth examinations of burn and anoxia injury cases were undertaken with nine individuals to assess physical functioning; psychological impacts and lost quality of life; out-of-pocket costs; lost work, caregiver expense, and education for the patient and his family; and long-term treatment costs. The questions and conclusions were geared to the circumstances of the smokers who were responsible for the fires that caused their burns, and therefore, were not especially applicable to firefighters who suffer burn injuries. The summary of these nine cases did not produce any relevant information to this current study.

JURY VERDICTS TO VALUE PAIN AND SUFFERING – In this task, researchers attempted to establish values related to the pain and suffering that result from burn and anoxia injuries. Using data on nonfatal burn verdicts and settlements, they applied regression analysis to draw quantitative conclusions. The number of cases summarized in Table 15 is different in each category of settlement.

Table 15. Mean Litigation Settlements for Burn Survivors - 1992

Type of Settlement	Number of Cases	Mean Settlement
Medical	85	$ 140,000
Wages	34	121,000
Future losses	12	115,000
Compensatory damage	190	2,246,000
Pain and suffering*	87	1,675,000

*Defined here as the difference between compensatory damage awards and the three loss categories: medical, wages, and future losses.

Source: Societal Costs of Cigarette Fires*, National Public Services Research Institute*

MODEL LITIGATION COSTS – The legal costs of burn cases were modeled by combining published data on costs per case, the frequency of litigation, estimated economic costs from the first task, and data from CPSC's injury cost model. The study reported that for firefighter occupational injuries the claim rate is about seven percent, over twice the claim rate of burn injury victims overall. Based on studies by RAND Corporation, the researchers noted the following legal costs, which have been adjusted for inflation to 2002:

- Non-auto tort claims average $1,200
- Defense attorney fees and expenses average $15,000
- Time and out-of-pocket expenses (e.g., transportation) were valued at $2,400 (plaintiffs) and $8,500 (defendants)
- Defendants spend an average of $1,600 on claims processing.

EMERGENCY TRANSPORT COSTS – Expenses related to transporting a burn victim to a treatment center covered ambulances, helicopter, and fixed-wing aircraft, including base fees, mileage charges, and medical team professional fees, if applicable. In 2002 dollars these costs varied by severity of burn injury and ranged from $230 (anoxia only) to $770 (burn with anoxia).

TOTAL COST – The NPSRI research included a brief estimate and analysis of firefighter injuries in cigarette fires that are of particular interest. Working with 1,349 non-fatal firefighter injuries in 1990, the report concludes that the average total cost per case was $27,00. Adjusted to 2002 dollars, this cost would be $34,100. The approximate average costs by category (numbers also are rounded and adjusted to 2002 dollars) are shown in Table 16.

Table 16. Firefighter Injuries Costs Based on *Societal Cost of Cigarette-Ignited Fires* (NPSRI/CPSC)

Cost Category	*Per-Injury Cost Non-fatal Injury $1992*	*Per-Injury Cost Non-fatal Injury $2002*	*Total Non-fatal Costs* $2002*
Medical/ EMS	$ 1,000	$ 1,300	$ 102,000,000
Productivity	3,000	3,800	306,000,000
Pain/ Suffering	22,000	28,000	2,247,000,000
Legal/ Administrative	2,000	2,600	204,000,000
Total Cost*	**$27,000**	**$34,100**	**$2,758,000,000**

* Original totals were computed before rounding component costs; totals will not add.

If the assumption is made that all non-fatal firefighter injuries follow the same pattern, this analysis indicates that the total societal costs of firefighter injury would be $2.8 billion.

The Total Cost of Fire (NFPA)

John Hall, in the NFPA's annual *The Total Cost of Fire in the United States,*[17] notes that the variation in estimates and valuations is wide. Based on NFPA's review of a number of significant research studies and liability valuations, Hall uses $166,000 per injury, civilian or firefighter, in 1993 dollars and indexes this value to inflation. This method results in an estimated cost of $16.7 billion as the total lifetime cost of firefighter injuries in 2002. It clearly yields the largest estimate.

Estimates of Individual Cost Components

The studies cited in the previous section provided one means of calculating estimated costs related to firefighter injuries. Though the previous studies successfully investigated certain aspects of what fires or what injuries cost, each had limitations. For example, one dealt broadly with the cost of fire, but not the costs of injuries. Another contained an excellent analysis of injuries, but not of fire injuries, and it covered the general population in non-work settings (i.e., vehicle accidents).

Unique costs emanate from occupational injuries that occur to firefighters. There also are indirect, but associated, costs that factor into preventing injuries. These special types of costs have not been addressed previously in cost assessments. The study team analyzed such elements as the labor costs incurred from investigating injuries, along with the hours required for data collection, report writing, and filing. Other costs relate to what employers of firefighters pay to

[17] National Fire Protection Association, *The Total Cost of Fire in the United States,* June 2003.

provide insurance coverage, safety training, physical fitness programs, and protective gear and equipment. All of these expenses relate to preventing injuries and reducing their severity.

This section addresses key components of costs of firefighter injuries. Estimates are discussed for those components for which the study team felt there were either sufficient data available or a reasonable methodology to calculate the associated costs.

Workplace Costs

BACKFILL TIME – There is no clear assessment of the cost of replacement labor for an injured firefighter. Often, the void is filled by other firefighters who earn overtime covering the shifts. Depending on the extent of injury, the firefighter may return quickly to full duties, be assigned to light duty temporarily, or be unable to return to work at all.

Typically, fire departments accommodate this issue with flexible firefighter staffing based on the departmental experience. This staffing mechanism is often referred to as the shift staffing factor (SSF). The SSF is the number of personnel per shift needed to staff one position (e.g., a driver or officer on an engine company, a paramedic on a medic unit) on a 24-hour-a-day basis. Because employees cannot work every shift for which they are scheduled due to training, departmental meetings, annual leave, sick leave, or injury it is necessary to build extra capacity into a fire department's employee roster.

A typical ratio of people needed per firefighting on-duty position per shift to accommodate the reduction in available work time is 1.1-1.3. With a three-shift schedule for example, the SSF at the lower end is 3.3; at the upper end 3.9. For example, for a department with 20 positions to fill on a three-shift schedule between 66 and 78 firefighters would be required.[18]

The cost to backfill then is already absorbed in the typical fire department staffing and budget and no additional cost burden results. Further investigation to determine the sensitivity of the SSF to changes in its components (e.g., reductions in firefighter injuries) would be necessary to quantify the injury component cost.

Administrative Costs

LEGAL FEES – This category of fees was difficult to develop independently within the scope of this project. Costs related to legal action were mostly found to be included as part of an overall estimate in the studies examined and not specifically addressed as a separate cost

[18] An example of the calculation of SSF can be found in the TriData management study for the Arlington County, Virginia, Fire Department.

element. In the 1991 NPSRI/CPSC study, however, legal expenses were estimated and documented. As was shown in Table 16, this estimate of the legal and administrative costs translates to $204 million for 2002.

PAPERWORK AND DATA COLLECTION – Most, if not all, workplace injuries require some level of paperwork or data collection management to document the injury, its cause, and follow-up actions. The time to carry out these administrative procedures, while not labor intensive, adds to the cost. Based on minimal staffing time as shown in Table 17, the estimate for this cost is $7 million.

Table 17. Estimated Salary Costs for Injury Documentation and Data Collection

Personnel	*Hours*	*Rate / hour**	*Estimated Cost*
Fire Department Officer	1	$24.50	$ 25
Support Staff	4	14.77	59
Per Injury Cost			$ 84
Firefighter Injuries			80,910
Total Cost**			**$ 6,762,000**

* Hourly wage data are from the Bureau of Labor Statistics.
**Costs are rounded, totals may not add.

INVESTIGATIONS – To calculate an estimated cost relative to injury investigations, the study team consulted an experienced OSHA-certified trainer and investigator.[19] Based on experience, the investigator indicated that an investigation for a moderately severe non-fatal accident or injury is about three days, including travel time. The study team assumed any incident involving an OSHA investigation would also result in comparable investigation time for fire department staff plus administrative support. It was assumed that the equivalent of two fire department personnel, a union representative and a senior officer, would be necessary to assist in investigating and documenting the incident. Per-investigation costs and overall costs based on the injury severity estimates from Table 7 are shown in Table 18 and total $57 million.

