CHAPTER I

INTRODUCTION

The purpose and significance of the following report are discussed in this introductory chapter. In order to provide a context for such a discussion, a general description of our study on socio-behavioral aspects of chemical disasters is provided. This chapter concludes with a brief outline of the material presented in the succeeding sections of the report.

Purposes and Significance of the Report

This report is rooted in the real world. The descriptions and implications are drawn from what actually occurs at times of acute chemical emergencies. As such, it is an account of what "is" rather than what "ought" to be.

Too often, planning recommendations, and sometimes even accounts of actual chemical disasters, stress what ought to be or should have been which is in contrast to the realities of the real world. This emphasis upon ideal conditions can be very misleading. A fire chief, a civil defense director and other local community officials are not faced with the ideal in an actual emergency but with a situation which will vary considerably from what might be desirable. This is also true when preparing for or trying to prevent possible disasters. Therefore, it is not surprising to find that representatives from both the public and private sectors complain about the safety criteria established by various federal regulatory agencies. Most of these complaints stem from the belief that many of the criteria are unrealistic and have been established for purposes of protecting the environment and citizens from technological threats. In other words, it is generally felt that the criteria were established on the basis of what ideally ought to exist as opposed to the typical conditions present today.

This report focuses on the actual state of emergency response to acute chemical hazards. As such, planners and operational personnel may find that the situations depicted in the following case studies would resemble the ones they would face in similar circumstances. There is no vision here of an ideal situation. Instead, the following chapters describe response-related emergency events which transpired in three communities upon experiencing an actual chemical disaster. The purpose of this publication is to provide a picture of the complexities involved in local disaster operations and the means by which community officials cope with the concomitant uncertainties. This report is not written in an effort to provide readers a "cookbook" approach to hazardous chemical response. That is, it is not a step-by-step algorithm or field manual to which responders can refer in the event of a dangerous chemical incident. Rather, it is a descriptive report aimed at illuminating aspects of disaster response traditionally ignored in the more technically-oriented body of literature.

Specifically, this report delves into the underlying conditions and circumstances associated with the more salient social features of acute chemical

emergencies. For instance, organizational structure and community context are emphasized in order to demonstrate the central relevance these social characteristics have for community response capability. All too often there is a tendency for those involved in a chemical incident to engage in a type of "scape-goating" behavior in order to explain the difficulties encountered during the event. The increasing number of public inquiries aimed at uncovering who was to blame for faulty decisions associated with the response, as well as the rising number of disaster litigations throughout the country, attest to the general propensity for placing blame on specific individuals or particular organizational entities.

The contents of this report indicate, however, that problems and difficulties encountered during the course of disaster response are rarely attributable to activities at the individual level or actions of specific agencies. Our case studies suggest that it is more appropriate to examine problematics at the macro-level for explanation of such difficulties. For instance, in any given chemical disaster response, attempts to neutralize the threat or mitigate its impact on the affected population may be impeded by some inherent conflicts among responders from different jurisdictional levels of government. A number of empirical studies suggest that interorganizational conflicts generally arise from difficulties involved in the integration of multiple outside organizations, particularly higher governmental agencies, into the community disaster response efforts. (See, for example, Dynes, Quarantelli and Kreps, 1981.) The high degree of autonomy typically assumed by organizations from higher jurisdictional levels is at variance with the organizational structure and pattern of authority within the local community, thereby creating conditions conducive to confusion and controversy. As a result, disaster operations may be delayed, rendered ineffective, or otherwise complicated. No one official or specific organization is responsible for this type of operational inadequacy; rather, it is a consequence of the manner in which American organizations are structured and interrelated. This example is not presented to discourage potential responders or suggest that societal or organizational structuring precludes effective and efficient responses to chemical emergencies. Rather, it is offered in an attempt to illustrate the importance of group factors in any disaster response.

In addition to discussing the influence which general social features have on community response efforts, this publication attempts to identify the manner in which specific community characteristics may affect the overall response to an acute chemical emergency. To illustrate the ways in which specific community characteristics affect response, we look at three rather dissimilar communities in this report. The wide differences in the social settings of the communities presented in these case studies should also enhance the applicability of this report.

In order to provide variation in terms of relevant community characteristics, we had to identify those aspects of the social setting which have significant influence on response efforts and outcomes. In the course of our field studies, it became apparent that certain situational circumstances had particular effects on community responses to chemical disasters. For example, whether an incident occurs as a result of a production or processing problem or results from a transportation accident has definite implications in terms of the response which ensues. Furthermore, the size and location of the

community in which the event occurs seems important for distinguishing differences in response types. Finally, the degree of social disruption occasioned by the event (usually measured in terms of number of people evacuated) seems to provide a means by which different community responses can be compared. We, therefore, selected communities for inclusion in this report on the basis of these three distinguishing characteristics.

The first case study involving a transportation-related incident occurring in the relatively small and isolated town of Baer, exemplifies the fact that no community, regardless of the absence of visible chemical hazards, is immune to disasters resulting from dangerous chemicals. While the degree of social disruption caused by this incident was minimal, several interorganizational problems emerging during the course of the event had serious consequences for the community as a whole. The second case study looks at the city of Minutilli which dealt with an in-plant chemical incident. This event occasioned a moderate degree of social disruption, prompting the evacuation of some 3,000 residents. The last case study describes the events which occurred as a result of the Mississauga, Canada train derailment of November 11, 1979. This chemical disaster, eventuating the evacuation of nearly 240,000 people, provides an exemplary illustration of interorganizational coordination and cooperation in emergency response systems.

