The inherent risks and dangers in emergency response set it apart from most other professions. Compared with the average worker, emergency responders are about three times as likely to be injured or killed on their jobs (Clarke and Zak, 1999; Bureau of Labor Statistics, 2002). Compared with protecting workers in hazardous industrial environments, protecting emergency responders is particularly challenging because their working environment is varied and unpredictable, making it more difficult to catalog the risks they face and implement protections for them. The hazards that emergency responders face range from the mundane to the life-threatening and can change suddenly and considerably from day to day, incident to incident, and moment to moment.

This chapter presents an overview of the emergency responder community in terms of its size, activities, hazards, and injuries. This overview was compiled from data gathered during a comprehensive survey of publicly available sources and provides background for interpreting the community views presented in the subsequent chapters. It also provides an opportunity to examine the extent to which the views on hazards and protection needs expressed in the discussions compare with the available data on responder activities and injuries.

SERVICES IN THE EMERGENCY RESPONDER COMMUNITY

The emergency responder community examined in this study is typically divided into three services: fire, emergency medical, and law enforcement. While these three divisions serve as a useful classification scheme for discussing emergency responder career patterns and overall job functions, in terms of the community’s activities and hazards, the boundaries among services are often blurred, especially the boundaries between fire and emergency medical services. This overlapping of activities and hazards is further complicated by the fact that a common mode of EMS delivery is through fire departments. Therefore, it is fairly common for firefighters to be cross-trained as emergency medical responders. A small fraction of law enforcement departments are also
responsible for fire and emergency medical services, leading to additional overlapping. These overlaps in personnel and job functions led to some ambiguity in our compiling and interpreting statistics on the emergency responder community.

**The Fire Service**

In 2000, the United States had approximately 1.1 million firefighters working in more than 26,000 fire departments. About one-quarter of these firefighters were career (paid) personnel and three-quarters were active volunteers (Karter, 2001). These figures apply to municipal fire departments and exclude state and federal government agencies (which employ many wildland firefighters) and private fire brigades that protect industrial facilities.

Despite the fact that volunteers far outnumber career firefighters, 62 percent of the country's population is served by the latter (Karter, 2001). While there has been a slow shift among firefighters from volunteer to paid status over the past decade and a half, the total number of municipal firefighters has remained nearly constant (Karter, 2001). Figure 2.1 shows the number and size of fire departments and the total number of firefighters as a function of the size of the population served.

While fire departments in the largest cities employ thousands of firefighters, most other departments are much smaller: More than 80 percent of departments protect populations of less than 10,000 and have an average size of fewer than 50 firefighters. As discussed later in this report, the decentralized structure of the fire and other emergency responder services makes it difficult for the emergency responder community to drive research and development which, in turn, impedes innovation and the flow of new technologies into the community.

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1This results from the fact that populations protected by volunteer departments tend to have a higher ratio of firefighters to residents than those protected by career firefighter departments. This occurs primarily for two reasons: (1) compared with career firefighters, many more volunteer firefighters work part time, which requires a greater number of firefighters for a given population, and (2) most volunteer firefighters belong to smaller suburban and rural departments; because there is a minimum required size for a functional department regardless of the size of the protected population, volunteer departments protecting small populations have more firefighters per resident.
The Emergency Medical Service

Because of the multiplicity of emergency medical service delivery systems, emergency medical responders are difficult to count. One or more of a number of organizations may provide EMS in a community. Those organizations include fire departments, independent third-service municipal agencies, hospitals, private firms, and law enforcement agencies. As a result, estimates of the emergency medical responder population vary considerably. Our evaluation of these estimates suggests that the population of active EMS responders may be around 500,000.\(^2\)

Note that because of the common practice of cross-training

\(^2\)Bureau of Labor Statistics (2003a) data indicate that there were 171,000 paid emergency medical technicians (EMTs) and paramedics in 2001. However, the emergency medical services population contains both paid and volunteer personnel. Data from the National Public Safety Information Bureau (2002) and conversations with Bureau staff show that 5,885 EMS departments employed about 212,000 emergency medical service responders, and 28,579 fire departments employed about 465,000 “emergency personnel,” which includes emergency medical responders. Estimates of the
between fire and emergency medical service, there may be considerable overlap between the personnel included in this estimate and those in firefighting. As discussed in the following chapters, participants felt that the overlap of personnel and the multiplicity of agency types contributed to a lack of attention being paid to personal protection for the emergency medical response community.

