

FIREFIGHTER AUTOPSY PROTOCOL



Federal Emergency Management Agency



United States Fire Administration

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I. BACKGROUND

The United States Fire Administration (USFA) has a major commitment to improving the health and safety of firefighters. This mission has created an accompanying interest in learning about the causes of firefighter deaths and injuries. In the process of researching firefighter deaths, it was determined that there is no standard protocol in forensic medicine that would assist a coroner or medical examiner in determining the cause of a firefighter death.

Responding to this concern, the USFA, in 1993, initiated a project to develop a standard firefighter autopsy protocol. Experts in forensic pathology, toxicology, epidemiology, and medicolegal aspects of autopsy, as well as representatives of several national fire service organizations, were selected to serve as a Technical Advisory Committee (TAC), providing guidance, consultation, and review during the development of the protocol. The members of the TAC provided the expertise and experience to develop the actual protocol, which accompanies this report.

The consensus of the TAC is reflected in the protocol, which is intended to provide guidance to medical examiners, coroners, and pathologists on uniform recommended procedures for investigating the causes and contributing factors related to firefighter deaths. The protocol recognizes and addresses those attributes of firefighter casualties which distinguish them from the general population, as well as from civilian fire casualties. These differences include the use of protective clothing and equipment, prolonged exposures to the hazardous environment, and specialized training and duties.

The accompanying documentation is intended to describe the need for the protocol, the situational context under which it was developed, and the major issues that relate to it.

Scope of Problem

Firefighting has been described as one of the nation's most hazardous occupations. The National Fire Protection Association (Karter, 1993) estimates that 1,058,300 people in the United States are either full- or part-time firefighters, including both career and volunteer personnel. The number of career firefighters (253,000) has been rising steadily throughout the past decade, while the number of volunteer firefighters (805,300) is declining. According to statistics compiled jointly by the USFA and the National Fire Protection Association (NFPA), 1,920 firefighters have lost their lives while on duty in the United States over the past 15 years -- an average of 128 per year. Approximately 45 percent of all firefighter duty deaths during this period were attributed to heart attacks.

Improvements in firefighter health and safety standards and practices, particularly in the areas of personal protective equipment, physical fitness, and training, are widely believed to be responsible for a significant downward trend in line-of-duty deaths during the last 15 years. Between 1977 and 1991, the nation experienced a 32 percent drop in the annual number of firefighter line-of-duty deaths (see Figure 1). The number of line-

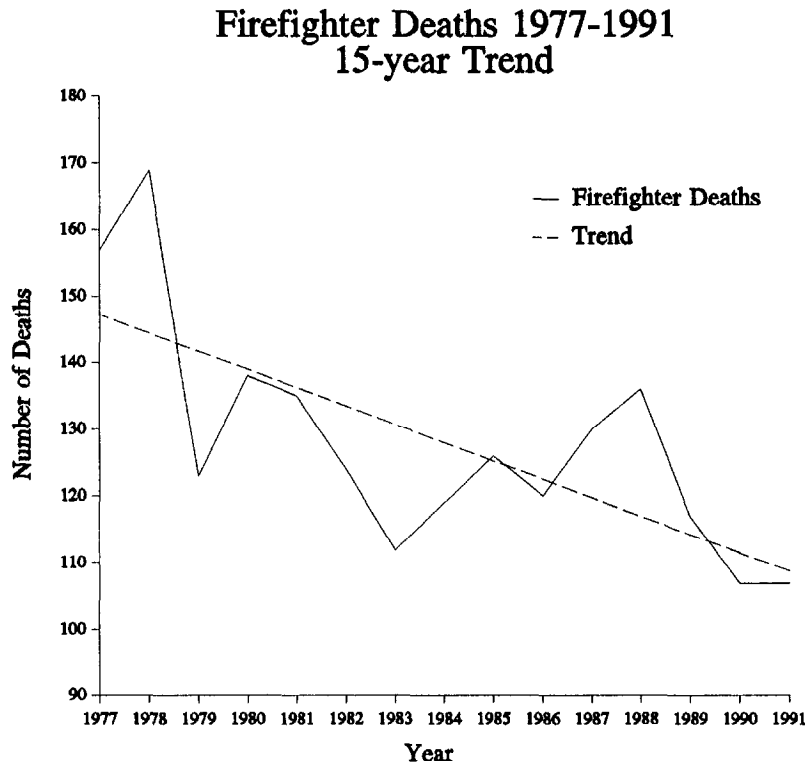


Figure 1

of-duty deaths in 1992 was a record low of 74. Notwithstanding the significant drop in firefighter deaths, too many firefighters die needlessly each year.

The statistical analysis of firefighter fatalities accounts for *how* many firefighters have died and to some extent explains *how* they died, but the available data do not explain *why* firefighters die. Moreover, a dramatic downward shift in the total number of firefighter deaths in 1992 (and preliminary statistics for 1993) begs still more questions about what, if anything, is being done correctly to prevent line-of-duty deaths.

Epidemiological studies of firefighter mortality conducted in recent years provide interesting insights into how firefighter health and mortality rates compare to other population groups, but they too fall short of explaining conclusively why firefighters die (especially any individual firefighter). The interest in occupational health factors relates

to the frequency of sudden deaths due to heart attacks, as well as chronic conditions which include respiratory disorders, heart disease, and cancer.

Rationale for the Protocol

The autopsy protocol was developed to give guidance to qualified professionals on the specific procedures that will be most appropriate in performing an autopsy on a deceased firefighter. The recommended procedures are intended to address the complex relationship between the firefighter and the inherently dangerous work environment where the duties of a firefighter must be performed. **It has been assumed that the user will be qualified, skilled and experienced in performing autopsies, as the protocol is intended only to provide guidance on the special considerations that should apply to a firefighter autopsy.**

It is hoped that a uniform firefighter autopsy protocol will lead to a more thorough documentation of the causes of firefighter deaths for three purposes:

- 1) to advance the analysis of the causes of firefighter deaths to aid in the development of improved firefighter health and safety equipment, procedures, and standards;
- 2) to help determine eligibility for death benefits under the federal government's Public Safety Officer Benefits Program, as well as state and local programs; and
- 3) to address an increasing interest in the study of deaths that could be related to occupational illnesses among firefighters, both active and retired.

