

Fire Fighter Fatality Investigation and Prevention Program: Findings from a National Evaluation

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Abstract

Firefighters are called on to rescue people and protect property under serious and hazardous conditions. Some 100 firefighters die each year on duty, and another 95,000 are injured. Recommendations developed through the National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) point to many safety practices that could improve the health and safety of the nation's firefighters.

The purpose of this report is to summarize the findings of a recent evaluation of the FFFIPP. Based on a national survey of fire departments and focus groups with frontline firefighters, the evaluation focused on firefighters' awareness of FFFIPP recommendations, the extent to which recommendations are being implemented, the factors affecting implementation, and NIOSH's dissemination practices.

We learned that most fire departments are aware of the FFFIPP and follow its recommendations; nevertheless, various shortfalls, especially regarding cardiovascular health, motor vehicle safety, and procedures on the fireground, persist. The greatest shortfalls exist in small and volunteer fire departments where resources limit the ability to purchase needed equipment and prepare firefighters to carry out their duties safely. We identified numerous specific improvements that NIOSH could make to promote health and safety.

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Introduction

Background

Firefighters have a dangerous job. In 2004, the nation's 1.1 million firefighters responded to 22.6 million calls: 1.6 million fires; 14 million medical aid calls; 2.1 million false alarms; 984,000 mutual aid calls; 354,000 hazardous materials; 671,000 hazardous conditions; and 2.8 million other incidents (National Fire Protection Association [NFPA], 2005).

Firefighters are called on to rescue people and protect property under serious and hazardous conditions. They are also exposed to dangers en route to emergencies and while responding to roadside incidents. Each year, some 100 firefighters in the United States die in the line of duty. Another 95,000 are injured each year (National Institute for Occupational Safety and Health [NIOSH], 2006). How many of these deaths and injuries are preventable is unknown.

About one-third of on-duty firefighter fatalities occur on the fireground, i.e., in the operational area at the scene of a fire (Fahy and LeBlanc, 2006). These deaths are typically due to sudden cardiac death, asphyxiation, internal trauma, electrocution, burns, crushing injuries, and stroke while extinguishing or suppressing fires. Another one-third of on-duty deaths occur en route to or from an incident in motor vehicle and other accidents. Ten percent of firefighter fatalities take place during training (Fahy and LeBlanc), such as apparatus and equipment drills, physical fitness activities, live fire training, underwater/dive training, and classes or seminars (Fahy, 2006). Firefighters also die while performing nonemergency on-duty activities and at non-fire emergencies.

More than one-half of all on-duty firefighter fatalities are from traumatic injuries, including internal trauma, asphyxiation, crushing injuries, burns, drowning, and electrical shock. Other firefighter fatalities (about 45 percent) are due to cardiovascular causes, primarily sudden cardiac deaths (heart attacks) from stress or overexertion. NFPA reports that sudden cardiac death accounts

for about 40 percent of fatalities "on the fireground and while responding to and returning from alarms" and more than 50 percent of the deaths during training activities, particularly during apparatus and equipment drills (Fahy, 2005, p. 6; 2006, p. 2). Many victims include firefighters who had previous heart attacks or had undergone bypass surgery, angioplasty, or stent placement (Fahy, 2005).

The long-term trend in firefighter fatalities at structure fires is declining, but because the annual number of structure fires is also declining, the "rate of deaths due to traumatic injuries while operating inside structures" has actually increased (Fahy, 2002, p. 2). Similarly, although the number of sudden cardiac deaths declined by about one-third from the late 1970s to the early 1990s, the number of deaths since then has remained 40 to 50 each year (Fahy, 2005).

Most fire departments are small, all-volunteer departments serving a rural community (US Fire Administration [USFA], 2002). Of the estimated 30,400 fire departments in the United States,

- 6.3 percent are staffed by paid, career firefighters,
- 4.1 percent are mostly career,
- 13.4 percent are mostly volunteer, and
- 76.2 percent are all volunteer.¹

Mostly career departments are made up of 51 percent to 99 percent career firefighters. Mostly volunteer departments are made up of 51 percent to 99 percent volunteer firefighters.

Of the 1.1 million firefighters in the United States, about three-fourths are volunteer firefighters; only one-fourth are career firefighters (Karter & Stein, 2009). Career firefighters tend to be located in large metropolitan areas, whereas volunteer firefighters are more likely to serve in less densely populated areas.

¹ Statistics cited in this paragraph, taken from the US Fire Administration, differ from the summary statistics obtained in the sample frame used for the Fire Department Survey discussed below. A narrower target population for the Fire Department Survey and use of different data sources account for the differences in population counts.

Studies by the US Fire Administration and the NFPA show that, numerically, more volunteer firefighters are killed in the line of duty each year than are career firefighters. Overall, the rate of fatalities among career firefighters is higher than for volunteer firefighters. USFA found that, in 2000, full-time career personnel accounted for 33 percent of firefighter fatalities but only 26 percent of the American fire service (USFA, 2002). However, the rates of sudden cardiac death are similar for volunteer and career firefighters. NFPA found that, of the 440 victims of sudden cardiac death from 1995 through 2004, 307 (72.4 percent) were volunteer firefighters and 117 (27.6 percent) were career firefighters, which roughly represents their proportions in the fire service (Fahy, 2005; NFPA, 2009). Sixteen of those 440 victims of sudden cardiac death (3.6 percent) were either employees of state or federal wildland management agencies, the military, or an industrial fire department or prison inmates working on a wildland firefighting crew.

Rates of firefighter fatalities may also differ by region of the country. Based on per capita state-level data, fatalities at structural fires are more common in the densely populated eastern United States. Fatalities in wildland incidents (i.e., in forests, grasslands, prairies, or other natural areas) are more common in the West. Fatalities related to motor vehicle crashes show no regional pattern (USFA, 2002).

The Fire Fighter Fatality Investigation and Prevention Program

The purpose of this report is to summarize the methods and findings of a recent evaluation of the Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) that we conducted (Peterson et al., 2004). The extensive appendices on which this report is based can be found at www.cdc.gov/niosh/fire/FFSurvey.html.

The FFFIPP is a program of the National Institute for Occupational Safety and Health (NIOSH), which since 1998 has conducted investigations of firefighter line-of-duty deaths and formulated recommendations for preventing future deaths and injuries. NIOSH also

conducts research for prevention of nonfatal injuries. The goals of the program are to

- better define the magnitude and characteristics of line-of-duty deaths among firefighters,
- develop recommendations for the prevention of deaths and injuries, and
- disseminate prevention strategies to the fire service (NIOSH, 2006).

The program uses the Fatality Assessment and Control Evaluation (FACE) model to conduct investigations. Each investigation results in a report summarizing the incident and includes recommendations for preventing future similar events. NIOSH's FACE program is a research program designed to identify and study fatal occupational injuries. The goal of the FACE program is to prevent occupational fatalities across the nation by identifying and investigating work situations presenting high risk for injury, and then formulating and disseminating prevention strategies to those who can intervene in the workplace (NIOSH, 2006).

For cardiovascular deaths, NIOSH investigations include assessing the contribution of personal and workplace factors. Personal factors include identifying individual risk factors for coronary artery disease (CAD). The workplace evaluation involves estimating the immediate physical demands placed on the firefighter and the firefighter's acute exposure to hazardous chemicals, assessing efforts by the fire department to screen for CAD risk factors, and developing fitness and wellness programs (NIOSH, 2006). NIOSH investigative reports do not include personal and fire department identifiers.

The FFFIPP is a research and dissemination program. Its aims are to gather information about the injuries and fatalities and to prevent future similar events (NIOSH, 2006). FFFIPP does not enforce compliance with safety and health standards and does not determine fault or blame. Enforcement is primarily the responsibility of state occupational safety and health administrations.

NIOSH develops recommendations based on consensus and mandatory standards, such as standards promulgated by NFPA and the Occupational Safety and Health Administration (OSHA), firefighting practices recommended in fire service texts, and findings and recommendations presented in the safety and medical literature. NIOSH directs recommendations principally to fire departments but also to manufacturers, municipalities, standard-setting bodies, and research organizations. Recommendations involve cardiovascular health, fitness and wellness programs, standard operating procedures or guidelines, communications, incident command, motor vehicles, personal protective equipment, strategies and tactics, rapid intervention teams, and staffing (Ridenour et al., 2004).

FFFIPP investigations may suggest the need for new research or prevention efforts or for new or revised regulations to protect workers. As of February 2006, NIOSH had conducted 324 fatality investigations in 48 states since the program began: 175 were traumatic injury incidents and 149 were cardiovascular/medical incidents. These investigations had spawned more than 600 recommendations. Although circumstances of investigations are varied, similar recommendations may often apply in multiple investigations.

NIOSH communicates the findings from FFFIPP investigations via publications and presentations and through collaborative research and policy activities with partner organizations in the fire service. Publications include line-of-duty death reports, NIOSH Alerts, health hazard evaluation reports, and special documents such as NIOSH Workplace Solutions.

The NIOSH publications are disseminated to fire departments through the mail, e-mail, conferences, and other venues and are available on the Internet through the NIOSH home page (www.cdc.gov/niosh/fire). The NIOSH reports are produced in both hard

copy and electronic formats. Periodically, NIOSH sends a packet of five or six reports to all 30,000 fire departments in the United States. As of the end of 2008, there had been 21 mailings, at least one each year of the program, beginning in 1998. Summaries of the NIOSH reports are also published in fire service trade journals.

Goals of the Evaluation

The purpose of the FFFIPP evaluation was to assess the effects of FFFIPP recommendations and information products on fire department policies and procedures to

- improve firefighter safety and health;
- gain insight into the impact of FFFIPP recommendations and information products on the safety knowledge, attitudes, and behavior of the nation's firefighters; and
- identify possible strategies for improving the impact of the FFFIPP, including improvements in the approaches used by NIOSH to disseminate the findings from FFFIPP investigations.

Broadly speaking, the evaluation was designed to address five questions:

1. Are firefighters aware of the NIOSH FFFIPP program and reports?
2. To what extent and how are FFFIPP recommendations being implemented in the nation's fire departments?
3. What factors, if any, hinder fire departments' ability to implement FFFIPP recommendations?
4. What characteristics of fire departments facilitate their adherence to FFFIPP recommendations?
5. What changes are appropriate, if any, in the content or format of health and safety materials developed by NIOSH?

Common abbreviations and terminology used in this report are defined in Table 1.

Table 1. Abbreviations and terminology

Abbreviation	Definition
AED	Automated external defibrillator: A portable automatic device used to restore normal heart rhythm to patients in cardiac arrest.
CDC	Centers for Disease Control and Prevention
CAD	Coronary artery disease
FFFIPP	Fire Fighter Fatality Investigation and Prevention Program
IC	Incident Commander: The IC is responsible for overall management of the incident.
ICS	Incident Command System: ICS consists of procedures for controlling personnel, facilities, equipment, and communications.
ISO	Incident Safety Officer: The ISO monitors incident operations and advises the IC on all matters relating to operational safety, including the health and safety of emergency response personnel.
LODD	Line-of-duty death report
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PASS device	Personal alert safety system device: A personal safety device that sounds a loud alert to notify others in the area that the firefighter is in distress.
PPE	Personal protective equipment: Protective clothing, helmets, equipment, or other garments designed to protect the wearer's body or clothing from injury.
RIC	Rapid Intervention Crew: A team of two or more firefighters dedicated solely to search for and rescue other firefighters in distress. Also referred to as a Firefighter Assist and Search Team (FAST).
RIT	Rapid Intervention Team: Another term for a RIC.
SCBA	Self-contained breathing apparatus: A device worn by rescue workers, firefighters, and others to provide breathable air in a hostile environment.
SOG	Standard operating guideline: A statement, indication, guide, or outline of policy by which to determine a current or future course of action.
SOP	Standard operating procedure: A statement that prescribes specific ways of doing specific activities (i.e., a series of steps followed in a particular order).