Law Enforcement

There were nearly 800,000 full-time, sworn law enforcement officers in the nation in 2000, the most recent year for which such data are available for all levels of government. More than half of those officers were in local police departments, with the remainder in county, state, and federal agencies (see Table 2.1). Approximately 73 percent, or 580,000, of these officers can be considered emergency responders based on their primary responsibility for patrol duty or crime investigation.

In contrast to the fire service, the number of police and other law enforcement officers has increased steadily over the past decade. From 1990 to 2000, local

<table>
<thead>
<tr>
<th>Type of Agency</th>
<th>Number of Agencies</th>
<th>Number of Full-Time Sworn Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local police</td>
<td>12,666</td>
<td>440,920</td>
</tr>
<tr>
<td>County sheriffs</td>
<td>3,070</td>
<td>164,711</td>
</tr>
<tr>
<td>Primary state police</td>
<td>49</td>
<td>56,348</td>
</tr>
<tr>
<td>Federal</td>
<td>N/A</td>
<td>88,496</td>
</tr>
<tr>
<td>Special police and Texas constables</td>
<td>1,999</td>
<td>46,043</td>
</tr>
<tr>
<td>Total</td>
<td>17,784</td>
<td>796,518</td>
</tr>
</tbody>
</table>

NOTES: Special police agencies serve a special geographic jurisdiction or have special enforcement responsibilities; examples are campus, transportation, and parks and recreation police at both the state and local level. The number of federal agencies was not available; therefore, those agencies are not included in the total.

SOURCES: Federal number from Reaves and Hart (2001); all others from Reaves and Hickman (2002).

number of EMS certifications are relatively consistent at approximately 830,000 to 880,000 (“State and Province Survey,” 2001; Heightman, 2000; National Association of Emergency Medical Technicians, 2002). Counts of certifications significantly overestimate the actual number of active responders because they include some emergency room and dispatch personnel and because certified individuals may hold more than one certification or not be working as EMS responders (Maguire et al., 2002). On the other hand, estimates of paid responders do not account for active volunteers. Taken together, these estimates suggest that 500,000 may be a reasonable estimate for the number of active EMS responders.
police, county sheriff, and state police officer levels increased by 21 percent, 16 percent, and 8 percent, respectively (Hickman and Reaves, 2001; Reaves, 1992). Federal law enforcement officers with firearms authorization and arrest powers saw an even larger increase—28 percent—from 1993 to 2000 (Reaves and Hart, 2001; Reaves, 1994).

As is the case with the fire service, the majority of police departments are relatively small: Nearly half of all local police departments had fewer than ten full-time officers in 2000. The size range of police departments is greater than that for fire departments, with police departments in the largest cities averaging more than twice the size of the corresponding fire departments, and police departments serving populations of fewer than 10,000 being four times smaller than the corresponding fire departments (see Figure 2.2). In contrast to the fire service, in which the vast majority of firefighters reside in small volunteer departments, police officers are more evenly distributed throughout departments of all sizes, with more in the largest departments (see Figure 2.2).