The work environment of the firefighter is inherently dangerous. To survive in that environment, the firefighter routinely uses protective clothing, respiratory protection, safety equipment, and standard operating procedures intended to reduce the level of risk, but which cannot eliminate all risks. It is extremely important, in the event of a failure of those protective systems, to fully and carefully determine what, if anything, may have gone wrong and how, if possible, similar occurrences may can be prevented from happening again. An autopsy may provide some of the essential evidence to make those determinations.

The specific issues relating to the determination of eligibility for death benefits are discussed in Part IV of this document. Several areas of interest in the study of chronic health issues are addressed in Part III of this document.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health*, section 8-4.3, recommends, "If a member dies as a result of occupational injury or illness, autopsy results, if available, shall be recorded in the health data base."



II. MEDICOLEGAL AUTOPSY PROCEDURES IN THE UNITED STATES

The need to investigate and understand the cause of death, particularly when it occurs under unusual, confusing, or ambiguous circumstances, is almost universal. Nearly every country has established requirements for the medicolegal investigation of unforseen, unnatural, or violent deaths, usually including workplace accidents and job-related deaths. However, unlike some other industrialized nations, no national system of death investigation exists in the United States. Death investigation in the United States falls under the authority of state and local officials.

Legal structures governing death investigation vary considerably among the 50 states, the District of Columbia, and the territories. Depending on the jurisdiction, the official responsible for determining the cause and manner of death may be a coroner or medical examiner. Most firefighter deaths are investigated as unusual or unforseen deaths according to state laws and regulations, and a high level of discretion is afforded to coroners and medical examiners in the manner of fulfilling their duties and responsibilities. Only one state, Maryland, specifically requires a medicolegal investigation of all firefighter deaths. Other states, such as New Jersey, have designated the Division of Fire Safety as the lead agency for investigating fire service accidents, but have established no autopsy requirements.

Two publications attempt to organize and describe medicolegal autopsy requirements in the United States:

- Combs, D. L., R. G. Parrish, and R. Ing. 1992. *Death Investigation in the United States and Canada, 1992*. Atlanta: Centers for Disease Control, U.S. Public Health Service; and
- Wecht, C. H. 1989. *United States Medicolegal Autopsy Laws*, 3rd ed. Arlington, Va.: Information Resources Press.

Notwithstanding the differences among the various systems, all death investigation systems are intended to respond to questions of who died, how and why a death occurred, and (as applicable) who is responsible for the occurrence. This information in turn may be used in legal proceedings, to compile vital statistics, to evaluate medical care and treatment, and to compile factual information on clinical, anatomical, pathological, physiological, and epidemiological subjects for research purposes.

When Is an Autopsy Required?

An autopsy is not performed as a part of every death investigation. In most cases, the determination of the need to perform an autopsy is a discretionary responsibility of

the coroner or medical examiner. The issuance of a death certificate does not require an autopsy and only a death certificate is needed to qualify for most insurance and death benefit programs. The coroner or medical examiner may determine that no autopsy is required in any situation where there is sufficient other evidence to make conclusive determinations on the cause and manner of death. Frequently, no autopsy is conducted when a firefighter death is believed to have been caused by natural causes, such as cardiac ischemia, even when it occurs on the scene of or responding to a fire or emergency incident (see Goode, 1990).

Many coroners and medical examiners have had to limit the number of autopsies performed because of cost and time constraints. Fiscal pressures have increased as the number of death investigation cases has increased, particularly those involving violent deaths. The cases in which an autopsy is most likely to be omitted include those where there is a known and undisputed cause of death without suspicion of criminal activity; line-of-duty deaths often fall within these parameters. Autopsies are sometimes omitted because of the religious or personal preferences of the deceased and his or her family.

The failure to conduct autopsies appears to be of significant concern throughout the medicolegal community. Performing autopsies, even in cases of prolonged illness or involving individuals with prior medical histories, would be valuable in conclusively determining the cause of death, gaining a more detailed understanding of injury and disease processes, and evaluating the quality of medical care. According to some in the death investigation profession, a decline in the level of interest in pathology and forensic pathology among medical students has led to a shortage of trained professionals to conduct these procedures.

Autopsies are usually performed to establish or verify the cause of death, or to gather information or evidence that would be helpful in an investigation. Without an autopsy, specific causes, contributing factors, and underlying conditions may go undiscovered and unreported. In the case of firefighter fatalities, this lack of information may significantly hamper our understanding of the hazards of firefighting and limit the ability to develop more effective ways to prevent firefighter deaths and injuries.

* * *

III. OCCUPATIONAL ASPECTS OF FIREFIGHTING OF SPECIFIC CONCERN TO AUTOPSY

Firefighter fatalities often result from complicated scenarios. Due to the nature of the occupation, a firefighter's death could be caused by a wide variety of single factors or a combination of several factors. For example, a firefighter could die from a stress-induced heart attack caused by simple over-exertion; or a firefighter could die from asphyxiation which is actually caused by the failure of his or her breathing apparatus; or a firefighter could die from hypothermia, resulting from being trapped in a structural collapse while fighting a fire on an extremely cold day. A firefighter's death could be caused by the inhalation of toxic products of combustion, burns, traumatic injury, exposure to hazardous materials, radiation, a variety of other singular causes, or a combination of factors.

A better understanding of the actual causes of firefighter deaths, including all of the causal factors, will require a thorough examination of the protective clothing and equipment that are involved in the incident, a detailed analysis of the situation, and the details that can only be obtained through an autopsy, such as carboxyhemoglobin levels and the presence of toxic products in the respiratory and circulatory systems.

Firefighter Death Classification

The joint USFA/NFPA annual analysis of firefighter line-of-duty deaths uses nine categories to describe the mechanism of injury, which are defined in NFPA 901, *Uniform Coding for Fire Protection*. Statistics are compiled according to the cause of death as listed on the death certificate for each case. Additional information may be provided to further define the cause, when incident reports and witness accounts are available. The nine causal categories reported in the USFA/NFPA system are:

- Fell/slipped
- Struck by
- Overexertion/Strain
- Fire Department Apparatus Accident
- Caught/Trapped
- Contact with/Exposure to
- Exiting or Escaping/Jumped
- Assaulted
- Other

While cardiac arrest and other stress-related fatalities are the leading cause of fireground deaths, this classification system does not differentiate the causes of cardiac- and stress-related cases; all are classified as "Overexertion/Strain." Although firefighting is widely recognized as a highly stressful occupation, the physiological and psychological effects of job-related stress have not been clearly established or differentiated, particularly as they affect mortality and morbidity.

