



# SCIENCE AND TECHNOLOGY

CHILDREN AND ADOLESCENTS  
CIVIL JUSTICE  
EDUCATION  
ENERGY AND ENVIRONMENT  
HEALTH AND HEALTH CARE  
INTERNATIONAL AFFAIRS  
POPULATION AND AGING  
PUBLIC SAFETY  
SCIENCE AND TECHNOLOGY  
SUBSTANCE ABUSE  
TERRORISM AND  
HOMELAND SECURITY  
TRANSPORTATION AND  
INFRASTRUCTURE  
U.S. NATIONAL SECURITY

This PDF document was made available from [www.rand.org](http://www.rand.org) as a public service of the RAND Corporation.

[Jump down to document](#) ▼

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world.

## Support RAND

[Browse Books & Publications](#)

[Make a charitable contribution](#)

## For More Information

Visit RAND at [www.rand.org](http://www.rand.org)

Explore [RAND Science and Technology](#)

View [document details](#)

## Limited Electronic Distribution Rights

This document and trademark(s) contained herein are protected by law as indicated in a notice appearing later in this work. This electronic representation of RAND intellectual property is provided for non-commercial use only. Permission is required from RAND to reproduce, or reuse in another form, any of our research documents for commercial use.

This product is part of the RAND Corporation monograph series. RAND monographs present major research findings that address the challenges facing the public and private sectors. All RAND monographs undergo rigorous peer review to ensure high standards for research quality and objectivity.



**P R O T E C T I N G**  
**EMERGENCY**  
**RESPONDERS**

————— **VOLUME 3** —————

**SAFETY MANAGEMENT IN DISASTER  
AND TERRORISM RESPONSE**

**Brian A. Jackson**  
**John C. Baker**  
**M. Susan Ridgely**  
**James T. Bartis**  
**Herbert I. Linn**



DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health

The research described in this report was a joint effort of the Science and Technology Policy Institute (operated by RAND from 1992-November 2003 under Contract ENG-9812731) and the National Institute for Occupational Safety and Health.

**Disclaimer**

Mention of any company name or product does not constitute endorsement by the National Institute for Occupational Safety and Health or RAND.

This document is in the public domain and may be freely copied or reprinted.

Copies of this and other NIOSH documents are available from NIOSH.

For information about occupational safety and health topics contact NIOSH at:

1-800-35-NIOSH (1-800-356-4674)  
Fax: 513-533-8573  
E-mail: [pubstaff@cdc.gov](mailto:pubstaff@cdc.gov)  
<http://www.cdc.gov/niosh>

National Institute for Occupational Safety and Health  
Publications Dissemination  
4676 Columbia Parkway  
Cincinnati, OH 45226-1998

For information about RAND and its research contact:

RAND Corporation  
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138  
1200 South Hayes Street, Arlington, VA 22202-5050  
201 North Craig Street, Suite 202, Pittsburgh, PA 15213-1516  
310-393-0411  
Fax: 310-393-4818  
<http://www.rand.org/>

*Cover design by Stephen Bloodsworth  
Cover photograph © Mark M. Lawrence/CORBIS*

The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

**RAND**<sup>®</sup> is a registered trademark.

DHHS (NIOSH) Publication No. 2004-144 RAND Publication No. MG-170

## Summary

---

When disaster strikes, the nation depends on the emergency response community. No events demonstrated this truth as dramatically as the catastrophic terrorist attacks of September 11, 2001. But the same holds true every time the nation faces a major natural disaster or industrial incident. Emergency responders are an indispensable part of the country's homeland security system. To ensure that this system can meet the challenges of major disasters, the nation must take every measure to protect emergency workers from the safety and health risks inherent in their work.

In the aftermath of the September 11 terrorist attacks, the National Institute for Occupational Safety and Health (NIOSH) and the Science and Technology Policy Institute (S&TPI), formerly managed by the RAND Corporation, organized a conference in New York City on the protective equipment needs of emergency responders during responses to terrorism. Over the course of this meeting, participants repeatedly emphasized that, in addition to protective equipment, responders need effective safety management to ensure their well-being as they bring these devastating situations under control.

As a result, NIOSH and S&TPI undertook this study to develop a better understanding of safety management in major disasters, both manmade and natural, and to develop recommendations for improving safety management for emergency responders. Through an extensive literature review, interviews with members of the response community, and workshop discussions including more than 100 participants, the research team determined areas for improvement and developed recommendations to guide needed changes. This report provides a comprehensive set of strategies and tactics for enhancing the safety of responders by preparing thoroughly before an event and managing effectively afterwards.