Methods

We based the evaluation on data from two sources: (1) a national survey of fire departments and (2) a series of focus groups with frontline firefighters. The data, which were collected in 2006, focus on the implementation and impact of a subset of the recommendations that the FFFIPP has issued.

Sentinel Recommendations

In preparation for this evaluation, NIOSH developed an inventory of the several hundred FFFIPP recommendations and rank-ordered them by frequency of mention in FFFIPP investigation reports (Ridenour et al., 2004).² NIOSH then categorized the resulting recommendations by domain of activity, each with one to six recommendations associated with it. One list was produced for recommendations emanating from investigations of traumatic injury fatalities; another concerned recommendations resulting from investigations of cardiovascular health fatalities on the job.

This process identified 31 key recommendations: 22 involving traumatic injury fatalities and 9 involving cardiovascular fatalities. The recommendations for traumatic injury fatalities fall into the following domains:

- Incident Command—6 recommendations
- Motor vehicle: drive—4 recommendations
- Motor vehicle: seat belts—1 recommendation
- Equipment: maintenance—2 recommendations
- Rapid Intervention Teams—1 recommendation
- Staffing—1 recommendation
- Personal protective equipment (PPE): clothing—1 recommendation
- PPE: personal alert safety system (PASS)—2 recommendations
- Radio communications—4 recommendations.

The recommendations for cardiovascular fatalities fall into two domains:

- Medical screening—5 recommendations
- Fitness and wellness—3 recommendations.

From the two lists, we selected 17 recommendations to serve as sentinel recommendations for the evaluation (Table 2). Our selections were based on frequency of mention in FFFIPP reports, specificity of the recommendation, and overall balance among the categories of safety recommendations. The evaluation focused on the impacts of these recommendations on firefighter training, standard operating procedures (SOPs), safety practices, and the safety environment of the fire departments. Details of the methods for the survey, including reproductions of all forms and communications, and for the focus groups can be found in Appendices A, D, and E to the final report on the NIOSH website (www.cdc.gov/niosh/fire/pdfs/appendices.pdf).

Fire Department Survey

Sample Design

The unit of analysis for the Fire Department Survey is the fire department. Fire departments are defined here as departments in the 50 United States and the District of Columbia that are listed in the NFPA database and that are involved with fire suppression. The NFPA list includes 30,611 departments, of which 30,308 are involved with fire suppression. Fire departments that are excluded from the sample frame include fire training schools and those agencies that keep records but are not responsible for fire suppression. Also excluded are fire departments on military bases, commercial departments at businesses, and fire departments associated with airports and harbors.

² This inventory has recently been updated and posted on the NIOSH website at www.cdc.gov/niosh/docs/2009-100/pdfs/2009-100.pdf

Table 2. Sentinel recommendations for the FFFIPP evaluation

Domain / Recommendation
Domain #1: Incident Command
Recommendation #1: Fire Departments should establish and implement an Incident Command System with written standard operating procedures for all firefighters.
Recommendation #2: Ensure that the Incident Command always maintains close accountability for all personnel at the fire scene.
Recommendation #3: Ensure that the Incident Command conducts an initial size-up of the incident before initiating firefighting efforts and continually evaluates the risk versus gain during operations at an incident.
Recommendation #4: Ensure that a separate Incident Safety Officer, independent from the Incident Commander, is appointed.
Domain #2: Motor Vehicle Safety
Recommendation #5: Ensure that all firefighters riding in emergency fire apparatus are wearing and are properly belted and secured by seat belts.
Recommendation #6: Ensure that all drivers of fire department vehicles are responsible for the safe and prudent operation of the vehicle under all conditions.
Recommendation #7: Ensure that all drivers of fire department vehicles receive driver training at least twice a year and document the training.
Domain #3: Equipment
Recommendation #8: Develop and implement a preventive maintenance program to ensure that all self-contained breathing apparatus are adequately maintained.
Recommendation #9: Fire departments, emergency medical services, and other users of automated external defibrillators should follow the manufacturers' instructions to replace battery packs immediately when the unit indicates a low battery or replace battery message.
Recommendation #10: Fire departments should develop and implement a policy requiring the use of personal protective equipment and protective clothing.
Domain #4: Radio Communication
Recommendation #11: Fire departments should ensure that those firefighters who enter hazardous areas, e.g., burning or suspected unsafe structures, are equipped with two-way communications with Incident Command.
Recommendation #12: Ensure that firefighters are equipped with a radio that does not bleed over, cause interference, or lose communication under field conditions.
Domain #5: Safety on the Fireground
Recommendation #13: Ensure that a Rapid Intervention Team is established and in position immediately upon arrival.
Recommendation #14: Fire departments should strictly enforce the wearing and use of PASS [personal alert safety system] devices when firefighters are involved in firefighting, rescue, and other hazardous duties.
Recommendation #15: Ensure that officers enforce and firefighters wear their SCBAs [self-contained breathing apparatus] whenever there is a chance they might be exposed to a toxic or oxygen-deficient atmosphere, including the initial assessment.
Domain #6: Fitness/Wellness
Recommendation #16: Fitness/wellness programs should be mandatory.
Recommendation #17: Conduct medical evaluations to screen firefighters for coronary artery disease (CAD) risk factors and CAD.

The Fire Department Survey used a cross-sectional design with stratified random sampling. We selected a probability sample of 3,000 fire departments representing about 10 percent of the 30,308 eligible fire departments. The sampling frame came from the database maintained by NFPA, supplemented with information from NIOSH's Division of Safety Research. The sample includes

- all 208 fire departments that had experienced a FFFIPP investigation as of December 31, 2003;
- a random sample of 215 additional fire departments in which a firefighter fatality had occurred but no FFFIPP investigation had been conducted;
- the 10 largest fire departments, because of their unique status³; and
- a stratified random sample of 2,575 fire departments that had not experienced a fatality as of December 31, 2003. (This sample includes representative subpopulations defined by geographic location, department type [career and volunteer], jurisdiction size, and jurisdiction type [population density].)

The goal of the sampling design was to help determine factors that influence the extent to which departments implemented FFFIPP recommendations. In particular, the sample was designed to help determine the impact of firefighter fatality investigations and previous firefighter fatalities on the knowledge, behavior, attitudes, and safety practices of firefighters. These factors thus define four of the five high-priority strata for the sample selection. These four-high priority strata are (1) previous firefighter fatality investigation following a traumatic injury fatality, (2) previous firefighter fatality investigation following a cardiovascular fatality, (3) traumatic injury fatality but no firefighter fatality investigation, and (4) the 10 largest fire departments. All fire departments on the sample frame that are categorized into one of these four groups were selected for the Fire Department Survey sample.

The fifth high-priority stratum consists of those fire departments that had a cardiovascular fatality but no FFFIPP investigation. It was considered a noncertainty stratum because some of the 189 fire departments on the sample frame that fall within this stratum were not selected. We selected 95 of these departments to provide a stratum sample size commensurate with the other high-priority strata. Because four of the high-priority strata are certainty strata and the sample for this fifth stratum was selected at a rate of 50 percent, the resulting variance of any comparison estimates was expected to be sufficiently small for the data analyses.

Factors that previous studies have shown to influence fire department practices include geographic location, department type (career and volunteer), department size, and population density (Fahy, 2005, 2006; Karter, 2005; Fahy and LeBlanc, 2006). We included a representative sample of subpopulations defined by each of these as additional strata in the sample design. The additional strata were defined by the interaction of the following variables (see Table 3):

- census region (Northeast, South, Midwest, and West)
- department type (volunteer, career, or combination)
- jurisdiction size (size of population served: large, medium, or small), and
- jurisdiction type (population density: rural versus urban).

Within each of these noncertainty strata, the sample of fire departments was selected randomly and with equal probability. Table 4 describes the final sample for the survey.

³ The 10 largest departments (based on size of the population served) are the California Department of Forestry, Los Angeles City Fire Department, Los Angeles County Fire Department, Miami-Dade Fire-Rescue, Houston Fire Department, Chicago Fire Department, New York City Fire Department, Arkansas Forestry Commission, San Bernardino County Fire Department, and Philadelphia Fire Department.

Table 3. Definitions of the stratification variables

Census region	The US Census Bureau's definition of the four geographic regions as applied to the state in which the fire department is located. The four geographic regions are defined as follows:
1. Northeast	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
2. South	Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia; plus the District of Columbia
3. Midwest	Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
4. West	Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming
Department type	Percentage of firefighters who are paid, career versus volunteer firefighters:
1. All career	100% career firefighters
2. Mostly career	51% to 99% career firefighters
3. Mostly volunteer	1% to 50% career firefighters
4. All volunteer	100% volunteer firefighters
Jurisdiction size	Size of protected population as reported on the National Fire Protection Association database:
1. Large	At least 50,000 persons protected
2. Medium	At least 5,000 but fewer than 50,000 persons protected
3. Small	Fewer than 5,000 persons protected
Jurisdiction type	The population density of the area served by a fire department (population protected by square miles covered): ^a
1. Urban	Fire departments with at least 825 persons per square mile
2. Rural	Fewer than 825 persons per square mile

^a This definition assumes that 65 percent of the fire department's coverage area would be considered the central area, and 35 percent of the coverage area would be considered the surrounding area. In the 2000 Census, the US Census Bureau defines "urban" as all territory, population, and housing units located within an urbanized area or an urban cluster. The Census Bureau defines urbanized areas and urban clusters as densely populated areas that consist of core block groups or blocks with a population density of at least 1,000 people per square mile and surrounding census blocks that have an overall density of at least 500 people per square mile (US Census, 2003).

Table 4. Fire Department Survey: sample sizes, eligibility rates, and response rates

Characteristic	Sample Size	Eligibility Rate	Response Rate
Total	3,000	98.5	54.9
High-priority strata			
Total	425	98.4	62.7
Strata			
• Previous FFFIPP investigation involving a traumatic injury fatality	117	100.0	70.9
• Previous FFFIPP investigation involving a cardiovascular fatality	91	95.6	66.7
• Traumatic injury fire fighter fatality without investigation	120	98.3	54.2
• Cardiovascular fire fighter fatality without investigation	95	98.9	60.6
• 10 largest fire departments ^a	2	100.0	0.0
Remainder strata			
Total	2,575	98.5	53.6
Census region			
• Northeast	542	99.6	49.3
• South	879	98.2	50.2
• Midwest	780	98.3	59.1
• West	374	97.9	56.8
Rural/urban			
• Rural	1,555	98.8	53.6
• Urban	613	98.9	68.0
• Unknown	407	96.8	31.7
Size (defined by population protected)			
• Large (at least 50,000 persons)	279	98.2	77.0
• Medium (5,000–49,999 persons)	752	98.9	63.3
• Small (0–4,999 persons)	1,544	98.3	44.7
Department type			
• All career	359	98.9	76.3
• All volunteer	816	97.5	50.8

^a Eight of the 10 largest fire departments are counted in the “other high priority” strata.