The annual USFA/NFPA report also describes firefighter fatalities according to the nature of the death (i.e., the medical cause death), using the following fifteen categories:

- Cardiac arrest
- Internal trauma
- Asphyxiation
- Crushing
- Burns
- Drowning
- Stroke
- Electrocution
- Hemorrhage
- Gunshot
- Aneurysm
- Fracture
- Heat stroke
- Pneumonia
- Other

It should be noted that the USFA/NFPA categories do not correspond with International Classification of Disease (ICD-9) or SNOMED (Standardized Nomenclature of Medicine) cause categories.

Trends in Line-of-Duty Deaths

The overall downward trend in line-of-duty deaths has been primarily driven by the downward trend in deaths during fireground operations or while at the fire scene. Fireground deaths account for more than half (963) of all firefighter duty deaths over the last 15 years. Training deaths increased significantly from an average of 5.2 deaths per year during the first 9 years to 11.5 deaths per year during the last 6 years of the period. Responding to and returning from alarms accounted for 26.3 percent of the deaths over the 15-year period.

Heart attacks lead all categories of line-of-duty deaths. Between 1977 and 1991, 45 percent of all firefighter deaths resulted from cardiac disorders, most from myocardial infarction. The proportion of deaths resulting from heart attacks has varied from 33.6 percent to 53.9 percent over the 15-year period.

Fahy (1993) reported that an NFPA study of fatal firefighter heart attacks conducted for the United States Fire Administration determined that about 40 percent of the firefighters who died on duty from heart attacks between 1981 and 1990 (and for whom medical documentation was available) had prior histories of cardiac ischemia, myocardial infarction, or coronary artery bypass surgery. An additional 39 percent had prior histories of acute atherosclerosis (defined as more than 50 percent occlusion); most of these cases involved occlusions greater than 70 percent. Any of these conditions could have represented sufficient cause for disqualification from continued firefighting duty under the provisions of NFPA 1582, *Medical Requirements for Firefighters*, which was adopted in 1992.

The adoption of health maintenance and physical fitness requirements for firefighters is a controversial subject and the requirements of NFPA 1582 have not been widely adopted. This subject is further complicated by the provisions of the Americans

with Disabilities Act (ADA), which may restrict the ability of fire departments to limit the duties of high risk individuals.

Investigation of Line-of-Duty Deaths

Fire suppression and emergency operations are inherently dangerous; however, the data on firefighter line-of-duty deaths presented by the statistics in this document suggest that a significant proportion of firefighter deaths, particularly those on the fireground, are preventable. The International Association of Fire Chiefs (IAFC) has developed the *Guide for Investigation of a Line-of-Duty Death*, which provides a systematic approach to the overall investigation of fireground fatalities. The IAFC guide notes that an autopsy should be requested for every line-of-duty death and the results of the autopsy should be included in the report of the investigation.

There has been a significant decline in the number of firefighter deaths during fireground operations, particularly from exposure to combustion products, which appears to be related to the increased use of better protective equipment. Firefighter deaths due to cardiac ailments remain a significant concern, as do traumatic injuries from vehicle accidents and training accidents.

Evaluating the thermal performance of various types of firefighter protective clothing is an example of an area where considerable insight can be gained through accurate anatomical descriptions obtained from an autopsy. Toxicological studies can help investigators better understand the effectiveness of SCBA use and operating procedures on preventing fireground exposures to hazardous atmospheres. Evaluations of body fat, muscle development, and special coronary studies can help develop a database on the relative fitness of firefighters. These types of studies will help reinforce lessons which should help the fire service improve fireground operating procedures, protective equipment, training, and physical fitness. They can also help support the development and use of criteria for regular medical evaluations for firefighters.

If the number of line-of-duty deaths continues to decline it will become more difficult to evaluate improvements in firefighter safety through the mortality statistics. This will place increased emphasis on the need for a detailed investigation and documentation of each and every line-of-duty death. It is a matter of compelling public interest that information about the cause and manner of all firefighter line-of-duty deaths should be thoroughly and systematically collected. The autopsy results should be an important part of the record in each case.

Fire Toxicology

A complete understanding of the cause of a firefighter's death must include some consideration of toxicological agents that may have been involved and how they may have interacted with the deceased's biological processes and systems to cause death. For

instance, did the inhalation of carbon monoxide result in cardiac ischemia and subsequent cardiac arrest? Did a toxin enter the body through some route other than the respiratory system? Did protective clothing or self-contained breathing apparatus (SCBA) fail to protect the user, or was the user's air supply depleted? These conditions are often accompanied by other injuries which may or may not themselves have caused death, such as crushing forces or prolonged exposure to high radiant heat levels.

Toxicology reports in most autopsies document the positive and negative findings of a series of tests conducted to detect specific substances which may have caused death. Such tests commonly include tests for the presence of pharmacological agents and illegal drugs. In the case of fire victims, the toxicology report should include blood, urine, other body fluids, and tissue analyses for the presence of combustion products and other toxicants (and their biomarkers), as well as alcohol and drugs.

The most common products of combustion are carbon monoxide and either soot or ash, however, acrolein, cyanide, formaldehyde, hydrogen chloride, phenol, phosgene, polyaromatic hydrocarbons (PAHs), nitrogen oxides, sulfur oxides, water vapor, and carbon dioxide may also be present. Blood tests for the presence of ethyl alcohol are typically conducted to determine whether the deceased was under the influence of an intoxicating beverage at the time of death. Urinalysis should include tests for the presence of common narcotics, barbiturates, amphetamines, hallucinogens, or cannabinoids. Tests for other prescription and non-prescription drugs are occasionally performed to detect such compounds as common steroids, analgesics, and other indicators of co-existing illnesses/conditions, as well as of drugs used in emergency resuscitation attempts.

Personal Protective Equipment

Detailed knowledge of the manner of death requires, among other things, an evaluation of the performance of the firefighter's personal protective equipment, which includes protective clothing and breathing apparatus. There is voluminous anecdotal evidence that failure to use proper protective equipment has been responsible for many of firefighter injuries, illnesses, and deaths.