### **Major Disasters Make It Difficult to Safeguard Responders**

Unlike the smaller-scale emergencies normally handled by one or more local response organizations, major disasters have special characteristics that present unique safety risks and management challenges. Major disasters can

- affect, injure, or kill large numbers of people
- cover large geographic areas
- require prolonged response operations
- involve multiple, highly varied hazards
- require a wide range of capabilities and resources not routinely maintained by local response organizations
- attract a sizeable influx of independent (“convergent”) volunteers and supplies
- damage vital transportation, communications, and public works infrastructures
- directly affect the operational capacity of responder organizations.

These characteristics make it particularly difficult to manage the safety of responders.<sup>1</sup>

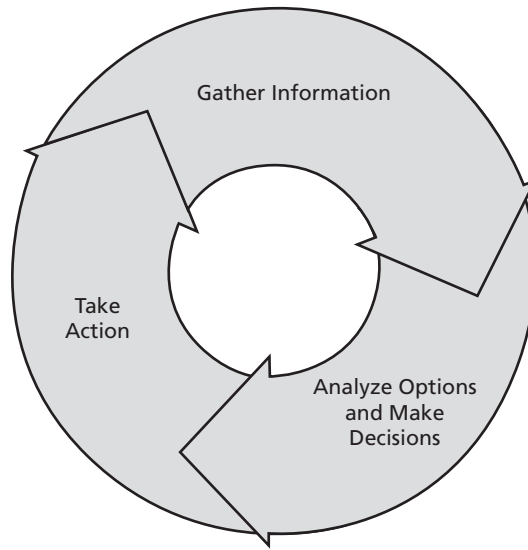
## **Safety Management Is Risk Management**

Because the work of emergency responders is inherently dangerous, managing their safety is more accurately described as managing their level of risk. When handling safety issues at the scene of a major disaster, decisionmakers must weigh the potential benefits of a responder’s action against the risks involved in carrying it out. This risk management process can be broken down into three functions: (1) gathering information about the situation, (2) analyzing available options and making decisions, and (3) taking action to implement decisions. As shown in Figure S.1, decisionmakers carry out these three functions continuously until the response operation ends. Most response organizations have their own standard procedures for carrying out these activities during smaller-scale events. But in the unfamiliar, chaotic, and complex environment of a major disaster, their methods may not be practical, creating real problems for efforts to ensure responder safety. To improve responder safety in major disasters, mechanisms must be put in place to allow safety management to readily scale up to meet the needs of the more complex and hazardous circumstances.

---

<sup>1</sup> Disaster response operations involve large numbers of responders. In addition to traditional responders such as firefighters, police, emergency medical services, and emergency managers, they also require many other workers such as federal, state, and local personnel; public health professionals; skilled support personnel (including construction/demolition workers, transit workers, and utility services workers); disaster relief workers; and members of volunteer organizations. For the purposes of this study, these workers are referred to collectively as “emergency responders.”

**Figure S.1**  
**The Safety Management Cycle**



## **Making Safety Management Better: Overcoming the Challenges of Major Disasters**

Significant systems and capabilities are already in place to protect emergency responders as they carry out their critical missions. But the results of this study show that opportunities exist to build upon those foundations—by both improving functional capabilities to protect responders and improving the organizational structures needed to manage the effort. Indeed, during a major disaster, when potentially hundreds of agencies<sup>2</sup> must work side by side to cope with a barrage of situations, safety concerns cannot be fully resolved without effective multiagency coordination. To improve responder protection, steps must be taken to address problems that can arise in executing the three functions of the safety management cycle and to adopt a more fully integrated, incident-wide approach to protecting the welfare of responders.

### **Improving Effectiveness Within the Safety Management Cycle**

**Gathering Information.** Decisionmakers responsible for safeguarding responders at the scene of a major disaster depend on accurate, comprehensive information to as-

<sup>2</sup> Throughout the text, we use the term “multiagency” to describe disaster response operations. This term is intended to convey the involvement of not just many government agencies but nongovernmental and private organizations as well.

sess the risks that workers face. But the scale and complexity of a major disaster can prevent response organizations from gathering all the information they need. For example, local agencies may have difficulty

- identifying, measuring, and monitoring unfamiliar hazards
- maintaining and coordinating information on responding individuals and units, especially those from other jurisdictions
- collecting and communicating timely data on responders' injuries, illnesses, and exposures to toxic substances and physical hazards.