With one exception, pseudonyms have replaced the actual names of the communities selected for discussion in this publication. Pseudonyms were assigned not only to assure the anonymity of those who cooperated in our research, but also to enhance the generalizability of the case studies. That is, by removing many of the particulars, the general issues which emerged and the lessons which can be learned become more apparent. The Mississauga incident was not disguised since all the identifiable information we report has already appeared in other publications (e.g. Whyte, 1980).

General Project Description

Congruent with an increase in general awareness of technological hazards, the Disaster Research Center (DRC) obtained a grant from the National Science Foundation to undertake a three year study of chemically induced disasters. The primary research objective of this study was to determine how communities plan for, respond to, and recover from relatively sudden chemical emergencies. As is traditional in DRC research, the study focused on the activities of emergency-relevant organizations in the pre- and post-disaster setting as well as their involvement during the actual emergency time period.

The study, in part, examined similarities and differences between the human and group aspects of natural disasters and those of chemical disasters. An effort was also made to identify the distinctive characteristics of organizational and community preparedness measures for and emergency responses to the sudden release of hazardous chemical substances. Most importantly, DRC looked at the conditions and circumstances responsible for the social features observed in acute chemical disasters. The findings of the study are intended to help bring about improvements in preparations for and responses to an ever-increasing threat and danger in industrial and technological societies.

The study was divided into three phases. During the first phase, which was initiated in September, 1977, research efforts focused on local preparedness for chemical incidents. Field studies were conducted in 10 communities throughout the U. S. in order to collect empirical data relevant to the study's objective. These communities were selected with the purpose of introducing as much variance in levels of chemical disaster preparedness as possible into the base-line sample. For instance, an attempt was made to select communities exhibiting varying degrees of vulnerability to or potential for acute chemical disasters. In addition, the selected communities also differed in respect to size and geographical location.

Scopious field work was conducted in each community and information was obtained through fairly open-ended interviewing of key officials in both the public and private sectors. Informants and respondents were interviewed from police and fire departments; civil defense offices; relief agencies; hospital and ambulance services; mass media units; organizations involved in producing, using, and storing dangerous chemicals; and all other groups likely to become involved in planning for and/or responding to chemical disasters. Supplementary information was gathered through the collection of pertinent community and organizational documentary and statistical data such as disaster plans, resource lists, and historical records of disaster experience.

With this information, efforts were made to ascertain the level of community awareness of chemical threats and determine how the general social climate in the community affected the planning process. Additionally, an attempt was made to identify the typical resources available to communities and the manner in which these would be deployed in an emergency situation. Therefore, this phase of the work also entailed an examination of community or social linkages (or in other words, the manner in and degree to which organizations cooperate with one another in sharing expertise and physical resources during the planning process). In general, the information collected during this phase of the study enabled DRC personnel to determine the general nature and range of community and organizational preparedness for disasters in general, and acute chemical emergencies in particular.

The second phase of the work, which began in January of 1978, focused on the crisis period of actual chemical disasters. This research involved on-the-scene observations and field interviews with members of emergency-relevant organizations as well as representatives from the group or groups on whose property the incident occurred. In order to directly observe community response to chemical disasters, it was imperative that DRC field researchers arrive at the disaster site during the actual emergency time period or shortly thereafter. Therefore, teams of trained field workers were continuously standing-by, prepared to leave for any community within hours of initial notification.

Through participant observation of the event and interviews with relevant actors in the response, the field team was expected to gather information which would enable them to retrospectively reconstruct the decisions and activities of all groups involved in the incident. This information concerning <u>which</u> organizations did <u>what</u> at particular times was subsequently recorded chronologically onto a response matrix which graphically profiles the manner in which the response developed. This matrix not only provided a time sequence

of the response-related events but also a general picture of inter-organizational coordination.

Furthermore, while at the emergency site, researchers attempted to gather data relevant to five particularly important aspects of disaster response. These were: (1) identification of the disaster agent; (2) safety and security of the affected area; (3) overall coordination of the activities of individuals and groups involved in the response; (4) evacuation of the population group within the hazardous area; and (5) stabilization and neutralization of the chemical threat. Finally, efforts were made to gather information concerning the community's state of preparedness in order to determine the effect that any prior planning activities had on the response in terms of organizational and official reactions.

A total of twenty events was studied, ranging from very major chemical incidents to relatively localized and less serious chemical accidents. In selecting the actual emergencies to be studied, a deliberate effort was made to seek variety in the sample in terms of the type of chemical agent involved, the magnitude and geographical location of the event and the degree of social disruption occasioned by the incident.

In general, the information obtained during this second phase of the study enabled DRC researchers to determine if and how preparedness planning efforts affect emergency responses, examine the extent to which responses in chemical incidents differ from those in other types of disasters, and identify the distinctive social features of the response.

The third phase of the work involved a longitudinal study which focused on the longer-run consequences of acute chemical disasters. Early in the study, extensive field work was conducted in two communities which had experienced very major chemical disasters. Periodically, these localities were revisited by field workers in order to gather additional community and organizational data. The purpose of this phase of the research was to trace the effects, if any, recovery from chemical disasters has on local preparedness planning for chemically-induced emergencies in the future.

The information gathered throughout the duration of the study was systematically analyzed through the application of both qualitative and quantitative data techniques. Some of the material analyzed has already been published elsewhere. (See, for example, Quarantelli et al., 1979; Quarantelli and Tierney, 1979; Gabor and Griffith, 1980; Gray and Quarantelli, 1981.) This particular publication is the product of a case study analysis comparing responses to chemical incidents which occurred in three widely different settings.