[19] James Spano, CHSM, Regional Coordinator for Safety, Occupational Health, and Wellness, USDA Forest Service, Atlanta, GA.

Table 18. Estimated Salary Costs for Incident Investigations

Personnel	Hours		Rate / Hour*	Estimated Cost	
	Moderate	Severe		Moderate	Severe
OSHA Investigator	24	40	$24.50	$ 588	$ 980
Fire Department (2)	48	80	24.50	1,176	1,960
Support Staff	12	36	14.77	177	532
Per-Investigation Cost				1,941	3,472
Firefighter Injuries**				26,395	1,609
Total Cost* **				**$51,240,000**	**$5,586,000**

* Hourly wage data are from the Bureau of Labor Statistics.
** Based on estimates from Table 7, with adjustments made for military firefighters; severe injuries were combined to include severe and life threatening.
*** Costs are rounded, totals may not add.

This preliminary estimate of labor costs could be higher in situations that involved a complicated incident with severe injuries where many interviews might be conducted. OSHA is not the only agency likely to be involved in a major investigation, which in turn, would demand more time from fire department personnel and from the investigating agency or group. Salaries vary considerably from region to region and by size of department. As such, the salaries above are only a general estimate.

Insurance

THE NATIONAL COUNCIL ON COMPENSATION INSURANCE, INC. (NCCI) – NCCI is the primary rating service organization that compiles loss and exposure data from workers compensation claims to establish experience modifiers and other ratings guidelines. The management of workers' compensation programs varies among the 50 states though most (36) participate in NCCI[20]. NCCI collects and aggregates loss and exposure data per policy information maintained by states for every workers compensation policy issued. NCCI uses an experience period of three years.

Through the assistance of several insurance industry representatives,[21] a subset of workers compensation summary data for worker code, "Firefighters and Drivers," was obtained.

[20] California, Delaware, Michigan, New Jersey, New York, Pennsylvania, and Texas have different experience rating plans from NCCI's. Also, Ohio, West Virginia, North Dakota, Washington, Wyoming, Puerto Rico, and the U.S. Virgin Islands do not permit private insurers to write workers compensation insurance, which must be purchased directly through the individual state funds.
[21] David Schaefer, a Principal at Armfield, Harrison and Thomas; Terri Katzenberger, Senior Associate, Armfield, Harrison and Thomas; and Robert Reed, Travelers Insurance.

Workers compensation claims summary characteristics for the firefighter codes were analyzed for the 36 states that participate. The data presented in Table 19 shows average claim data over three years for the 36 states, and then extrapolated for all 50 states. Indemnity losses refer to wages paid or payments to heirs. Medical losses refer to payments for medical treatment, including all types of medical providers, prescriptions, physical and occupational therapy, and so forth. The full set of data, by state, is found in Appendix B. The estimated total workers compensation payments per year for injured firefighters are about $68 million. From the difference in premiums paid and the total payouts, a gross estimate of the cost of insurance "overhead," the administrative and corporate costs, is about $15 million.

Table 19. NCCI Workers Compensation Claims Data Related to Firefighters (based on three-year averages)

Compensation Payment	*Average Cost Per Year for 36 States (6,690 Claims)*	*Per-Year Cost Estimate for All States*
Total developed indemnity losses	$21,787,000	$30,260,000
Total developed medical payments	26,839,000	37,276,000
Total Developed Losses*	**$48,626,000**	**$67,536,000**
Premiums paid	59,393,000	82,491,000
Net Insurance Overhead Cost*	**$10,676,000**	**$14,954,000**

*Costs are rounded, totals may not add.

Source: National Council on Compensation Insurance, Inc.

CITY EXPENDITURES FOR INSURANCE FOR FIREFIGHTERS – The International City Management Association (ICMA) surveys local officials on a variety of local government management subjects. ICMA staff analyzes the data generated from these questionnaires and produces the *Municipal Year Book*. As another source of insurance estimates, the study team collected data on insurance expenditures for full-time paid firefighters from the 2002 edition of ICMA Year Book. Data from approximately 1,300 U.S. cities was reviewed.[22] Included under insurance is the package of health, hospitalization, disability, and life insurance however the package is structured in each locale. Of these four insurance categories, health and hospitalization insurance costs dominate. Disability insurance includes both workers compensation and long- and short-term disability insurance.

[22] Only data with both the number of personnel and insurance costs available were used in this analysis. From Table 3/18, "Fire Department Personnel, Salaries, and Expenditures for Cities 10,000 and Over: 2001," ICMA's *Municipal Year Book*.

Summarized ICMA city expenditure data by size of city were used in combination with NFPA firefighter data by population protected (roughly equivalent to city size) to calculate estimates of overall insurances costs. The NFPA firefighter data is shown in Table 20.

Table 20. Firefighters by Population Protected

Population Protected	Career	Volunteer	Total
Over 1,000,000	32,850	100	32,950
500,000–1,000,000	31,500	5,000	36,500
250,000–499,999	24,550	5,050	29,600
100,000–249,999	44,500	3,500	48,000
50,000–99,999	43,750	5,200	48,950
25,000–49,999	44,200	23,150	67,350
10,000–24,999	42,650	79,750	122,400
Under 10,000	27,650	694,850	722,500
Total	**291,650**	**816,600**	**1,108,250**

Source: National Fire Protection Association

In Table 21 presents the estimated figures for insurance premiums that are paid to cover firefighters. The low estimate assumes that insurance costs are only paid for career firefighters. The high estimate assumes that all local firefighters, including volunteers, have disability insurance paid for them. While this upper estimate clearly overstates the cost, it provides an upper bound on the insurance. Assuming that approximately 10 percent of these costs are attributable to disability insurance, split equally between workers compensation and short- and long-term disability,[23] the overall annual insurance costs were calculated to range from $64 to $155 million. This range is in line with the data on premiums paid ($82 million, Table 19 above) provided by NCCI.

[23] This estimate of the relative proportion of insurance costs was based on the experience of Arlington County, VA as well as local Washington, DC companies. Only workers compensation insurance is considered, as firefighter injuries are workplace injuries.

Table 21. Estimated City Expenditures for Insurance of Firefighters

City Size	Full-time Paid Personnel	City Contribution to Insurance*	Contribution Per Firefighter	Low Estimate**	High Estimate**
Over 1,000,000	3,088	$ 9,351,000	$3,028	$ 99,476,000	$ 99,778,000
500,000–1,000,000	3,845	14,712,000	3,826	120,527,000	139,659,000
250,000–499,999	7,857	38,318,000	4,877	119,729,000	144,357,000
100,000–249,999	14,084	72,526,000	5,150	229,154,000	247,178,000
50,000–99,999	11,112	62,189,000	5,597	244,850,000	273,952,000
25,000–49,999	10,906	50,553,000	4,635	204,882,000	312,190,000
10,000–24,999	8,211	40,897,000	4,981	212,429,000	609,645,000
Under 10,000	243	426,000	1,753	48,473,000	1,266,605,000
Total Insurance Costs**				**$1,279,519,000**	**$3,093,363,000**
Worker Compensation Insurance Estimate (5%)**				**$ 63,976,000**	**$ 154,668,000**

* Includes contributions to health, hospitalization, disability, and life insurance programs
**Costs are rounded, totals may not add.

Source: International City Management Association and National Fire Protection Association

BURNS – Burn treatment can be one of the most expensive medical procedures. If one to two percent of the burns to firefighters are serious enough to require treatment at a burn unit then about 50 to 100 firefighters in 2002 sustained burn injuries severe enough for burn center hospitalization (from Table 8). The process of medical treatment associated with burns is a long and arduous one and involves many steps and treatment modalities. These costs are presented for informational purposes only as they assumed to be reflected in the medical costs above.