*Hazard Information.* Collecting information about existing and potential hazards at a major disaster site is a critical component of safety management. Safety managers need timely, unambiguous information. However, major disasters present numerous impediments to the information collection process. For example, most response agencies lack the capabilities needed to monitor the wide variety of hazards potentially involved in disasters of this magnitude, and the involvement of many separate agencies in monitoring efforts can present problems coordinating hazard data. Over the course of the study, the following recommendations for hazard information were developed.<sup>3</sup>

#### **Recommendations: Hazard Information**

- 4.1. As part of preparedness efforts, put in place a coordinated, multiagency plan for monitoring hazards (p. 26).
- 4.2. Develop assessment methods, checklists, guidelines, and standards to assist in hazard monitoring efforts among multiple agencies (p. 29).
- 4.3. Develop information management systems and processes so that response organizations can use hazard data more effectively (p. 30).
- 4.4. Undertake joint exercises that include multiagency hazard monitoring efforts (p. 31).

*Information on the Responder Workforce.* To assess risks, implement safety decisions, and account for responders, managers need to know which emergency workers are taking part in the operation, where they are, what they are doing, and what capabilities they bring. However, because major disaster scenes cover such large areas and require the involvement of so many response organizations, it is difficult to account for all responders.

---

<sup>3</sup> Page numbers refer to the corresponding discussion of the recommendation in the main body of the report.



**Recommendations: Information on the Responder Workforce**

- 4.5. Bolster the role of response units in accounting for personnel (p. 33).
- 4.6. Develop personnel identification and credentialing systems better suited to major disaster response operations (p. 34).
- 4.7. Utilize scene control to improve cross-agency accountability (p. 35).
- 4.8. Develop minimum standards for safety and health training for all responders involved in disaster response operations (p. 36).

*Information on Responders' Health and Injuries.* Data on responders' injuries, illnesses, and exposures to toxic substances and physical hazards—as well as the general status of their health—is another critical information category. It enables safety managers to address the health and safety issues of specific workers and to intervene to reduce risks for the responder force as a whole as an operation evolves.

**Recommendation: Information on Responders' Health and Injuries**

- 4.9. Develop systems to provide timely information on responder injuries and exposures (p. 38).

Yet in a major disaster, with so many people seriously injured or killed, responders frequently focus on victims' medical needs instead of monitoring and reporting on their own health. The large number of response organizations that take part in large-scale operations further complicates the collection and coordination of information about injuries and health status.

**Analyzing Options and Making Decisions.** With reliable information in hand, safety decisionmakers can assess its importance and decide on a course of action to protect responders in the trenches. But in the aftermath of a major disaster, this process may encounter serious obstacles. Major disasters make it challenging for decisionmakers to

- assess hazards
- manage risks
- choose among protective options
- plan for safety needs.

*Assessing Hazards.* Effective safety decisionmaking requires managers to draw together the technical expertise to evaluate the hazards present at the disaster site and the risks these hazards pose to responders. But because of the wide variety of hazards involved in major disasters, individual response organizations frequently lack the ex-

expertise needed to assess every possible danger. The many different response organizations taking part in an operation of this scale may also use different criteria to assess hazards, providing an uneven foundation on which to base decisions.

**Recommendations: Assessing Hazards**

- 5.1. Identify and connect with experts in hazard assessment during preparedness planning (p. 43).
- 5.2. Develop a better understanding of relevant exposure thresholds and guidelines for disaster response conditions (p. 44).

*Managing Risk.* To evaluate any possible action, decisionmakers must weigh its potential gains in protecting lives against its level of risk, factoring in the overall needs of the operation. But in a major disaster, where the extent of the destruction can be so great and the number of victims so high, it is hard to establish a clear boundary between when “rescue” is still possible and when the operation needs to move into the “recovery” phase. When many different organizations bring separate approaches to this issue, determining the appropriate transition point becomes even more problematic.

**Recommendation: Managing Risk**

- 5.3. Address the transition between the rescue and recovery phases of disaster response operations in preparedness planning (p. 46).

*Choosing Protective Options and Planning for Safety Needs.* Effective safety management involves selecting appropriate protective equipment for responders. Managers must understand the options available and how to choose among them. They must also be able to determine what additional safety resources the many different participating organizations may need when an operation begins and as it

**Recommendations: Choosing Protective Options and Planning for Safety Needs**

- 5.4. During disaster planning, address issues concerning safety equipment and multi-agency coordination of safety logistics (p. 47).
- 5.5. Develop guidelines for selecting protective equipment to use in the early phase of response (p. 49).
- 5.6. Develop guidelines for estimating the safety equipment requirements for disaster response operations (p. 49).

evolves. However, the high degree of uncertainty about the hazard environment during a major disaster complicates efforts to select among protective options and project future needs.

**Taking Action.** The most effective efforts to gather information, analyze options, and make decisions would not benefit responder safety without the ability to turn those decisions into actions. Implementing and enforcing a course of action during a major disaster can prove to be highly problematic, however. Crises of this magnitude can prevent safety managers from having access to

- effective mechanisms for implementing safety decisions
- measures to protect the health of responders
- human resource and equipment management.