The use of self-contained breathing apparatus (SCBA) has significantly reduced the number of firefighter injuries and deaths that are attributable to smoke inhalation. While thermal and respiratory injuries remain a concern in cases of firefighter autopsies, the widespread use of SCBA has introduced new considerations into the evaluation of these injuries. For example, knowing that a firefighter's death was the result of inhalation of combustion products, when the firefighter was using an SCBA, would indicate the need to fully evaluate the performance of the SCBA.

Experts may need to be consulted to determine how a firefighter's protective clothing and equipment performed or failed to perform. The National Institute of Occupational Safety and Health and several independent consultants are available to assist in the evaluation of personal protective equipment.

Non-Line-of-Duty Deaths

Because of their repetitive exposure to toxic environments and carcinogens, many firefighters are concerned that they are at a higher risk to die prematurely, particularly as their longevity on the job increases. The causes of firefighter deaths that occur off-duty (or non-line-of-duty) can sometimes be attributed to one exposure or to a series of exposures to toxins. There have been some major, well documented exposures of firefighters to certain known carcinogens. It has been suggested, for instance, that fires in occupancies manufacturing or storing chemicals in Elizabeth, New Jersey and Fort Lauderdale, Florida are responsible for increased incidence of cancer among the firefighters who fought these blazes.

In recent years, as many as 29 cases of cancer, including 19 cancer deaths, have occurred among the approximately 100 firefighters who fought a fire in 1968 at the Everglades Fertilizer Plant in Fort Lauderdale, Florida. All but one of these cases was diagnosed after the firefighter had retired or resigned from the fire department. This case has prompted the National Institutes of Occupational Safety and Health (NIOSH) to initiate an epidemiological study of firefighters involved in the Everglades fire.

It can be very difficult to directly attribute a non-line-of-duty death to a line-of-duty exposure, especially if the exposure occurred years before the death. Comprehensive autopsies of firefighters whose death may have been caused by a line-of-duty exposure could help establish a better understanding of the relationship between exposures and premature deaths, however this will require much better data be obtained and maintained than is currently the norm.

Many fire departments have mandated physical requirements and medical examinations for firefighters. Regular medical exams and physical testing can track a firefighter's physical and medical status from hire to retirement, and can serve as a baseline against which to compare, especially after an incident or series of incidents where a firefighter may be concerned that an exposure has jeopardized his or her health. Records of exposures to particular toxins should be kept by the fire department along with the medical records. Such documentation would be valuable in determining whether an exposure led to medical problems, or whether a non-line-of-duty death is related to firefighting or other emergency or occupational activities.

The firefighter autopsy protocol is primarily intended to be applicable to line-of-duty deaths, however it would also be appropriate for non-line-of-duty deaths where an occupational factor is suspected to be involved in the cause of death. For most firefighter deaths which are not duty-related or which involve former firefighters, existing clinical autopsy procedures consistent with the individual's medical history should be appropriate. The USFA firefighter autopsy protocol has been designed to uncover pertinent forensic information consistent with the distinct occupational aspects of firefighting.

Firefighter Health

Several studies have looked at the frequency of premature death rates among active and retired firefighters. Rubin (1992) has described the relationships between the hazards of fire suppression and the risk of premature death from heart disease or cancer as "Firefighter's Disease." He notes that relatively little research has been conducted on firefighter mortality and morbidity or the medical treatment of firefighters.

Rubin proposes that a concern for firefighter health should begin with prevention. He suggests that diet, lack of exercise, and lifestyle may be as responsible for premature firefighter deaths as any job-related exposure. The relationships of lifestyle, exercise, and diet with firefighter mortality appear to be more than just conjecture. Epidemiological studies have demonstrated that firefighters are much less likely than the general population to die from natural causes at a given age, early in their careers, because they must be healthier than the average person to pass the rigorous health and fitness standards in order to be hired or approved for volunteer duty. The death rate for firefighters catches up with the rest of the population by their retirement age, which suggests that the so-called "healthy worker effect" diminishes with time, especially if the individuals do not take care of themselves. This takes into account the factor that firefighters tend to retire at a younger age than the general population.



IV. PUBLIC SAFETY OFFICER BENEFITS PROGRAM

The Bureau of Justice Assistance of the U.S. Department of Justice, administers the Public Safety Officer Benefits (PSOB) program, which was established by Congress to provide death benefits to family members of “public safety officers found to have died as the direct and proximate result of a personal injury sustained in the line of duty.” (28 CFR 32.1).

Evaluation Criteria

Title 28, Part 32 of the *Code of Federal Regulations* outlines the eligibility criteria for receiving benefits under this program. Claimants are required to demonstrate that the injury resulting in the death of the public safety officer was the direct result of activities performed in the line of duty. Several claims have been filed in cases where the death resulted from disease or chronic health conditions that were not clearly related to a specific on-duty event. Many of the claims involving deaths resulting from chronic health conditions, such as coronary artery disease, hypertension, and cancer, have been denied because causality could not be clearly and convincingly demonstrated.

Several states have adopted statutes or regulations that establish a presumption in the case of firefighters, that any cardiac or pulmonary disease is occupationally related. Most of these presumptive regulations were adopted in an era when firefighters were routinely exposed to products of combustion without respiratory protection. Some states have more recently extended this presumption to cover cancer as well.

To determine when cardiac deaths could be considered duty-related under the PSOB regulations, an expert panel was convened by the Law Enforcement Assistance Administration, in April 1978 to consider the relative contributions of carbon monoxide and heart disease in firefighter deaths. As a result of this meeting, a standard was established for evaluating claims involving heart attacks, based on evidence that carbon monoxide can increase the susceptibility of an individual to a sudden myocardial infarction. This standard requires that in order to be considered eligible for PSOB compensation, non-smoking firefighters must have a blood carboxyhemoglobin (COHb) level above 10 percent by volume and that firefighters who smoke must have COHb levels above 15 percent by volume. Even if these criteria are met, benefits can still be denied if the medical examiner or coroner performing the autopsy and the pathologist reviewing the case for PSOB determine that carbon monoxide inhalation was not a significant factor in the death or the COHb level found was not a direct causal factor as defined in the PSOB regulations.