The Baltimore Regional Burn Center affiliated with The Johns Hopkins University Hospital provided summary information on age, length of stay, and mortality (Table 22.) Some of the data provided clues to the average cost of hospitalization for burn victims. For instance, the average length of stay (over the last five years) was approximately 10 days. The Burn Center indicated that the cost per day for a burn patient was approximately $5,000; thus, the cost of an average 10-day treatment at the Baltimore Burn Center would be $50,000 or $2.5 to $5 million for firefighter burn injuries.[24] This cost does not include plastic surgery or long-term rehabilitation costs, both of which could be substantial.

[24] While this data includes injuries to children, hospital staff indicated it was a reasonable estimate for any burn injury.

Table 22. Data from the Baltimore Burn Center (1998-2003)
(all patients)

	FY 98-99	FY 99-00	FY 00-01	FY 01-02	FY 02-03
Number of Patients	293	276	310	322	341
Adults	198	208	233	232	290
Children	95	68	77	90	51
Average Age	32	36	35	35	39
Average Length of Stay (days)	9.1	9.3	10.1	10.3	11.3
Mortality	7	12	16	19	0

Source: The Johns Hopkins Burn Center, Baltimore, MD

Federal Payments

The Federal Public Safety Officer Benefit (PSOB) program administered by the Department of Justice provides a one-time payment for line-of-duty deaths as well as for permanent and total disabling injuries. Data on death benefits was readily available, but not for the benefit payments that accrue to disabled public safety officers. As this study examines non-fatal injuries only, the death benefit payment information was not useful.

Physical Changes to Home and Workplace

Disabling injuries require the retrofitting of workplace and home. Under the Americans with Disabilities Act, most offices are built to accommodate workers with disabilities or are retrofitted to meet the requirements. The study team did not assess these costs for firefighters. The team, however, was able to ascertain costs to remodel a home (e.g., doorways, ramps, counter height, accessible fixtures.) Based on information from a Virginia builder, the cost to retrofit an average home with two bathrooms would cost about $30,000; for a large home with three bathrooms and more counter space the cost would approach $50,000. These costs would only apply to serious, disabling injuries.[25]

Prevention

PERSONAL PROTECTIVE EQUIPMENT (PPE) AND FIREFIGHTER GEAR – Another cost involved in firefighter injury prevention is the cost of turnout gear and SCBA—essential armor for firefighter safety. Discussions with Lion Apparel,[26] a major manufacturer of firefighter

[25] Estimates for home remodeling are based on information from Bruce Butterworth, Butterworth Management Corporation, a Northern Virginia real estate developer.
[26] Steve Schwartz, Senior Vice President, Lion Apparel Inc.

turnout gear, estimated the annual cost of firefighter clothing to be $250 million alone. This estimate did not include the cost of essential hardware: radio, SCBA, and other gear.

An alternate approach was also pursued. Approximate costs of basic PPE were gathered as shown in Table 23. Turnout gear is replaced as needed. Larger departments may have a short replacement cycle while smaller departments with fewer calls may have a longer cycle. The helmet, once issued, rarely needs replacing; the hood and gloves need replacing more often. Local Washington, DC fire departments suggested that, on average, the replacement cycle for the apparel issued to individual firefighters is about every five to six years. This is equivalent to providing new turnout apparel for one-fifth to one-sixth of the over 1.1 million firefighters each year for an approximate annual cost of $221 million to $265 million, which compares well to the Lion Apparel estimate. The replacement cycle for equipment is approximately the same. Equipment, however, is assigned to the position in the apparatus, not to the firefighter, and there are fewer pieces to replace. With a 2:1 ratio of equipment to firefighter on a five to six year replacement cycle, the annual replacement cost would be $120 million to $144 million. The combined costs would range from $341 million to $409 million.

Table 23. Sample Firefighter Turnout Gear Ensemble

Required/Standard Firefighter Equipment	*Estimated Price**	*Example Product*
Turnout Coat	$ 480	Liberty Nomex® turnout coat
Turnout Pants	200	Janesville® Bravo Express™ Nomex IIIA turnout pants
Helmet	225	Morning Pride® traditional style "Ben 2 Plus" helmet
Boots	198	Ranger® Insulated Firewalker™ fire boots ($115) or Ranger® leather bunker boots ($280)
Nomex Hood	20	Nomex fire hood
Gloves	48	Ringer's® short wrist extrication gloves
Apparel Cost	**$1,171**	
SCBAs	895	SCBA—NIOSH approved
PASS Device	225	Super Pass® II motion/temperature detector
Radio	150	Waterproof two-way radios with general mobile radio service (GMRS)
Equipment Cost	**$1,270**	
Total Cost	**$2,441**	

**Source: http://www.galls.com, accessed April 30, 2004.*

BASIC AND RECRUIT TRAINING – One way to prevent injuries is to aggressively promote safety and injury prevention practices during basic and recruit training. For purposes of this analysis, *basic training* encompasses Firefighter I, Firefighter II, HAZMAT Operations, EMT-Basic, and CPR. Generally, jurisdictions require volunteers to complete all of these classes or

some combination to meet minimum apparatus staffing requirements. *Recruit training* refers to programs specifically geared toward training career personnel; the length of such training varies widely by department, from six weeks in some places to nearly 22 in others. The shorter programs are used by career fire departments that will only hire personnel who have already completed their basic training classes; recruit training is used primarily as a skills refresher and to ensure that personnel are familiar with departmental policies and procedures. For longer recruit training programs, the curricula typically meet or exceed the basic training requirements and include segments to address departmental policies and procedures, and so forth.

Training typically includes lectures and practical exercises that explicitly address firefighter or EMT safety, health, and wellness. For this study, the following lectures and practical exercises were also considered to relate to health, wellness, safety, and injury prevention:

- Incident command systems (ICS) and personnel accountability systems (PAS);
- Bloodborne/airborne pathogens
- Use of self-contained breathing apparatus (SCBA) and personal protective equipment (PPE)
- Flashover simulators
- Firefighter down/Mayday
- Proper techniques for patient lifting and moving
- Emergency vehicle operator courses (EVOC)

To calculate the costs associated with basic and recruit training, the study team estimated that 10 percent of non-safety specific training time is related to safety and injury prevention. For example, while learning to deploy ground ladders, personnel are taught the proper way to lift ladders to prevent injury and to be cautious of overhead obstructions (e.g., power lines) that could cause injury or death.

Table 24 shows the total cost of basic safety and injury prevention training to the fire service. The cost estimates ranges from a low of $65 million to a high of $147 million.

Table 24. Cost of Basic Safety and Injury Prevention Training

Cost Component	High Estimate Career	High Estimate Volunteer	Low Estimate Career	Low Estimate Volunteer
Total basic training hours [a]	650	650	325	325
Total recruit training hours	1000	580	720	275
Hours specifically dedicated to safety/injury prevention	70	70	50	50
Additional hours dedicated to safety [b]	50	30	35	15

Cost Component	High Estimate Career	High Estimate Volunteer	Low Estimate Career	Low Estimate Volunteer
Total hours dedicated to safety/injury prevention:	120	100	85	65
Hands-On [c]	90	75	64	49
Classroom [d]	30	25	21	16
Average hourly wage (career firefighter) [e]	$17.25		$17.25	
Average hourly wage (instructor)	$21.18	$21.18	$21.18	$21
Average hourly wage (volunteer)		$16.35		$16
Hours to safety x hourly wage (firefighter)	$2,070	$1,635	$1,466	$1,063
Hours to safety x hourly wage (instructor)	$2,542	$2,118	$1,800	$1,377
4 % Turnover			11,644	32,914
Instructors required [f]			2,329	6,583
6 % Turnover	17,466	49,371		
Instructors required [f]	3,493	9,874		
Per-firefighter cost of training*	$36,155,000	$80,722,000	$17,073,000	$34,979,000
Per-firefighter cost of training instructors*	$8,878,000	$20,914,000	$4,193,000	$9,063,000
Total Per-firefight Cost*	**$45,033,000**	**$101,635,000**	**$21,280,000**	**$44,081,000**
	Total High: $146,668,000		**Total Low: $65,361,000**	

[a] Low estimate based on an 18-week recruit school; 40-hour work week. High estimate based on a 20-week recruit school; 50-hour work week.
[b] Assumes 5 percent of non-safety specific coursework.
[c] Assumes 1:4 instructor-student ratio.
[d] Assumes 1:20 instructor-student ratio.
[e] Hourly wage data are from the Bureau of Labor Statistics. Volunteer wages are based on the average hourly wage for all occupations in the United States. Inspector and instructor wages are assumed to be roughly equal and approximately 20 percent higher than firefighter wages.
[f] Assumes 1:5 instructor-student ratio.