Outline of the Report

The following three chapters provide descriptive accounts of organized responses to acute chemical emergencies occurring in three different communities. These three chapters comprise the actual case studies contained within this publication. To facilitate comparison among the studies, each of the three chapters is organized in a similar manner. First, a narrative

description of the event is presented to indicate the scope and duration of disaster impact and the degree of social disruption incurred by the incident. Second, specific community characteristics are identified, followed by a discussion of the community's disaster vulnerability and resource availability. Third, the extent to which the community has engaged in disaster preparedness efforts especially those specific to chemical agents is described. Fourth, a detailed description of the interorganizational response to the chemical emergency is presented. Included within this section is a discussion of disaster task allocation and time sequencing, as well as a description of the prevalent patterns of authority and coordination. Finally, each case study concludes with a brief evaluation of the response.

The final chapter in this report discusses the overall impressions derived from, and the implications of the case studies. A more general examination of organized responses to acute chemical emergencies is provided elsewhere. (See, for example, Gray, 1981.)

CHAPTER II

THE EXPLOSION IN BAER

Nature of the Event

Shortly after 2:00 a.m., one spring night, an Interstate Line tractor-trailer burst into flames at an intersection west of the downtown area of Baer, which is located in a northeastern state. The truck carried twenty-one tons of yellow and red mixed phosphorous which were contained within eighty-nine thirty-gallon drums. The explosion appeared to have been an aftereffect of a fire in the tandem wheels of the carrier's truck, presumably caused by a leaking mixture of the phosphorous substance and water. Intense heat from the fire caused one of the water-sealed phosphorous drums to explode, sparking subsequent explosions of remaining drums. This volatile chain reaction launched many of the drums into the air, some soaring as high as fifteen hundred feet. The numerous explosions accompanied by the presence of toxic fumes, prompted the evacuation of all residents within a one-block radius of the accident site. The evacuation message, advising residents to simply leave the area until the situation was under control. was informally communicated on a door-to-door basis.

Initial fires were extinguished within one hour of the explosion, yet, due to the unstable nature of the phosphorous mixture, explosions continued throughout the following day. Serious complications arising from recovery operations necessitated declaring the site a county disaster area.

Although there were no deaths resulting from the incident, a number of citizens and emergency-relevant personnel were treated at a county hospital for burns and chemical fume inhalation. Specifically, 203 persons were treated at the site; 163 were treated at the hospital; ninety were re-examined at the hospital; seventeen victims were then hospitalized; and two people were detained for three-hour observation periods. Certain victims reported residual effects, primarily respiratory disorders for three to four days following the incident. Initial estimates of damages were reported to be approximately $150,000, a figure including property damage, medical fees, and services related to clean-up operations. However, this did not include other losses eventuating from the incident. Specific businesses located adjacent to the disaster site were forced to close for one or two days. These proprietors hoped to recover their losses. Even though this incident occurred in a residential area thus resulting in the evacuation of 100 residents, it did affect a partially commercial sector. Although no official recall was issued, most of the residents were able to return to their homes within twenty-four hours after the explosion.

At the time of the initial explosion and fire, a potential threat was circumvented when a truck driver transporting dynamite along the same route as the phosphorous truck noticed the fire two blocks ahead. He stopped, backed up, and pursued an alternate route through the area.

The first assessment of environmental damage was restricted to the site's road surface area, to the topsoil of an adjacent schoolyard, and to a small run-off stream. At the time of the incident, environmental experts expressed an expectation that these problems would be alleviated in the following weeks. Within one week state Department of Transportation personnel resurfaced the contaminated roadway; within two weeks following the incident, local workers had completed decontaminating and resurfacing the nearby schoolyard and creekbed.

Community Characteristics

Rolling hills of green farmland surround this community, which is located in the south-central section of the state. Roblee County in which Baer is located, covers 1,700 square miles and is 600 feet above sea level. As there are no major bodies of water in the area, transportation of commodities is limited to rail and highway.

The major existing highway transportation routes are the State Turnpike, situated about twenty miles to the north, and two U.S. highways. Thirteen large motor freight companies operate from this area. The community is also served by two major rail systems.

Roblee County has approximately 65,000 inhabitants, almost all of whom are white since minority group members consist of less than three percent of the total population. Around 15 percent of the population is over 65 years of age. Less than 10 percent have had some college education. The inhabitants live in about 17,000 housing units, about a fifth of which lie within Baer.

Traditionally, the dominate voting pattern is Republican as reflected by the 1972 and 1976 presidential elections. In 1976, three fifths of the populace voted Republican; two fifths voted Democrat. Locally, the government consists of three county commissioners who are elected for three-year terms. The nearby three dozen communities within Roblee County elect their own council members who serve as supervisors. The communities, themselves, characteristically exercise an independent form of government, with the usual mayor or city manager kinds of arrangements.

The area is predominantly agricultural. Principal industries include furniture and appliance manufacturing and food processing. In 1972 Baer industrial payroll totaled about $8 million, earned by some 1,500 employees. The total civilian work force in the area numbers approximately 22,000. Their median cash income was approximately $9,500 per household. Those unemployed averaged 4 percent of the total work force.

In 1972, Roblee County had more than 100 business establishments; most of which employed twenty or more workers. The county's payroll totaled $45 million, earned by some 7,000. Their median per capita income neared $10,000. In relation to occupational types, the county labor force is evenly distributed between blue collar and white collar workers. There was no chemical industry to speak of anywhere in the county.

Disaster Preparedness

Such disaster preparedness which has been undertaken in the county consists primarily of written plans oriented to natural hazards. This reflects recent experience in the area. Just in the last decade there have been floods and severe blizzards. Three major floods alone have impacted the area since 1972. The flood in 1975 resulted in several deaths and injuries as well as extensive property losses.