In addition to the requirement to demonstrate that the personal injury was incurred in the line of duty, PSOB awards are contingent upon a finding that the death was not caused by intentional misconduct, grossly negligent conduct, or intoxication of

the deceased. The Department of Justice has never denied a PSOB claim on the basis of intentional misconduct or gross negligence on the part of the deceased, and denials for intoxication have been rare.

Program History

Between 1976 and 1992, 1,428 firefighter claims were reported to the PSOB office. During this period, 855 cases were approved and 603 were denied. (The additional cases include 30 carried over from previous years.) The majority of the cases denied involved coronary artery or related cardiovascular diseases without supporting evidence of elevated COHb levels.

The PSOB regulations do not require that an autopsy be performed to document the cause of death. Only a death certificate must be provided to establish death and indicate the proximate cause; however, cases can be delayed or complicated by failure to provide toxicological evidence to support the cause of death or rule that intoxication is not involved. According to PSOB officials, autopsy reports were submitted in approximately half of the cases processed; however, the overwhelming majority of those for which claims were denied involved cases where no autopsy was performed. PSOB officials point out that of the claims denied, the majority involved cardiac deaths which were unlikely to qualify, even if autopsies had been performed.

Issues and Concerns

Due to the substantial number of firefighter line-of-duty deaths caused by heart attacks, firefighters have expressed considerable interest in the standards used to evaluate these cases. Although it is generally accepted that carbon monoxide exposure can cause cardiac ischemia and subsequent death, considerable disagreement exists regarding the assumption that exposure to combustion products should be the sole determinant to qualify individual heart attack cases as job-related. Many individuals and organizations in the fire service contend that several job-related factors conspire to increase a firefighter's risk of acquiring heart disease.

Similar arguments surround the question of chronic conditions such as cancer. Department of Justice officials indicate that only two claims have been paid in the last 15 years for cancer deaths. Both of these cases involved police officers who died of testicular cancer and in each case there was substantial evidence that the cancer resulted from a single job-related exposure. While it has been established that firefighters routinely operate in environments filled with toxic and carcinogenic compounds, no firefighter cancer death claims have been approved under the PSOB regulations.



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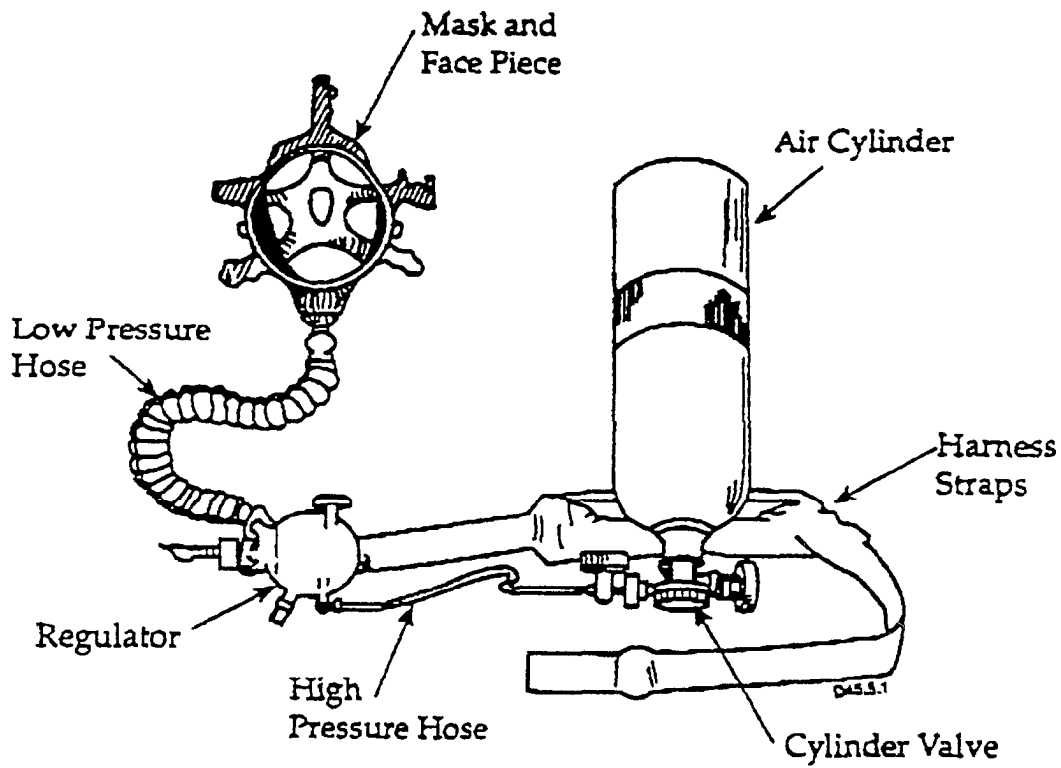
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Wecht, C. H. 1989. *United States Medicolegal Autopsy Laws*, 3rd ed. Arlington, Va.: Information Resources Press.