![Figure 2.2—Number and Average Size of Local Police Departments and Number of Officers in 2000](image_url)

Summary

The large number of small emergency response agencies in the United States, and the large variation in jurisdiction size and type, have great significance for the demand and supply of personal protective technology in the emergency responder community. Smaller organizations typically have greater funding constraints and more difficulty staying current on PPT information, acquisitions, and training. As discussed in subsequent chapters, RAND’s discussions with the responder community revealed that the majority of personal protection innovation enters the fire service through the largest departments, and that smaller departments often turn to the larger services to stay abreast of information and trends. In addition, organizational heterogeneity combined with the highly dispersed and decentralized organization of firefighting, EMS, and law enforcement creates structural impediments to coordination within each sector, for instance, in the areas of PPT assessment, acquisitions, and deployment. Finally, organizational heterogeneity, combined with great uncertainty about potential risks in the future, results in widely differing views as to what are the most pressing PPT needs. Not surprisingly, a wide variety of perspectives were expressed in the discussions.

EMERGENCY RESPONSE ACTIVITIES

Fire and Emergency Medical Service

Over the past decade and a half, the role of the fire service has changed because of increased numbers of responses for emergency medical services, hazardous materials incidents, natural disasters, and terrorist attacks, and because of a substantial drop in the number of fire responses. In 2000, fire services responded to more than 20 million emergency calls; of those, about 60 percent were calls for emergency medical services and less than 10 percent were fire incidents. Between 1986 and 2000, the number of medical responses increased by 90 percent (see Figure 2.3).

In conjunction with their evolving role, fire departments are increasingly fielding specialized emergency response capabilities. Emergency medical service is the most common fire department specialization, with more than half of all departments and more than 75 percent of departments serving populations of 25,000 or more providing EMS response. Approximately 15–20 percent of fire departments maintain heavy rescue, hazardous materials response, and water rescue capabilities (Karter, 2001; National Public Safety Information Bureau, 2002). These specializations involve unique tasks, unique hazards, and special-
ized equipment, and therefore present new protection concerns. One of the major issues to emerge from the RAND discussions is the increase in specialized tasks that emergency responder operations must undertake and debates over the extent to which more-specialized personal protection equipment should be developed to better address the corresponding changes in hazard exposure.

Law Enforcement

Because police departments regularly patrol their jurisdictions as part of crime prevention and community interaction, a significant fraction of police activities is not initiated by a "call for service" in the same way that fire or EMS response is. As a result, a useful way to examine police activities is to consider all interactions between law enforcement officers and the public. A recent survey found that, of those citizens who had one or more contacts with police in 1999, 52 percent were involved in a traffic stop; 28 percent reported, witnessed, or were the victim of a crime; 21 percent asked for general assistance or reported a neighborhood problem; 13 percent were involved in or witnessed an accident; 3
percent were suspects in a crime; and 23 percent had other reasons for having police contact (Langan, 2001). Although only about 1 percent of these interactions involved the use of force, the potentially serious consequences of the use of force make it an important consideration for officer safety and health protection.

Police departments may also perform more specialized functions, including bomb disposal, search and rescue, tactical operations (e.g., SWAT), underwater recovery, animal control, civil defense, harbor protection, and fire and emergency medical services. Most specialized capabilities are more common in larger departments: More than three-fourths of local police departments serving 250,000 or more people have bomb disposal responsibility, and more than three-fourths of local police departments serving 50,000 or more people have SWAT or tactical operations responsibility (Hickman and Reaves, 2001). Smaller departments are less likely to have such specializations and may depend on major jurisdictions nearby or state or federal assets for these functions. Some specializations, including fire and emergency medical services, are more common in smaller police departments. As is the case with the fire service, specialized capabilities involve a range of operations and hazards that differ from those in routine police work and have significant implications for protecting responder health and safety.

**EMERGENCY RESPONDER INJURIES AND FATALITIES**

Given the high levels of risk associated with their mission and the unpredictable aspects of their work, emergency responders face a broad range of hazards and are subject to significant numbers of occupational injuries, illnesses, and fatalities. The historical injury and fatality rates for police and career firefighters are approximately three times greater than the average for all professions, and place these careers in the top 15 occupations for risk of fatal occupational injury (Clarke and Zak, 1999; Bureau of Labor Statistics, 2002).