Note: Eligibility and response rates displayed in this table are unweighted percentages.

Development of the Questionnaire

Items for the Fire Department Survey questionnaire address the key questions about the impact of the FFFIPP as related to the sentinel FFFIPP recommendations. Performance indicators for the impact of FFFIPP recommendations concern changes in the knowledge, behavior, attitudes, and safety practices at the management level. Questionnaire items related to safety practices focus on

- SOPs (or standard operating guidelines [SOGs]),
- standard performance requirements,
- content and timing of training offered to firefighters,
- communication of safety practices and standards, and
- investment in and maintenance of firefighter safety equipment.

We developed two types of questions to capture the impact of the sentinel recommendations on knowledge, behavior, attitudes, and safety practices. One set consists of direct questions with language closely tied to the language of the recommendations. The other set has questions designed to capture the general approach conveyed by the recommendations. These latter questions bridge more than one specific recommendation or set of recommendations. The questionnaire is provided in Appendix A to the final report on the NIOSH website (www.cdc.gov/niosh/fire/pdfs/appendices.pdf).

We first tested a draft of the questionnaire through a series of cognitive interviews with fire department officers and firefighters. We then revised the questions and reviewed them in accordance with RTI's Question Appraisal System, which analyzes questionnaire items in relation to the tasks required of the respondents (to understand and respond to the questions) and evaluates the structure and effectiveness of the questionnaire form itself. The Question Appraisal System is a coding system with an item taxonomy that describes the cognitive demands of the questionnaire and documents the question features that are likely to lead to response error. These potential errors include comprehension, task definition, information retrieval, judgment, and response generation. We

used this appraisal analysis to identify possible revisions needed in item wording, response wording, questionnaire formats, and question ordering or instrument flow.

Implementation Approach

We mailed the Fire Department Survey to the fire chiefs of the 3,000 sample fire departments during spring 2006. The data collection process included

- a lead letter and a brochure describing the evaluation,
- presurvey publicity via newsletters and websites of several fire service organizations (including NIOSH, International Association of Fire Chiefs [IAFC], Fire Department Safety Officers Association [FDSOA], National Fire Protection Association [NFPA], and National Volunteer Fire Council [NVFC]),
- the questionnaire packet, including a business reply envelope, and
- two reminder letters, the second with a second copy of the questionnaire, sent by priority mail.

Because many participants were public employees, we could not offer any cash incentive for participating in the survey. Instead, we enclosed a complementary CD-ROM with FFFIPP information products with the questionnaire as a token of appreciation for the officers' time.

Analysis Approach

The analytic approach to the survey data is primarily descriptive and exploratory. All questionnaire data from responding fire departments were pooled into one analysis file. This file included the sample weights, sample design information, and any variables needed for proper estimation of variance.

We developed statistical analysis weights to enable the estimation of population parameters that are consistent with the sample design by scaling the disproportionalities between the study respondents and the population at large. We adjusted the weights to compensate for potential biases attributable to differential response and coverage among sample members. This weight consists of a product of

two factors: the base weight and the nonresponse adjustment. These are defined as follows:

1. The base weight is the inverse, unconditional probability of selecting the fire department into the sample. This weight accounts for the clustering and stratification used in the sample design.
2. The nonresponse adjustment is an adjustment imposed on the sampling weight of fire department respondents to account for those departments that did not respond to the survey. In general, this adjustment was greater than 1 so that each respondent fire department accounts for itself as well as for some portion of the nonrespondents in the final estimate.

For the FFFIPP survey response propensity model, we considered those variables that we suspected would be significant predictors of response propensity. The statistical significance of these variables was tested during the model-building process. The statistical significance of lower-order interactions of these variables was also considered.

We produced estimates of population percentages, computed as follows. We let

δ_i = a 0/1 indicator identifying those fire departments that belong to some subgroup of interest

x_i = response to a particular questionnaire item. Because most of the items on the Fire Department Survey are categorical, this will equal 1 if fire department i gives a particular response on a question and 0 otherwise.

The estimates of means (e.g., percentages) were computed as:

$$\frac{\sum_{i \in \text{Respondents}} w_i \delta_i x_i}{\sum_{i \in \text{Respondents}} w_i \delta_i}.$$

Using the weighted analysis file, we first examined the findings about the key evaluation questions across all fire departments. For each question, we then conducted bivariate analyses to investigate whether any systematic differences can be attributed

to specific fire department characteristics (region, type of jurisdiction, size of department, and type of department), experience with FFFIPP investigations, and firefighter fatalities.

We tested the overall differences between types of fire departments for statistical significance using a standard t -test. The null hypothesis for these tests is that the difference between population estimates among two groups of fire departments is zero. All population estimates generated from the Fire Department Survey data also have accompanying estimates of standard errors and confidence intervals.

To examine the combined explanatory effects of region, jurisdiction type, jurisdiction size, department type, and experience with a FFFIPP investigation and fatality, we also examined multivariate logistic regression models. The tables for this analysis can be found in Appendix C to the final report on the NIOSH website (www.cdc.gov/niosh/fire/pdfs/appendices.pdf).

The eligibility rate of those cases of unknown eligibility was assumed to be the same as those for which the eligibility was known. The cases of unknown eligibility were defined as fire departments from which we did not receive a response and that we were unable to contact to inquire about their eligibility. Known eligibility status was defined by the responses that we received from the survey and/or the information we received through ad hoc inquiries with the fire department about their eligibility. The eligibility rates were defined using the following formula:

$$\text{Eligibility Rate} = \frac{KE + e(UK)}{KE + KI + UK},$$

where

KE = Known Eligible

KI = Known Ineligible

UK = Unknown Eligibility

$$e = \frac{KE}{KE + KI}.$$

The response rates for the survey were calculated based on the recommendations of the American Association for Public Opinion Research (AAPOR) published in its *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*. As with the eligibility rate, this formula assumes that a proportion of the cases with unknown eligibility are eligible. The formula for the response rate was defined as follows:

$$RR4 = \frac{(I + P)}{(I + P) + (R + NC + O) + e(UK)},$$

where

I = Complete Interview

P = Partial Interview

R = Refusal

NC = Noncontact

O = Other Nonresponse

UK = Unknown Eligibility

$$e = \frac{KE}{KE + KI}.$$

We conducted a nonresponse follow-up analysis to assess any nonresponse bias. To implement this, we contacted a stratified random sample of approximately 10 percent of nonresponders by telephone and administered a shortened version of the original survey to gather data to assess any nonresponse bias. The total sample for the nonresponse follow-up survey was 215 fire departments. Of these 215 departments, we received responses from 132. The results of this follow-up analysis suggest that nonresponse bias may exist for at least some of the response options in the Fire Department Survey. These results are inconclusive for some questionnaire items, however, because skip patterns in the nonresponse questionnaire differ from those in the Fire Department Survey. Nevertheless, the results of the Fire Department Survey should be viewed with this caveat in mind.

Firefighter Focus Groups

Throughout the analysis, we supplemented information from the Fire Department Survey with available information derived from focus groups. We conducted a series of six focus groups with frontline firefighters to capture aspects of the FFFIPP's influence that could not fully be assessed in a survey of fire department officers. Information collected through the focus groups thus contributed to a greater understanding of how the FFFIPP influences fire departments and their officers and firefighters. The primary objectives of the focus groups were to

- identify the impact of the FFFIPP on the knowledge of firefighters,
- identify the impact of the FFFIPP on fire department operations (for example, impact on the content of training, SOPs, and SOGs),
- identify the impact of the FFFIPP on fire safety practices, and
- explore how the organizational climate of fire departments contributes to the overall safety environment in which firefighters work.

The focus groups also contributed information about the barriers and facilitators that influence the impact of FFFIPP recommendations.

The focus groups took place during March and April 2006 and included participants from both career and volunteer fire departments and from departments in both rural and urban jurisdictions. We conducted two of the focus groups in fire departments in North Carolina. One is a career fire department in a midsized city in central North Carolina. The other is an all-volunteer department located in a small, rural community in south-central North Carolina. One department is unionized; the other is not. We did the remaining four focus groups with firefighters attending the 2006 annual Fire Department Instructors Conference in Indianapolis, Indiana. Conducting the focus groups at a national conference provided the greatest level of access to a wide variety of fire department personnel from around the country and from departments of different size, career status, jurisdiction, and background.

We selected participants for the focus groups using a targeted, convenience sampling approach. The

composition of these focus groups was designed to reflect the primary groupings represented in the Fire Department Survey design. Every effort was made to recruit participants who represented the various kinds of fire department characteristics, including size (small, medium, large), type of department (career, volunteer), and type of jurisdiction (urban, rural). Although the participants represented a wide cross-section of firefighters, they were not a random probability sample of all firefighters. The six groups included one focus group consisting of all volunteer firefighters, one focus group consisting of all career firefighters, and four focus groups consisting of a mix of career and volunteer firefighters (Table 5).

Each focus group lasted approximately 90 minutes. Participants were offered refreshments and free safety guides developed by NIOSH; no cash incentives were provided. Using a semi-structured guide to organize the discussion, the moderator targeted issues related to knowledge of FFFIPP recommendations,

procedures for disseminating safety information, and other issues related to firefighter safety. Moderators brought samples of FFFIPP information materials for discussion.

The focus groups yielded a rich store of qualitative data on the problems and safety concerns of firefighters. Using simple thematic analysis techniques (Miles & Huberman, 1994), we compiled a list of the major themes in the focus group participant responses to questions about the safety climate, dissemination of safety recommendations, and impact of the FFFIPP on firefighter safety. In the following sections of this report, we provide illustrative quotes from the focus group participants. Unless otherwise noted, these quotes are representative of the general sentiments of the focus groups.

Results

This section presents the results of the evaluation. It is organized by the five research evaluation questions described above in [Goals of the Evaluation](#). We discuss the survey questionnaire items that capture answers to these questions in turn, using descriptive statistics. Where appropriate, we supplement the survey findings with findings from focus groups. For the items related to awareness and impact of the FFFIPP, we also report the results of multivariate analyses that include in the models the five categories of fire departments we examined (region, department type, jurisdiction size, jurisdiction type, and experience with on-duty firefighter fatalities and FFFIPP investigations). These analyses provide additional evidence about the barriers and facilitators to implementing FFFIPP recommendations.

The overall response rate for the survey was 54.9 percent. The overall eligibility rate was 98.5 percent. The rates by strata are documented in [Table 4](#). Of the 1,751 respondents to the Fire Department Survey, 70.2 percent were fire chiefs, 2.8 percent were safety officers, 6.5 percent were training officers, 14.3 percent were other officers, 2.2 percent were administrative assistants, 1.7 percent were firefighters, and 0.8 percent were other fire department staff. Throughout this discussion, we refer to this group of respondents collectively as “fire department officers”

Table 5. Characteristics of focus group participants

Characteristic	Number of Participants (N = 34)
Employment Status	
Career firefighters	16
Volunteer firefighters	18
Sex	
Male	29
Female	5
Type of Jurisdiction	
Urban	5
Suburban	14
Rural	15
Region of the Country	
Northeast	6
South	22
Midwest	6
West	0
Unionized	
Yes	15
No	19

or “fire departments.” We use these two terms interchangeably, depending on the context.