These occurrences did heighten the level of preparedness. The aforementioned flood led to a reorganization of community planning efforts. In cooperation with the health department and other agencies, the county civil defense office developed a master plan delineating responsibilities and activities pursuant to disaster events. Prior to the 1975 flood, these operations were uncoordinated across organizational lines. Agency responses were characteristically haphazard. After 1975, Roblee, at least on paper, was better prepared to deal with natural disaster agents. Little existed at the local community level, such as in Baer.

Some thought had been given to the issue of hazardous material training prior to the incident discussed in this chapter. Specifically, one training session had been conducted in the area a few months before the event. Also, local officials had hoped to schedule regular seminars on the topic in the future. Ironically, a second training session had been scheduled to take place three weeks after the event occurred. Inasmuch as local responders had merely been introduced to the topic, no specialized expertise for responding to chemical accidents existed in the area at the time of the disaster event.

Resources

The county has a number of traditional local emergency-relevant agencies which are available in the event of a disaster. The county disaster plan describes the relevant tasks for most of these agencies.

Communicative resources such as the Emergency Broadcast System (EBS) outlet at a local radio station assume primary responsibility for broadcasting warnings and public information. The radio station employs a Public Information Officer for on-the-scene coverage of a disaster. The station is authorized to operate only in the capacity of EBS in the event a county commissioner declares a disaster. Even though the EBS system receives initial emergency information from any number of sources, the primary source originates from Roblee County's emergency operations center (EOC).

The county civil defense agency operates a notably effective EOC communicationl system. Its center contains a variety of communications hardware (i.e., ham, CB phones, etc.) available for use in notification and communication maintenance during a disaster. In addition, the EOC functions as an emergency dispatch center for the county's volunteer fire departments and community police departments. Under specified circumstances, the EOC is responsible for transmitting a mutual aid fire call in accordance with the county's mutual aid agreement. The center's resources include phone numbers and pertinent emergency information.

The Roblee County's civil defense office is mandated to prepare and coordinate disaster planning activities and response within the county. Too, the civil defense agency is responsible for operating the county ECC and the dispatch center. Twenty full and part-time employees as well as a number of volunteers coordinate these activities. Prior to the chemical disaster, CD's expertise and experience was limited to natural disasters.

Roblee County supports twenty-seven volunteer fire departments. All components participate in a county-wide mutual aid system which originates from the county ECC. During the phosphorous incident, seventeen of the volunteer fire departments contributed their services. No total count of county fire manpower is attainable. Nevertheless, a crude estimate of manpower capabilities can be made by counting the number of firefighters at the scene of this phosphorous incident. Around one thousand firefighters from twenty-eight different fire departments within and outside the county responded to the chemical disaster. Conceivably, the number of firefighters in Roblee County approximates one thousand.

In Baer itself, the fire department owns two ambulances, four engines, one squad, one aerial ladder, and one five-inch hose wagon. This volunteer organization has a total of approximately 190 members.

Police resources in Roblee County include a state police barracks manned by a total of thirty officers. A sheriff's department is staffed by one sheriff and four deputies. There are various municipal police departments all of very small size. The Baer Police Department is composed of approximately a dozen members. The municipality provides two vehicles for enforcement activities. The county dispatching center disseminates information for the Baer department.

There are few other disaster relevant groups in the area. The one hospital in the area is very small and was in the process of revising its disaster plan at the time of the chemical incident. The local public health department depends heavily upon volunteers. The Red Cross chapter does have a skeletal paid administrative staff but is an almost totally volunteer staffed organization.

There does not appear to be any formal ties between Roblee County disaster relevant organizations and those in nearby counties. State government authority delegates local coordination for disasters to the local civil defense office, in this case, the one in Roblee County. In addition, the state plan indicates what state resources could be used and how the state would become involved in a local disaster situation.

There is specific reference to hazardous material incidents in the state plan. Among other things, the plan lists organizations which could provide resources in the instance of a chemical disaster. Among the groups listed are the state civil defense agency, the state department of transportation as well as the state environmental agency, the state public utilities commission (PUC), etc.; also federal agencies such as the Federal Aviation Administration (FAA), the Hazardous Materials Transportation Board, etc.; and a chemical industry group, CHEMTREC (the Chemical Transportation Emergency Center).

The plan indicates the scope of the response should be dependent upon the type and magnitude of the chemical disaster. According to the plan, CHEMTREC and the state civil defense agency should be contacted in all hazardous chemical incidents. In the instance of a highway incident, the federal Hazardous Materials Transportation Board is to be contacted. In the case of a rail incident, the PUC is to be notified; whereas, the FAA is to be informed in an air incident.

Organized Response to the Disaster

Approximately 2:17 a.m. private citizens telephoned the control center notifying personnel of the chemical explosion. The callers reported it as a "vehicle fire" but provided no additional information. This message was transmitted over the county emergency airwaves. Within fifteen minutes of the onset of the fire, the local fire department, police, and state police arrived on the scene. Flames reported to be as expansive as seventy feet could be seen as far away as two miles on land. Several airlines reported having observed the flames from the air. One firefighter depicted the gravity of the event, "It looked like someone had opened the gates of hell".

Since emergency personnel could not immediately locate the truck driver, a state police officer and the fire chief examined the truck's manifest, which identified the flaming materials as red and yellow phosphorous. The manifest erroneously indicated that in case of a phosphorous fire, water should not be used to extinguish it. Ensuing operations were delayed about thirty minutes. The fire chief contacted CHEMTREC, which advised that the use of water was indeed appropriate for extinguishing phosphorous fires.

During the thirty-minute interval, the phosphorous cargo simultaneously exploded causing barrels of the substance to fly in all directions. Chemical foam could have been used to combat the explosive fires but was inaccessible to firefighters. Initial problems were compounded by the absence of sufficient firefighting equipment such as air packs, boots, gloves and masks. The magnitude of the incident found emergency personnel contending with significant complications.