* Costs are rounded, totals may not add.

WELLNESS AND FITNESS PROGRAMS – While wellness and fitness program are designed to improve overall firefighter health and reduce the occurrence of injury, it is difficult to determine the annual cost of these programs. Most departments do not have an in-place program. To obtain a general idea of what departments pay, information on fitness programs was gathered from eight departments across the country. Wellness programs appear to be the exception and not the rule. The results of our review are shown in Appendix C.

The departments expressed a range of $0-$420,000 for the cost of their physical fitness and training programs. At the bottom end, there is no discernable cost as the programs only involve walking and basic exercises. At the upper end, two departments, Baltimore County, MD and Ft. Lauderdale, FL each have received federal fire grant funds to support physical training. In Ft. Lauderdale, $420,000 in grant monies was used to cover all startup costs of their new program. Neither department had any information on the annual upkeep of these programs.

Using $50,000 as an average annualized cost (startup costs would be more expensive; however, once programs are initiated, the annual cost could be relatively low) for five percent of the estimated 30,000 fire departments, the annual cost of these programs would be $75 million.

Overall Estimated Annual Cost of Firefighter Injuries

As can be seen from the analyses in this report, applying the methods described and estimating the number of firefighter injuries and their associated costs yields vastly different figures. Table 25 below summarizes, in ascending cost, the estimates that resulted from using the five sources previously discussed.

Table 25. Estimated Total Annual Cost of Firefighter Injuries

Assessment Model	*Cost of Firefighter Injuries $Billion (2002)*
The Cost of Injury to Victoria (Australia)	0.3
Societal Costs of Cigarette Fires (CPSC/NPSRI)	2.8
Cost of Fire Safety (Meade)	4.6
NHTSA (Motor Vehicle Crashes)	6.0 to 7.8
Total Cost of Fire (NFPA)	16.7

From the range, it is clear that no single, available, all-encompassing strategy can be employed to generate a single, bottom line dollar figure for the cost of firefighter injuries. The Watson study in Australia tightly assesses the direct costs and is predicated on a different medical and compensation system; it is unclear whether this model is appropriate for the purposes of estimating U.S. firefighter injuries, as the estimate is quite low. The NFPA estimate, on the other hand, is an outlier at the far end of the spectrum. Without further details on the derivation of the per-injury lifetime cost basis, this method may also be unsuitable for estimating firefighter injuries. What remains are three methods: those from the Meade, NHTSA, and CPSC/NPSRI studies. Two of these are well-reasoned and comprehensive approaches. The third approach, by Meade, appears to produce a reasonable estimate, but it is an estimate of the cost of fire per business and industrial equipment, residential and industrial property, and business interrupting losses and does not account for the human cost of fire. Nonetheless, taking the range of derived estimates from those three methods, then, yields a final estimate for the cost of firefighter injuries that is between $2.8 billion and $7.8 billion.

Because firefighter injuries are unique subset of workplace injuries, not all the methodologies in the studies above address key aspects of costs of these injuries. The research documented in this study is summarized in Table 26 below and accounts for a minimum of $830 million to $980 million in direct and indirect costs.

Table 26. Estimates of Cost Components

Type of Cost	Component	Estimate ($ Million)	Discussion
Direct			
Workplace	Backfill		Included in staffing factors. Also included in NHTSA and CPSC/NPSRI study as part of overall workplace costs but not as a separate estimate.
Administration	Legal Fees	$204	Based on CPSC/NPSRI studies; CPSC study provides separate category.
	Paperwork and Data Collection	7	Unclear if included in cost assessments. Includes cost of personnel time and systems used in filing reports of injury, claims for compensation, insurance forms, collecting information, etc. Estimate based on staff time.
	Investigations	57	Unclear if included in cost assessments. Time, expenses, and materials associated with investigating and documenting injury claims. Based on the average time spent by investigator, professional level personnel, and support staff.
Insurance	Non-Medical Payouts	30	From NCCI. ICMA-derived estimates ranged from $64–$155 million. Some insurance estimates included as part of NHTSA and CPSC/NPSRI studies and, to a limited extent, other studies.
	Medical Payouts	37	From NCCI. Included as part of NHTSA and CPSC studies. NHTSA estimate in $2002 would range from $1.6 to $2.1 billion
Federal Payments	Public Safety Officers Benefit Program		Data on benefits paid for total disability (rather than death) not available.
Lost Income	Volunteer		Included as part of NCCI, DCI, NHTSA, and other studies
	Career		Included as part of NCCI, DCI, NHTSA, and other studies.
	Additional Sources		Not addressed in studies.
	Caregiver		Included in NHTSA study.
	Physical Changes to Home and Workplace		$30,000 to $50,000 per home. Applies to serious, disabling injuries only. No overall estimate derived.

Type of Cost	Component	Estimate ($ Million)	Discussion
	Lost Productivity		Included as part of NCCI, DCI, NHTSA, and other studies
Indirect			
Insurance	Overhead	$15	From NCCI. Calculated as difference between premium payment and indemnity and medical payouts.
Prevention	Turn-out gear and other PPE	$341–$409	Based on 5-year replacement cycle (high estimate) and 6-year replacement cycle (low estimate)
	Vehicle Safety Measures		Not included. Part of new vehicle purchases.
	Personnel Accountability		Not included.
	Safety and Survival Training	$65–$147	Based on salaries and required certification hours.
	Physical Fitness and Wellness Program	$75	Based on discussions with fire departments.
Community	Deprivation of Volunteerism		Not included. Intangible costs of removing viable volunteers from the community. Only a cost if volunteer is not replaced.
Secondary Economic Effects	Reduced Tax Revenues		Included in NHTSA study.
Tertiary Economic Effects	Reduced Spending		Included in NHTSA study.
Pain and Suffering			Included in NHTSA, CPSC/NPSRI, and Hall studies

IV. SOLUTIONS

PREVENTING INCIDENTS – One of the best ways to reduce injuries to firefighters is through improved prevention and public education programs that reduce the number of emergency calls. It is simple logic: the fewer fires and other incidents firefighters are called to, the lower the exposure to injury risks. Well-funded fire prevention and inspection programs pay off—not just in terms of reducing civilian losses, but in reducing firefighter injuries and the multiple costs associated with them. One of the main reasons other nations (and U.S. military firefighters) have fewer firefighter injuries than public sector (career and volunteer) U.S. firefighters is because they go to fewer incidents per firefighter. Although emphasizing prevention is rarely raised by the fire service as a major avenue to reducing firefighter injuries, all research and activities that contribute to reducing the number and severity of fires, the number of EMS calls, and the number of all other fire service calls clearly reap a positive impact on firefighter safety.

When injuries are reduced, the costs of covering injury leave and of medical payments go down. The bulk of overtime costs relate to coverage for vacation and sickness/injury, so by reducing either factor fewer personnel hours are needed to maintain continuous service coverage, and the staffing ratio can be reduced. For example, to keep a firefighter position on a fire engine staffed around the clock with a three-shift schedule requires more than three people, because of the need to fill-in when an individual is injured and on sick leave or is on scheduled leave. As noted earlier, typical ratio of people needed per on-duty position per shift is 1.1-1.3. At the upper end, it takes 3.9 people to staff one position (three shifts) round-the-clock; at the lower end it is 3.3. As fewer hours are needed to cover injury, the ratio goes down.

A related but different view holds that adding staffing per company will improve safety. The argument often made in favor of four-person staffing rather than three-person staffing has been that the additional personnel will spread out the work and fewer injuries will occur. It is not known whether that view is correct because no scientific or statistic research has been conducted to date that adequately compares three- and four-person staffing in terms of the incidence and severity of injuries. Perhaps more firefighters could actually translate to more injuries, all other things being equal.