*Effective Mechanisms for Implementing Safety Decisions.* Putting decisions into action during the response to a major disaster depends on the ability to coordinate the efforts of multiple agencies. Safety managers must have successful strategies for communicating safety information, policies, and procedures to all participating response organizations. Mechanisms to enforce standard procedures incident-wide are also critical. But with so many independent response organizations involved, each taking its own approach to safety management, it is difficult to consistently implement safety measures across an operation.

#### **Recommendations: Effective Mechanisms for Implementing Safety Decisions**

- 6.1. As part of multiagency preparedness efforts, address the issue of safety implementation (p. 53).
- 6.2. As part of preparedness planning, include safety and risk communication (p. 54).
- 6.3. Pursue effective scene control as a safety enforcement measure (p. 55).
- 6.4. Provide on-site training, but not as a substitute for pre-incident training (p. 56).

*Measures to Protect the Health of Responders.* Safety managers need to be able to meet the medical needs of responders at every stage of a response operation. Meeting these needs entails not only caring for responders after injuries happen, but doing everything possible to keep responders out of harm's way—for example, enforcing reasonable work shifts and providing decontamination.

Yet the prolonged duration of operations during a major disaster requires response organizations to implement unfamiliar sustainability measures. In addition, the effects of many hazards stemming from major disasters may not appear until well after the response operation has ended.

**Recommendations: Measures to Protect the Health of Responders**

- 6.5. Improve health maintenance by preparing and implementing sustainability measures (p. 58).
- 6.6. Provide medical care to responders during the early phase of a disaster response operation (p. 61).
- 6.7. Protect the mental health of the response workforce by managing critical incident stress (p. 62).
- 6.8. Improve long-term surveillance of responders' health following major response operations (p. 64).

*Human Resource and Equipment Management.* To protect responders, safety managers must be able to control the flow of volunteers, safety resources, and safety-related equipment to an incident. But in addition to a huge influx of responders from multiple organizations, major disasters typically draw large numbers of independent, or convergent, volunteers. The large number of volunteers makes it difficult to manage human resources during extended disaster operations, particularly if no mechanism exists to connect them with the incident command system. Moreover, the complex hazards at the scene of a major disaster complicate efforts to manage safety logistics.

**Recommendations: Human Resource and Equipment Management**

- 6.9. Adopt better measures to manage the recall and mutual aid processes for responders (p. 66).
- 6.10. Implement better mechanisms to utilize and manage disaster volunteers (p. 67).
- 6.11. As part of preparedness efforts, establish systems for managing the logistics of safety equipment (p. 68).

**Implementing Integrated, Incident-Wide Safety Management**

Instituting better ways for organizations to carry out the three functions of the safety management cycle is a key step toward improving responder safety during responses to major disasters. But for operations that demand the involvement of multiple organizations, these measures are not enough. Indeed, many of the preceding functional recommendations require some form of multiagency coordination. To optimize safety management during an operation of this magnitude, in our judgment it is vital to integrate the safety resources of multiple organizations into a single, incident-wide effort.

During routine operations, response organizations tend to regard safety management as an activity carried out primarily by individual organizations. But the ad hoc efforts to coordinate safety management during the World Trade Center and Pentagon responses show that response organizations recognize a need for multi-agency safety efforts during major disasters. To build on these models of integrated, incident-wide safety management, safety must be viewed as a multiagency function within the response management structure. After that, there are a number of important initiatives that are needed to formalize this approach in disaster preparedness efforts.

#### **Recommendations: Implementing Integrated, Incident-Wide Safety Management**

- 7.1. Build an integrated safety function into the Incident Command System (p. 76).
- 7.2. As part of preparedness efforts, coordinate plans for implementing safety management (p. 78).
- 7.3. Develop a group of highly trained safety managers to facilitate coordination at major incidents (p. 83).
- 7.4. Improve joint exercises and training by incorporating realistic safety and health issues (p. 85).
- 7.5. Develop a common terminology for disaster safety and health issues and processes for use during response operations (p. 86).

#### **Next Steps: Preparing Now to Protect Responder Safety**

To better protect responders to the next potential natural disaster or terrorist attack, the nation has the opportunity to improve preparedness for responder safety management. Many of the recommendations emerging from this study can be pursued right away by individual response organizations, with immediate gains. Others involve a longer-term effort but may provide greater gains. These include recommendations that are still conceptual and consequently require pilot projects and other evaluation efforts, those that require the coordinated efforts of multiple agencies, and those that need leadership and coordination at the national level.

Every time emergency responders take action, they put their lives on the line. The risks to their health and safety are particularly intense during responses to major natural disasters and terrorist attacks. Although the dangers can never be eliminated, much can be done to manage the risks involved and protect the nation's responders as fully as possible.