At 2:50 a.m. the firefighters applied a fog of water over the truck and its cargo, hoping to stabilize the fire. Meanwhile, a local fire department arrived on-scene to assist, thus expressing the realization that this incident was nonroutine. Conversely, the Roblee civil defense deputy director was notified of the incident by an emergency monitor, but he did not respond to the site, believing the call was routine. (Not until five hours later did he realize the seriousness of the incident.)

Before firefighters began stabilization attempts, state and local police initiated a door-to-door informal evacuation of the immediate area while simultaneously establishing roadblocks. Through the county dispatcher, they requested additional help from the state police for setting up additional roadblocks.

Interorganizational conflicts arose within the first hour of the fire. The fire chief was on the scene and took charge of the response. Observers

reported that an "excited" state trooper ordered the chief to move the flame-engulfed truck. The fire chief then told the trooper either to assume responsibility for the entire incident or to stop creating problems and to continue his duties as a police officer. Consequently, the trooper offered no further objections.

In addition to the inadequacies previously mentioned, problems emerged as a result of unsatisfactory utilization of communications hardware. For example, radio communication was of no use due to frequency overloads which resulted in garbled messages. As is usual in such situations, the problem was not a lack of communication hardware and technology, but rather a lack of organization in regard to who should communicate what to whom.

By 3:00 a.m. the state police had called their headquarters requesting it to notify the environmental agency and the Department of Transportation's Hazardous Substance Transportation Board. Roadblocks were being manned by fire and police, and a county-wide mutual aid call was effected. Having heard the initial explosions from his home a few blocks away, one fire chief from another department rushed to the scene.

At 3:15 a.m. the local police chief arrived at the scene and assumed command of police activities. The civil defense director was already at the site in the capacity of volunteer firefighter. The civil defense director conferred with a county commissioner and the fire chief concerning his assumed position of commander over coordination of activities. Once the county commissioner declared the site a disaster area and more and more emergency units began to arrive, the civil defense director assumed official command. Since it was agreed that the fire chief would assist the CD director in coordinating response efforts, all emergency responders arriving at the site were instructed to report to these two individuals.

By the time the CD director assumed command, power in the vicinity of the site had been disconnected. The power company discontinued service because flames from the truck had burned cables along the street. Too, a car knocked out a major power line, which caused a fifteen-hour emergency power period. When the lines were repaired, emergency power was instituted.

By 3:30 a.m. the fire began to stabilize and firefighters had gained complete control of the blaze. Fogging efforts continued in order to prevent further phosphorous ignitions. The extensive use of water during the event caused a serious threat to community water pressure and supply. The municipal water department was later required to broadcast a conservation plea. Community members were asked to limit their water use until the emergency subsided and demand diminished.

Upon receiving word of the disaster, the public information officer from the local EBS radio station, appeared on the scene shortly after 3:30 a.m. He first learned of the chemical nature of the cargo upon arrival at the site.

The night emergency room supervisor was notified of the incoming injured, and at approximately 3:30 a.m. the hospital emergency room personnel began to receive response victims who had received burns and/or inhaled toxic fumes at the site. By 4:00 a.m. a physician came to the disaster site in order to

evaluate the situation. Having surveyed the situation, she drove directly to the hospital, which was located three minutes away, in order to care for emergency patients awaiting her. Twenty of the patients awaiting the physician had already been examined. At this time hospital personnel decided that full implementation of the hospital disaster plan was unnecessary. Only a portion of the plan was implemented.

At 5:00 a.m. the head emergency room physician directed a call to CHEMTREC and another to a nearby Poison Control Center. Uncertain of the long- and short-term physical effects of the phosphorous, she asked for advice for treatment of patients exposed to the chemical and its fumes. While awaiting a return call from the Poison Center, she examined the hospital's TOXIFILE. The TOXIFILE is a collection of information regarding toxic substances which alludes to their symptoms and treatment. The physician was especially concerned about the effects of phosphorous poisoning. At 5:30 a.m. the Poison Control Center returned the call. Their recommendations were similar to those of the TOXIFILE. Nevertheless, the long-term effects of phosphorous fume inhalation were not completely known by any agency or person contacted. The physician, therefore, requested that all emergency responders be reexamined every three to four hours for symptoms of toxic poisoning.

By the early morning hours the community became increasingly aware of the incident as they awoke to prepare for their daily activities. The emergency broadcast station decided to begin broadcasting information about the incident in response to the public's inquiries about the nature of the disaster. Thus, at 5:45 a.m. the first emergency broadcast was issued. Initially, there was a problem contacting the station's morning disc-jockey, which delayed the first broadcast for almost two hours. The broadcast pattern for the duration of the disaster consisted of an updated report every twenty minutes. In his reports the broadcaster attempted to downplay the exposure symptomology of the phosphorous. He hoped this would relieve hospital phone lines which were already becoming jammed. Another implemented plan routed all media calls to the station for broadcasting information. Both implementation policies served to minimize citizenry use of important phone lines.

By 6:00 a.m. attempts were being made to convince the chemical company to send representatives to the site for aid in stabilization and cleanup activities. A phosphorous company, the shipping source for the chemical, was contacted. Immediately the company organized a team of experts to be deployed to the disaster site. Assuming that expertise was forthcoming, state regulatory agencies advised the county civil defense personnel to cooperate with and to work in conjunction with representatives from the truck lines and the chemical corporation. At this time, however, such representatives had not yet arrived. Until their arrival, at approximately 11:00 a.m., firefighting activities were restricted to applying a continual fog of water to the wreckage.

