CHAPTER 29

EMERGENCIES

29-1 INTRODUCTION

Disasters and emergencies fill the pages of history. The burning of Rome, the Great Chicago Fire, the Johnstown flood, the Three Mile Island incident, the Bhopal tragedy, World Trade Center events of September 11, 2001, the tsunami of December 26, 2004, and many other events have generated lessons learned, many of which led to changes in standards, codes, and laws.

One problem remains for every disaster and emergency situation: what to do when it occurs. People must decide what to do and how to act. Their actions should help minimize the danger and losses. Quick and proper action can prevent unnecessary losses. Proper design can reduce losses as well.

An emergency is any event that (1) happens suddenly, (2) disrupts the routine of an organization or community and affects its ability to function normally, and (3) requires immediate action. A disaster is an emergency that results in multiple injuries or deaths, produces major property damage, or both.

No one is isolated from emergency situations. Emergencies can occur anywhere and can affect anyone. One can prevent many emergencies, but not all.

Different emergencies have different lead times. For some there is reasonable time to act and prevent at least some losses; for others, there is little or no time to act before the emergency is present.

29-2 TYPES OF EMERGENCIES

There are several types of emergencies. Some result from the forces of nature, some involve fire and explosion, and others may involve system failures. Some emergencies entail traffic or transportation problems and some result from the behavior of people. On occasion, there are also police and military actions.

Natural Emergencies

Natural emergencies include floods, hurricanes, tornadoes, wind storms, snow, sleet, earthquakes, mud slides, avalanches, volcanic eruptions, and even dust or sand storms. In some locations, an insect infestation may create an emergency.

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Fire and Explosion

Chapters 16 and 17 discussed fires and explosions. A fire in a hotel, theater, or other high-occupancy facility may injure many people. Explosions can damage buildings far from the explosion site and glass and other flying materials can inflict injury. Fires involving hazardous materials have caused the evacuation of entire communities. Fires in compressed air lines can lead to explosions.

System Failures

There are many kinds of system failures that can create emergencies. For example, interruption of operations may create hazardous conditions: boiler overheating can cause dangerous conditions; failure of temperature-limit controls can lead to runaway processes; failure of pressure-limit controls can lead to rupture of pipes, gaskets, vessels, and other equipment; sudden releases of steam, gas, fuel, or hazardous chemicals can create dangers for plant personnel and surrounding communities. System failures may lead to fire and explosion. In 1988, a fire in a telephone switching center near Chicago interrupted businesses in a wide area, affecting some for more than 1 month. Applying water to an industrial magnesium fire intensified the fire.

Traffic Problems

Transportation accidents can interfere with traffic movement. Overturned tank trucks, multiple car accidents, and derailed railroad cars may block traffic for extended periods of time. If there are hazardous materials in a mishap, clearing, or evacuating the area may be important. Spilled materials may require proper treatment to prevent further disaster. For example, gasoline running into a storm sewer could lead to an explosion.

Behavior of People

The behavior of people can lead to emergencies. Some behaviors intend to cause harm; others do not, but have the same result. Strong feelings may lead to riots and mob behavior. Strikes and work stoppages sometimes lead to problems. Crowds rushing to sales when goods are in short supply and crowds fighting for tickets to public events or pressing to enter auditoriums and stadiums have led to disasters. In April, 1989, people at a soccer stadium in England continued to fill a standing room area near the playing field. In a few minutes, more than 100 fans were killed because the people at the front were pressed against a crowd-restraining fence and crushed so they were unable to breath and died. There are episodes where disgruntled workers or terrorists commit sabotage that leads to emergencies.

Military Action

Military action in time of war creates emergency situations. Even when the military is used for police actions, there is often an emergency situation and there are dangers to the general population. Keeping people clear of the dangerous areas is important.

29-3 PRIORITIES IN EMERGENCIES

There are well-established priorities for emergencies, the first of which is safety of people. The people may be employees, customers, visitors, or the public. Evacuation of people who could be injured and care for those injured have the highest priority. Actions to prevent involvement of additional people are also important. Isolating an area from inadvertent involvement or keeping the curious away can avoid further injury. If a snow storm or hurricane is imminent, people should be moved from dangerous areas. In emergencies, evacuation routes from buildings, sites, or communities must stay clear.

The second priority is protection of property. This may involve turning off power, fuel, or supplies to prevent further damage. Processes may be shut down manually or automatically to render them safe or to minimize loss of materials and products. Controlling and extinguishing fires will keep losses down. The proper actions depend on the kind of emergency and the kind of facility, process, or location. For example, if there is danger of a flood, creating dikes may prevent flooding of property.