EARLY DETECTION – Early detection of fires using smoke detectors is another means to reduce fire incidents to which the fire service is called. NIST has made enormous contributions leading to improved and less expensive detectors, another factor contributing to firefighter safety. Early detection not only allows the occupant to extinguish fires and not involve the fire service at all, but also allows the occupant to report fires at an earlier, less intense stage. Fighting a small fire generally is less of a risk than fighting a large one.

FIREFIGHTER ATTITUDE – Firefighters go in harm's way while other people are escaping from a building. Firefighter bravery is legendary and real. Firefighters are injured trying to rescue citizens and going to the aid of each other. They get hurt rescuing pets and trying to reduce property loss. It is an inherently dangerous profession. The degree to which firefighters behave without regard to their safety, and to standard procedures, affects that safety. A major report on wildland firefighters found that improving attitudes toward safety were a major factor in firefighter safety. Research on ways to instill safety awareness in firefighters contributes to their safety.[27]

PPE – Another major approach to reducing firefighter injuries is through improved technology of personal protective equipment. NIST research and research by others has improved PPE. One of NIST's major contributions to society that has saved literally billions of dollars was to accelerate the development of inexpensive, affordable home smoke detectors. Much other technology exists that the fire service could use, but is too expensive to be widespread (e.g., voice-activated radios built into helmets, and hands-free infrared night vision). Engineering lower cost versions would improve safety by allowing wider use of the technology. Further improvements in firefighter protective gear must trade-off between better protections vs. the loss of senses, such as ears heating up. Firefighters now advance further into a fire than they used to, resulting in perhaps a similar level of risk to what they had before the protective clothing was developed and when they had to be more cautious.

TRAINING – Improved safety of training itself can reduce injuries. Improved training can reduce risks and increase the level of experience, which is a key factor in safety-related decisions on the fireground. This can be done, for example, by developing better virtual reality simulations for use in training firefighters. NIST's fire models might include effects of water application and ventilation by firefighters, and might be developed into improved virtual reality simulations, something of great demand in the fire service. A word about training, however—there are many training-related injuries each year, and it is believed that substantial numbers are not reported. Not only is good training important to reducing risks and risky practices, but real (not realistic) training must be established under rigid safety standards and monitored closely by training officers so that firefighters do not get hurt learning how not to get hurt.

USE OF ROBOTICS – The Japanese, Chinese and other nations are increasingly looking to robotics to reduce risks to firefighters. The United States has done little research in this area for firefighting, in contrast to our military, which is thinking in terms of increasing safety of soldiers by use of surveillance drones, tracked robots, and other means to do reconnaissance and even actual fighting.

[27] *Wildland Firefighter Safety Awareness Study*, prepared for the U.S. Forest Service et al, TriData Corporation, Arlington, VA, 1996.

IMPROVE INCIDENT COMMAND – The ability to maintain situational awareness—keeping up to date on the location of resources and the location and nature of threats—is key to safe operations. For example, the ability to deploy inexpensive cameras around a building could give incident commanders the capability that Navy Seals and others already have.

A variety of technologies are being considered (and some look like they will work) for accurately locating firefighters inside structures, either electronically or through an enhanced visibility or acoustic approach. NIST can advance that technology.

EARLY SENSING OF FIREFIGHTER INJURIES/ILLNESS – The Defense Advanced Research Projects Agency (DARPA) and the Department of Defense have been developing sensors for remotely identifying injuries and illnesses on soldiers on the battlefield. They are slowly being considered for adoption to firefighters. The possibilities range from transmitting pulse rates and blood oxygenation levels to sensors that can detect wounds and how serious they are by blood flow rates. One of the main roadblocks has been trying to develop sensors that operate reliably in the firefighter's domain—within closed structures, as opposed to open battlefields. The technology could be applied earlier for wildland firefighters.

DEPLOYMENT MODELING – Neither the USFA nor other federal agencies are funding development of operations research models to improve deployment of fire department resources. In fact, our profession has taken a large step backwards from the capability that existed two decades ago when the New York City Rand Institute and PTI computer models were available for mainframes. They have been lost to this PC era. Coupling the simulation capability of modern computers with the geographic information systems (GIS) already developed would surely improve tools needed by every fire department in the nation.

EARLY DETECTION OF BUILDING COLLAPSE OR OTHER RISKS – Technology exists and can be improved to signal potential collapse of structures. The University of Pittsburgh, for example, is developing a prototype sensor with complex data transmission capabilities that could measure and report on the condition of structural elements across many indicators of stress and collapse potential.

FIREFIGHTER PHYSICAL FITNESS—In August 2000, the NFPA published the current standard on health-related fitness programs for firefighters.[28] It establishes the minimum requirements for a health-related fitness program for fire department members who are involved in rescue, fire suppression, EMS, hazardous materials operations, special operations, and related activities. The standard requires fire departments to establish a "health-related fitness program

[28] National Fire Protection Association, NFPA 1583*, Standard on Health-Related Fitness Programs for Fire Fighters*, August 2000.

that enables members to develop and maintain a level of health and fitness to safely perform their assigned functions." Departments must appoint a health and fitness coordinator (HFC) to coordinate the program and perform periodic fitness assessments to determine an individual's exercise needs.

Table 27 shows how 26,354 departments responded to a U.S. Fire Administration/NFPA survey question in 2002 regarding whether they maintain a fitness and health program. Eighty percent indicated they do not, a significant finding given the known positive impact that fitness has on injury prevention, especially since such a high percentage of firefighter injuries involve the back and overexertion.

Table 27. Program to Maintain Basic Firefighter Fitness and Health by Community Size

Population of Community	YES		NO		TOTAL	
	Number Depts.	Percent	Number Depts.	Percent	Number Depts.	Percent
1,000,000 or more	8	61.5	5	38.5	13	100.0
500,000 to 999,999	27	71.1	11	28.9	38	100.0
250,000 to 499,999	38	59.4	26	40.6	64	100.0
100,000 to 249,999	115	53.5	100	46.5	215	100.0
50,000 to 99,999	243	49.9	244	50.1	487	100.0
25,000 to 49,999	501	47.6	552	52.4	1,053	100.0
10,000 to 24,999	962	33.8	1,881	66.2	2,843	100.0
5,000 to 9,999	873	24.1	2,756	75.9	3,629	100.0
2,500 to 4,999	798	17.5	3,774	82.5	4,572	100.0
Under 2,500	1639	12.2	11,801	87.8	13,440	100.0
TOTAL	**5,205**	**19.8**	**21,149**	**80.2**	**26,354**	**100.0**

Note: The above projections are based on 8,267 departments reporting. Numbers may not add to totals due to rounding.

Source: United States Fire Administration, Survey of the Needs of the U.S. Fire Service – 2002

A 2001 study at the Applied Exercise Science Laboratory at Texas A&M University investigated firefighters' risk of suffering a heart attack. The study followed 74 firefighters ages 20–60 years old over a 6-year period and concluded that firefighters have long periods of stress-free activity during the day. When the call for help comes, there is a "sudden, intense energy demand required, and if they are not in adequate physical condition, the results can be deadly."[29]

A 1996 study performed by the Montgomery (AL) Fire Department in cooperation with The Human Performance Laboratory at Auburn University found that added weight and body fat affected performance of firefighters on the fireground. The research showed that there was a

[29] Womack, Wade, *Cardiovascular Risk Markers in Firefighters: A Longitudinal Study,* Applied Exercise Laboratory, Texas A&M University, May 2001.

direct relationship between added body weight and decreased physical performance. Additionally, as body weight increased, efficiency decreased and fatigue set in faster. Today, the Montgomery Fire Department monitors firefighters' height, weight, and body fat composition at various points throughout their careers.[30]

Many fire departments are implementing mandatory physical fitness programs. The Oklahoma City Fire Department implemented a mandatory, on-the-job exercise program. These firefighters are required to exercise for 1½ hours on each 24-hour shift. Officials with the Oklahoma City Fire Department hope that by implementing the workout program, firefighters will live longer and prevent heart attacks. Firefighters meet with a physician at the beginning of the program and are then assigned to a physical wellness coordinator. The coordinator runs through a series of exercises to see what shape the firefighter is in and, based on the results, creates an aerobic and weightlifting regimen. Firefighters are reevaluated every 6 months. Officials with the department have noted that the overall fitness of the department has improved with the implementation of the program.[31]

A variety of commercial fitness programs are widely available. Such programs include strength building, endurance, and flexibility exercises as well as tips on nutritional habits. Programs like step aerobics and Tae-Bo are becoming popular in fire departments across the country. These programs incorporate fun into cardiovascular exercise, motivating participants to continue with the workout regimen. Where possible, fire departments should incorporate physical training into the firefighter's daily schedule. This should be done in conjunction with fitness experts, physicians, and nutritionists to ensure that firefighters get in shape in a safe, healthy manner.