Authorities in charge felt that a safer method of dealing with the potentially dangerous cannisters of phosphorous was in order. Specifically, they felt that covering the cannisters with sand would prevent major damage in the event of another explosion. After unsuccessful attempts to obtain sand from the state department of transportation and from the department of public works, the fire chief contacted a friend who owned a cement company. The cement company supplied him with three hundred tons of sand and a backhoe for applying it.

As workers applied the sand, the phosphorous began to erupt into flames. A constant spray of water was then applied to the sand and wreckage. One phase of the civil defense director's organizational coordination efforts was directed towards contacting the public health department. In response to the most recent eruption, he requested an on-site first-aid and medical station for the care of emergency response personnel. Accordingly, within thirty minutes the public health volunteer staff was mobilized. They, in turn, contacted the state environmental agency for regulatory advice and the Red Cross for aid in establishing an on-site medical monitoring center. A triage area was then established. A public health nurse suggested to fire officials that personnel be rotated in the event of an extended recovery operation.

Shortly before 7:00 a.m. emergency personnel decided it was necessary to contact the telephone company. The caller suggested that the telephone company examine the phone lines for damage from the fire and explosions. Maximum communications capability was vital to emergency response efforts. Thus, any damage to the cables would have hindered communications.

Also at 7:00 a.m. the emergency room physician contacted the public health nurse stationed at the site. In that message, the physician requested that all seriously injured personnel be sent to the emergency room.

At 7:30 a.m. the civil defense deputy director arrived at his office; at that time personnel apprised him of the gravity of the incident. Upon receiving notification of the event at his office, the deputy director drove to the site, where he and the civil defense director discussed further response procedures. According to prescribed procedures previously outlined by the civil defense director, his subordinates should have been notified of the emergency before the area had been declared a disaster site. In this case, however, the deputy director was not notified of the severity of the incident. The deputy remained virtually unaware of the extent of the disaster until he reached his office approximately five hours after the disaster declaration was affirmed.

By 8:00 a.m. the civil defense staff's coordination efforts were concentrated on acquiring needed equipment. For instance, a "cherry picker" was secured for use in fogging the debris. By this hour interorganizational integration and communication were well established. Coordination endeavors continued relatively smoothly. An organizational meeting for emergency personnel was scheduled for 11:00 a.m.

By 8:30 a.m. the chemical company had organized a response team consisting of two chemical engineers, a foreman, and two laborers, who were selected from their phosphorous plant location. Such response teams ordinarily are selected on the basis of their knowledge of the nature of chemicals involved. In addition, other corporate representatives from another state joined the team on a company jet at the phosphorous plant location prior to coming to the disaster site. Upon the group's arrival, a state official apprised the company's environmental control manager of his rights. Corporate attorneys were subsequently summoned to the site.

Also by 8:30 a.m. a Tactical Command Post (TCP) was created. However, this command post did not include a viable communications system. All on-site

communications were transmitted via radio hardware. Messages were routed to the county dispatcher, who then forwarded messages to their respective parties.

The on-site medical component was completed when Red Cross volunteers arrived at 9:00 a.m. Volunteers soon provided refreshments and medical treatment to emergency personnel. Medical supplies were furnished by agencies themselves. Food and refreshments were donated by local restaurants and businesses.

Concerned for the effect the incident could have on student affairs at the local college, the Dean contacted the civil defense director requesting advice as to whether or not classes should be cancelled for the day. The CD director decided the college could remain open for classes. Businesses nearer the site reported the presence of effusive fumes. Those proprietors were thus required to close for the day.

Water running off the truck and debris for the past eight hours caused a specialist from the environmental agency to become concerned about water runoff into a nearby creek. Therefore, agency workers constantly monitored the stream. At no time during the event did evidences of contamination appear.

At 11:15 a.m. a Roblee County commissioner arrived at the site. He stayed for five hours to assist in administration of response efforts.

At noon TCP personnel decided to reposition the command post "to a better location". A new post was then established in the same parking lot, in close proximity to the original TCP. At the new post, communications procedures continued essentially as before.

Changes in the nature of activities were negligible until representatives from the chemical company and the truck lines arrived. The emergency room physician went off duty, but she telephoned every two hours for updates and to see if she was needed. She did not return to the site until 7:00 a.m. the following day.

At 2:30 p.m. a major strategy planning meeting was held between corporate representatives and local authorities. Forty people attended the meeting, sixteen of whom were representative of the chemical company. The attendance by such a high number of company officials prompted suspicion by community members and the news media regarding corporate motivation and interest in the response. Medical personnel were excluded altogether from the meeting, placing a strain upon relations between medical and emergency administrative personnel.

The expressed purpose of the meeting was to devise a plan to dispose of the contaminated debris. During the meeting, company officials dominated proceedings. Officials devoted most of their time to downplaying the severity of the existing hazard. Despite the irrefutable indications that the fumes were adversely affecting numerous individuals in the area, chemical representatives commented, "Phosphorous is contained in much of our daily diet". Officials further contended that no environmental damage would result from the spill--a statement later proved to be false. A strategy was developed to place all ruptured drums in larger, water-sealed drums and then move them to a land-fill area. Upon insistence from a local chemistry professor, the company agreed to

assume the responsibility for disposing of the contaminated sand. Prior to the professor's protestations, local officials and citizenry had no conception of the potential dangers the contaminated sand posed. Their primary concern had focused on cannister recovery operations. Most community officials at the meeting assumed an extremely passive posture regarding the tenor of the proceedings. DRC field study observers gained the impression that community officials deemed it appropriate for corporate officials to take charge of ensuing operations. Assuming that an incident of this kind was routine for the chemical people, community officials trusted the "experts". They were unaware that this incident was the first of its type since the chemical company's establishment.

At 5:00 p.m. the local fire chief and all responding fire departments held a meeting. The purpose of the meeting was to explain and discuss the agenda from the 2:30 meeting. Too, the planned cleanup procedures were to be described.