In the sections that follow, we report our principal subgroup analyses using the variables noted earlier (region, department type, jurisdiction size, jurisdiction type, fatality experience, and FFFIPP investigation experience).⁴ The overall percentages cited in the text are documented in the analysis tables in Appendices B and C to the final report posted on the NIOSH website (www.cdc.gov/niosh/fire/pdfs/appendices.pdf).

Familiarity with the FFFIPP

The picture that emerges from the evaluation suggests that the FFFIPP is only moderately known within the fire service. Although most fire department officers (67.4 percent) were familiar with NIOSH, only about half (53.3 percent) had seen and read a FFFIPP report in the prior 12 months. Slightly more than half (54.3 percent) were not familiar with the FFFIPP; Figure 1 shows the distribution of responses about familiarity with the FFFIPP by the fatality and investigation variables. Both experience with an on-duty firefighter fatality and experience with a FFFIPP

investigation increase the likelihood that the officer is familiar with NIOSH.

Officers' Knowledge of NIOSH Reports

Fire department officers learn about FFFIPP recommendations primarily through NIOSH mailings, trade publications, websites, and other firefighters and fire departments. Overall, about two-fifths of the fire department officers (38.9 percent) reported seeing FFFIPP reports several times per year or more. One-quarter (26.8 percent) said they had never seen a FFFIPP report. The percentage of officers who had never seen a FFFIPP report was highest among rural (27.6 percent) and volunteer (23.5 percent) fire departments and fire departments that had a mixture of volunteer and career staff (29.5 percent) (Figure 2).⁵

More than half (53.3 percent) of all fire department officers had read a FFFIPP report within the previous 12 months. The percentage of officers who had not read a FFFIPP report during the past 12 months was highest among small departments (21.3 percent) (Figure 3). Fire department officers are significantly more likely to have read part or all of a FFFIPP report

Figure 1. Officers' familiarity with the FFFIPP (by fatality and FFFIPP investigation, percent)

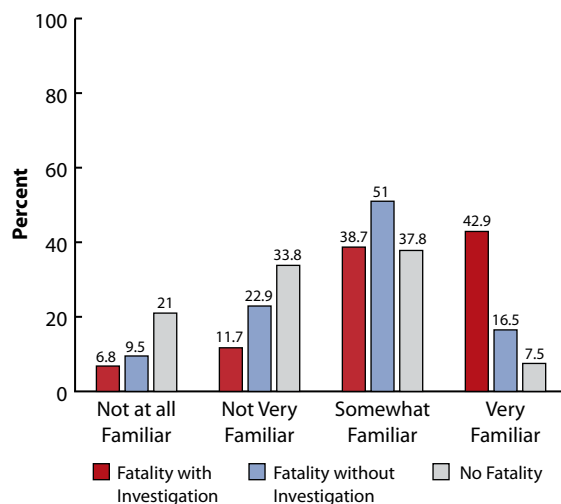
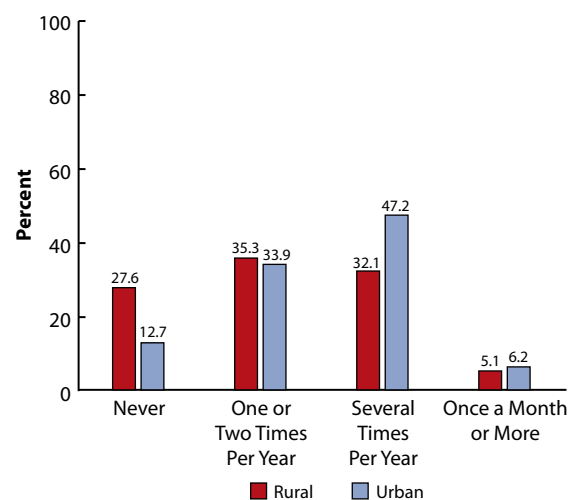


Figure 2. Frequency of officers' receipt of FFFIPP line-of-duty death reports (percentage by type of jurisdiction)



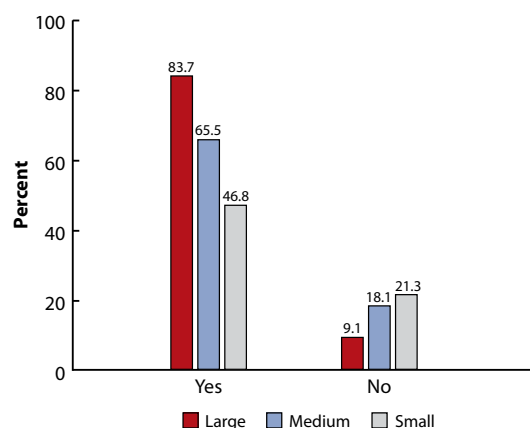
⁴ All percentages in this report are based on weighted data.

⁵ Data for all the subgroup analyses are not shown in the exhibits of this report, but they are available from Appendix C of the final report to NIOSH at www.cdc.gov/niosh/fire/pdfs/appendices.pdf.

if their jurisdiction is large, urban, or in the West, or if the department is career, has had a prior firefighter fatality, or has had a prior FFFIPP investigation.

The majority of fire department officers (57.4 percent) reported that they had seen NIOSH's *Pocket Guide to Chemical Hazards* (NIOSH, 2007a). The knowledge base was lower for Alerts and CDs: 31.7 percent had seen an Alert, and 28.0 percent had seen a CD of firefighter program materials. Relatively few had seen a Hazard ID (16.6 percent) or a Workplace Solutions document (12.5 percent). One-quarter of fire department officers (25.2 percent) reported that they had not seen any NIOSH materials.

Figure 3. Do officers read the FFFIPP reports? (percentage by size of jurisdiction)

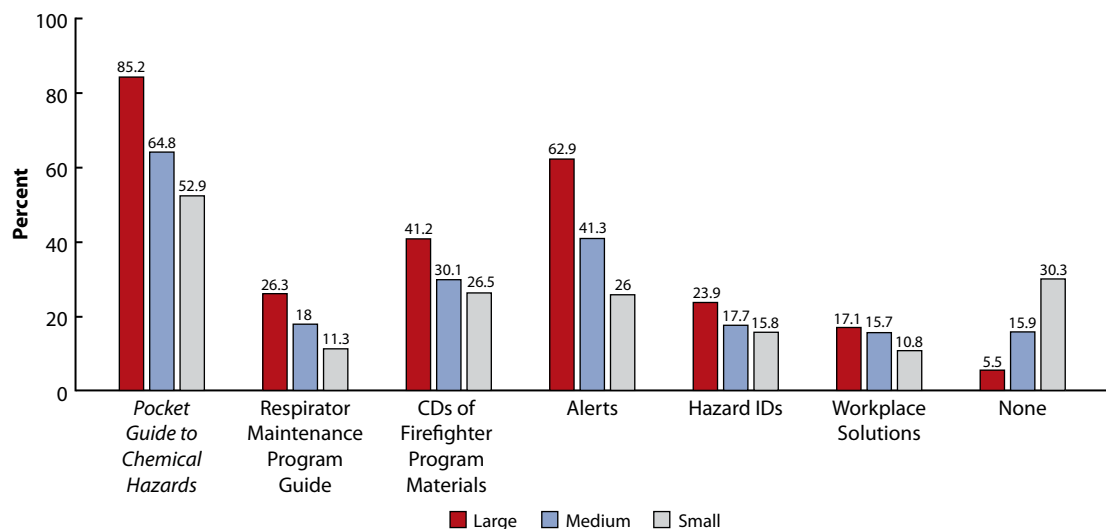


As reflected in Figure 4, the percentages of department officers who had or had not seen various NIOSH materials varied considerably by size of the department and by type of material or publication. The larger the jurisdiction of the fire department, the more likely the officers were to report that they had seen other NIOSH materials, particularly NIOSH's *Pocket Guide to Chemical Hazards*, respirator maintenance program guide, CD of firefighter program materials, and Alerts. Almost one-third of the fire department officers in small jurisdictions did not recall having seen any other NIOSH materials. Across all the subgroup analyses, the percentage who had not seen any NIOSH material was highest among small (30.3 percent), rural (25.4 percent), volunteer (25.0 percent), and a mixture of volunteer and career (26.2 percent) fire departments.

Dissemination to Firefighters

Awareness of FFFIPP recommendations is in part a function of dissemination practices within the department. The majority of officers (60.7 percent) reported that their fire department disseminated information it received from NIOSH to their firefighters. Fire departments that are not as likely to disseminate information are those in small jurisdictions, combination career-volunteer fire

Figure 4. Other NIOSH materials officers have seen (percentage by size of jurisdiction)



departments, fire departments in the South and Midwest, and those in rural jurisdictions (Figure 5).

Fire departments used a variety of approaches to disseminate NIOSH information. The primary approaches were training (44.2 percent of all departments), posting the FFFIPP report on the station bulletin board (38.5 percent), and briefings during regular staff meetings (23.5 percent). For example, fire departments reported using NIOSH recommendations to train firefighters on personal protective equipment (PPE), self-contained breathing apparatus (SCBA), personal alert safety system

(PASS) devices, the Incident Command System, traffic hazards, radio communications, and other topics. Departments also developed (26.3 percent) or updated (34.9 percent) SOPs/SOGs based on NIOSH recommendations.

Figure 6 depicts the considerable diversity of mechanisms that fire departments of different sizes used to disseminate information about NIOSH recommendations. In general, the larger the jurisdiction served, the more likely the fire department uses each of the methods for disseminating information to firefighters. Fire departments in large jurisdictions are significantly more likely than those in medium and small jurisdictions to disseminate information on NIOSH recommendations to firefighters through training, e-mail, copies of the NIOSH reports, summaries prepared by the department, and posting the report on the department's website.

In the focus group discussions, frontline firefighters suggested that all these mechanisms can be effective approaches for communicating safety messages. One training officer explained how he uses FFFIPP line-of-duty death (LODD) reports for training:

We use the information from NIOSH all the time for training. I hand out different LODDs and then require the trainees to answer six questions about the incident and to make a presentation to the full class. It's a valuable tool for training.