The IAFF, International Association of Fire Chiefs (ICHIEFS), and 10 pairs of local unions and their municipalities joined together to form the Fire Service Joint Labor Management Wellness–Fitness Task Force. The task force created the Fire Service Joint Labor Management Wellness–Fitness Initiative in an attempt to build a stronger and healthier fire service. The initiative is a fitness program that includes physical, physiological, and psychological components. The program comes complete with a physical fitness and wellness program package that includes a manual and a video. It is hoped that all departments affiliated with the IAFF will implement the program.[32]

[30] Williford, Henry N. and Michele Scharff-Olson, "Fitness and Body Fat: An Issue of Performance." *Fire Engineering*, August 1998.
[31] "Oklahoma Department Fights Fat, Fatigue," *Firehouse.Com News*, May 24, 2001.
[32] *Fire Service Joint Labor Management Wellness–Fitness Initiative*, International Association of Fire Fighters.

While it might appear that most physical fitness programs are targeted to career departments, many volunteer departments are encouraging their members to be more health conscious. To facilitate this, some departments have built weight rooms with state-of-the-art fitness equipment for use by their members. For departments that cannot afford expensive equipment, other options include soliciting donations of used exercise equipment. Other departments have approached commercial gyms or local recreation centers and formed agreements granting members free or reduced-price memberships. Some departments have hired fitness consultants who meet with members on a regular basis to develop individual and department-wide fitness programs.

As part of this study, team members discussed physical fitness programs with a sampling of eight fire departments from different size communities to get first-hand information on the departments' programs, whether the standards were enforced, if they had tracked the payoff of physical fitness to reducing injuries and their severity, etc. Consistent with other data, strains, sprains, and back injuries represent the vast majority of injuries. These would be priorities for physical fitness prevention efforts. The results of our review are shown in Appendix C.

Half of these eight departments indicated they had a physical fitness program. One of the four with a program indicated that the program is not strongly enforced and is not a high enough priority, and only one department could say that the program was successful in reducing firefighter injuries because either the programs are too new or records are not kept that would be necessary to demonstrate a definitive connection between fitness and injury reduction. Several of the departments track how firefighters improve the fitness levels; however, they have not compared that information to the rate and severity of injuries experienced. This is one area of technical assistance that would be valuable to local fire departments.

One way to prevent firefighters from having poor fitness habits is to recruit and hire firefighters with good fitness habits. Hiring healthy individuals to serve as firefighters may reduce firefighter fatalities from heart attacks and other medical conditions; physically fit individuals may also be at less of a risk of incurring traumatic injuries. However, a fair standard must be applied to all applicants.

The members of the Fire Service Joint Labor Management Wellness–Fitness Task Force developed the candidate physical agility test (CPAT) to establish a non-discriminating, fitness-based test for hiring firefighters. The CPAT is administered along with other recruiting and mentoring practices. The CPAT was designed for the recruitment process for career departments, but it can also be applied during recruitment of volunteer firefighters. When practical, departments should have EMS personnel and equipment standing by during the actual test should any candidate suffer a medical problem or injury.

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APPENDICES

APPENDIX A – Number Of Nonfatal Occupational Injuries And Illnesses Involving Days Away From Work By Selected Worker And Case Characteristics And Occupation For 2001

APPENDIX B – Claims Reported By Participating States For Workers Compensation For Class Code: Firefighters And Drivers For Three Years

APPENDIX C – Review Of Fire Department Physical Training Information

APPENDIX A

Number of Nonfatal Occupational Injuries and Illnesses Involving Days Away From Work
Local Government Occupational Codes
2001

Characteristic	STATE															
	California		Connecticut		Kentucky		Michigan		New Jersey		Oregon		Virginia		Washington	
	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only
Total:	52,580	2,024	4,229	630	2,464	150	6,234	155	11,595	873	21,159	92	3,317	552	5,208	91
Number of days away from work:																
Cases involving 1 day	4,614	253	342	39	384	18	687	19	1,971	177	3,432	8	778	189	746	11
Cases involving 2 days	4,773	192	450	44	450	16	1,150	23	1,740	125	2,645	10	539	81	543	17
Cases involving 3-5 days	8,807	332	1,033	101	357	43	1,041	40	2,574	152	4,553	18	766	132	1,081	8
Cases involving 6-10 days	6,951	287	540	74	378	18	565	29	1,577	147	3,342	17	453	40	947	28
Cases involving 11-20 days	7,179	332	575	92	422	10	666	14	1,354	111	2,766	3	348	53	585	15
Cases involving 21-30 days	4,384	123	330	55	157	8	390	4	662	58	986	--	166	11	342	--
Cases involving 31 or more days	15,871	506	957	226	316	38	1,734	27	1,719	102	3,436	38	267	45	966	13
Median days away from work	11	10	7	17	6	5	8	5	5	5	5	6	3	3	6	8
Nature of injury, illness:																
Sprains, strains	22,947	922	1,754	256	1,515	92	2,895	97	3,806	312	10,640	37	1,236	199	3,214	61
Fractures	2,100	--	352	82	72	--	465	--	461	29	1,155	--	131	17	226	--
Cuts, lacerations, punctures	1,326	154	161	28	52	18	580	--	568	61	1,460	--	137	--	82	--
Bruises, contusions	3,753	--	390	23	268	17	488	--	1,259	42	1,862	--	407	18	368	--
Heat burns	172	--	39	14	--	--	109	--	115	38	256	--	120	57	96	--
Chemical burns	--	--	--	--	--	--	--	--	46	5	123	--	18	--	11	--
Amputations	--	--	--	--	--	--	--	--	10	--	134	--	--	--	--	--
Carpal tunnel syndrome	638	--	19	--	--	--	40	--	32	--	279	--	--	--	95	--
Tendonitis	489	--	26	--	--	--	87	--	15	--	345	--	14	--	179	--
Multiple injuries	3,257	85	161	16	122	--	237	--	640	31	978	--	207	11	208	--
With fractures	229	--	64	--	--	--	132	--	67	7	310	--	10	--	--	--
With sprains	1,618	--	71	16	72	--	85	--	345	8	349	--	134	11	74	--
Soreness, Pain	2,192	82	634	98	38	--	373	--	2,324	140	567	--	446	181	216	--
Back pain	1,103	--	232	50	16	--	178	--	664	40	241	--	107	45	73	--