By 6:45 p.m. cleanup operations had begun. Two chemical company workers assisted local firefighters in the task. They shoveled sand, uncovering the phosphorous drums for removal. The workmen appeared to be unaware of the potential danger involved in handling the drums. They did not wear the proper protective clothing. Lack of precaution proved to be a serious error. At 8:00 p.m. one of the cannisters exploded. Two chemical company workers and four firefighters suffered minor eye damage from the contaminated sand. The victims were transported to the hospital for treatment but returned to the site within the hour to begin redigging. This time, the workers wore flame retardant suits and masks.

The onset of the explosion caused the fire chief to become skeptical of the technique used to remove the barrels. The strategy was subsequently changed to including repackaging all cannisters into larger, watertight drums and using a crane to lift the barrels out of the sand. Nonetheless, the barrels still had to be handled manually when attaching and unattaching them to and from the crane. This procedure began in the early morning hours of the next day. Shoveling continued and the state of events remained relatively calm. The public information officer was allowed to leave the site for four and a half hours during this interval.

At 7:00 a.m., the day after the incident, the emergency room physician returned to the site for an update and then drove to the hospital. At 8:00 the Emergency Broadcasting System resumed reporting. A routine meeting of emergency personnel was held at 9:00 to discuss problems which may have arisen between meetings.

Both chemical company workers and local volunteer firemen performed the operations which began in the early morning. None of the workers wore protective head gear, boots, or gloves, as was previously required. This lack of regard for safety was consistent with the general atmosphere prevailing in the vicinity of the accident site. Apparently, corporate representatives had succeeded in convincing everyone concerned that they had the situation in command, that the danger had passed, and that remaining operations were routine in nature. Workers involved were lighthearted, even joking about the task. One of the members of the chemical company's delegation indicated that he expected operations to be completed by 6:00 that same morning.

In the beginning, cleanup operations progressed smoothly, interrupted only by minor flare-ups of the ruptured containers. At 11:00 a.m., however, (while digging was in progress) a major explosion occurred. As a result of this explosion, fourteen persons were injured; four of whom were hospitalized with one suffering serious facial burns. With this explosion, further recovery attempts were halted for about six and a half hours.

At this point the mood of the community and emergency personnel changed abruptly. The unexpected turn of events converted the community's confidence in the chemical "experts" to suspicion of their motives and obvious lack of expertise. Corporate representatives responded with hostility, stating that they "didn't have to be here" and that the community should be grateful for their presence. The site's periphery was immediately roped-off from all non-responding persons. Inasmuch as radio frequencies were once again becoming overloaded, a new TCP was established, possessing more sophisticated communications hardware than the original post. An emergency pass system was initiated whereby all eligible personnel were issued I.D. passes. One could not pass through the roadblocks without the I.D. The hospital was notified of the new procedure. Ambulances and additional medical personnel were dispatched to the site and the local station assumed total coverage of the incident.

The emergency pass system was established for many reasons. One significant aim was to exclude the "media". Prior to the establishment of the pass system, a number of incorrect news releases created problems for respondents. Emergency-relevant personnel felt that the pass system was a welcome addition. On the other hand, the media felt that it was unfair. Consequently problems arose for the public information (PI) officer, due to his advantage over other news personnel. His dual role as news director at his radio station and PI officer at the site was perceived as giving him an "unfair" advantage. In order to clarify his emergency-relevant position, he called his radio manager, requesting him to assume a primary role as news director, so as to minimize the conflict with other media representatives.

At 1:20 p.m. the state police announced that there would be a reorganizational meeting for all emergency administrative personnel at 2:00 p.m. This time, although hospital administrators were again uninvited, they attended the meeting.

At the 2:00 p.m. meeting, it was decided that a crane with a longer arm would be employed, thereby avoiding manual handling of the cannisters until they could be safely placed in the water-filled drums. Henceforth, front-line operations would be performed solely by chemical personnel. They would be wearing flame-retardant suits, hand, facial, head and foot gear. At this point the civil defense director and the fire chief resumed the authoritative roles in the response rather than allowing the chemical company to continue as the directing entity. Emergency officials elected to exercise greater caution throughout the remaining cleanup and recovery operations. Specifically, they added four backup hoses to existing lines and ordered personnel to move emergency apparatus back another thirty feet from the debris. By this time, the cleanup crew had cleared away all but fifteen drums of the phosphorous.

That evening, when the crane arrived, workmen performed several rehearsals so as to ensure their procedures were adequate. The remaining barrels and

debris were removed by 9:00 the following morning, without incident.

By then emergency procedures were generally terminated. Except for a one-block area, all roadblocks were removed. The only task remaining was the removal of the sand and several inches of roadbed affected by contamination from several ignitions of the roadbed. Flash fires continued a full week following the onset of the last explosion. One further injury was sustained four days after the apparent termination of the emergency.

Evaluation of Response

Technological and interpersonal problems prevailed throughout the duration of the response. Significant difficulties encountered during the response may be attributed to the ambiguity of the situation in terms of responsibility and/or liability of public and private sector respondents. Further, resources were scarce. The acquisition of additional equipment (such as cranes, drums, sand, protective clothing, etc.) was hindered by a lack of understanding of which parties had the responsibility for securing needed equipment. Since the reason for the accident could not be thoroughly investigated until stabilization was achieved, there was a great deal of dispute concerning who was to blame. Similarly, there was the question of who was responsible for the recovery and cleanup operations.

Regarding technological problems, the following difficulties were noted:

1. The truck's bill of lading was mislabeled as "...cargo fire, avoid water". This company error resulted in several minutes of delay in extinguishing the initial blaze and probably exacerbated property damage.