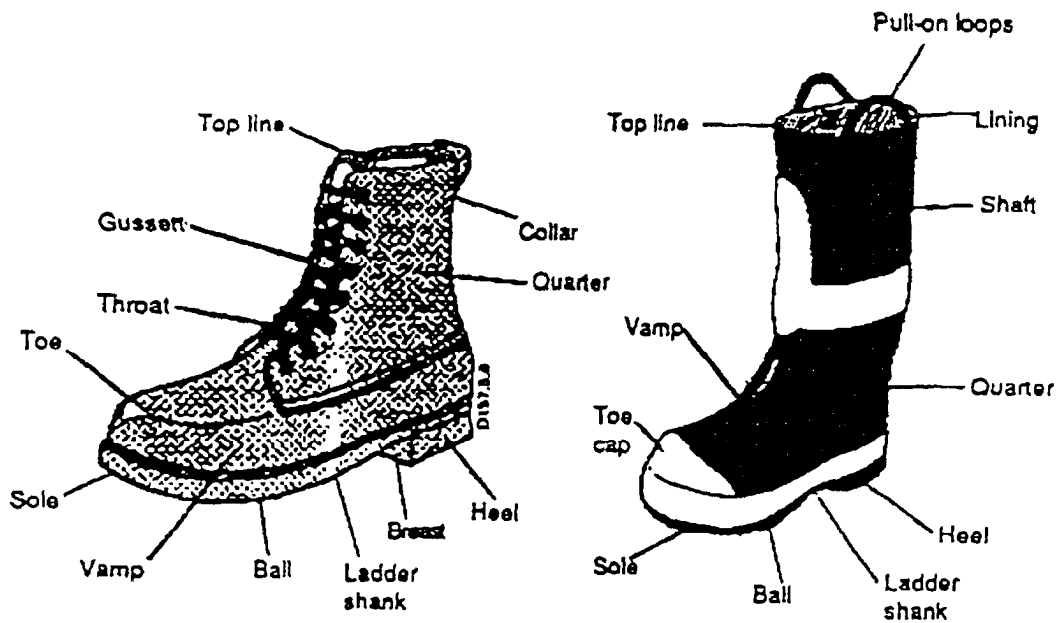


APPENDIX 1

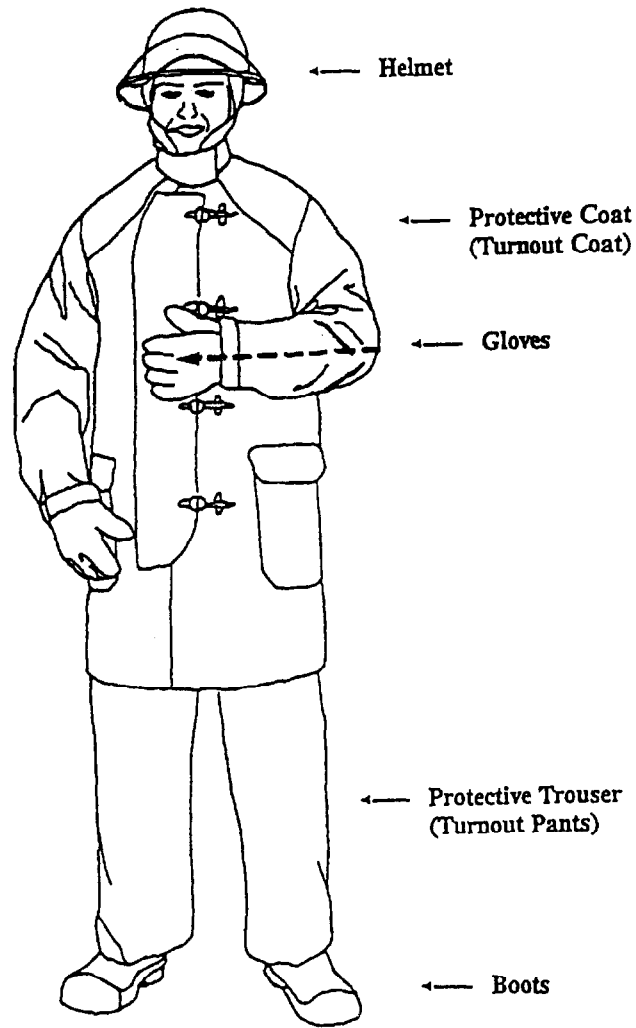
Firefighter Personal Protective Equipment



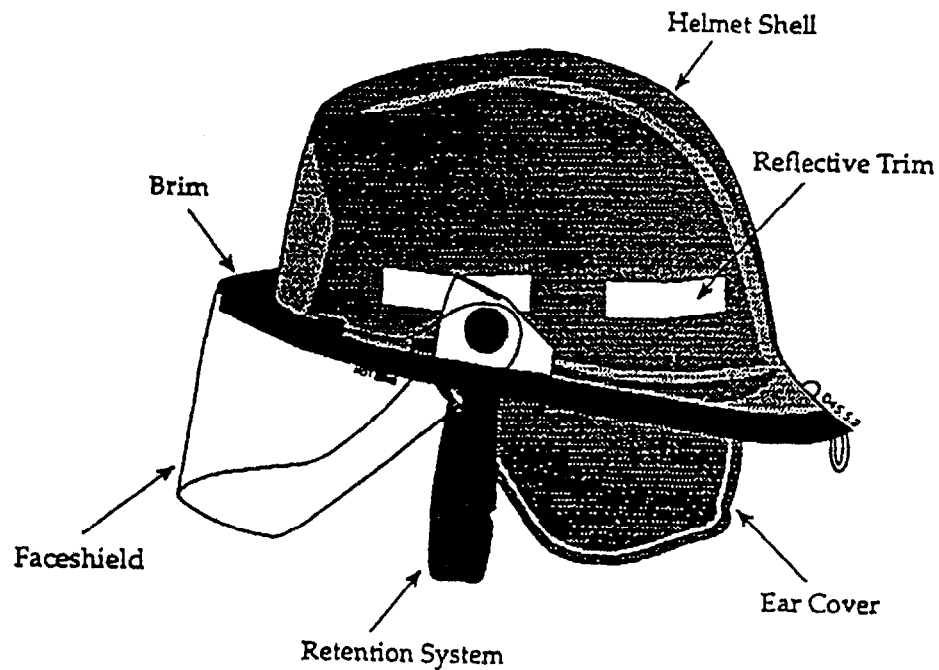
Typical Self-Contained Breathing Apparatus (SCBA)