The third priority is cleanup and salvage. Spilled hazardous materials must be removed to make an area safe. Fires sometimes leave building walls standing without support, which could collapse on passers by. Damaged equipment may be restorable with proper treatment. In removing debris or rubble, careful action will prevent further damage or injury. Managing cleanup and salvage is an important task. Communities struck by tornadoes often receive generous but misplaced help from volunteers. As a result, people waste resources and destroy salvageable items. Cleaning up damage to power, communications, fuel, and processes requires trained and qualified people.

The fourth priority is restoring operations and returning things to normal. For companies or businesses, there are losses in income and production until operations begin again. After an emergency, the condition and safety of equipment must be checked and items must be repaired. Startup procedures require extra care.

29-4 PREVENTING LOSSES IN EMERGENCIES

The main objective in dealing with emergencies is to be prepared to take proper actions. The actions may involve company, community, state, medical, and other organizations and participants. Preparedness for emergencies involves analysis to identify potential emergency situations, planning to detail the actions and participants, design to remedy physical deficiencies, training to ensure proper implementation, and having prepositioned contracts or agreements for specialized equipment or personnel.

Regulations and Programs

Some federal regulations require preparation for emergencies. They may be supplemented by state and local requirements. However, many emergencies are not covered by regulations.

Chemical Releases Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) required chemical plants to develop emergency response plans. Title III, called the Emergency Planning and Community Right-To-Know Act of 1986, created state Emergency Response Commissions and emergency planning districts. Facilities subject to SARA Title III participate in a local emergency planning process. Each facility also

submits material safety data sheets to local or state elements, or both. Each district completes and maintains an emergency plan.

In response to SARA Title III, the Environmental Protection Agency (EPA) developed the Chemical Emergency Preparedness Program (CEPP).[1] The Synthetic Organic Chemical Manufacturers Association (SOCMA) also developed the Community Awareness and Emergency Response (CAER) Program.[2] These programs help organizations prepare for emergencies.

Radiological Accidents There are regulations involving several federal agencies (the Federal Emergency Management Agency [FEMA], the Nuclear Regulatory Commission [NRC], the EPA) and state and local governments regarding preparedness for radiation releases and accidents.[3] Much of the emergency response responsibility of the federal government falls under the Department of Homeland Security.

Analysis

It is not a simple task to identify what natural and human-made conditions may lead to emergencies. One must brainstorm, work through operations, evaluate historical evidence from past events, involve people with experience, seek help of experts, and apply other techniques to list events that lead to emergencies. The situations may involve on-site activities, off-site activities, and events that one cannot control. The situations may involve activities and equipment of others. Examples are a railroad that passes near a plant, delivery companies that enter a plant site, children or visitors on a plant site, activities on adjacent properties, drivers losing control on a nearby road, or a plane crashing into a plant. One must look at interruption of power and system failures that could create an emergency. One must consider security and terrorist threats, even hacker efforts and sabotage of critical computer and communication systems.

It is not enough to identify the scenarios that spawn emergencies. The situations that can result also should be considered: whether is there danger to life, danger to property, or both and how severe the situation could become. The time of day or the presence of other conditions that could make things worse or less dangerous also should be taken into account.

There may not be enough time or resources to plan for every potential emergency, but the more situations one is prepared for, the better. A scheme to rank situations allows one to start with those situations that could have the greatest impact on life and property or have the greatest likelihood of occurrence.

Computer tools may help visualize potential problems in an emergency. For example, there are programs to aid in analyzing the flow of people exiting a fire. There are programs to estimate the dispersion of chemical vapors and gases and to aid in locating routes of travel and alternate routes when some are blocked. These and similar tools may help determine if emergencies create other problems. There are programs that show the historical distribution of lightning and the paths of tornadoes and hurricanes on record.

Planning

A key to emergency preparedness is planning. Plans can be strategic or tactical, general or specific. Planning should include actions, participants, authority and agreements, communication, data and information resources, supplies and equipment, locations for actions teams, and training procedures. Table 38-1 provides an example outline of an emergency response plan.

Actions The first component of an emergency plan is what actions should be taken. The actions can be general or very specific. For example, an evacuation of a plant can begin with an automatic or manual alert. Department and section heads could proceed to lead their people to a safe location based on preestablished maps and routes. The plan could assign responsibility for checking all areas to ensure that no one lingers.