2. During the primary phase of the recovery operation (prior to the major secondary explosion) front-line personnel neglected to wear sufficiently protective clothing, probably due to the chemical company's lack of experience with phosphorous accidents. Despite initial and continuous fires and explosions, the absence of precautionary measures prevailed until the major secondary explosion.

3. During the first phase of the recovery operation the control center was inundated by citizens' calls which paralyzed communication between emergency organizations until the command post could install a private line.

4. Emergency-relevant personnel and volunteers worked unusually long shifts; some worked up to forty-eight hours. This may have contributed to individuals' decreased capabilities, as many were front-line responders. This particular problem was compounded when corporate representatives offered to pay volunteer firefighters who were "off duty" to remain on the scene to help in clean-up activities.

5. Resources (chemical foam, masks, boots, drums, etc.) were in short supply throughout the response. In fact, the final recovery attempt was delayed several hours until flame-retardant suits were procurred by corporate personnel.

6. Medical personnel were unfamiliar with the treatment and effects of phosphorous burns and fume inhalation. They expressed concern for the as yet "unverified" long-term effects of phosphorous exposure.

Several interorganizational difficulties emerged throughout the response, and became especially problematic after the explosion on the second day. The problems emanated from the issue of corporate loss of credibility as "experts" in the recovery operations. Several factors contributed to the community's waning confidence in the chemical company's response. They were as follows:

1. The chemical company failed to inform all responding firemen of the details involved in the strategy for recovering the chemical. The firefighters resented the corporate involvement.

2. The large and diversified number of corporate personnel dispatched to the site created an air of suspicion among the citizenry regarding corporate liability. The press reinforced these suspicions by alluding to the possibility of criminal violations resulting from complaisant attitudes about recovery operations and concealment of contamination hazards posed by the sand and roadbed.

3. Prior to the major secondary explosion, corporate representatives gave the impression that responses of this nature were highly routine. Later, they admitted having no such previous experience with phosphorous incidents.

In addition to problems emerging between the public and private sectors, difficulties were noted between emergency-relevant organizations within the community. The following are some of the noted major areas of conflict:

1. Several community organizations were excluded from the preparatory sessions prior to recovery operations, engendering hostility among responders. Specifically, the hospital, the Red Cross, and the county health department were not even notified of the meetings. Personnel in these agencies grew to resent the civil defense, the agency responsible for off-site coordination. Resulting communication gaps among community organizations were not an unexpected consequence.

2. The Red Cross complained of civil defense personnel's general lack of efficiency in previous disaster situations as well as in the present incident. They accused the civil defense director of treating the county disaster plan as a "jealously guarded secret". Red Cross officials also stated that since the present civil defense director had assumed his position, the county health department had supplanted the Red Cross in victim relief during disasters.

3. Unaware of the magnitude of the incident, officials of the local school board expressed irritation with the fire chief for ordering the closing of a nearby elementary school. By the second day, the discord was alleviated when hazards posed by the phosphorous became readily apparent.

Some details of the response which deserve further consideration are listed below:

1. The composition of the corporate delegation dispatched to the site

seemed to create an expectation that chemical personnel were better able to direct response operations, since at the time, command of operations was shifted from the civil defense director and fire chief to corporate representatives.

2. Members of the community complimented the civil defense director and the fire chief for their leadership and receptivity to suggestions from others. However, criticism was leveled against the civil defense director, who had attended a hazardous materials seminar months earlier, but obviously lacked knowledge about hazardous materials.

3. There was an abrupt attitudinal change displayed by community officials following the major secondary explosion, which motivated the fire chief and civil defense director to resume authoritative roles for the duration of the event rather than allow corporate interests to dominate response activities.

4. The role of the media in public information activities, primarily due to multiple organizational membership was influential. The news director of a nearby radio station also maintains a post within the county civil defense agency as public information officer. Therefore, continuous updates of the event were broadcasted from the site every twenty minutes throughout the four-day period. Interestingly, the public information officer also chose to downplay the seriousness of the event, presuming that such a posture would alleviate the inundation of phone lines. Perhaps a more accurate assessment of the event would also have alerted listeners to the necessity of reserving phone lines for inter-agency communication.

Concluding Remarks

The technological problems of insufficient firefighting equipment and scarce material and human resources needed to contain the explosive chemicals and to effect a safe recovery and cleanup operation may be interpreted in terms of greater organizational conflict. The immediate problem of a scarcity of resources can be seen to be symptomatic of an element of confusion as to the liability for response activities. Since local responders, the first to arrive, are mandated by communities to provide for public safety, the initial responsibility for containment fell to this component. Their relative unfamiliarity with chemical disaster procedure, as well as the absence of clearly defined lines of authority and task coordination produced a situation wherein local response personnel were extremely vulnerable to the pressures of public scrutiny as well as the intervention of private chemical personnel.

In general, local agencies were ill prepared for a crisis involving hazardous materials. The consequent conflict among individuals and among particular organizations, engendered the rise of substantial barriers to cohesion and cooperation among response personnel. Especially problematic was the lack of communication regarding specificity in delegating authority for certain tasks regarding recovery operations. After personnel from the chemical sector arrived, local public sector responders expected them to show expertise in handling the problem. However, when it became apparent that the extracommunity personnel were uncertain as to the correct procedure to follow, members from local agencies again assumed the primary role for the remaining tasks.

Interorganizational conflict during response and recovery operations was compounded by communication problems, an overlap in jurisdictional boundaries and barriers to task coordination. Conceivably, had emergency-relevant organizations enjoyed a more compatible relationship prior to the disaster and a shared understanding of lines of authority and task functioning, as well as knowledge about extracommunity resources available to them, some of the confusion and emerging conflict could have been avoided.