Typical Boots



**Typical Protective Clothing Ensemble
(Full Ensemble Includes SCBA)**



Typical Helmet

FIREFIGHTER AUTOPSY PROTOCOL



October 1994

<p style="text-align: center;">PROTOCOL</p>	<p style="text-align: center;">DISCUSSION</p>
<p><u>I. Preliminary</u></p> <ul style="list-style-type: none"> A. Circumstances of Death <ul style="list-style-type: none"> 1. Line-of-Duty <ul style="list-style-type: none"> a. Fire suppression activity b. Other official activity 2. Non-Line-of-Duty <ul style="list-style-type: none"> a. Active firefighter, unrelated activity b. Former firefighter activity B. Medical Records Review <ul style="list-style-type: none"> 1. Fire department injury/exposure records 2. Current medical conditions/medications <ul style="list-style-type: none"> a. Prescribed b. Over-the-counter c. Administered by paramedics C. Complete Work History <ul style="list-style-type: none"> 1. Length of fire combat duty 2. Other jobs held during fire service 3. Jobs held after fire service D. Scene Investigation E. Scene Photography F. Jurisdiction/Authority to Conduct Autopsy 	<p>Firefighters are subject to many uncommon occupational hazards, including toxic and superheated atmospheres, explosions, falls, crushing/penetrating forces, contact with fire, electricity, or hazardous materials, and extremely strenuous and stressful physical activities.</p> <p>The autopsy results may be essential to determine why or how a firefighter was incapacitated, how the activity related to the cause of death, and whether protective equipment performed properly. Having a clear picture of the nature of firefighting operations that were taking place (and to which the deceased was assigned) will assist in identifying possible mechanisms of injury. If the firefighter was reported missing, try to determine the time of last contact or the length of time between the initial report and the finding of the body.</p> <p>The fire department should have an officer or internal Line-of-Duty Death Investigation Team assigned to conduct a death investigation. Other investigators may include the police, the state fire marshal (or other state officials), and/or federal/state agencies responsible for occupational safety and health. Consult with these officials as necessary.</p> <p>In conducting the medical records review, obtain a documents which pertain to the incident. Document the occupational history of the deceased, including the number of years assigned as a “combat” firefighter, any history of unusual exposures (or changes in frequency of exposure) to hazardous substances, and any relevant occupational medical history. Finally, all recent medical history should be reviewed, including documentation of any attempts at on-scene resuscitation.</p>

PROTOCOL	DISCUSSION
<p>II. Initial Examination</p> <p>A. Identification of Victim</p> <p>B. Document Condition of Personal Protective Equipment (PPE)</p> <ol style="list-style-type: none"> 1. Refer to PPE Identification Diagrams on page 6 for standardized nomenclature PPE description should include: <ol style="list-style-type: none"> a. Turnout coat b. Turnout pants c. Helmet d. Gloves e. Boots f. Self-Contained Breathing Apparatus g. Personal Alert Safety System (PASS) h. Protective hood i. Clothing worn under turnouts 2. Use photographs to enhance documentation <p>C. Maintenance of Custody of Equipment</p>	<p>Exercise caution when handling contaminated personal protective equipment (PPE), especially from hazardous materials incidents, as residue may be harmful to those involved in the autopsy.</p> <p>PPE should be sealed in a metal can/drum if fire accelerants or other volatile/toxic chemicals are suspected to be present; otherwise PPE should be air-dried and preserved for examination. Preservation of the original state of PPE, including clothing, is essential. PPE should be considered as evidence, and handled accordingly. The Death Investigation Team should perform or assist in the evaluation/documentation of PPE condition and performance. Documentation of the chain of custody of the PPE is required, especially as it may be examined by a number of individuals. Upon completion of any examination, PPE should be secured in an evidence storage area. (International Association of Fire Chiefs. 1993. Guide <i>for Investigation of a Line-of-Duty Death</i>. Fairfax, VA: pp. 14, 19).</p> <p>Observations and photos recorded at the scene should indicate whether the deceased was found wearing self-contained breathing apparatus (SCBA) and/or other PPE. If SCBA and personal alert safety system (PASS) are user-controlled, were they properly activated or working at the time of discovery of the deceased? A swab from the inside of the SCBA facepiece may help in determining operability-</p> <p>A qualified specialist should inspect the PPE and note any damage. The National Institute for Occupational Safety and Health (NIOSH) can assist in the determination of any contribution of the deceased's SCBA to the death. PPE manufacturers may be able to assist in evaluating damage, but PPE should <u>not</u> be returned to the manufacturer for examination (because of concerns about product liability). Breathing apparatus filter cartridges, if any, should be retained.</p>

PROTOCOL	DISCUSSION
<p>III, External Examination</p> <ul style="list-style-type: none"> A. Document Condition of Body <ul style="list-style-type: none"> 1. Photograph 2. Radiograph B. Document Evidence of Injury C. Document Evidence of Medical Treatment D. Collect Evidence from External Surfaces <ul style="list-style-type: none"> 1. Swabs of nasal/oral soot or other substances 2. Hair 3. Injection Sites E. Collect Vitreous Fluid F. Document Bums <ul style="list-style-type: none"> 1. Location 2. Degree 3. Etiology 4. Percentage of body surface area (BSA) G. Biopsy Skin Lesions 	<p>Firefighters are trained to provide emergency medical care for fire casualties. Of particular importance is that <u>resuscitative efforts for fellow firefighters are likely to be heroic and prolonged</u>. This fact should be taken into account when examining the body for evidence of medical intervention <u>and</u> when interpreting the results of blood gas assay.</p> <p>Note the presence of soot or other unidentified substances on the skin and place samples (swabs) in a sealed container.</p> <p>Certain internal samples (such as soot swabs and vitreous fluid) which can be done before the body is opened are taken at this point because collection can be accomplished in a more controlled manner, thus reducing the potential for cross-contamination of the surfaces.</p> <p>Hair samples should be about the thickness of a finger, pulled out so as to include the roots, tied around the middle, with the proximal and distal ends marked, and stored in a plastic evidence bag.</p> <p>Vitreous fluid should be taken from both eyes. Vitreous fluid can be used to corroborate blood alcohol levels.</p>

PROTOCOL	DISCUSSION
<p>IV. Internal Examination</p> <p>A. Document Evidence of Injury</p> <p>B. Document Evidence of Medical Treatment</p> <p>C. Describe Internal Organ System</p> <p>D. Collect Samples for Toxicologic Analysis</p> <ol style="list-style-type: none"> 1. Blood (2 x 20cc red- and grey-top tubes) 2. Urine (20 to 30cc) and/or trimmed bladder 3. Bile (all available) or Gallbladder (ii bile unavailable) 4. Cerebrospinal Fluid (up to approx. 30 ml) 5. Soot swabs from airway <ol style="list-style-type: none"> a. Tracheal b. Bronchial 6. Representative sampling of gastric and duodenal contents (50g; note total amount) 7. Take and retain fresh-frozen samples <ol style="list-style-type: none"> a. Lung 100g b. Kidney 100g c. Liver 100g d. Spleen 100g e. Skeletal muscle (Psoas or Thigh) 20g f. Subcutaneous fat 20g g. Section of bone with marrow (3-4 cm) h. Brain 100g 8. Additional specific samples to be taken: <ol style="list-style-type: none"> a. Tied-off lower lobe of right lung (store in arson debris paint can) b. Peripheral blood from leg vein (fluoridated and red-top tubes) c. Any specimens taken in field or during hospital resuscitation d. Sample hematomas e. Any other sites should be labelled 	<p>Soot swabs should be obtained from the upper and lower airways as well as from the inside of the SCBA facepiece. These will assist in the determination of SCBA usage and operability.</p> <p>Note any unusual odors/colors of anything found during the internal examination.</p> <p>Fresh-frozen samples of vital organs should be taken and retained a minimum of 90 days, preferably longer as storage space permits.</p> <p>An area of growing interest is the cancer rate of firefighters. Potentially cancerous tissue should be biopsied and saved. Additionally, histological type and the exact location of the tumor (if site-specific) within an organ should be documented in detail.</p> <p>In the case of incinerated remains, bone marrow or spleen may be the only source of tissue for toxicological studies, especially for those establishing carbon monoxide levels.</p> <p>Gastric and duodenal contents should be representative. Solid dosage forms should be removed, counted, and analyzed.</p> <p>When taking lung samples, use the right lung because aspirated foreign materials have a greater propensity to lodge in the right lung.</p>