Figure 5. Fire department dissemination of NIOSH information to firefighters (percentage by size of jurisdiction)

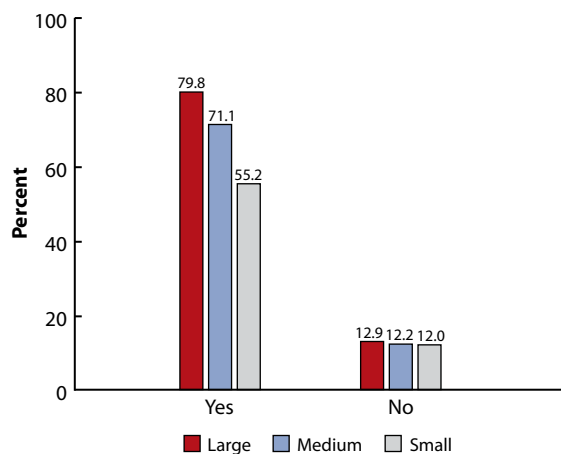
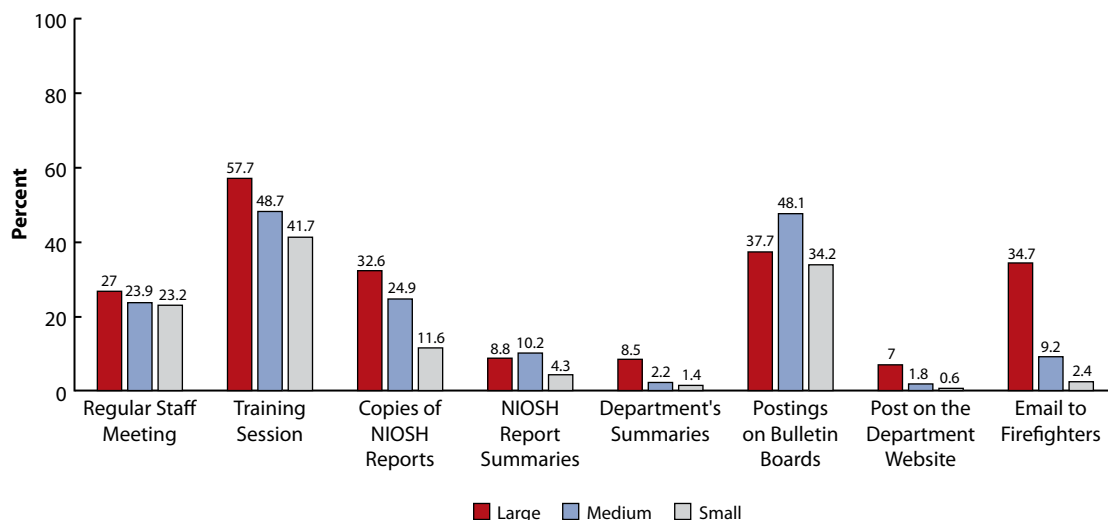


Figure 6. Methods of dissemination to firefighters (percentage by size of jurisdiction)



Results of the Multivariate Analyses

Multivariate analyses show that the size of the jurisdiction was the most consistent predictor of fire department dissemination activities. When we controlled all other factors in the model, size of jurisdiction remained a significant explanatory factor: the larger the jurisdiction, the more likely it was that FFFIPP recommendations were disseminated throughout the fire department. The type of department (career, volunteer, or combination) and region of the country were seldom or never significant factors in the dissemination process once size of jurisdiction was taken into account. Details can be found in the [appendices to the final report](#).

Jurisdiction type (urban, rural) is a significant factor for determining whether the fire chief is familiar with NIOSH reports or has read the LODD reports or the Pocket Guide; similarly, urban vs. rural status is a significant factor for determining whether firefighters were trained on NIOSH recommendations. Officers in urban fire departments were more likely than other departments to be aware of and to make use of FFFIPP recommendations. A fire chief in a department that had had a FFFIPP investigation was more likely to have read LODD reports, even after controlling for other factors in a multivariate analysis.

Implementation of FFFIPP Recommendations

To assess how FFFIPP recommendations are being implemented, we collected information from the fire departments on

- the SOPs that fire departments have established to reinforce safe practices,
- the nature of the training fire departments provide their firefighters, and
- other ways departments have implemented FFFIPP recommendations.

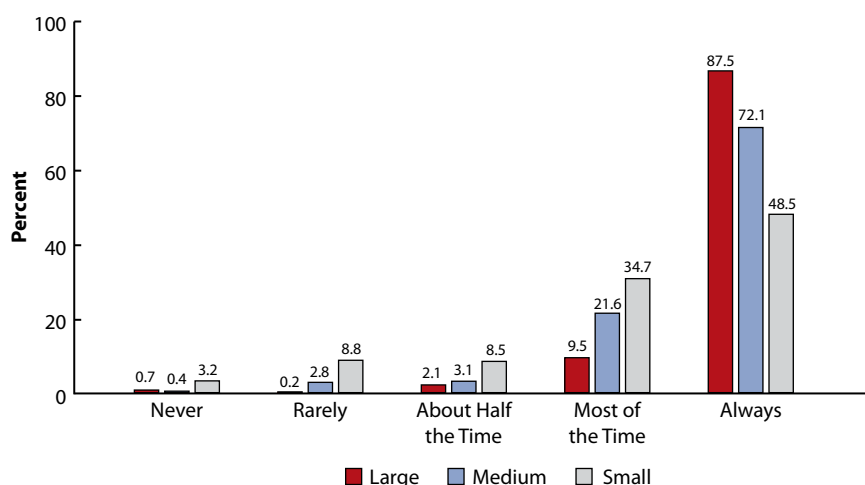
A summary of the findings related to the implementation of the 17 sentinel recommendations is provided below.

Incident Command

Recommendation #1: Fire departments should establish and implement an Incident Command System with written standard operating procedures for all firefighters.

According to the Fire Department Survey, Incident Command was established by most (84.2 percent) fire departments on a routine basis (i.e., most of the time or always) when responding to structure fires (Figure 7). The larger the jurisdiction, the more likely that Incident Command is established by the fire department. Large departments and career

Figure 7. Frequency of use of Incident Command for structure fires (percentage by size of jurisdiction)



departments were most likely to indicate that they “always” followed this procedure. However, focus group participants identified the failure to implement Incident Command as a quite common safety concern. Firefighters in four of the focus groups said there is “a lot of freelancing” rather than Incident Command.

Most fire departments had SOPs on the Incident Command System (83.7 percent; Figure 8), and most also required firefighters to be trained in using the system (69.9 percent). Firefighters in urban jurisdictions are significantly more likely than those

in rural jurisdictions to be trained on Incident Command (Figure 9). In addition, departments in large jurisdictions and career fire departments are more likely than their counterparts to require firefighters to be trained on this system.

Recommendation #2: Ensure that the Incident Command always maintains close accountability for all personnel at the fire scene.

Recommendation #3: Ensure that the Incident Command conducts an initial size-up of the incident before initiating firefighting efforts and continually evaluates the risk versus gain during operations at an incident.

Figure 8. Fire department SOPs, part 1 (percentage by type of department)

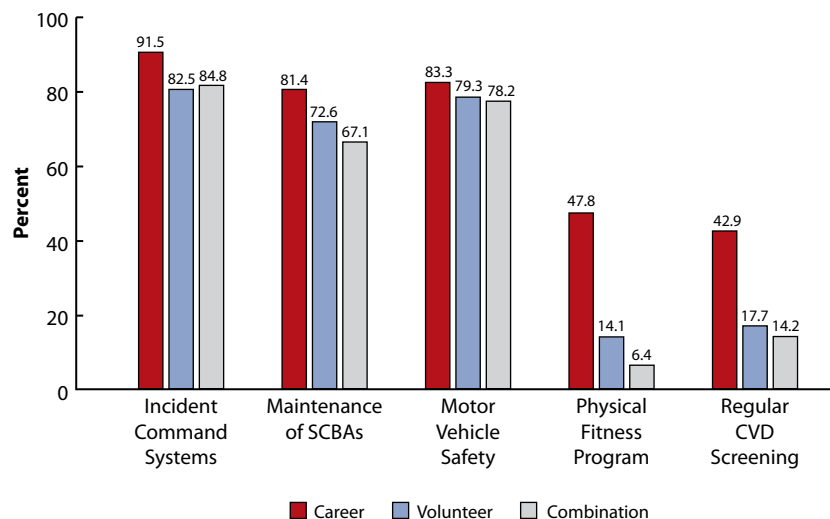
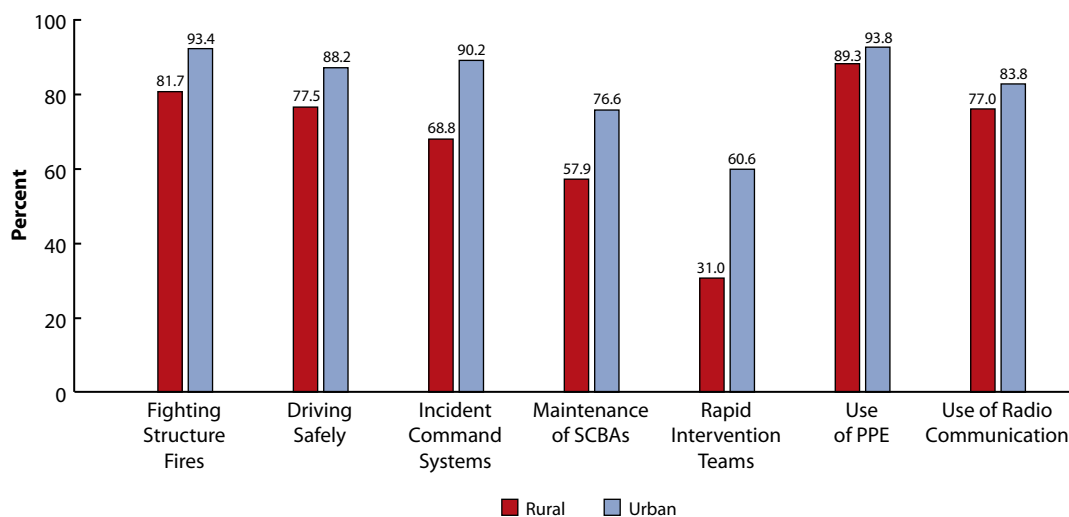


Figure 9. Training required by fire departments (percentage by type of jurisdiction)



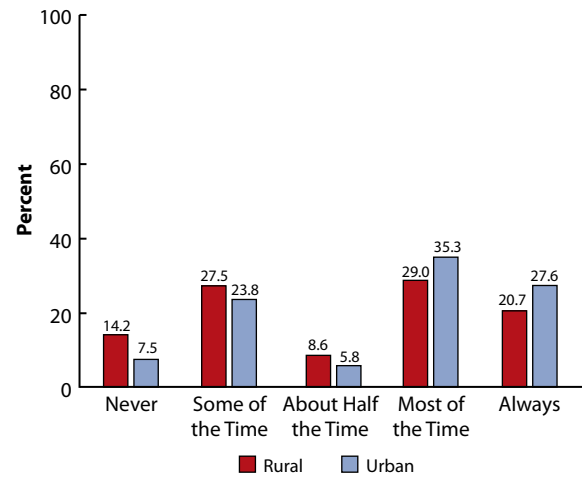
The tasks that fire departments most often said were part of an Incident Commander's responsibilities include all three tasks that NIOSH recommendations identify. Officers reported that the tasks of Incident Commanders (in order of mention) are to

- develop and coordinate the fire attack strategy (93.1 percent of all departments),
- conduct an initial assessment (Recommendation #3) (91.0 percent),
- monitor location of all firefighters at the scene (Recommendation #2) (76.2 percent),
- ensure that at least four firefighters are on the scene before entering the building (68.6 percent),
- identify and implement a communication strategy (64.7 percent),
- develop and initiate a risk management plan (Recommendation #3) (52.3 percent),
- establish a collapse zone around the building (49.1 percent),
- establish a Rapid Intervention Team (RIT) or Rapid Intervention Crew (RIC) (48.5 percent), and
- document all assessments, plans, and events related to the fire (38.8 percent).