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2001

Characteristic	STATE															
	California		Connecticut		Kentucky		Michigan		New Jersey		Oregon		Virginia		Washington	
	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only
All other	15,618	670	688	113	374	19	932	--	2,320	215	3,361	--	594	68	511	14
Part of body affected:																
Head	1,792	--	220	29	216	--	331	--	649	48	1,379	--	253	18	152	14
Eye	828	--	76	--	71	--	198	--	233	26	651	--	105	--	59	14
Neck	798	--	184	18	--	--	169	--	218	30	362	--	68	--	226	--
Trunk	17,387	737	1,450	244	1,177	58	2,199	70	3,511	235	8,572	--	1,008	179	2,212	31
Back	9,981	303	791	134	817	38	1,312	--	2,011	118	5,630	--	611	145	1,632	27
Shoulder	2,870	114	341	53	75	--	429	--	654	48	1,552	--	161	--	473	--
Upper extremities	7,607	384	647	51	198	--	1,357	18	1,906	158	4,308	--	463	69	879	17
Finger	1,382	171	151	11	55	--	551	--	568	52	1,274	--	149	--	128	--
Hand, except finger	1,386	81	122	--	43	--	181	--	403	44	621	--	53	11	186	--
Wrist	1,845	80	137	--	--	--	230	--	361	25	884	--	46	--	340	--
Lower extremities	10,669	525	1,084	208	568	45	1,538	41	2,875	241	4,286	32	976	195	1,051	19
Knee	4,371	157	426	68	261	--	684	--	1,263	115	1,810	--	397	97	473	--
Foot, toe	1,170	--	169	15	--	--	241	--	410	22	690	--	127	29	149	--
Body systems	2,697	--	125	41	39	--	65	--	423	67	342	--	28	11	118	--
Multiple	10,101	317	488	31	242	--	521	--	1,858	87	1,834	18	498	57	544	--
All other	1,530	--	30	--	--	--	55	--	154	8	76	--	--	--	27	--
Source of injury, illness:																
Chemicals, chemical products	470	--	15	10	13	--	49	--	110	5	285	--	29	--	107	14
Containers	3,077	90	309	48	355	17	364	--	851	85	2,714	--	233	58	337	--
Furniture, fixtures	1,953	--	164	--	145	--	173	--	564	10	786	--	97	11	219	--
Machinery	602	--	128	--	62	--	101	--	327	14	1,648	--	67	--	161	--
Parts and materials	935	--	142	19	156	15	505	--	481	47	2,002	--	95	11	253	--
Worker motion or position	15,966	808	378	48	425	45	1,072	--	1,766	154	3,677	--	389	93	1,169	--
Floor, ground surfaces	8,971	101	1,254	184	375	--	1,147	--	2,526	157	2,878	17	936	103	792	--
Handtools	537	--	144	--	148	--	193	--	295	32	918	--	42	--	187	--
Vehicles	3,568	--	485	37	258	18	529	--	1,294	58	1,919	--	440	--	578	--
Health care patient	1,727	87	82	67	70	--	537	39	206	14	873	--	30	30	176	17

Number of Nonfatal Occupational Injuries and Illnesses Involving Days Away From Work
Local Government Occupational Codes
2001

Characteristic	STATE															
	California		Connecticut		Kentucky		Michigan		New Jersey		Oregon		Virginia		Washington	
	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only	All codes	Fire-fighting only
All other	14,774	816	--	--	455	36	1,565	65	3,176	298	3,459	53	960	241	1,231	--
Event or exposure:																
Contact with object, equipment	6,256	183	581	56	442	38	1,197	--	2,148	173	4,606	--	635	121	638	17
Struck by object	3,601	118	304	37	211	--	334	--	1,111	85	2,280	--	272	17	330	--
Struck against object	1,370	--	175	20	212	--	218	--	685	54	994	--	247	52	167	--
Caught in object, equipment, material	366	--	34	--	15	--	425	--	236	25	827	--	71	40	66	--
Fall to lower level	1,957	--	528	161	72	--	329	--	727	81	1,420	--	216	--	239	--
Fall on same level	7,078	74	792	36	303	--	849	--	1,948	84	2,067	18	639	35	603	--
Slips, trips	1,520	97	38	--	40	--	173	--	444	40	611	--	35	--	150	--
Overexertion	9,213	403	903	210	832	41	1,600	57	2,263	168	6,121	--	526	156	1,672	42
Overexertion in lifting	4,667	328	487	93	537	18	588	37	1,089	44	2,995	--	202	41	962	28
Repetitive motion	1,604	--	47	--	51	--	154	--	75	6	1,251	--	16	--	252	--
Exposed to harmful substance	2,165	105	98	13	104	--	216	--	576	88	926	--	224	57	264	14
Transportation accidents	2,383	--	391	19	134	--	279	--	908	38	1,022	--	389	--	386	--
Fires, explosions	--	--	48	48	--	--	50	--	74	22	37	--	--	--	--	--
Assault, violent act	3,220	--	355	--	95	--	474	--	710	--	362	--	159	--	170	--
by person	2,871	--	306	--	93	--	462	--	639	--	309	--	144	--	131	--
by other	349	--	49	--	--	--	--	--	71	--	54	--	15	--	39	--
All other	17,118	997	448	83	390	45	915	--	1,723	173	2,737	--	478	161	834	11

Source: U.S. Department of Labor, Bureau of Labor Statistics

APPENDIX B

Workers' Compensation Claims Reported to the National Council on Compensation Insurance Class Code: Firefighters and Drivers (3-year Averages)							
State	Period	Policies	Developed Claim Count	Developed Indemnity Losses	Developed Medical Losses	Developed Total Losses	Average Cost Per Claim
Alabama	11/1998 - 10/2001	525	560	$ 1,016,729	$ 1,266,263	$ 2,282,992	$ 4,077
Alaska)	10/1998 - 9/2001	32	161	320,212	550,383	870,595	5,407
Arizona	9/1998 - 8/2001	215	1,260	1,441,301	4,334,844	5,776,145	4,584
Arkansas	8/1998 - 7/2001	17	30	24,016	41,236	65,252	2,175
Colorado	9/1998 - 8/2001	743	1,657	4,996,839	5,858,432	10,855,271	6,551
Connecticut	2/1999 - 1/2002	75	382	686,220	747,164	1,433,384	8,683
Florida	1/1999 - 12/2001	429	3,921	14,830,367	24,439,214	39,269,581	10,015
Georgia	1/1999 - 12/2001	129	241	788,191	1,187,377	1,975,568	8,197
Idaho	1/1999 - 12/2001	28	114	200,166	208,584	408,750	3,586
Illinois	10/1998 - 9/2001	1,920	1,660	6,440,725	4,623,106	11,063,831	6,665
Indiana	1/1999 - 12/2001	101	212	165,318	645,058	810,376	3,823
Iowa	9/1998 - 8/2001	1,253	585	3,493,226	1,309,535	4,802,761	8,210
Kansas	1/1999 - 12/2001	458	629	1,262,180	1,614,017	2,876,198	4,573
Kentucky	11/1998 - 10/2001	115	267	737,082	1,549,169	2,286,251	8,563
Louisiana	3/1998 - 2/2001	564	611	2,140,012	2,813,278	4,953,290	8,107
Maine	12/1998 - 11/2001	105	69	108,153	163,096	271,249	3,931
Maryland	10/1998 - 9/2001	208	603	1,320,430	1,246,898	2,567,328	4,258
Michigan	4/1998 - 3/2001	681	521	1,102,292	1,298,801	2,401,093	4,609
Mississippi	3/1999 - 2/2002	88	402	655,802	1,630,091	2,285,894	5,686
Missouri	1/1999 - 12/2001	939	1,248	3,548,332	4,039,150	7,587,483	6,080
Montana	7/1998 - 6/2001	98	66	135,581	190,981	326,562	4,948

State	Period	Policies	Developed Claim Count	Developed Indemnity Losses	Developed Medical Losses	Developed Total Losses	Average Cost Per Claim
Nebraska	2/1999 - 1/2002	680	455	1,366,646	1,024,071	2,390,717	5,254
Nevada	12/1997 - 11/2000	16	264	7,365,280	2,281,312	9,646,593	36,540
New Hampshire	10/1998 - 9/2001	47	46	669,187	648,286	1,317,472	28,641
New Mexico	1/1999 - 12/2001	11	31	436,528	3,353,142	3,789,670	122,247
North Carolina	1/1999 - 12/2001	344	264	1,424,019	487,969	1,911,987	7,242
Oklahoma	12/1998 - 11/2001	587	368	1,992,020	2,540,183	4,532,203	12,316
Oregon	7/1998 - 6/2001	50	487	1,452,502	2,633,126	4,085,628	8,389
South Carolina	11/1998 - 10/2001	123	272	1,194,297	928,847	2,123,144	7,806
South Dakota	7/1998 - 6/2001	311	99	88,116	242,378	330,494	3,338
Tennessee	12/1998 - 11/2001	551	562	813,799	1,895,712	2,709,511	4,821
Texas	1/1999 - 12/2001	358	462	341,845	840,136	1,181,981	2,558
Utah	1/1999 - 12/2001	57	318	362,968	544,937	907,905	2,855
Vermont	1/1999 - 12/2001	270	198	826,210	590,419	1,416,630	7,155
Virginia	8/1998 - 7/2001	44	74	27,144	104,294	131,438	1,776
Wisconsin	1/1999 - 12/2001	19	969	1,588,249	2,645,142	4,233,390	4,369
TOTAL		**12,191**	**20,068**	**$65,361,984**	**$80,516,631**	**$145,878,617**	
3-Year Average		**4,064**	**6,689**	**$21,787,328**	**$26,838,877**	**$ 48,626,206**	**$ 7,269**