**Firefighters**

Although firefighters undertake a variety of activities in the line of duty, those activities are not all equally hazardous. In particular, while firefighting calls rep-
resent less than 10 percent of all fire department calls (National Fire Protection Association, 2002a), half of all firefighter injuries occur at fire scenes (Karter, 2000; National Fire Protection Association, 1995–2000). Of these fireground injuries, about half occur during fire attack, about 10 percent during ventilation and forcible entry, and about 16 percent during salvage and overhaul\(^5\) (Karter, 2000).

Overall, approximately 88,000 firefighters were injured on the job each year from 1995 to 2000 (National Fire Protection Association, 1995–2000). Based on RAND’s analysis of data gathered by the U.S. Fire Administration (1998), we estimated that more than 54,000 of these injuries were minor, while about 31,000 of these injuries were moderate, and 2,000 were severe or worse.\(^6\) From 1990 to 2001, an average of 97 firefighters died in the line of duty each year (U.S. Fire Administration, 2002).\(^7\)

The primary cause of both nonfatal injuries and death among firefighters is physical stress and overexertion (see Figure 2.4). Between 1995 and 2001, 45 percent of firefighter fatalities involved heart attacks (National Fire Protection Association, 1995-2001). These data are consistent with points that were made in the community discussions, which are discussed later, that physical and heat stress are critical hazards for firefighters.

Other major causes of nonfatal injuries occurring on the fireground include falls, exposure to fire products or chemicals, and being struck by or making contact with objects (see Figure 2.4). Of these other causes, exposure to fire products is the most serious, producing approximately twice as many severe fireground injuries as falling and being struck by or making contact with objects combined.

The other main causes of death among firefighters include becoming lost, caught, or trapped and motor vehicle accidents (see Figure 2.4). The risk of getting lost, caught, or trapped is another issue that figured prominently in the community discussions, with participants repeatedly emphasizing the need for improved fireground personnel accountability and personnel location tech-

\(^5\)Overhaul begins when the main fire has been suppressed and entails activities such as searching for hidden hot spots, salvaging property, and cleaning up debris and equipment.

\(^6\)The RAND estimate of injury severity is based on analysis of data from the National Fire Incident Reporting System, in which a *moderate injury* is defined as: “Little danger of death or permanent disability. Quick medical care is advisable.” This category includes injuries such as fractures or lacerations requiring sutures. A *severe injury* is defined as a potentially life-threatening situation “if the condition remains uncontrolled. Immediate medical care is necessary.” (U.S. Fire Administration, 1998).

\(^7\)This average does not include responders killed in the terrorist attacks on September 11, 2001.
NOTE: Injury data are for fireground only.

SOURCES: Injury data are from an analysis of the National Fire Incident Reporting System Firefighter Casualty Module (U.S. Fire Administration, 1998). This database captures data for approximately 10 percent of all firefighter injuries. Only moderate, severe, and life-threatening injuries occurring on the fireground, as defined by the database, are included here. Assaults and vehicle accidents are included in the “struck by or contact with object” category, and “exposure to fire products and chemicals” is broken out from that category. Fatalities data are from National Fire Protection Association (1995–2001).

Figure 2.4—Causes of Firefighter Injuries and Fatalities

nologies. In sum, while being out on call represents only a portion of a firefighter’s duty time, and fire calls account for less than 10 percent of calls for service, the fireground is an extremely high-risk zone.

Emergency Medical Responders

Because the labor force and activities of the emergency medical services are more difficult to define precisely than those of the fire service, injury and fatality data for emergency medical responders are more uncertain than the data for firefighters.

By far, the main cause of emergency medical responder line-of-duty deaths for which data are available is vehicle accidents. Our analysis of National EMS Memorial Service (2002) data indicates that there were at least 58 emergency medical responder line-of-duty deaths, or an average of about 11 per year, be-
between 1998 and 2002.\textsuperscript{8} We found that about half of all deaths resulted from rescue helicopter accidents, and approximately another third were due to ground transportation accidents or a responder being struck by a vehicle. An analysis of fatality data for 1992–1997 from three different databases by Maguire et al. (2002) gives a higher fatality rate: 114 deaths over 6 years, or 19 deaths per year.\textsuperscript{9} Maguire et al. found a similarly high proportion of transportation-related causes: Nearly 60 percent were due to ground transportation accidents, and another 17 percent were caused by air ambulance crashes. Other major causes of fatalities were cardiovascular incidents (11 percent) and homicides (9 percent).