Recommendation #4: Ensure that a separate Incident Safety Officer, independent from the Incident Commander, is appointed.

Incident Commanders in about half (52.1 percent) of all fire departments assigned an Incident Safety Officer (ISO) at least most of the time. By contrast, 13.3 percent of fire departments never assigned an ISO. Incident Commanders in urban fire departments are more likely than those in rural jurisdictions to assign an ISO when they respond to structure fires (Figure 10).

Figure 10. Assignment of an Incident Safety Officer, by jurisdiction type (percentage by type of jurisdiction)



Motor Vehicle Safety

Recommendation #5: Ensure that all firefighters riding in emergency fire apparatus are wearing and are properly belted and secured by seat belts.

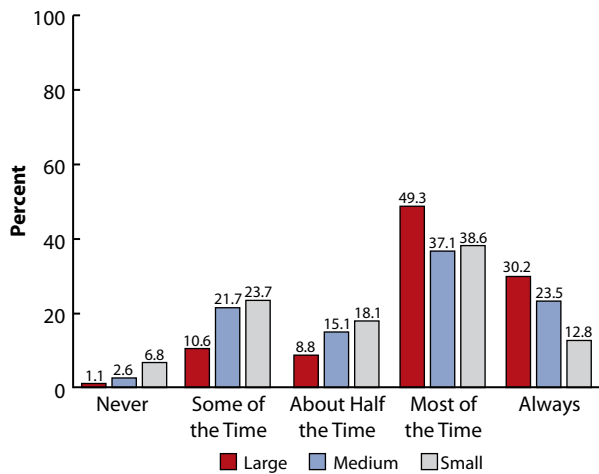
The findings from the Fire Department Survey indicate that the majority of fire departments (84.2 percent) required their firefighters to wear seat belts while they were in emergency vehicles. However, only about one-half of the nation's firefighters (54.9 percent) were thought to use their seat belts "most of the time" or "always"; 5.4 percent never used seat belts, and 22.7 percent used seat belts only some of the time.

Figure 11 shows that respondents representing large departments were more likely than medium, and especially small, departments to believe their firefighters used seatbelts always or most of the time. Respondents from small departments were the least likely to think their personnel used seatbelts.

Recommendation #6: Ensure that all drivers of fire department vehicles are responsible for the safe and prudent operation of the vehicle under all conditions.

Recommendation #7: Ensure that all drivers of fire department vehicles receive driver training at least twice a year and document the training.

Figure 11. Firefighters use of seat belts when riding in emergency vehicles (percentage by size of jurisdiction)



According to survey respondents, most fire departments had SOPs on motor vehicle safety (78.8 percent). The larger the jurisdiction, the more likely the fire department is to have an SOP on motor vehicle safety. Similarly, fire departments in urban jurisdictions are significantly more likely than rural fire departments to have a motor vehicle safety SOP in place.

In addition, most firefighters responsible for driving emergency vehicles (93.6 percent) received driver training for those types of vehicles before being allowed to operate the vehicles. The majority of fire departments in the country also required firefighters to be trained on motor vehicle safety (77.7 percent). Firefighters in about one-half of all fire departments (54.5 percent) also received refresher driver training for these vehicles at least once a year. Firefighters in fire departments that had a prior FFFIPP investigation are more likely than those that had a fatality without investigation and those that had not had a fatality to require this training. Departments in large jurisdictions and career fire departments are also more likely than their counterparts to require firefighters to be trained on motor vehicle safety.

During the focus group discussions, firefighters said that better driver training is needed. They specified that firefighters need to be trained to the class of the vehicle, especially drivers of water tankers. Volunteer firefighters who do not live at the fire station—the home responders—should also be trained.

Equipment

Recommendation #8: Develop and implement a preventive maintenance program to ensure that all self-contained breathing apparatus are adequately maintained.

About three-fourths (76.0 percent) of fire departments performed maintenance on SCBA equipment at least several times a year. Fewer than 5 percent performed maintenance “less than once a year” or “never.” The majority of fire departments in the country required firefighters to be trained on maintaining SCBA (60.3 percent). Most fire departments had SOPs on maintenance of SCBA (69.7 percent), with statistically significant variation by type of department.

Recommendation #9: Fire departments, emergency medical services, and other users of automated external defibrillators should follow the manufacturers’ instructions to replace battery packs immediately when the unit indicates a low battery or replace battery message.

About three-quarters (77.4 percent) of all fire departments had automated external defibrillators (AEDs). Among fire departments that had AEDs, most kept them on the emergency vehicles (82.4 percent), at the fire station (3.7 percent), or in both locations (13.8 percent). Among fire departments that had AEDs, most (86.3 percent) reported that they performed routine maintenance on AEDs between once a year and once a month or more, or “after every time they are used.”

Recommendation #10: Fire departments should develop and implement a policy requiring the use of personal protective equipment and protective clothing.

Most fire departments had SOPs on personal protective equipment (PPE) and clothing (89.1 percent of all departments). Most fire departments also required firefighters to be trained on using PPE (88.9 percent). The larger the jurisdiction, the more likely the fire department has an SOP on use of PPE

and protective clothing. As Figure 12 indicates, 94.1 percent of career departments had such standard procedures in place.

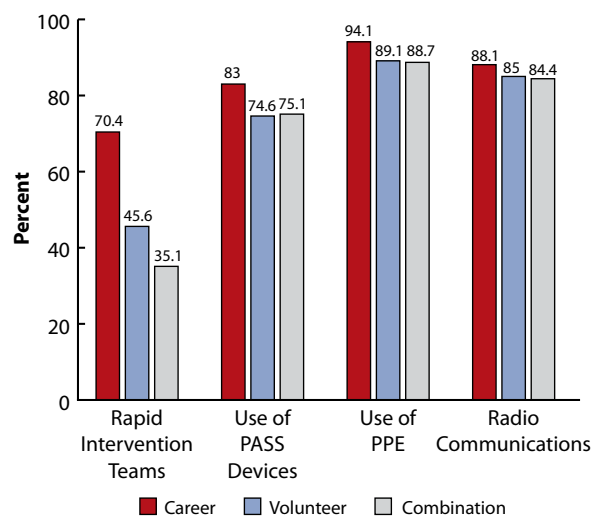
Radio Communication

Recommendation #11: Fire departments should ensure those firefighters who enter hazardous areas, e.g., burning or suspected unsafe structures, are equipped with two-way communications with Incident Command.

Recommendation #12: Ensure that firefighters are equipped with a radio that does not bleed over, cause interference, or lose communication under field conditions.

Firefighters in almost all (91.0 percent) fire departments had radios or other two-way communication devices at least “most of the time” while they were responding to structure fires. Only 18 percent reported, however, that they “never” had problems under field conditions with these devices. The majority of fire departments in the country required firefighters to be trained on using radio communication devices (76.2 percent). Most fire departments had SOPs on radio communications (84.8 percent), as reflected in Figure 12.

Figure 12. Fire department SOPs, part 2 (percentage by type of department)



Safety on the Fireground

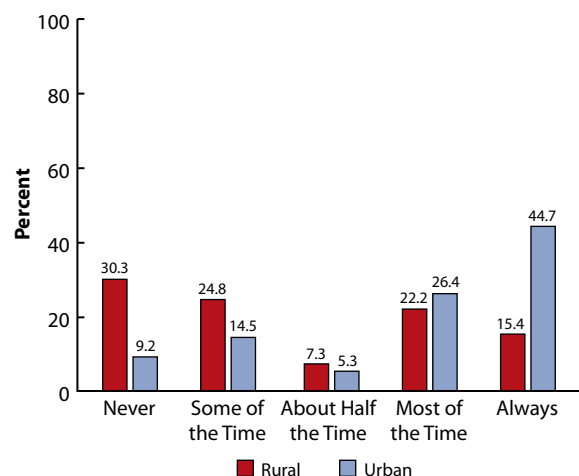
Recommendation #13: Ensure that a Rapid Intervention Team is established and in position immediately upon arrival at a fire scene.

Firefighters in focus groups said that one of their main safety concerns is the failure to use RITs routinely (i.e., “most of the time” or “always”). Firefighters (in focus groups) explained that, without enough personnel on the scene, they sometimes need to enter structures without the RITs in place. In the survey, fewer than one-half (42.4 percent) said that they had RITs available at least most of the time. Urban fire departments and departments in large jurisdictions were more likely to establish RITs than were rural fire departments (Figure 13).

Recommendation #14: Fire departments should strictly enforce the wearing and use of personal alert safety system (PASS) devices when firefighters are involved in firefighting, rescue, and other hazardous duties.

Most fire departments (75.4 percent) had SOPs on PASS devices. Only about three-quarters (78.8 percent) of all fire departments, however, said they had enough PASS devices for all of their firefighters to use when fighting structure fires. More than 93 percent of fire departments that had experience with a FFFIPP investigation reported having enough PASS

Figure 13. Availability of RITs at structure fires (percentage by jurisdiction type)



devices (Figure 14). Almost all (88.0 percent) fire departments reported that their firefighters used PASS devices at least most of the time.

Recommendation #15: Ensure that officers enforce and firefighters wear their SCBAs whenever there is a chance they might be exposed to a toxic or oxygen-deficient atmosphere, including the initial assessment.

Almost all (99.2 percent) fire departments reported that they had SCBA for their firefighters to use when they combat structure fires. Among those departments with SCBA, about one-half (49.7 percent) said that their firefighters had to share face pieces for SCBA. Sharing face pieces was required more often in the small fire departments (56.5 percent) than in large fire departments (10.4 percent). Firefighters in almost all (89.8 percent) fire departments with SCBA reportedly used SCBAs at least most of the time while fighting structure fires.

Fitness/Wellness

Recommendation #16: Fitness/wellness programs should be mandatory for firefighters.

Less than one-quarter (21.5 percent) of fire departments in the United States have a fitness training program for their firefighters. Few fire departments

(11.0 percent) had SOPs for participating in a personal physical fitness program. The percentage of fire departments with SOPs for personal physical fitness programs was lowest in volunteer (14.1 percent) and combination volunteer-career (6.4 percent), Southern (9.3 percent), and rural (8.4 percent) departments.

Recommendation #17: Conduct medical evaluations to screen firefighters for coronary artery disease (CAD) risk factors and CAD.

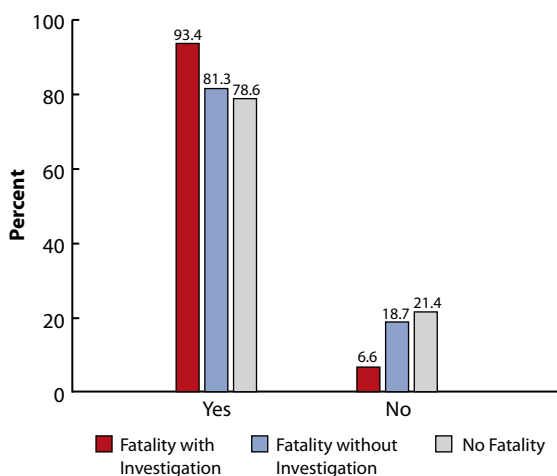
Less than one-half (39.1 percent) of all fire departments required screening for CAD. Of those that did require such screening, 17.1 percent required annual screenings; 14.5 percent screened only at the time of employment. Only 16.8 percent of fire departments had an SOP for participating in regular CAD screenings.