Source: National Council on Compensation Insurance, Inc

APPENDIX C

Review of Fire Department Physical Training							
Is there a formal physical fitness program?	***Program generally followed and enforced?***	***Program been successful in reducing injuries?***	***Any injury or accident reports from separate worker' compensation?***	***Average annual overtime costs associated with covering injuries for firefighters?***	***Approximately cost to run your PT program?***	***The two leading types of injuries with regards to costs?***	***Other factors that might have contributed to reduction in FF injuries?***
Anne Arundel Co. MD, Fire Department							
Yes, a 2-tier program. Tier one is mandatory and FF involves walking 20 minutes per day. Tier 2 is voluntary and includes weight training and cardiovascular training. Employees complete a physical examination at their own expense before Tier 2.	Yes, by the station officer. No reported problems to date.	The impact the physical fitness program has had reducing injuries is not tracked.	Developed an injury/accident reporting package containing all necessary forms for accidents, injuries, and exposures during bio/haz-mat incidents. It contains supervisor, personal injury, and workers compensation reports, extended treatment forms, and CDS test request forms.	The County has the ability to conduct cost code analysis, but has not done at this time.	Since the mandatory physical fitness program involves only walking, there is no budget for the program.	Strains and sprains.	Established a safety division four years ago. Also use safety officers during fires to monitor and ensure fireground safety
Baltimore Co. MD, Fire Department							
No. The County does provide each station with basic equipment. Many personnel bring their own equipment.	No. Personnel are not required to follow a formal physical fitness program.	N/A	The County has reports that must be completed for on-the-job injuries. They include supervisor, personnel injury, and workers compensation reports.	The County does not track the overtime expenses by specific category such as on-the-job injuries.	Unknown. County received a grant through the Fire Act, and 300 firefighters received a stress test. Males over 45 and females over 40 were required to take the stress test.	Back injuries related to sprains, strains, and disc; and shoulder injuries.	Five safety officer positions have been created that respond to all fires of second or greater alarms. They monitor fireground safety, and have the authority to intervene if there are unsafe practices.

Review of Fire Department Physical Training							
Is there a formal physical fitness program?	***Program generally followed and enforced?***	***Program been successful in reducing injuries?***	***Any injury or accident reports from separate worker' compensation?***	***Average annual overtime costs associated with covering injuries for firefighters?***	***Approximately cost to run your PT program?***	***The two leading types of injuries with regards to costs?***	***Other factors that might have contributed to reduction in FF injuries?***
City of Newburgh, NY, Fire Department							
No.	N/A	N/A	Yes. Have an internal form, filled out by the injured firefighter and the officer, and a City Injury Report Form. The insurance carrier handles, processes, and decides all workers compensation claims.	The cost is difficult to calculate. It could cost as much as $10,000 per year per injury firefighter, if a member is out for a lengthy period.	N/A	Back injuries and joint injuries (knees and shoulders).	Adequate training and supervision.
Dayton OH, Fire Department							
Yes. In collaboration with NovaCare Physical Therapists have developed a workout regimen based on the everyday tasks performed by firefighters. The program was initiated in February 2004.	Yes. It is a mandatory program under the Ohio Administrative Code 4121:1-21-07 Section E.	Because the program is new, it is not measurable at this time, but so far this year, injuries noticeably reduced.	Yes, report submitted to compensation insurance carrier. The injured FF and his officer generate a report every time an injury occurs and is reported.	Not reported.	$7,600—cost of contracting with NovaCare to develop the PT planning regime for one year.	Sprains, strains and back injuries.	Yes. Changes were made in PPE policies and SOPs and that have helped. Improved the policies by ensuring prompt repair of turnout gear. Training sessions include safety measures.
Denver CO, Fire Department							
No. New recruits are encouraged to continue their physical fitness training upon completing recruit school. All operational personnel are required to pass an annual fitness test.	The fire department encourages personnel to exercise. All fire stations have physical fitness equipment paid for and provided by the firefighters.	Statistics not reported, but each year the department has seen an increase in the number of personnel who pass the physical fitness test on their first attempt.	The Fire Department has an accident and injury package that must be completed. The package includes workman compensation forms, clinic pass, supervisors' first report of injury/ accident, and firefighter injury report.	The Fire Department does not track overtime costs attributed to on-job injuries.	All costs associated with the purchase of physical fitness equipment are bore by the station firefighters.	Exposure to communicable diseases and strains and sprains.	The Fire Department has instituted an Officer Candidate School (OCS) that all would be officers must attend before they are eligible for promotion. During this training they are taught health and wellness issues.

Review of Fire Department Physical Training							
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Fairfax City VA, Fire and Rescue Department							
Yes. Established after positive results were realized from the earlier PT program initiated in 1980. The firefighters that are certified serve as peer trainers and assist other firefighters. The training involves weight, training and aerobic (at least 25-30 minutes). Personnel are given two hours per day to participate in physical fitness training.	Yes. Any physical fitness training must be requested and approved by the station supervisor. Peer trainers coordinate with the Administrative Battalion Chief to review performance evaluation results.	Not reported.	Yes. Supervisors must complete injury and property damage reports, which are reviewed by the fire chief and forwarded to the city's risk management division. Risk management is responsible for completing the OSHA 300 report, and the information is compiled and tracked to identify trends in injuries.	Nor reported.	Approximately $6,000 annually. Also spent approximately $15,000 to purchase equipment that is used in the fire stations.	Lower back strain and sprains.	Certified peer trainers is a unique concept: RIT teams used during fire suppression operations can help reduce personnel on-the-job injuries. The department evaluates noise levels in the stations to help prevent hearing loss. Also, an accountability system during working fires.
Fort Lauderdale FL, Fire Department							
No. The department is in the process of developing a new physical fitness program. All fire stations will be provided physical fitness equipment. The current program consists of an annual physical fitness test.	No. The Fire Department's current program is not enforced.	No data exists; the results of the program are not tracked by the department	The Fire Department and city risk management division have developed an accident/injury report policy.	Information, but it is not certain if they do or not.	Not known. Received a grant through the "Fire Act" for funds to establish a new physical fitness program. The initial grant of $420,000 covered all start-up costs.	Lower back injuries, and strains and sprains of the knees and ankles.	Extensive training, fireground safety officers, and their accountability system to help reduce injuries.

Review of Fire Department Physical Training							
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Prince George's MD, Fire Department							
Yes. The department is working on improvements to the 1985 program, which includes stretching; aerobics, running; strength and training.	No. For many reasons: volume of calls/no time, disinterest, and lack of priority. Some stations are better than others.	No. Current indications point to the fact that due to lack of participation it has no impact. 15-20 years ago it did have an impact, but because of lack of enforcement the impact has greatly lessened.	All injuries are recorded on an ACCORD 4 form, for workers compensation. All forms are forwarded to a contracted insurance carrier who processes all claims. The County is self-insured.	These types of statistics are not kept. However, the cost of disability claims to the county overall. In 2003 that cost was $893,252.69. 30,352 hours were lost due to injuries.	In the current format there is no cost. The personnel are already on duty during the time they are supposed to be training. No data has been kept on how the PT program may offset the cost of overtime.	Sprains and strains (163) and cuts, wounds and bruises (48).	Maryland Occupational Health and Safety (MOSH). Office handles and monitors all safety standards for the state of Maryland. Fire Department reports to MOSH, and must comply with standards similar to federal standards. These standards contribute in a significant way to the mitigation of on the job injuries.