Among hospital-based emergency medical technicians, 18 percent of those whose records were publicly available reported exposure to potentially infectious bodily fluids between June 1995 and February 2002, with 1 percent being exposed more than once. About half of the exposures were due to percutaneous injuries, such as needle sticks, while the other half were due mostly to skin and mucous membrane exposures (Panlilio, 2002). Note that these numbers do not reflect actual infections.

In contrast to these data, which indicate that the primary hazards are vehicle accidents, heart attacks, and assaults, the primary concern among emergency medical service responders that was voiced during their discussions with RAND was exposure to infectious diseases. This discrepancy may reflect the status of current protective technologies: Decreasing the number of injuries from vehicle accidents and assaults may be viewed as being doable through better use of existing protective technologies and practices, whereas participants saw less possibility for greater personal protection from infectious diseases.

**Law Enforcement**

Assaults and physical stress each account for one-quarter of all police nonfatal injuries (see Figure 2.5). Other principal injury risk categories include falls (19 percent), motor vehicle accidents (16 percent), and being struck by or having contact with objects (10 percent).

From 1990 to 2001, an average of 155 police officers were killed in the line of duty each year (National Law Enforcement Officers Memorial Fund, 2002a).\textsuperscript{10}

\textsuperscript{8}Reporting of fatalities to the National EMS Memorial Service is voluntary, so the stated values represent lower bounds. This total and average do not include responders who are included in firefighter fatality data (presented in the previous section) or those killed in the terrorist attacks on September 11, 2001.

\textsuperscript{9}Maguire et al. (2002) did not systematically correct for possible double reporting of fatalities in both firefighter and EMS data sets.

\textsuperscript{10}This average does not include responders killed in the terrorist attacks on September 11, 2001.
About 42 percent of line-of-duty fatalities are caused by assaults, and 44 percent involve vehicle-related accidents (including aircraft crashes and being struck by vehicles).

As discussed earlier, very few interactions between law enforcement officers and the public reportedly involve the use of force. However, the high incidence of police officer injury and death due to assaults suggests (albeit indirectly) that during the relatively brief periods of time they encounter hostile situations, law enforcement personnel are at very high risk of injury or death. This concern was expressed in the RAND discussions.

**SUMMARY**

The views expressed in the community discussions presented in the following chapters are generally consistent with the data cited in this chapter in terms of the activities that are most hazardous and the areas in which protection needs are greatest. However, because of the unpredictability of the risks faced by re-
sponders, it should be noted that injury and fatality surveillance data alone do not fully define responders’ protection needs. Such surveillance data preferentially reflect the “routine” activities and hazards that occupy the majority of responders’ time. The levels of injury are not, therefore, direct measures of the level of risk faced by responders for all activities.

Activities performed by responders for short periods of time or during events that occur infrequently could involve levels of risk much greater than the level of risk with more common tasks. Events such as a major disaster, structural collapse, civil disturbance, bomb disposal, hostage situation, or terrorism response involve hazards not normally encountered in routine activities. As a result, injury and fatality data do not effectively describe the potential consequences of such events, and the concern and attention they warrant for protecting emergency responders will not be reflected in those data. This concern was, however, apparent in the community discussions. Since September 11, 2001, attacks, the specter of terrorism involving the use of weapons of mass destruction has been central in guiding the priorities of the response community, particularly organizations in major urban centers. Such scenarios must be considered separately from more-routine responses, and preparedness needs for low-probability but very high-consequence incidents must be integrated into an overall protection strategy for the emergency response community.