Results of the Multivariate Analyses

Among the six factors in the logistic regression models, the size of the fire department's jurisdiction was the most consistent predictor of its safety practices. When we controlled for all other factors, the larger the jurisdiction, the more likely it was that fire departments followed FFFIPP recommendations. Type of department (career, volunteer, or combination) and jurisdiction (urban or rural) were seldom significant factors affecting the impact of the FFFIPP.

A notable exception was the provision of a physical fitness program. Even controlling for other factors in the model, urban and career fire departments were more likely than other departments to have either optional or required physical fitness programs. In addition, fire departments in the Northeast and West were more likely than those in other regions to have followed FFFIPP recommendations. Finally, fire departments that had experienced a fatality were more likely than those that had not to have made changes to their training programs and their existing SOPs based on NIOSH recommendations. Fire departments that had experience with a FFFIPP investigation were more likely to have developed new SOPs and used NIOSH recommendations for justifying grant applications.

Figure 14. Availability of enough PASS devices for all firefighters for use when fighting structure fires (percentage by fatality and FFFIPP investigation)



Barriers to Implementing Safe Practices

The Fire Department Survey included seven questions for which respondents could select from a list of possible reasons for not being able to implement a FFFIPP-recommended safety practice. The FFFIPP recommendations that were addressed in these questions concern the use of equipment—SCBA, personally fitted SCBA face pieces, PASS devices, seat belts, and turnout gear generally—and procedures on the fireground, such as Incident Command, ISOs, and RITs. The response options for these items included several factors that potentially make it difficult to follow safety guidelines, such as funding, equipment, personnel, fire department practices, the situation on the fireground, and firefighter resistance.

The survey also included three questions about the extent to which funding is generally adequate for various purposes. These items focused on equipment, training, and personnel.

Effect of Limited Resources on Implementation of FFFIPP Recommendations

A substantial portion of the nation's fire departments did not have enough funding to purchase the equipment, training, and personnel needed to implement FFFIPP-recommended safety practices.

- Almost half of all departments (48.6 percent) said that they did not have enough funding for equipment.
- One-third of the fire departments (31.8 percent) said that they did not have enough funding for personally fitted SCBA face pieces for all of their firefighters.
- Two-fifths (39.1 percent) of all fire departments said that they did not have enough funds for training.
- More than half of fire departments (51.5 percent) did not have enough funding for the personnel they need.

Adequacy of Personal Protective Gear

A lack of equipment hinders some departments from implementing FFFIPP-recommended safety practices. Fire departments also reported that problems with

existing equipment can keep firefighters from following safety practices.

- Almost half (49.7 percent) said their firefighters had to share face pieces.
- One-quarter of all fire departments (24.6 percent) did not have enough SCBA for all of their firefighters to use.
- One-quarter (24.9 percent) said their firefighters were not able to fit comfortably in their seat belts while wearing turnout gear in emergency vehicles.
- One-fifth (21.2 percent) said they did not have enough PASS devices for all fire fighters when fighting structure fires.

Factors that Limit Fire Departments' Ability to Follow Recommended Safety Practices

Several additional barriers to implementing FFFIPP-recommended safety practices emerged from the survey. The most commonly cited barrier is insufficient personnel at the scene. More than half said this prevented them from assigning an ISO (51.7 percent) and establishing RITs (53.5 percent). One-fifth (21.2 percent) said it prevented them from establishing Incident Command.

The second most common reason for not implementing a FFFIPP-recommended safety practice was the situation on the fireground:

- One-third of the departments (34.9 percent) did not establish RITs because the fire was not large enough.
- One-third of the departments (32.3 percent) said that they sometimes did not assign an ISO because the fire was not large enough.
- One-quarter of the departments (25.9 percent) said that their firefighters sometimes did not use SCBA because the situation did not require them.
- One-fifth (22.5 percent) sometimes did not establish Incident Command because the fire was not large enough to require it.
- About 9.5 percent said that their firefighters sometimes did not use their PASS devices because the situation did not require them.
- "Usual fire department practice" was cited as the reason in some cases.

- Almost one-quarter of fire departments (23.4 percent) said that their firefighters did not use personally fitted face pieces for their SCBA (because “shared systems work fine for our needs”).
- About one-fifth (19.7 percent) did not have chemical/biological/radiological/nuclear (CBRN) SCBA (“We do not have enough technical information to purchase CBRN SCBAs”).

Very few fire departments cited firefighter resistance as a reason a FFFIPP-recommended safety practice was not followed:

- Only 10.3 percent said firefighters did not think they need SCBA.
- Only 4.6 percent said firefighters did not think they need PASS devices.
- Less than 1.0 percent (0.3 percent) said firefighters did not like using the personally fitted SCBA face pieces.

Facilitators for Promoting Safe Practices

The results of the firefighter focus groups suggest that several circumstances encourage safe practices. Among these factors are experience with an on-duty firefighter fatality, experience with a FFFIPP investigation, financial and legal penalties, an officer’s attention to specific safety issues, and union representation.

Experience with an On-Duty Firefighter Fatality

The survey showed that departments that had a prior fatality were less likely than other departments to identify personnel, equipment, or situational barriers to implementing FFFIPP-recommended safety practices. Data from the focus group discussions support these findings. Firefighters whose departments had experienced a line-of-duty death were aware of the FFFIPP and its impact on department policy. One firefighter expressed the sentiments of several focus groups as follows:

If there is a specific incident and it gets a lot of media attention, the impact can be huge and immediate.

Experiencing a FFFIPP Investigation

FFFIPP investigations appear to have had a significant impact on some departmental policies, training programs, and the availability of safety equipment. The survey results suggest that FFFIPP investigations may have influenced

- changes in training programs regarding structure fires, driver safety, Incident Command, and RITs;
- SOPs/SOGs on SCBA maintenance and the use of PASS devices; and
- the availability of individual SCBA face pieces.

Table 6 provides details about these impacts. Columns 1 and 2 report percentages of fire departments that experienced a fatality and that have safety elements in place. Column 1 provides the percentages of those that also had a FFFIPP investigation. Column 2 provides percentages of those departments that did not have a FFFIPP investigation. Column 3 provides the percentages of departments that have not experienced a firefighter fatality but have safety elements in place.

Statistically significant results are indicated by the superscript numbers in column 1. For example, 80.8 percent of fire departments with a prior fatality and FFFIPP investigation have an SOP or SOG in place regarding SCBA maintenance. This percentage is significantly higher than that for departments that have had a fatality but no FFFIPP investigation (column 2) and for departments that have had no prior fatality (column 3).

Data from the focus group discussions support these findings. For example, one frontline firefighter whose department had experienced a FFFIPP investigation told us the following:

We had a NIOSH investigation at my department, and it was really tough. They came in and they really reamed us. But afterwards, it was like we made 25 years of progress in a few months. We didn’t have an accountability system. The gear was 10 years old and had never been cleaned. It really raised the Chief’s consciousness. Until then, we just got away with it. Then a light bulb went off.

Table 6. Percentages of fire departments that have safety elements and that experienced a fatality or a FFFIPP investigation

Safety Element	1 Fatality and FFFIPP Investigation ^a	2 Fatality and No FFFIPP investigation	3 No Fatality
SOPs/SOGs in place for			
• SCBA maintenance	80.8% ^[2,3]	68.7%	69.6%
• motor vehicle safety	90.3% ^[3]	82.7%	78.7%
• personal physical fitness	24.3% ^[3]	18.1%	10.9%
• RITs	64.0% ^[3]	55.5%	40.1%
• use of PASS devices	83.2% ^[2,3]	71.5%	75.3%
Require training on			
• structure fires	90.4% ^[2,3]	76.3%	82.8%
• driver safety	92.0% ^[2,3]	80.3%	77.6%
• Incident Command	86.3% ^[2,3]	73.6%	69.7%
• maintenance of SCBA	73.4% ^[3]	61.1%	60.2%
• RITs	60.5% ^[2,3]	36.1%	35.4%
Made changes to SOPs/SOGs	66.2% ^[2,3]	51.3%	34.5%
Made changes to training program	68.0%	56.3%	39.8%
Train firefighters on physical fitness and CAD	28.8% ^[2,3]	16.3%	8.3%
Provide annual CAD screening	32.6%	24.4%	17.0%
Use RITs at least most of the time	64.4% ^[3]	59.1%	42.0%
Have enough PASS devices	93.4% ^[2,3]	81.3%	78.6%
Always use PASS devices	91.0% ^[2,3]	74.4%	75.1%
Firefighters do not have to share SCBA face pieces	64.1% ^[2,3]	44.2%	49.4%
Always carry radios or other 2-way communication devices while responding to structure fires	82.5% ^[2,3]	66.6%	70.4%

CAD = coronary artery disease; PASS = personal alert safety system; RIT = rapid intervention team; SCBA = self-contained breathing apparatus; SOG = standard operating guideline; SOP = standard operating procedure.

^a The numbers in the square brackets indicate that the percentage estimate is statistically significantly different at the 95 percent confidence interval from the corresponding estimate in the column identified (column 2 or 3). The superscript [2] indicates that, among departments that had experienced a firefighter fatality, the presence of the safety feature differs significantly depending on whether the fire department had experienced a FFFIPP investigation or not. The superscript [3] indicates that the presence of the safety feature differs significantly between fire departments that had experienced a fatality and a FFFIPP investigation and fire departments that had not experienced a fatality at all.

Enforcement Mechanisms

Firefighters indicated that the most effective ways to encourage safety practices were enforcement mechanisms tied to financial and other penalties. The focus group data suggest that financial and legal penalties, as well as their officer's attention to specific safety issues, can have a significant impact on firefighter behavior.

Firefighters acknowledged that they take safety precautions more seriously if tangible personal penalties for ignoring them are in place. The penalties that can be imposed on firefighters include days off without pay, denied promotions, demotions or loss of job, and loss of death benefits in the event of a line-of-duty death. One firefighter said:

Our chief makes us take days off without pay if the firefighter does not use a seat belt. That gets people's attention. He's also said that if you lose an eye because you failed to have your gear on properly, you will be fired.

As these comments suggest, fire department officers play a key role in promoting safety. However, firefighters can receive mixed messages from their officers, as the following comment shows:

Most of the awards for valor usually involve ... doing things you aren't supposed to do. It's in our nature to want to save someone. If nothing goes wrong despite ignoring the rule, you'll be praised for saving someone.

Firefighters also told us that union representation promotes safety.

Recommended Changes to Content and Format of NIOSH Materials

Several questions in both the survey and the focus group discussions concerned NIOSH's current materials for disseminating the findings of the FFFIPP investigations. Firefighters said that learning about specific incidents helps them develop safer work practices, and they appreciate that the LODD reports are unbiased. Firefighters thought the LODD reports are generally well designed, but they recommended that NIOSH add more visual aids to clarify the fire scene. Fire department officers wanted more straightforward and less generic

recommendations. They also wanted help translating FFFIPP recommendations into ready-made training material and sample SOPs.

The most common recommendation from firefighters was for improvements in the ways that FFFIPP materials are disseminated and marketed. They recommended that NIOSH update the FFFIPP mailing list and e-mail listserv, implement procedures for refreshing these lists regularly, and better advertise the lists.