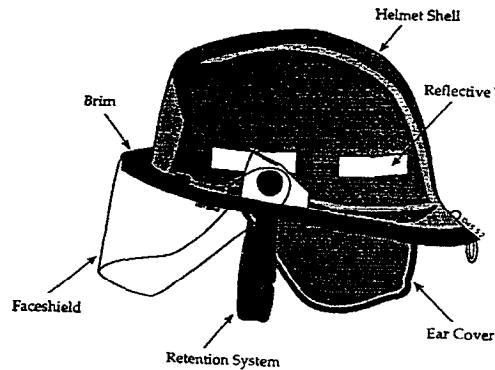
<p style="text-align: center;">PROTOCOL</p>	<p style="text-align: center;">DISCUSSION</p>
<p><u>V. Toxicological Examination</u></p> <p>A. Urine Screen/Analysis</p> <ol style="list-style-type: none"> 1. Volatile compounds (e.g., Benzene, Hydrocarbons including accelerants, Ethanol) 2. Psychoactive substances (e.g. Opiate derivatives, Marijuana metabolites, Cocaine metabolites, Stimulants, Phencyclidine) <p>B. Blood Analysis</p> <ol style="list-style-type: none"> 1. Carboxyhemoglobin, Methemoglobin, Sulfhemoglobin 2. Volatile compounds (see A.I. above) 3. Other (e.g., Hydrocyanic Acid, Flouride) 4. Confirm results of positive urine screen <p>C. Subcutaneous Fat Analysis</p> <ol style="list-style-type: none"> 1. Organic compounds, including: <ol style="list-style-type: none"> a. Herbicides b. Pesticides 2. Polychlorinated Biphenyls (PCBs) <p>D. Soot Screen (from swabs)</p> <ol style="list-style-type: none"> 1. Metals, including: <ol style="list-style-type: none"> a. Arsenic b. Antimony c. Lead 2. Organics, including: <ol style="list-style-type: none"> a. Pesticides b. Herbicides c. Vinyl Chloride d. Acrylonitrile e. Acrolein 3. Particulate analysis 	<p>The toxicologic analysis performed for firefighters should be of a higher order than that performed for civilian fire casualties. In addition to ascertaining blood levels of various toxic products that are commonly found in a fire environment, it is beneficial to know about the presence of any judgment-impairing substances. This may be important in the determination of eligibility for death benefits as well as for determining causality.</p> <p>Determination of specific levels of metals, organic compounds, and gross particulate matter should be conducted because firefighter exposure to these substances is believed to be greater than that for civilians. Additionally, this information may yield important clues about the cause, manner, and mechanism of firefighter death.</p> <p>Use vitreous fluids or bile to confirm presence of ethanol in either blood or urine.</p> <p>Use caution when noting the presence of Hydrocyanic Acid as it can be produced by bacterial decomposition within the tissues of the deceased.</p> <p>Check for the presence of PCBs in the subcutaneous fat, as this will help in the determination of a history of exposure.</p>

PROTOCOL	DISCUSSION
<p>VI. Microscopic Examination</p> <p>A. Findings of Microscopic Examination</p>	<p>Representative samples of all organs and body systems should be collected. The sections should be microscopically examined for malignant neoplasms and other abnormalities, including suggestive pre-malignant changes</p>
<p>VII. Summary of Pathological Findings</p> <p>A. Medical Facts</p> <p>1. Correlation</p>	<p>State objective findings related to gross and microscopic examinations. Correlate physical circumstances, toxicological analyses, and other investigative studies to pathological findings.</p>
<p>VIII. Conclusions</p> <p>A. Discrepancies</p> <p>1. Inconsistent observations</p> <p>2. Differences between death certificate and subsequent findings</p> <p>B. Conclusions</p> <p>1. List diagnoses on a separate page</p> <p>2. Cause and manner of death</p>	<p>Include determination of cause and manner of death. Describe discrepancies between evidence collected or observations of eyewitnesses and the autopsy findings.</p>

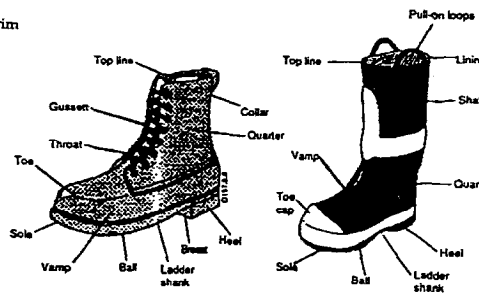
Sample Firefighter Personal Protective Equipment (PPE) Identification Diagrams
(actual PPE styles vary depending on manufacturer)



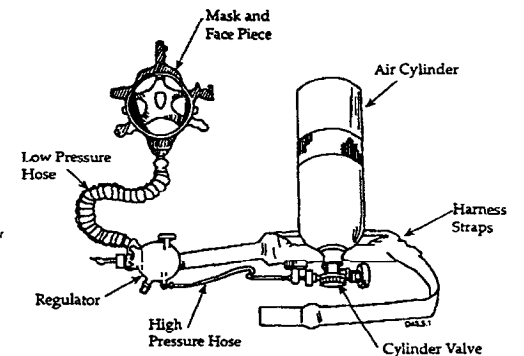
Protective Clothing Ensemble
(Full PPE Includes SCBA)



Helmet



Boots



Self-Contained Breathing Apparatus