Besides evacuation, the plan may call for actions on the part of particular people to trip fire doors or shut off power or fuel sources or to shut down computers. The plan may call for individuals to notify local fire departments, police, or nearby facilities. Actions should include site security and control.

Participants For each action, there should be people to perform them. The person or group responsible for an action must be assigned to the action. Examples are the plant fire brigade, first aid team, an emergency response committee, or all department heads.

Participants may be contractors who are used only for an emergency. For example, at the time of a flood, there is a great demand for earth-moving equipment. If the only source is a contractor, arrangements for services must be in place in advance. A call while water levels are rising may be too late because others may have already arranged for the contractor's services.

Participants also may include arrangements with local fire and police departments through mutual aid agreements or other instruments.

Authority Participants must have authority when an emergency occurs. If they have authority for assigned actions during normal conditions, there is no need for additional authority. If responsibilities change from normal conditions, the authorities must be established clearly for emergency conditions. For example, because someone else has been delegated, a section head may lose responsibility for his or her staff during an evacuation. After an emergency occurs, it may be too late to contact the necessary specialists. That authority must be in place, as should the authority for mutual aid units to enter a site.

Communication Communication is one of the most critical components in an emergency because information flow is essential. The status of conditions must be current because decisions must be made quickly and accurately. The more information available and the more accurate it is, the better the decisions are likely to be. There should be a command center to lead emergency operations. Information for public release should emanate from this center. Communication systems should be functional during emergencies or separate systems may be needed.

Data and Information Resources During an emergency, there is a need for key information. Not only is the status of the current situation essential, but so is data about the site, utilities, evacuation routes, road conditions, materials and equipment involved, people injured, location of resources, and other elements. Decision makers need access to maps, charts, tables, data bases, phone directories, and other information sources.

For chemical releases, there are computer programs that will track a chemical cloud. The value of these programs is limited by the accuracy of real-time data and the accuracy of computer modeling. The actual events may not follow the projections made by the model. At least these tools are helpful in developing plans because they can generate various scenarios that may be similar to real releases. Other computer tools are helpful in managing communication and data during emergencies.

Supplies and Equipment Emergency supplies and equipment must be available when an emergency occurs. It is usually too late to obtain the correct items after an emergency exists. Emergency plans need to identify what supplies and equipment are needed, in what quantities, and at what locations. If supplies and equipment are not on site, contracts must be in place for immediate delivery on demand. Planning should consider potential problems with deliveries because if delivery delays are possible, planners should consider propositioning and storing needed items where they are easier to obtain and near the points where they will be needed.

Supplies could include medical and first aid supplies, neutralizing agents for spills, sand or salt for sleet or snow conditions, and sand for sandbags. Equipment could include rescue equipment, fire extinguishing equipment, traffic control devices, and barricades. Powered or manual materials-handling equipment, like cranes, wreckers, end loaders, and shovels, also may be needed.

Supplies and equipment may include food, drink, and cooking equipment, tables and chairs, and cots for workers to rest or to temporarily house stranded people.

Locations and Facilities There should be locations for emergency teams to prepare for work or from which communications teams operate. Designed locations in existing areas may serve nicely and easily may be converted to alternate uses. In some cases, there should be mobile facilities. Sanitary facilities should be available. All emergency facilities should be safe from dangers. There may be a designated and equipped command and control location.

Medical Services Any emergency planning must consider the potential for injuries to people. Medical staff, first aid staff and evacuation teams, rescue equipment, and vehicles should be part of any emergency plan. Hospital emergency rooms, operating rooms, or decontamination facilities may be necessary. Travel routes and alternate routes must be considered. There should be alternate sites to support special types of injuries, like burns or radiation injuries, and there should be backup sites to support overloads at primary support sites.

Training Emergency plans need to include training requirements for participants. Planners should identify clearly the knowledge, skills, and abilities for each "player." There should be training records for each participant or team and there should be training scenarios that one can test. Emergency 911 call centers need information to alert appropriate authorities when callers report certain kinds of emergencies.

Design

After analysis identifies potential emergencies and plans detail what needs to be in place, it may be necessary to change some facilities and equipment to meet the identified needs. Building evacuation routes and exits may need changes or special features may need to be installed to ensure that proper emergency components are in place. For example, regular phone lines may go out when there is loss of power. Even cell phones may not operate under certain kinds of emergencies. A backup power supply and supporting fuel supplies should be in place. Emergency lighting may be needed or there may be a need for backup power for computer system or processing equipment to be sure that operations are reduced to safe levels.