Specific recommendations on the format of the materials included the following:

- Make it easier to skim through the LODD reports by making more effective use of headings and headlines, adding more visual aids to clarify the fire scene (a timeline, a diagram of the fire scene, and more photos), and including information about the victim(s).
- Add more technical detail about the scene.
- Provide context by adding statistics showing the number of deaths and injuries due to specific unsafe practices.

Recommendations for improving the impact of the findings from FFFIPP investigations included the following:

- Improve the ways FFFIPP materials are disseminated (e.g., by developing, maintaining, and marketing e-mail listservs and by mailing materials directly to safety and training officers).
- Use additional media for dissemination (e.g., popularized versions of the reports to make them more accessible to the average firefighter; one-page summaries).
- Conduct coordinated campaigns about specific issues, focusing on one issue at a time to raise awareness throughout the fire service.
- Design materials for training (e.g., PowerPoint presentations and lesson plans) based on the LODD reports.
- Partner with other organizations to promote recommendations (e.g., trade journals, fire service organizations, and state and federal training programs).

- Add content to materials on how to implement recommendations (e.g., sample SOPs and other management tools for implementing recommendations).
- Prepare summary documents with statistics showing the number of deaths and injuries due to specific unsafe practices.

Discussion

The evidence from our evaluation indicates that shortfalls persist in current firefighter safety practices. Not all fire departments and firefighters follow FFFIPP recommendations. For example, relatively few departments had an SOP for a physical fitness program or required annual CAD screenings. Only one-half of fire departments reported that their firefighters use seat belts at least “most of the time.” Many departments do not have adequate two-way radios or sufficient numbers of PASS devices. About one-half of all departments did not follow recommended safety procedures on the fireground (e.g., regarding implementing a risk management plan, assigning an Incident Safety Officer, establishing RITs).

These shortfalls provide opportunities to enhance the implementation of FFFIPP recommendations; they point to numerous safety practices that could improve the health and safety of the nation’s firefighters. In the following sections, we present the implications of the evaluation data for these issues and suggest approaches NIOSH could consider to address the existing gap between safety knowledge and practice in the nation’s fire service.

Small, Volunteer Departments Have the Greatest Challenges to Following Safety Guidelines

Several distinct patterns in the survey data suggest where efforts are most needed to minimize the gap between knowledge and practice. With few exceptions, the fire departments that are most likely to be implementing FFFIPP recommendations are career departments in large, urban jurisdictions, particularly those in the Northeast. Fire departments with lower levels of implementation tend to be volunteer or combination career-volunteer

departments in small, rural jurisdictions, particularly those in the South and Midwest. Small, volunteer fire departments typically had fewer financial resources and staff. On the basis of these findings, we recommend that outreach efforts to improve the dissemination and use of FFFIPP information be targeted at small, rural, and volunteer fire departments.

Existing Resources Limit Safety Practices

The adequacy of financial and personnel resources appears to play a large role in whether a fire department is implementing the FFFIPP recommendations. Almost half of all fire departments did not have enough funding for the equipment they need. Two-fifths did not have enough funding to train firefighters. Lack of personnel at a fire scene prevents more than half of all fire departments from assigning an Incident Safety Officer and establishing RITs.

Fire departments may need help identifying financial resources. To improve use of the FFFIPP information, we suggest that NIOSH develop documents that fire departments could use to justify budget requests for recommended equipment, training, or procedures and that NIOSH should provide smaller, volunteer departments with additional technical assistance in preparing grant applications.

Gaps in Knowledge and Attitudes Limit Safety

Survey and focus group evidence from our evaluation supports the conclusion that the level of knowledge and varying attitudes of firefighters and officers play a role in safety practices. For example, one-quarter of all fire department officers did not think that personally fitted face pieces are needed for SCBA (i.e., shared face pieces work fine for their needs). About 10 percent said firefighters sometimes did not think that they need SCBA.

On the basis of these findings, we recommend that NIOSH take two major actions:

- Improve the FFFIPP website with a firefighter-friendly page that connects broad topics with recommendations and action items, along with links to specific FFFIPP LODD reports and other FFFIPP materials and resources.

- Contact fire departments that experience a firefighter fatality or a near miss incident, regardless of whether an investigation is planned. Partner with other organizations as needed, provide relevant FFFIPP materials, and offer technical assistance to help address safety issues.

FFFIPP Investigations and LODD Reports Provide Useful Information

Experiencing a FFFIPP investigation was associated with adherence to many firefighter safety practices. For example, fire departments that had had FFFIPP investigations were statistically significantly more likely than others to offer training on several important fire safety elements, to update their SOPs and SOGs for major fire safety elements, and to have enough SCBA face pieces so that firefighters did not have to share them.

Many firefighters value LODD reports because they are unbiased, detailed, and factual. Learning about specific incidents helps firefighters understand safety issues and appears to improve their safety practices. Most fire departments (88.2 percent) thought the amount of detail provided in these reports is about right, but only about half of those who had seen these FFFIPP reports said that they are practical, easy to understand, specific, and concrete. Fire departments that had experienced a line-of-duty death were more appreciative of the LODD reports than were departments that had not.

Fire Departments Need Additional Information to Enhance the Effectiveness of the LODD Reports

On the basis of these findings, we recommend that NIOSH change certain elements of LODD reports. These changes include additional graphics such as a timeline of events, a diagram of the fire scene, and more photographs. In addition, making more effective use of headings and headlines would make the information presented in the reports easier to understand quickly and more compelling to read.

Repeating generic recommendations across multiple LODD reports appears to be ineffective. Many fire department officers said that they need more straightforward recommendations.

On the basis of these findings, we believe that the value of the FFFIPP information could be improved in several ways. More photographs, timelines, diagrams, and other visual aids should be incorporated into the FFFIPP reports. To obtain more specific recommendations from the FFFIPP investigations, we also recommend that NIOSH increase its use of outside panels of experts to review findings.

Fire Departments Need Additional Training and Communication Tools

Fire departments are already trying to improve the translation of knowledge to practice. Training officers, for example, spend hours creating training materials based on the LODD reports. Usually, these take the form of PowerPoint slides to which they add media clips and other visuals. Because such efforts are more challenging for small, volunteer departments to fulfill, the knowledge-to-practice gap could be narrowed if NIOSH were to provide departments with training tools based on the FFFIPP's findings.

In addition to training officers, other officers need guidance and tools for implementing FFFIPP recommendations. Needed tools include sample SOPs and materials that could be shared with budget authorities and funding agencies to support the department's requests for additional resources. Officers from small departments also need recommendations that take into account their limited financial and personnel resources.

In addition, firefighters would be more likely to learn about and act on FFFIPP recommendations if the information were presented in more accessible formats. These could range from one-page summaries on specific operational issues (such as the use of Incident Command and RITs) to coordinated campaigns on individual topics and video reenactments of incidents.

On the basis of these findings, we recommend several actions to improve the dissemination and use of the FFFIPP information. NIOSH should

- Help transfer knowledge gained from FFFIPP investigations by creating training tools based on the FFFIPP reports, including PowerPoint slides and lesson plans. These should incorporate photographs, timelines, diagrams, and other visual aids.
- Expand the production of existing publications, such as Safety First, Workplace Solutions, and Hazard IDs, to include additional topics. These publications, too, should extensively incorporate graphics, statistics, and other tools to communicate the level of risk and to lay out the practical steps firefighters and fire departments can take to promote safety.
- Explore new technology for disseminating the findings of FFFIPP investigations in a public service campaign format. Videos, public service channels, and Internet streaming video are all media by which to present safety messages on each key FFFIPP recommendation. These messages should draw from multiple fatality investigations and should employ public safety advocacy techniques.

FFFIPP Materials Need to Be Better Marketed and Distributed

Although most fire departments are aware of FFFIPP reports, more than one quarter had never seen a FFFIPP report. Many fire departments are unaware of FFFIPP resources. Many firefighters did not understand the FFFIPP's role or how FFFIPP investigations are conducted. More than half of all officers are not familiar with the FFFIPP. Over half of small departments are not aware of the FFFIPP. Tellingly, participants in the focus groups suggested a number of ideas for presenting FFFIPP findings that demonstrated they were not aware of already existing NIOSH resources. These resources include the NIOSH website www.cdc.gov/niosh/fire, the FFFIPP CD-ROM, and the summary reports.

These findings indicate that there is room for improvement in the way current FFFIPP documents are disseminated. NIOSH could improve its impact by better marketing existing resources and by

diversifying the communication channels used for dissemination. Firefighters and their officers offer useful suggestions to address this issue. Specifically, we recommend that NIOSH take the following actions to improve the dissemination and use of the FFFIPP information:

- Institute new measures to maintain a complete and up-to-date mailing list to ensure that its materials reach all fire departments.
- Ensure that its e-mail lists are up to date (e.g., with an e-mail cohort maintenance or refresher program that generates automatic e-mails to listserv members to confirm addresses).
- Improve the promotion of the FFFIPP website. Among other steps, this could entail creating a poster suitable for fire station bulletin boards, with the NIOSH website featured prominently.
- Consider coordinated promotional campaigns on single themes.

Increasing Awareness of the FFFIPP and Its Investigations Can Improve Safety Practices

In both the focus group discussions and the survey responses, firefighters made it clear that they are more receptive to safety information when its importance is reinforced by media coverage, political pressure, potential sanctions from insurance companies, state occupational safety and health agencies, and their officers.

This finding suggests that an important opportunity exists to increase knowledge of FFFIPP recommendations by increasing awareness of the program itself. Raising the profile of FFFIPP investigators, for example, could increase the attention given to investigation reports; this in turn could increase the attention that firefighters, fire departments, and local funding authorities give to the FFFIPP recommendations. The recommendation at the 2006 NIOSH stakeholders' conference that FFFIPP investigators wear identifiable clothing (i.e., caps and jackets with the NIOSH logo) was an acknowledgment of this causal link in the knowledge-to-practice chain.

Limitations of This Research

This evaluation was based on survey and focus group data that were collected at one point in time. Because of this, we were unable to capture the dynamic nature of the process involved in raising awareness about safety and implementing safety practices. Our cross-sectional design was limited to inferring this causal connection by measuring fire department practices. We were also limited by not incorporating data from FFFIPP investigations into the analytic model. Data on the nature of the incidents and their causes, for example, could be used to enhance the analysis of the impact of specific FFFIPP recommendations on subsequent fire department and firefighter safety practices. Adding additional data to the analysis (e.g., follow-up survey data and FFFIPP investigation data) would greatly strengthen our understanding of the most effective means of communicating safety and health messages.

Future Directions for NIOSH

Our evaluation addressed questions about the role and impact of the FFFIPP investigations on firefighter safety and health. We identified many factors that either promote or hinder fire departments in their efforts to implement FFFIPP recommendations. NIOSH is now implementing many modifications to the FFFIPP program, including many based on the recommendations from the evaluation (NIOSH, 2007b). NIOSH also continues to seek stakeholder input to (1) ensure that the program is meeting the needs of the stakeholders and (2) identify ways in which the program can be improved to increase its impact on the safety and health of firefighters across the United States. Details about how NIOSH is implementing the recommendations from stakeholders and from this evaluation may be found on its website at www.cdc.gov/niosh/fire/future.html.

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