Access routes for emergency equipment may be inadequate and need change. The capacity of pedestrian routes or shelters may have to be updated to meet the occupancy level of expanded facilities and operations.

Training and Execution

A key to making any emergency plan work is training. To attempt execution of a plan without training will probably result in failure, at least in part. Each plan may be different, and individuals and teams need training for their role in each plan. There should be opportunities to test equipment and to assess supplies that can deteriorate and become unusable if stored for too long.

Training programs should make participants in emergency responses knowledgeable about the hazards. For example, local fire departments may not be familiar with fire equipment on site or they may not have training in dealing with the unique hazards within a plant.

29-5 RESOURCES

There are a variety of resources available in planning and dealing with emergencies. This section will note a few. One resource is governmental bodies. At the federal level, there is FEMA. There are similar organizations at state and local levels that can help. Local police, fire, and medical services may provide help.

There are private organizations that provide contracted services for planning and management of emergencies. There are information resources on hazardous substances, such as the Chemical Transportation Emergency Center (CHEMTREC).[4] It offers a public service hotline for fire fighters, law enforcement, and other emergency responders and for manufacturers and shippers to obtain information and assistance for emergency incidents involving chemicals and hazardous materials. Callers can obtain information on nearly three million material safety data sheets. The American Institute of Chemical Engineers in New York has a Center for Chemical Process Safety that prepares guidance documents.

There are a number of industry and professional membership organizations that provide publications or other assistance with emergency planning. A few examples are the Amercian Chemistry Council and the Center for Chemical Process Safety of the American Institute of Chemical Engineers.

29-6 A DISASTER DILEMMA

Technology solves some problems, but creates others. Trust in technology may lead to emergencies and disasters that may not have otherwise occurred. This is not something new. An engineer sold the town elders of Dixon, Illinois, a solution to their 600-ft river span: an iron bridge. On May 3, 1873, during the dedication of the new bridge, 200 people fell into the river and at least 38 died when the bridge collapsed.

The invention of the automobile was hailed as a solution to the traffic congestion and pollution of horse-drawn vehicles. At the turn of the century in New York City, horses deposited 2.5 million pounds of manure and 60,000 gallons of urine per day on the streets. Now the automobile has led to pollution problems, gridlock, and nearly 50,000 deaths per year in the United States.

During the twentieth century, the United States spent billions of dollars to control the erratic behavior of waterways. It appeared that levees could control rivers and coastal areas. However, hurricanes and abnormal water loads still produce wide destruction. Some of the damage results from people building on reclaimed land with an expectation that the area is safe.

The 1984 chemical plant tragedies in Mexico City and Bhopal, India, would probably have been much less destructive had there been restrictions on dense populations living adjacent to the plants. Both locations had squatters' shacks in close proximity to the industrial complexes.

The past events should not dampen the use of technology to solve the problems of the human race. Perhaps with greater foresight and a wider view of potential consequences, we would need fewer emergencies and disasters to teach us how to make technology safer. Planning for emergencies should also lead to preventive actions so that emergencies are less likely to occur.

EXERCISES

1. Locate the local public emergency response organization. Find out how it is organized and operated. Determine what kinds of emergencies it has plans for.
2. Obtain a copy of an emergency response plan from a company. Evaluate its contents.
3. Select a natural and a human-made emergency for your area. Develop an emergency plan for each.
4. Select an emergency or disaster, such as a hurricane that struck an east cost or Gulf of Mexico city. Identify what damage may have resulted from a trust in technology and what regulations were modified after the disaster to prevent similar damage in the future.

REVIEW QUESTIONS

1. What is an emergency?
2. What is a disaster?
3. Where and to whom can emergencies happen?
4. Name five kinds of emergencies and give an example of each.
5. List the four priorities of an emergency in order from highest to lowest importance.
6. What kinds of emergencies do federal regulations cover?
7. List four actions necessary to prepare for emergencies.
8. List seven factors that must be considered in planning for emergencies.

NOTES

1 Chemical Emergency Preparedness Program, U.S. Environmental Protection Agency, Washington, DC.

2 Community Awareness and Emergency Response (CAER) Case Studies, Synthetic Organic Chemical Manufacturers Association, Washington, DC.

3 44 CFR 315 and *Federal Register* (1984) 49, No. 191:38596.

4 CHEMTREC, Arlington, VA.

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